

**HYDROGEN AND FUEL CELL TECHNICAL ADVISORY COMMITTEE  
MEETING MINUTES  
February 13–14, 2018  
National Renewable Energy Laboratory (NREL) Conference Room  
901 D Street SW, Suite 930  
Washington, DC 20024**

**TABLE OF CONTENTS**

<b>DAY 1 – February 13, 2018 .....</b>	<b>2</b>
1. Fuel Cell Technologies Office Updates, Sunita Satyapal, Director, Fuel Cell Technologies Office (FCTO), Office of Energy Efficiency and Renewable Energy (EERE), U.S. Department of Energy (DOE) .....	2
2. Update on H2@Scale Activities, Neha Rustagi, FCTO; and Mark Ruth, National Renewable Energy Laboratory (NREL).....	3
3. DOE Vehicle Market Segmentation Analysis, Geoff Morrison, The Cadmus Group LLC.....	4
4. DOE SuperTruck Program Overview, Ken Howden, EERE Vehicles Technologies Office.....	5
5. MDV and HDV Development and Demonstration Activities in California, Jack Kitowski, California Air Resources Board (CARB).....	6
6. Toyota Project Portal for Fuel Cell HDVs, Craig Scott, Toyota.....	7
7. Hydrogen and Fuel Cell Perspectives in China, Gary Flood, GSF Consulting LLC .....	8
8. HTAC Discussion.....	9
<b>DAY 2 – February 14, 2018 .....</b>	<b>11</b>
9. HydroGEN: An EMN Model for Early R&D, Huyen Dinh, NREL .....	11
10. HTAC Discussion.....	12
11. HTAC External Communications Subcommittee Report, Gary Stottler, General Motors.....	12
12. Zero Emission Zero Compromise, Connor Dolan, Fuel Cell & Hydrogen Energy Association (FCHEA) .....	13
13. HFC Nexus, Alleyn Harned, Virginia Clean Cities/James Madison University.....	14
14. Closing Remarks .....	14
<b>PARTICIPANT LIST .....</b>	<b>15</b>

## DAY 1 – February 13, 2018

The Designated Federal Official, Shawna McQueen, commenced the 2018 Hydrogen and Fuel Cell Technical Advisory Committee (HTAC or Committee) meeting at 8:34 a.m. Eastern Standard Time (EST). Charlie Freese, the HTAC Chairman, welcomed new Committee members and opened with an introduction of new and returning members. The full Committee then reviewed and approved the draft agenda.

Chairman Freese opened the floor for public comments.

- John M. Parkan, Providence Entertainment, presented a film trailer for *At War With the Dinosaurs*, a documentary on the history and future of hydrogen and fuel cells.
- Matthew Blieske, Global Hydrogen Product Manager for Royal Dutch Shell, spoke on behalf of the hydrogen business at Shell. Mr. Blieske commented that hydrogen is a core business strategy for Shell as an “energy company,” and that Shell and its corporate Board is committed to strong hydrogen partnerships with others in industry, states, the national labs and the Department of Energy (DOE).
- Bud DeFlaviis, Director of Government Affairs for the Fuel Cell and Hydrogen Energy Association (FCHEA), gave an update of the recently passed Fiscal Year 2018 congressional appropriations bills from the House and Senate. Mr. DeFlaviis noted that the budget included the re-instatement of the Section 48 investment tax credits (which allows project owners or investors to be eligible for Federal business energy investment tax credits for installing designated renewable energy generation equipment, including fuel cells), putting fuel cells on par with the tax credits available to other technologies like solar. FCEV tax credits were also extended through 2017, but beyond that there are no credits for FCEVs or hydrogen infrastructure, which places FCEVs at a disadvantage relative to plug-in battery vehicles which do have tax credits. He noted that the proposed budget for DOE’s Fuel Cell Technologies Office is higher in both the House (\$53 million) and Senate (\$85 million) bills than the DOE request (\$45 million), and both bills contain language that prescribes particular uses for some of the funding, with an emphasis on enabling hydrogen infrastructure.

Presentation summaries and highlights of the discussions that followed are provided below.

### 1. **Fuel Cell Technologies Office Updates, Sunita Satyapal, Director, Fuel Cell Technologies Office (FCTO), Office of Energy Efficiency and Renewable Energy (EERE), U.S. Department of Energy (DOE)**

>>see full presentation at [https://www.hydrogen.energy.gov/pdfs/htac\\_feb18\\_01\\_satyapal.pdf](https://www.hydrogen.energy.gov/pdfs/htac_feb18_01_satyapal.pdf)

Dr. Satyapal presented on FCTO updates since the last HTAC meeting. The presentation included an overview of HTAC scope, objectives, recommendations to DOE, DOE responses, HTAC annual reports, and other HTAC efforts (e.g., H-Prize). Dr. Satyapal also reviewed the White House’s March 2017 budget blueprint language and FCTO’s FY 2017 Omnibus budget. She provided an overview of DOE’s research and development activities and a snapshot of hydrogen and fuel cell technology deployments in the United States. Dr. Satyapal highlighted lessons learned and approaches to sustaining momentum in the United States. Dr. Satyapal also presented on areas with potential for HTAC to provide input.

#### ***Discussion Highlights***

- Mr. Mizroch expressed concern over the progress that has been made in the United States automotive fuel cell industry since the 2003 State of the Union address. He noted that Japan and Korea appear to be dominating the U.S. in automotive fuel cell progress and lithium ion battery technology progress. Mr. Mizroch asked how the U.S. can get back into the market and become more competitive.

