U.S. DEPARTMENT OF ENERGY

Response to Findings and Recommendations of the Hydrogen and Fuel Cell Technical Advisory Committee during Fiscal Years 2012 and 2013

Fourth Biennial Report to Congress
May 2014

United States Department of Energy
Washington, DC 20585

Message from the Secretary

This is the Department of Energy's fourth biennial Report to Congress, provided in response to section 807(d)(2) of the Energy Policy Act of 2005 ("EPACT 2005"), P.L. 109-58, August 8, 2005. EPACT 2005 established the Hydrogen and Fuel Cell Technical Advisory Committee ("HTAC") to advise the Department of Energy on programs and activities under EPACT 2005 Title VIII, *Hydrogen*.

EPACT 2005 states that HTAC is to review and make recommendations to the Secretary on:

1. The implementation of programs and activities under Title VIII of EPACT 2005;
2. The safety, economical, and environmental consequences of technologies for the production, distribution, delivery, storage or use of hydrogen energy and fuel cells; and
3. The plan called for by section 804 of EPACT 2005, known as the *DOE Hydrogen and Fuel Cells Program Plan* (formerly the *Hydrogen Posture Plan*).

Section 807 also requires the Department of Energy to transmit to Congress, with the budget request, a biennial report responding to recommendations made by HTAC since the previous report. This document, *Response to Findings and Recommendations of the Hydrogen and Fuel Cell Technical Advisory Committee: Fourth Biennial Report to Congress*, is the Department of Energy's official response to recommendations made by HTAC during fiscal years 2012 and 2013.

This report is being provided to the following members of Congress:

- **The Honorable Joseph Biden**
  President of the Senate
- **The Honorable John Boehner**
  Speaker of the House
- **The Honorable Barbara Mikulski**
  Chairwoman, Senate Committee on Appropriations
- **The Honorable Richard C. Shelby**
  Ranking Member, Senate Committee on Appropriations
- **The Honorable Harold Rogers**
  Chairman, House Committee on Appropriations
- **The Honorable Nita M. Lowey**
  Ranking Member, House Committee on Appropriations
- **The Honorable Dianne Feinstein**
  Chairman, Subcommittee on Energy and Water Development, Senate Committee on Appropriations
- **The Honorable Lamar Alexander**
  Ranking Member, Subcommittee on Energy and Water Development, Senate Committee on Appropriations

- **The Honorable Mike Simpson**
  Chairman, Subcommittee on Energy and Water Development, House Committee on Appropriations

- **The Honorable Marcy Kaptur**
  Ranking Member, Subcommittee on Energy and Water Development, House Committee on Appropriations

- **The Honorable Carl Levin**
  Chairman, Senate Committee on Armed Services

- **The Honorable James Inhofe**
  Ranking Member, Senate Committee on Armed Services

- **The Honorable Howard P. McKeon**
  Chairman, House Committee on Armed Services

- **The Honorable Adam Smith**
  Ranking Member, House Committee on Armed Services

- **The Honorable Fred Upton**
  Chairman, House Committee on Energy and Commerce

- **The Honorable Henry A. Waxman**
  Ranking Member, House Committee on Energy and Commerce

- **The Honorable Mary L. Landrieu**
  Chairwoman, Senate Committee on Energy and Natural Resources

- **The Honorable Lisa Murkowski**
  Ranking Member, Senate Committee on Energy and Natural Resources

- **The Honorable Lamar Smith**
  Chairman, House Committee on Science and Technology

- **The Honorable Eddie Bernice Johnson**
  Ranking Member, House Committee on Science and Technology

If you have any questions or need additional information, please contact me or Mr. Brad Crowell, Assistant Secretary for Congressional and Intergovernmental Affairs, at (202) 586-5450.