- Dr. Satyapal noted that DOE is focusing on early stage R&D to increase competitiveness and technology innovation. She highlighted four ways that DOE is fostering early stage R&D: 1) *Consortium* approaches leveraging R&D at the national laboratories; 2) *L’Innovator* (Lab Innovator) process by which national lab intellectual property is promoted to private industry for commercialization; 3) *Cooperative Research and Development Agreement (CRADA)* process by which DOE provides cost-sharing for research partnership projects between national labs and industry-lead teams; and 4) utilization of inducement prizes such as “H-Prize.”
- Dr. Mannan asked about hydrogen production emission metrics compared to other fuels, including fossil fuels; and noted the importance of life-cycle analysis of hydrogen production sources.
  - Dr. Satyapal replied that DOE has conducted a number of life-cycle emissions analysis of different fuels and hydrogen production pathways as well as cradle-to-grave emissions studies.
- Mr. Novachek suggested that it would be worthwhile for HTAC to hear more about light-duty vehicle battery vehicles versus fuel cell electric vehicles (FCEVs) at a future HTAC meeting. Specifically, Mr. Novachek expressed interest in a grid impact analysis of fast-charging electric vehicles versus hydrogen fueling of FCEVs.

## 2. Update on H2@Scale Activities, Neha Rustagi, FCTO; and Mark Ruth, National Renewable Energy Laboratory (NREL)

>>see full presentations at [https://www.hydrogen.energy.gov/pdfs/htac\\_feb18\\_02\\_rustagi.pdf](https://www.hydrogen.energy.gov/pdfs/htac_feb18_02_rustagi.pdf) and [https://www.hydrogen.energy.gov/pdfs/htac\\_feb18\\_03\\_ruth.pdf](https://www.hydrogen.energy.gov/pdfs/htac_feb18_03_ruth.pdf)

Ms. Rustagi provided an overview of DOE’s H2@Scale concept, ongoing activities, integration with nuclear power generation, and R&D needs. She described efforts to gather stakeholder feedback and R&D efforts to evaluate how hydrogen can support grid services. Ms. Rustagi also discussed demand for hydrogen in various market sectors, energy storage, and hydrogen infrastructure R&D needs. Next steps include cross-office requests for information (RFIs); an H2@Scale research, development, and deployment (RD&D) roadmap; evaluation of electrolyzer capacities; dynamic grid integration; and assessment of economic potential.

Mr. Ruth presented updates on DOE-funded H2@Scale analysis conducted by researchers at NREL, ANL, LBNL, and PNNL. The analysis focused on characterization of the technical potential, economic potential, and a spatial analysis of a larger hydrogen market. He specified that technical potential is dependent upon the available resources for hydrogen production while economic potential is dependent on the cost required to produce hydrogen. He concluded by saying that H2@Scale can provide value to curtailed renewable electricity and the hydrogen produced could be a feedstock for other industries.

### ***Discussion Highlights***

- Mr. Ruth asked the Committee who else or what other industries should be involved in H2@Scale process. Specifically, he asked for feedback on other industries, developers, regulators, policymakers, etc., that utilize hydrogen. Responses to Mr. Ruth’s question were:
  - Mr. Mizroch noted Germany has experience evaluating excess renewable electricity.
  - Mr. Mizroch suggested the Bonneville Power Administration (BPA) and collaboration on wind energy curtailment.
  - Mr. Leggett recommended engaging with private finance personnel in relation to the economics associated with power purchase agreements and curtailment of renewable resources.
- Mr. Leggett commended Mr. Ruth for the H2@Scale analysis. He also highlighted that H2@Scale could enable less East/West transportation of energy via rail and pipeline. He recommended that Mr. Ruth consider under-utilized natural gas power plants in addition to under-utilized nuclear plants in the analysis of hydrogen

production potential. Mr. Leggett stressed the importance of H2@Scale in terms of grid resilience and energy security.

- Ms. Rustagi noted that DOE has a collaborative project in place for incorporating data collection on the Power to Gas Concept.
- Mr. Eggert asked how this work is being translated to other models such as the Global Change Assessment Model (GCAM) as they relate to scenarios for vehicle adoption.
  - Mr. Ruth said linking this study to these models was deprioritized; instead, the focus of the work is on developing a few H2@Scale case studies.
- Mr. Novachek asked about using hydrogen for additional grid services and the potential saturation impact on the supply and demand curve.
  - Mr. Ruth stated that the demand response value for electrolyzers is difficult to determine right now and that capacity is the biggest factor.
- Mr. Freese asked whether H2@Scale modeling would also focus on forklifts, aerospace applications, or ground support equipment (GSE) at airports.
  - Mr. Ruth said that other mobile applications include city trucks; forklifts and other smaller applications are not as well-known but are worth examining, specifically opportunities to study GSE in Texas.
- Dr. Mannan asked about the scalability of the model: How much expansion from the hydrogen economy is needed? What are the biggest concerns with regard to the current model?
  - Mr. Ruth said that the Scenario Evaluation and Regionalization Analysis (SERA) model will be important to understanding transportation aspects of the hydrogen economy. The SERA tool models factors with the biggest uncertainty: costs, pipelines, availability, storage, resources, corridors, and other variables.
- Dr. Satyapal mentioned that follow-up H2@Scale analysis will focus on a clustered demand for hydrogen.

### **3. DOE Vehicle Market Segmentation Analysis, Geoff Morrison, The Cadmus Group LLC**

>>see full presentation at [https://www.hydrogen.energy.gov/pdfs/htac\\_feb18\\_04\\_morrison.pdf](https://www.hydrogen.energy.gov/pdfs/htac_feb18_04_morrison.pdf)

Dr. Morrison presented on DOE's vehicle market segmentation cost analysis comparing FCEVs and battery electric vehicles (BEVs). Dr. Morrison's analysis of both technologies evaluated size classes of vehicles, economies of scale, and inconvenience costs associated with each technology. Dr. Morrison discussed the vehicle class and time frame that was most cost advantageous for each technology. Dr. Morrison noted that further work needs to be done to capture the cost associated with limited infrastructure for each technology.

#### ***Discussion Highlights***

- Dr. Lipman asked why five-years was chosen as the vehicle amortization time for the cost analysis. He also asked whether a sensitivity analysis was done on the cost analysis.
  - Mr. Joseck mentioned that a five-year amortization time was chosen due to customers desire to have a five-year payback on vehicle purchases.
  - Dr. Morrison said that a cost sensitivity analysis was carried out, but not presented because the sensitivity variables were not the same for both types of vehicles. Dr. Morrison noted that hydrogen fuel costs had the highest cost sensitivity impact.
- Dr. Lipman asked about the cost of the battery in 2040.
  - Dr. Morrison said it was \$165 per kilowatt-hour.
- Mr. Koyama asked if any studies had been done to quantify consumer buying behavior associated with inconvenience factors such as range anxiety.

- Dr. Morrison and Mr. Joseck commented that studies have been done that evaluated consumer buying behavior and its effect on vehicle cost. An Oak Ridge National Laboratory study was cited for its evaluation of consumer buying behavior on types of vehicles.
- Dr. Lipman noted that some vehicle leases have been structured to help prevent inconvenience factors from affecting vehicle purchase, including provisions to allow customers to rent a vehicle for instances in which the leased vehicle will not be adequate.
- Chairman Freese suggested the concept of consumer purchase rationale as a good topic for a future HTAC meeting.
- Mr. Mizroch stressed that consumer behavior cost analysis needs to be ongoing. He cited geopolitical concerns and industry market decisions as significant factors that influence the consumer vehicle market and purchases.
- Mr. Markowitz asked whether the inconvenience cost of BEV recharge time versus FCEV fill time was factored into the cost analysis.
  - Dr. Morrison said that the fill time inconvenience factor was not directly included in the analysis.
  - Dr. Morrison also noted that most studies evaluating inconvenience assume that BEVs only charge once a day and only charge at nighttime.

#### 4. DOE SuperTruck Program Overview, Ken Howden, EERE Vehicles Technologies Office

>>see full presentation at [https://www.hydrogen.energy.gov/pdfs/htac\\_feb18\\_05\\_howden.pdf](https://www.hydrogen.energy.gov/pdfs/htac_feb18_05_howden.pdf)

Mr. Howden presented on the 21st Century Truck Partnership (21CTP), SuperTruck Initiative, and demonstration projects. He provided an overview of the organization and vision of the 21CTP, including government agencies and industry members involved and collaborative R&D. Mr. Howden indicated that there will be a regulatory need in the future for the 21CTP focus areas and specified that the 21CTP serves as a forum for connecting key stakeholders. He described accomplishments of the 21CTP initiatives, heavy duty vehicle and engine goals, and key challenges being addressed by the current activities.

##### ***Discussion Highlights***

- Chairman Freese asked if the Initiative is considering how their work/goals might change if the trucking industry moves towards an autonomous driving model.
  - Mr. Howden said that autonomous technologies are being evaluated in joint projects with agencies such as the U.S. Department of Transportation (DOT). He noted that driver turnover is high and can be a significant expense to trucking companies. Mr. Howden noted that trucking companies are evaluating how autonomous vehicles could improve a driver's job satisfaction to help decrease driver turnover and its associated costs.
- Dr. Lipman asked whether the electrification and hybridization strategies incorporate fuel cells or other battery technologies. He also asked whether Class 8 weight vehicles are being segmented by vehicle miles traveled (VMT) to identify the most appropriate technology (i.e., hybrid vehicles vs. FCEVs).
  - Mr. Howden said they are evaluating different types of hybridization strategies. He noted that vehicle duty cycle is more important to the analysis than the vehicle weight class.
- Dr. Satyapal mentioned that a comprehensive vehicle market segmentation analysis is underway across the Fuel Cell Technologies Office, Vehicle Technologies Office, and Bioenergy Technologies Office.
- Chairman Freese asked if the 21CTP is also evaluating drayage trucks as a part of the 21CTP initiatives.
  - Mr. Howden said that the 21CTP is evaluating drayage trucks and other trucking markets as a part of their long term mission/goals.

- Ms. Scott asked whether an increased fuel efficiency option is available as an option for new truck purchases or if a new truck's fuel efficiency is fixed/not changeable. Ms. Scott also asked if trailers are being evaluated as part of the 21CTP's efficiency improvement efforts.
  - Mr. Howden indicated that a new truck's fuel efficiency is variable, but that the buyer will purchase the truck that has the lowest operational cost over the vehicle's lifetime.
  - Mr. Howden noted that the truck/trailer interface is being evaluated by the DOT to make the interface aerodynamically consistent/better between different truck and trailer combinations.
- Chairman Freese asked what the infrastructure challenges are for adopting fuel cells and batteries in heavy-duty vehicles (HDVs).
  - Mr. Howden said there are infrastructure challenges to consider for battery powered/alternative fuel source trucks. Mr. Howden noted that the high-power charging requirement for battery powered trucks would change the charging infrastructure because a driver may not be able to physically move the large/heavy charging cables. He noted that fueling infrastructure standards would have to be developed for commonality. He also indicated that fuel cells may be advantageous due to faster fill times (vs. battery recharge times).
- Chairman Freese asked whether any evaluations have been done on the effects of truck refill/recharge time and if the evaluations have considered rest periods for one-driver trucks versus trucks with multiple drivers.
  - Mr. Howden indicated that analysis had been done. He said the average mileage per truck is decreasing because internet purchases are driving quicker delivery times. Mr. Howden indicated that the quicker delivery model may prove to be beneficial for alternate powertrain systems evaluations. He also said that it may lead to a more modular freight system.