Sincerely,

Ernest J. Moniz

Executive Summary

The body of this report consists of fifteen recommendations made by HTAC since the previous biennial report. These recommendations were delivered with two annual state-of-the-industry reports, in April 2012 and July 2013, and a special report developed by an HTAC sub-committee (*Report of the Hydrogen Production Expert Panel: A Subcommittee of the Hydrogen & Fuel Cell Technical Advisory Committee*). These documents are provided in the appendices to this report.

In the 2011 Annual Report and its accompanying transmittal letter, HTAC highlighted the accomplishments of the Department of Energy's ("DOE" or "the Department") Fuel Cell Technologies Program, noting that not all the goals have been met in full, but observing that progress has allowed successful commercial introduction of fuel cells to begin in several markets. HTAC voiced concern for growing overseas competition and threats to U.S. leadership in hydrogen and fuel cell technologies, and they urged DOE and the Administration "to take more vigorous steps to restore the nation's leadership position in these important elements of a balanced advanced energy portfolio." HTAC also urged DOE to continue to support investment in hydrogen and fuel cells, particularly for the purpose of stimulating private investment and encouraging success in key early markets.

In the *Report of the Hydrogen Production Expert Panel*, issued in May 2013, HTAC summarized the major findings from a workshop and the resulting recommendations to DOE. Key recommendations included:

1. Providing incentives to accelerate the production of hydrogen for transportation applications with a particular focus on the steam reforming of natural gas, leveraging this abundant and low-cost domestic resource;

2. Considering significant investments in hydrogen production and storage analyses and demonstrations;

3. Developing a cohesive plan for all pertinent research and development programs to provide consistent and long-term guidance; and

4. Establishing public-private partnerships and/or clusters to create well-defined plans for infrastructure roll-out, establishing appropriate incentives, and promoting uniform codes, standards, and safety regulations.

In his letter accompanying the 2012 Annual Report, HTAC Chairman John Hofmeister highlighted the essential role of DOE's Fuel Cell Technologies Office; the positive and productive relationship the Office maintains with HTAC; and the rapid pace of progress in hydrogen and fuel cells worldwide. He also expressed concern about growing international competition and the potential erosion of U.S. leadership in hydrogen and fuel cells; identified the need for increased attention to hydrogen refueling infrastructure; and highlighted the risk that diminished Federal funding for the

technologies—or even the perception of a lack of DOE support—will stall progress in the current critical stages of development.

This report presents these recommendations based on the source material, followed by DOE's responses. The report also includes a description of how the Secretary has implemented or plans to implement HTAC's recommendations or an explanation of the reasons that a recommendation will not be implemented.

RESPONSE TO FINDINGS AND RECOMMENDATIONS OF THE HYDROGEN AND FUEL CELL TECHNICAL ADVISORY COMMITTEE: FOURTH BIENNIAL REPORT TO CONGRESS

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I. Legislative Language

The Hydrogen and Fuel Cell Technical Advisory Committee ("HTAC") was established under the Energy Policy Act of 2005 ("EPACT 2005"), P.L. 109-58, August 8, 2005, to advise the Secretary on programs and activities under EPACT 2005 Title VIII, Hydrogen. Section 807 requires HTAC to review and make recommendations to the Secretary on:

1. The implementation of programs and activities under Title VIII of EPACT 2005;

2. The safety, economic, and environmental consequences of technologies for the production, distribution, delivery, storage, or use of hydrogen energy and fuel cells; and

3. The plan called for by section 804 of EPACT, also known as the *DOE Hydrogen and Fuel Cells Program Plan* (*Program Plan*, formerly the *Hydrogen Posture Plan*).