## 5. MDV and HDV Development and Demonstration Activities in California, Jack Kitowski, California Air Resources Board (CARB)

>>see full presentation at [https://www.hydrogen.energy.gov/pdfs/htac\\_feb18\\_06\\_kitowski.pdf](https://www.hydrogen.energy.gov/pdfs/htac_feb18_06_kitowski.pdf)

Mr. Kitowski presented on medium-duty vehicle (MDV) and HDV development and demonstration activities in California and CARB's mission and goals over the next 50 years to deploy near-zero-emissions equipment throughout California. Mr. Kitowski mentioned that current and future funding is extensive for zero-emissions freight applications and noted two goals: phasing in zero-emission bus (ZEB) fleets by 2020 with an end goal of a zero emission transit bus fleet by 2040. Mr. Kitowski also briefly highlighted other California hydrogen activities such as a California Senate Bill (SB 1505) setting requirements for renewable hydrogen production and the Low Carbon Fuel Standard regulation which aims to reduce greenhouse gas emissions.

### *Discussion Highlights*

- Chairman Freese and Mr. Eggert asked how CARB's request for proposals (RFPs) are structured in terms of competing technologies (battery electric, plug-in electric, fuel cell electric, etc.) and whether ease of technology deployment is captured.
  - Mr. Kitowski said it depends on the procurement and feedback from technical experts and stakeholders on key requirements.
- Chairman Freese asked about the length of time allowed for CARB's demonstrations activities and the data collected during the demonstrations.
  - Mr. Kitowski said the projects have a legislatively limited timeframe. He indicated that the demonstration time is an inherent weakness in the process of funding R&D projects. He noted that there is a contract in place with NREL to collect and aggregate demonstration data.
- Mr. Mizroch commented on the public health benefits of improved air quality as a result of California's zero emission vehicle deployments and suggested that CARB engage with China to help improve their air quality.



- Dr. Lipman asked how policies such as California Assembly Bill (AB) 617 will be factored into future RFPs and funding awards. (California AB 617 is bill targeting air pollution reduction in disadvantaged communities that are highly impacted by air pollution).
  - Mr. Kitowski said some of the demonstration projects give money back to disadvantaged communities. He indicated that AB 617 is a landmark way of looking at regional air quality and the impact it has on specific communities. The bill is also based on what communities need and want and it has the potential to move toward zero emissions faster in the targeted communities.
- Dr. Satyapal asked what more DOE and HTAC can do to work with the CARB. Specifically, she noted all of the separate work that is being carried out by DOE and California and how that work could be better aligned to accelerate progress.
  - Mr. Kitowski agreed with Dr. Satyapal in her desire to promote synergies between ongoing efforts at DOE and the CARB. However, he did not have an immediate answer for ways to promote those synergies. He noted that DOE leads CARB in its access to technical expertise and this could be very helpful to CARB's efforts.

## 6. Toyota Project Portal for Fuel Cell HDVs, Craig Scott, Toyota

>>see full presentation at [https://www.hydrogen.energy.gov/pdfs/htac\\_feb18\\_07\\_scott.pdf](https://www.hydrogen.energy.gov/pdfs/htac_feb18_07_scott.pdf)

Mr. Scott presented on fuel cell HDV development activities at Toyota including Toyota's Project Portal, noting the recent shift to electrification and strong ZEV and emissions reduction goals. Mr. Scott remarked upon the large potential market for MDV and HDV fleets. He discussed their inherent high mileage, long idle time, and low fuel economy. Mr. Scott described the tri-generation (hydrogen, heat, and power) activities taking place in Toyota's Long Beach port facility. Mr. Scott explained how Toyota's port activities are part Toyota's goal of reducing life cycle emissions in their manufacturing process while making positive impacts on disadvantaged (port) communities.

### *Discussion Highlights*

- Chairman Freese indicated that fuel cell drivetrains can improve acceleration times.
- Mr. Mizroch asked whether there was collaboration with California to help expand hydrogen infrastructure to the east coast.
  - Mr. Scott remarked that the Northeast infrastructure is getting started, but there are some complications associated with permitting and other regulations. He said that more time is needed to bring other states up to speed on the technology and its benefits.
- Commissioner Scott said that the California Energy Commission (CEC) has worked in partnership with Toyota to engage state and local officials beyond California. She noted that government representatives want more than just the industry perspective.
  - Mr. Markowitz noted that California fuel cell representatives made their way around cities on the east coast to promote fuel cell technologies. He noted that the east coast presents a different environment than California in relation to building hydrogen infrastructure. He cited regulatory, cost, and zoning complications.
- Chairman Freese asked whether the focus was on long-haul or short-haul drayage trucks.
  - Mr. Scott confirmed Toyota's focus on short haul drayage trucks because hydrogen storage is not as significant of an issue as it is in long haul trucks.
- Dr. Lipman asked about the durability of fuel cell trucks and expectations on how well they will perform.
  - Mr. Scott said Toyota has done some durability modeling, but further research and analysis are needed.

- Dr. Satyapal stated that it was beneficial to have Toyota present this work today because it focuses on MDV and HDV fuel cell vehicles. She noted that MDVs and HDVs have not had as much fuel cell development as the light-duty vehicle sector.
- Dr. Satyapal asked Mr. Scott about Toyota’s long-term goals in terms of its MDV and HDV fuel cell truck development programs.
  - Mr. Scott was not able to remark on the future plans of Toyota’s MDV and HDV fuel cell truck program. However, he did indicate that Toyota executives are paying close attention to the potential market.

## 7. Hydrogen and Fuel Cell Perspectives in China, Gary Flood, GSF Consulting LLC

>>see full presentation at [https://www.hydrogen.energy.gov/pdfs/htac\\_feb18\\_08\\_flood.pdf](https://www.hydrogen.energy.gov/pdfs/htac_feb18_08_flood.pdf)

Mr. Flood presented on China’s hydrogen and fuel cell technologies and industry activity. He noted that fuel cells are a technology area of focus in China’s current Five-Year Plan, but that FCEVs are still in the early development phase in China. He indicated that China has significant state and local incentives for FCVE development and deployment. Mr. Flood noted that China has focused on international collaboration as a primary method of developing fuel cell technologies in China. He indicated that China’s current vehicle development efforts are focused on bus and light duty truck fleets. However, he indicated that China is also pursuing light-duty passenger vehicles as a long-term effort.

### *Discussion Highlights*

- Mr. Mizroch commented on the size of China’s automotive market and China’s desire to gain fuel cell intellectual property and fuel cell automotive technologies. He asked Mr. Flood for his opinion on how successful China will be in developing a fuel cell automotive industry.
  - Mr. Flood indicated that it will take approximately two years to gauge China’s chances for success. He indicated that China’s ability to successfully produce, distribute and dispense hydrogen will be a key factor. He noted that China is investing a large amount of money into the success of the fuel cell industry.
- Dr. Ayers commented that if intellectual property (IP) is stolen and incorrectly applied by Chinese companies it may have negative safety consequences for the hydrogen and fuel cell industry.
  - Mr. Flood agreed by saying that China does not view IP, and its protection, in the same way as the U.S. and safety is a concern.
- Mr. Novachek asked what drives China to develop fuel cell technologies.
  - Mr. Flood said he believes that China wants to own the renewables market. He pointed to China’s dominance in the solar and battery electric industry.
- Dr. Thompson asked about the difference between how U.S. companies/universities develop new technologies and promote them to market vs. how China develops new technologies and promotes them to market.
  - Mr. Flood remarked that China appears to have unlimited money flowing from government, university, and private investors to fund R&D. He said that China is less worried about IP because they feel like they are accomplishing something for the greater good of their country. He noted that the U.S. needs to innovate faster than China can follow, but that will require a market for the products.
    - Dr. Nocera commented that Mr. Flood was right that we need to invest and innovate faster, but we have no way of winning without investment. He indicated that the U.S. is limited by its 5-year investment payback desire while China has a longer, 25-year, payback horizon for investments. He later commented that China progresses very quickly



when they dedicate to a technology. He noted how China developed an extensive high-speed train network in a 10-year time span.

- Mr. Flood stated that the U.S. venture capital industry used to be a good way of funding R&D efforts, but the venture capital system has changed over time. He noted that most venture capital firms no longer make small (~\$5M) investments, instead they want to make large (~\$50M) investments.
- Mr. Mizroch commented that if the U.S. does not keep pace with China's fuel cell R&D, China will eventually overtake all fuel cell markets in the U.S.
- Chairman Freese asked about China's military and its significant use of hydrogen.
  - Mr. Flood clarified that China's military is the primary user of *liquid* hydrogen for rocket fuel.
- Dr. Nocera commented that China already has a competitive edge in manufacturing, so an appropriate strategy needs to be set in place for the United States. He noted that U.S. investors' return-on-investments demands have driven manufacturing abroad which has fundamentally hurt the U.S.'s ability to compete in new technologies. He said that if the U.S. wants to make money on the fuel cell industry, we should focus on services and 'trading paper,' not on manufacturing.
- Mr. Markowitz noted that a lot of manufacturing still happens in the United States because some companies (e.g., Airbus, Mercedes) want to build manufacturing facilities close to their consumers.
- Chairman Freese suggested focusing an HTAC subcommittee effort on competitiveness. The Committee members agreed to form a subcommittee to investigate the topic further (see HTAC discussion below for additional information).

## 8. HTAC Discussion

- Mr. Mizroch asked if there are particular areas that DOE would like the HTAC to work on.
  - Dr. Satyapal indicated that the draft DOE Hydrogen and Fuel Cell Program Plan, H2@Scale, requests for information (RFIs), and the infrastructure plan were areas that the Committee can provide valuable feedback.
- Dr. Nocera proposed discussing new business partnership models and investment strategies for the hydrogen and fuel cell R&D industry. He noted that business partnerships linking inventors with very large companies with deep pockets can help bridge the "valley of death," although it may not necessarily be in the best financial interests of the inventors.
- After discussing several options for producing the Committee's Annual Report and letter to the Secretary on an accelerated time schedule, it was decided to: (1) produce a shorter, condensed version of the annual report, along with a letter to the Secretary and (2) follow that with a report from the HTAC Subcommittee on Competitiveness.
- The Committee discussed the features, themes and action plans for the two products, as summarized below:
  1. Subcommittee on Competitiveness
    - Use GLWN study on the global fuel cell supply chain as a reference – DOE will provide the final report to the subcommittee. Other resources suggested include a National Science Foundation on catalysis lessons learned (referenced by Dr. Thompson), and the four regional technical exchange centers (TECs) supported by the Fuel Cell Technologies Office (West Coast, Mountain Region, Midwest, and East Coast TECs).
    - Explore IP issues, areas where we can leverage and work together to diversify suppliers and build supply chains and larger scale manufacturing capabilities, including international partnerships and the importance of ensuring product safety.
    - Identify areas where DOE or others could invest strategically to advance American-made technology.
    - Cybersecurity is an Administration priority. Dr. Satyapal also recommended including energy security in the charter of the competitiveness subcommittee. Dr. Satyapal mentioned that the

Secretary of Energy established a new DOE Office of Cybersecurity, Energy Security, and Emergency Response. The new Office will focus on energy infrastructure security that will be important for the Hydrogen and Fuel Cells Program.