In this report, DOE is responding to section 807(d)(2) of EPACT 2005, which requires that:

> *The Secretary shall transmit a biennial report to Congress describing any recommendations made by the Technical Advisory Committee since the previous report. The report shall include a description of how the Secretary has implemented or plans to implement the recommendations, or an explanation of the reasons that a recommendation will not be implemented.*

II. Recommendations from HTAC's 2011 Annual Report and Cover Letter

Recommendations

- *HTAC noted that "Japan, Korea, and Germany are taking a much more aggressive approach than we are toward stimulating and supporting market introduction of HFC [hydrogen fuel cell] vehicles and stationary products." HTAC urged DOE and the Administration "to take more vigorous steps to restore the nation's leadership position in these important elements of a balanced advanced energy portfolio."*
- *HTAC voiced strong support for "the investments that DOE has been making in hydrogen and fuel cell technologies," and it urged DOE "to continue to do so even in these tight financial times." HTAC elaborated on this recommendation, stating: "This support can ensure that the early markets for HFC technologies successfully 'cross the chasm' that is so often associated with early technology adoption. This will further stimulate private investment in these products and technologies, which have already been shown to be assets in niche areas. With support, these technologies will play a vital, more widespread role in meeting the United States' energy objectives."*

Response

The Department appreciates HTAC's input and agrees that progress made in bringing hydrogen and fuel cell technologies to the marketplace has been very impressive. As HTAC indicated, the achievements of the Fuel Cell Technologies Program have placed hydrogen and fuel cells in position to be an important component of a sustainable and secure energy future.

In support of President Obama's all-of-the-above energy strategy to reduce America's reliance on foreign oil, the Department of Energy is committed to maintaining its leadership in advancing its portfolio of alternative energy technologies and strongly believes in the role of these technologies in advancing economic prosperity. DOE will continue to promote the advantages of hydrogen and fuel cells as a critical component of this portfolio. In the last year, DOE has published over 70 news articles, hosted several public webinars on a range of hydrogen and fuel cell-related topics, and released a number of statements promoting the success of the Program's work. In January 2012, Energy Secretary Steven Chu held a high level roundtable meeting in Detroit with executives from the U.S. and global automotive industry. Hydrogen and fuel cells were a key topic of the meeting, and the Secretary reiterated the progress that has been made.

The Department is focusing on hydrogen and fuel cell activities that will continue to yield technology advancements in key areas—including ongoing reduction in the cost and improvement in the durability of fuel cells, reductions in the cost of hydrogen produced from

renewable energy sources, and improvements in systems for storing hydrogen. Rebalancing the EERE portfolio allows the Department to focus on near-term transportation technologies while maintaining a strong effort in hydrogen and fuel cells for the 2015 timeframe and beyond. Also note that we plan to leverage funding from the Vehicle Technologies and Advanced Manufacturing programs in relevant areas such as carbon fiber and fuel cell manufacturing, subject to appropriations.

III. Recommendations from the Hydrogen Production Expert Panel (HTAC Subcommittee)

In 2012, HTAC established a subcommittee, the Hydrogen Production Expert Panel (HPEP), to provide recommendations to enable the widespread production of affordable, low-carbon hydrogen. In May 2012, HPEP held a workshop that included experts from industry, academia, and national laboratories. The resulting report was sent to the Secretary.

Recommendations

- *"The DOE should establish and leverage existing technology working groups to clearly define the specific research advances needed for each technology in order to drive funding strategies and competitive solicitations, similar to the pathway followed for proton exchange membrane fuel cells."*
- *"All pertinent offices and programs within the DOE (including Basic Energy Sciences [BES], Energy Efficiency and Renewable Energy [EERE], and Advanced Research Projects Agency-Energy [ARPA-E]), should develop a cohesive plan to provide consistent and longer-term (10-15 years) guidance and support for: 1) interdisciplinary research and development of hydrogen production from renewable resources, 2) detailed analyses of hydrogen production systems, and 3) demonstrations of electrical energy storage from intermittent renewable resources via hydrogen production."*
- *"Communications between EERE, BES, and ARPA-E, as well as other DOE Offices (such as FE and NE) and non-DOE agencies (such as NSF) should be strategically enhanced to foster scientific and technology advances."*
- *"Metrics should be defined to characterize progress of these efforts towards established goals and objectives."*