- Consider conducting a SWOT analysis on US competitiveness.
  - Perhaps partition the analysis into sector levels.
  - Answer the questions: (1) what does it mean to be “competitive? (2) do we need to be competitive in this space? (3) why? (4) if so, what do we need to do to get there?
  - Subcommittee members: Mr. Novachek, Dr. Ayers, Mr. Mizroch, Mr. Markowitz, Mr. Koyama and Dr. Thompson. Mr. Leggett and Dr. Nocera said they would also help review the subcommittee’s work.
  - Actions: Dr. Thompson will organize a teleconference of the subcommittee members to select a Chair and develop an action plan. A follow-up call will include Dr. Satyapal to review the subcommittee’s plans and charter.
2. HTAC Annual Report and Letter to the Secretary
- Trim the report down (4 pages suggested) and mention in the letter that an interim report on competitiveness is coming.
  - Include a dashboard of progress measures for quick reference. Chairman Freese mentioned the addition of FCTO’s Hydrogen Program’s Program Plan, mission and goals as dashboard elements in the condensed annual report.
    - Dr. Satyapal agreed with Chairman Freese and recommended that the dashboard include areas where more R&D focus is needed.
  - Consider defining the ‘early stage R&D’ that the hydrogen and fuel cell industry needs, even if that may be different than the new Administration’s definition of ‘early stage R&D.’
  - Key message should be the growth of the fuel cell industry (the report from E4tech is a good annual resource for industry data) and maintaining US competitiveness.
  - Contrast where we are now compared to the goals identified in EPACT, especially as related to the 2020 infrastructure goals.
  - Include feedback on H2@Scale strategies and activities.
  - Report writing subcommittee: Dr. Lipman, Ms. Scott, and Dr. Nocera. Chairman Freese will work with them and draft the letter to the Secretary.
  - Actions: Dr. Lipman and Ms. Scott will take the lead on drafting a 4-page report, with review input from Dr. Nocera.

Chairman Freese adjourned the meeting at 5:28 EST.

## DAY 2 – February 14, 2018

Chairman Freese began the meeting at 8:08 a.m. EST.

### 9. Hydrogen: An EMN Model for Early R&D, Huyen Dinh, NREL

>>see full presentation at [https://www.hydrogen.energy.gov/pdfs/htac\\_feb18\\_11\\_dinh.pdf](https://www.hydrogen.energy.gov/pdfs/htac_feb18_11_dinh.pdf)

Dr. Dinh presented on the HydroGEN Energy Materials Network (EMN) consortia model as a tool for accelerating early-stage material R&D. Dr. Dinh provided an overview of the EMN models' objectives, the framework of the national laboratory lead consortia, and the areas of expertise of the consortia.

#### *Discussion Highlights*

- Dr. Satyapal asked for feedback on the structure and strategies of the EMN.
- Mr. Koyama asked whether there was any R&D underway to evaluate replacements for the polymer.
  - Dr. Satyapal indicated that previous EMN work was done on polymer analysis.
- Dr. Thompson suggested that the EMN data hub should consider including information on R&D activities occurring outside the consortia, since technology status information from other public sources would be good for industry benchmarking.
- Dr. Ayers commented that EMNs are about more than materials discovery. It is also about benchmarking, developing testing standards and protocols, and exploring how materials perform under various conditions, including conditions that aren't the optimal conditions for a material.
  - Dr. Satyapal stressed that having industry engagement has been critical in developing protocols.
  - Dr. Miller mentioned that end-user involvement in this EMN is important. He stressed the importance of technology transfer in EMN consortia work.
  - Dr. Dinh and Dr. Ayer noted that information from the EMN is evaluated internally before it is disseminated to the public.
- Dr. Thompson asked whether similar materials/protocols will be evaluated by one lab or multiple labs. His question focused on whether consideration had been given to consistency of testing methods across labs.
  - Dr. Ayers said this depends on the technology being evaluated.
  - Dr. Dinh added that they have noticed test result discrepancies across labs using the same test articles.
- Chairman Freese noted that early stage R&D, similar to the EMN R&D, is challenging from a failure perspective. He noted that failure in early stage R&D is typical and it must be acceptable, because it helps with research progression. Failure is “early learning.”
  - Dr. Ayer and Dr. Satyapal agreed, and noted that success is also achieved when R&D projects are allowed to deviate from their proposed work scope if the deviation is viewed as a potentially more successful path to the research objectives.
- Mr. Mizroch noted that it could be challenging to communicate what “success” of the EMN means, and suggested defining some key metrics that resonate with legislators or other decision-makers. He noted some examples, such as number of patents produced, new technologies that are commercialized, faster materials discovery, and maintaining the national lab system's core expertise.
  - Dr. Dinh agreed that accelerated materials development is a key measure of success.
  - Dr. Miller noted that success is also realized when private industry reaches out to the EMN national lab consortium and engages with them directly on research projects.
  - Mr. Stetson emphasized that success is also achieved when properties of material are characterized and subsequently engineered for improved performance.

## 10. HTAC Discussion

- Chairman Freese discussed target dates for the next in-person HTAC meeting and solicited recommendations.
  - The Committee discussed the week of November 12, 2018 and the first two weeks of December 2018 as potential fall meeting dates.
  - The Committee also agreed to aim for a March 2019 meeting.
- Dr. Mannan asked to have future HTAC meeting presentations and agendas sent ahead of time so that the material could be reviewed in advance of the meeting.
- Chairman Freese asked whether there were any other items to discuss before some HTAC members have to leave for flights.
  - Mr. Novachek asked for clarity on the wording in DOE's response letter to HTAC's 2016 Annual Report to the Secretary. Specifically, Mr. Novachek asked about the wording in response to the HTAC request for an explicit plan of how the 2020 goals of Title VIII of the Energy Policy Act (EPACT) will be achieved.
    - Dr. Satyapal noted that the wording is a little ambiguous since the DOE focus is shifting to early-stage R&D, and budgets are still not finalized. She noted that DOE's intent is to produce a high-level strategic plan that will include H2@Scale roadmapping activities, and address the 2020 infrastructure goals of EPACT.
    - Dr. Satyapal suggested that HTAC could assist DOE in reviewing the 2020 infrastructure goals in both EPACT and the Program Plan to help identify the steps needed to enable hydrogen infrastructure.

## 11. HTAC External Communications Subcommittee Report, Gary Stottler, General Motors

>>see full presentation at [https://www.hydrogen.energy.gov/pdfs/htac\\_feb18\\_9\\_stottler.pdf](https://www.hydrogen.energy.gov/pdfs/htac_feb18_9_stottler.pdf)

Mr. Stottler presented an update on the HTAC external communications subcommittee activities that include external messaging, outreach, and a public-facing website providing information about hydrogen and fuel cells. Mr. Stottler provided an overview of the preliminary outreach website and asked for feedback from the HTAC committee.

### *Discussion Highlights*

- Mr. Stottler clarified that the website/outreach strategy was initiated over a year ago with preliminary ideas proposed by the HTAC.
- Dr. Mannan suggested that the communications should be aimed at 'informing' or 'increasing awareness' as opposed to 'educating.' He noted that some people may be offended by the term 'educating'.
- Mr. Novachek asked if the informational webpage should be linked from the HTAC website on EERE's webpage. He also recommended adding information related to the use of fuel cells for grid support and grid stability.
  - Mr. Stottler suggested that the website be linked to the EERE education and HTAC webpages since the intent is to provide the public with information.
- Mr. Stottler further discussed other website expansions ideas including: information about FCEVs vs BEVs, backup power applications, hydrogen safety information, fuel cell components, fuel cell markets, fuel cell recharging times, fuel cell efficiencies, renewables integration, and energy storage.
- Mr. Novachek proposed to add wording clarifying that BEVs are challenged (vs FCEVs) due to the fact that storing a lot of battery energy requires adding a lot of vehicle battery weight.
- Dr. Thompson suggested adding a table of technologies (e.g., BEVs, FCEVs, etc.) with a comparison of each technology's advantages and disadvantages.

- Dr. Thompson mentioned a study on the results of piercing a gasoline tank versus a hydrogen tank. He asked whether a visual could be added to the website to show the public that hydrogen vehicles are not more dangerous than gasoline vehicles.
  - Mr. Stottler said he has stayed away from visuals showing fires and crash tests, but this can be an area of further discussion.
  - Dr. Thompson noted that the battery industry is making videos of solid state battery testing as visual aids to convey safety messages to the public.
  - Dr. Satyapal commented that safety testing for hydrogen, natural gas, and other industries has been a challenging area to explain to the public. She suggested that the safety message could be tailored towards statistics on the significant numbers of safe hydrogen vehicle fills as opposed to videos of fires or crash tests.
- Dr. Mannan observed that safety messaging and modeling studies will become more important when the hydrogen economy begins to grow.
- Dr. Satyapal noted that H2@Scale is becoming a larger initiative in DOE and she recommended that the external communications subcommittee include it in its messaging. She also recommended including information on ‘what more needs to be done’ to help the hydrogen and fuel cell industry progress.
- Dr. Ayer suggested highlighting the similarities between hydrogen and fuel cell industry infrastructure and the conventional gasoline engine infrastructure. She noted that FCEVs and hydrogen fueling stations look externally identical to conventional gasoline vehicles/gasoline stations.
- Mr. Stottler closed by saying that the website material will go through a two-step review process before becoming publicly available: (1) the draft website layout will be provided to the Committee to review via a FTP site and (2) the final webpage will be provided to the Committee to review before it is made available to the public.
  - Dr. Satyapal noted that the DOE website is currently being revised and that DOE would have to decide where the best place is for the subcommittee’s website information and obtain the appropriate approvals to publish.

## 12. Zero Emission Zero Compromise, Connor Dolan, Fuel Cell & Hydrogen Energy Association (FCHEA)

>>see presentation at [https://www.hydrogen.energy.gov/pdfs/htac\\_feb18\\_10\\_dolan.pdf](https://www.hydrogen.energy.gov/pdfs/htac_feb18_10_dolan.pdf)

Mr. Dolan gave an overview of the Zero Emissions Zero Compromise fuel cell vehicle advocacy and outreach campaign conducted by FCHEA in the northeastern U.S. Mr. Dolan emphasized that increasing awareness and stakeholder engagement across the U.S. is crucial to the success of FCEVs. He highlighted the importance of ride-and-drive events and media outreach as methods to promote hydrogen and fuel cell vehicles. He noted that the outreach efforts will continue through 2018.

### ***Discussion Highlights***

- Mr. Novachek asked about the key lessons learned.
  - Mr. Dolan said the key lessons learned included how low the level of awareness is about hydrogen and fuel cells, even in areas like California where infrastructure and vehicles are being deployed; safety is a key concern and common misperception; and the idea of technological innovation really resonates.
  - Mr. Dolan emphasized that having California officials travel to the northeast U.S. to communicate their successes and positive experiences was a significant step forward. He stressed the importance of these direct state-to-state relationships, including the exchange of information on the important role fuel cell vehicles are expected to play in attaining state transportation emission and environmental goals.