Response

The Department appreciates these recommendations and will continue to foster intra- and inter-office coordination to leverage research, development, and technology demonstration across basic science and applied R&D offices. For example, DOE's Fuel Cell Technologies (FCT) Office convenes a bimonthly meeting with representatives from the FCT, BES, Fossil Energy (FE), and Nuclear Energy (NE) Offices to communicate and coordinate hydrogen and fuel cell research activities. The Department's hydrogen and fuel cell activities are further informed by participation in groups such as the Hydrogen and Fuel Cells Interagency Working Group and the Interagency Task Force, which bring together staff from EERE, FE, NE, and BES, as well as other agencies in the Federal government. Additionally, collaboration exists between FCT and BES in which expertise is shared through active participation in workshops, working groups, and

reviews, such as the Hydrogen and Fuel Cells Program Annual Merit Review.[1] Inter-office collaboration is being further developed through technology-specific working groups, including those related to photoelectrochemical, biological, and thermochemical hydrogen production. These working groups continually strive to define and refine quantitative and impactful technological metrics for benchmarking R&D progress toward goals and objectives of the DOE Hydrogen and Fuel Cells Program.

In addition, a new DOE-wide Fuel Cells Working Group was established in November 2012 that can help address external stakeholder recommendations, such as those provided by HTAC. This new group, which includes senior staff from EERE, BES, FE, NE, and ARPA-E, is well positioned to address the Expert Panel's recommendation to formulate funding strategies based on research needs for all of the near-term and long-term hydrogen and fuel cell technologies. The working group's initial meeting included the Under Secretary of Energy, the Director of the Office of Science, the Director of ARPA-E, and the Assistant Secretaries from EERE, FE, and NE, and is indicative of the senior level interest within the Department. With guidance from the working group, as well as external input, DOE looks to develop a cohesive plan that includes interdisciplinary R&D over the long term, covering both basic and applied activities. As one example, a joint funding opportunity announcement to be co-sponsored by the FCT Office and the National Science Foundation is currently under development.

Recommendations

- *"The government and industry should work together to inform the public and financial communities of the benefits of hydrogen as an energy carrier, thereby dispelling widely held misperceptions regarding near-term commercialization prospects."*
- *"Public-private partnerships and/or clusters should be established to create well-defined plans for infrastructure roll out, establish appropriate incentives, and promote uniform safety regulations, codes, and standards."*
- *"Incentives should be established to accelerate the production of hydrogen from all resources for transportation applications. Given the availability of large and accessible natural gas resources in the United States at historically low prices, hydrogen production using steam methane reforming technology represents an attractive near-term transitional approach."*

Response

The Department recognizes that collaboration with industry can help accelerate and strengthen our work. Under the U.S. DRIVE Partnership,[2] the Department strives to further strengthen the technology base of the U.S. auto industry through cooperative R&D with major automotive

[1] 2012 Annual Merit Review Proceedings (2012), *available at* http://www.hydrogen.energy.gov/annual_review12_proceedings.html.

[2] U.S. Department of Energy Announces Expanded Partnership with Industry to Advance Next-Generation Automotive Technologies (May 19, 2011), *available at* http://www.uscar.org/guest/partnership/1/us-drive.

industry stakeholders. Energy companies in the U.S. DRIVE Partnership provide valuable input through staff-level technical teams to identify barriers and R&D needs for widespread adaptation of hydrogen and fuel cell technologies, including infrastructure.

In January 2012, Secretary Chu attended a roundtable meeting in Detroit with executives from the U.S. and global automotive industry where he emphasized the significant progress that has been made in fuel cell technologies as well as key challenges. As a result of that meeting, *H_2USA*, a public-private partnership, was formed to help identify challenges and potential strategies for hydrogen infrastructure.[3] In addition, there is particular public and private interest in leveraging opportunities for synergy with our current natural gas supply and infrastructure.[4]