### 13. HFC Nexus, Alleyn Harned, Virginia Clean Cities/James Madison University

>>see full presentation at [https://www.hydrogen.energy.gov/pdfs/htac\\_feb18\\_12\\_harned.pdf](https://www.hydrogen.energy.gov/pdfs/htac_feb18_12_harned.pdf)

Dr. Harned presented an update on the Hydrogen and Fuel Cell Nexus project. He provided an overview of the project, recent changes, and revenue plans for the year ahead. Dr. Harned noted that the project is a business-to-business directory connecting fuel cell industry buyers to fuel cell industry suppliers. He gave an overview of the HFC Nexus directory website, including the partners and members involved. He mentioned the call to action for sponsors to advertise and support the website. Dr. Harned presented on the long-term goals and services this website can provide, and asked for feedback on other ways to raise revenue for maintaining website.

#### ***Discussion Highlights***

- Mr. Novachek commented on the wide revenue target range of \$20K to \$80K. He asked why the revenue target range was so large and what the ramifications are if they do not materialize.
  - Dr. Harned stated that travel to conferences and website reconfigurations will not happen if revenue falls on the low end of the range. He noted that \$20K is the base amount needed to maintain simple updates to the website.
- Dr. Thompson asked about the curation process for information that is added to the website.
  - Dr. Harned said a two-step curation process is used: 1) content providers upload their information to the website, and 2) the HFC Nexus team at James Madison University reviews the content uploaded for appropriateness.
- Dr. Harned suggested that a Nexus registration fee could be added as a revenue generation source for new contributors to Nexus.
- Chairman Freese asked about a finder fee business model as a method of generating income for Nexus.
  - Dr. Harned agreed with the idea but added that there are challenges associated with giving away information and contacts on the website.
  - Chairman Freese also suggested ‘website matchmaking’ as a method of generating revenue when Nexus is used to connect a buyer to a supplier.

### 14. Closing Remarks

Chairman Freese thanked the Committee and the DOE team for hosting and supporting the event, as well as the engagement in this event. Dr. Satyapal thanked the Committee members for their support of the program, as well as Chairman Freese for his service to the Committee.

Chairman Freese adjourned the meeting at 11:34 a.m. EST.



**THIRTIETH MEETING OF THE  
HYDROGEN AND FUEL CELL TECHNICAL ADVISORY COMMITTEE (HTAC)  
PARTICIPANT LIST  
February 13–14, 2018**

***HTAC Members Present***

- Kathy Ayers
- Anthony Eggert (Remote)
- Charles Freese
- Harol Koyama
- Paul Leggett
- Timothy Lipman
- M. Sam Mannan
- Morrie Markowitz
- John Mizroch
- Daniel Nocera
- Frank Novachek
- Janea Scott
- Levi Thompson

***HTAC Members Not Present***

- Inês Azevedo
- Kathryn Clay
- Joseph Powell
- Adele Ratcliff

***U.S. Department of Energy Staff***

*Office of Energy Efficiency and Renewable Energy*

- Shukhan Chan
- Peter Devlin
- Nancy Garland
- Erika Gupta
- Donna Ho
- Ken Howden (Speaker)
- Fred Joseck
- Maxim Lyubovsky
- Jason Marcinkoski
- Shawna McQueen (DFO)
- Eric Miller
- Dimitrios Papageorgopoulos
- Eric Parker
- Neha Rustagi (Speaker)
- Sunita Satyapal (Speaker)
- Gurpreet Singh
- Ned Stetson
- James Vickers

***U.S. Department of Navy Staff***

*Office of Naval Research*

- Leo Grassilli

***U.S. Department of Transportation Staff***

*Maritime Administration*

- Sugit Ghosh

***Members of the Public in Attendance***

- Matthew Blieske, Shell TechWorks
- John Blum, Triton Systems, Inc.
- Peter Bossard, Power & Energy, Inc.
- Victor Cervino, Mitsubishi Hitachi Power Systems Americas, Inc.
- Leland Cogliani, Lewis-Burke Associates, LLC
- Claus Daniel, Oak Ridge National Laboratory
- Emory DeCastro, Advent Technologies, Inc.
- Bud DeFlaviis, Fuel Cell & Hydrogen Energy Association
- Huyen Dinh, National Renewable Energy Laboratory (Speaker)
- Connor Dolan, Fuel Cell and Hydrogen Energy Association (Speaker)
- Gary Flood, GSF Consulting (Speaker)
- Alleyn Harned, Virginia Clean Cities (Speaker)
- Bob Hwang, Sandia National Laboratories
- Jack Kitowski, California Air Resources Board (Speaker)
- Geoff Morrison, Cadmus Group (Speaker)
- John Michael Parkan, Providence Entertainment
- Mark Ruth, National Renewable Energy Laboratory (Speaker)
- Craig Scott, Toyota (Speaker)
- Gary Stottler, General Motors (Speaker)
- George Sverdrup, GMS Consulting
- Sandy Thomas, retired H2Gen Innovations, Inc.
- Emanuel Wagner, California Hydrogen Business Council
- David Wood, Oak Ridge National Laboratory

***Support Staff***

- Judi Abraham—Alliance Technical Services, Inc.
- Dottie Bunn—Bunn & Associates
- Rachel Davenport—Alliance Technical Services, Inc.
- Neil Popovich—National Renewable Energy Laboratory
- Nicholas Ward—Energetics