Public outreach is an important part of DOE's mission, and our achievements in hydrogen and fuel cell R&D have been accompanied by a strong communication effort. In FY 2012 and FY 2013, the Department completed more than 140 public outreach items relating to hydrogen and fuel cells (including progress alerts, newsletters, FCT Office news alerts, blogs, and public webinars). Consistent with the above recommendations, DOE has educated more than 23,000 code officials and first responders, and more than 10,000 teachers through our coordination with industry and other stakeholders. Furthermore, DOE's early market deployments have been particularly effective as a catalyst for fuel cell market development. Using Recovery Act funds and annual appropriations, DOE has cost-shared the deployment of 1,600 fuel cells in key markets. These deployments have led to more than 12,000 additional orders for fuel cell forklifts and backup power units at major companies (including Coca-Cola, Sprint, Sysco, FedEx, and others)—*with no additional DOE funding*.

Recommendation

> *"Hydrogen is an excellent medium for energy storage and could enable greater penetration of renewables and enhanced grid stabilization. Consequently, the DOE should consider significant investments in both the analysis and demonstration of various hydrogen production and storage technologies."*

Response

The Department agrees that hydrogen can be a key enabler for energy storage, and appreciates the HPEP's recommendations on the R&D needs in this area. Hydrogen's potential role in energy storage and in enabling penetration of renewables into the electricity grid has been the subject of several recent studies funded by the Department. These have included a lifecycle

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[3] http://apps1.eere.energy.gov/news/daily.cfm/news_id=20935

[4] Critical hydrogen infrastructure needs and opportunities are highlighted in the U.S. DOE's *Report on the First Quadrennial Technology Review* (July 2011), *available at* http://energy.gov/sites/prod/files/ReportOnTheFirstQTR.pdf.

cost analysis of hydrogen for electrical energy storage[5] and a study of blending hydrogen into natural gas pipeline networks as a means to increase the output of renewable energy systems such as large wind farms.[6] A "Wind to Hydrogen" demonstration project at the National Renewable Energy Laboratory (NREL) has generated valuable data toward these studies.[7] In addition, the Department has invested $135 million to establish a state-of-the-art Energy Systems Integration Facility at NREL to focus on research, development, and demonstration of integrated energy systems. Work at this facility will enable the high penetration of renewables by advancing energy storage technologies—evaluating hydrogen as a key option.

Furthermore, in 2012 the Department established a DOE-wide Grid Integration Tech Team to coordinate efforts to modernize and develop a seamless, cost-effective electricity system capable of meeting the clean energy and capacity requirements of the United States. On the international front, DOE continues to engage in and assess relevant strategies for the United States, such as through the workshop entitled "Hydrogen – A Competitive Energy Storage Medium for Large Scale Integration of Renewable Electricity" sponsored by the International Partnership for Hydrogen and Fuel Cells in the Economy, a partnership between the United States, the European Commission, and 16 other countries.[8] Through such efforts, the Department will continue to assess the viability of hydrogen as well as other energy storage approaches.

[5] Steward, D., G. Saur, et al. (2009). Lifecycle Cost Analysis of Hydrogen Versus Other Technologies for Electrical Energy Storage. Golden, CO, NREL: NREL/TP-560-46719.

[6] Antonia, O., Melaina, M.W.,and Penev, M., *Blending Hydrogen into Natural Gas Pipeline Networks: A Review of Key Issues*, Golden, CO, NREL (in press).

[7] Wind-to-Hydrogen Project, *available at* http://www.nrel.gov/hydrogen/proj_wind_hydrogen.html.

[8] http://www.iphe.net/events/workshops/workshop_2012-11.html

IV. Recommendations from HTAC's 2012 Annual Report and Cover Letter

Recommendation

"Please include the importance of hydrogen and fuel cell technology and the progress being made in your formal and informal remarks to multiple audiences. The impact of your messages is significant and your voice amplifies the importance of the efforts underway."

Response

The Department concurs with HTAC regarding the importance of including statements about its technology activities in both formal and informal remarks to multiple audiences. The messaging provided to the investment community and other stakeholders is important, particularly in emerging technology areas such as hydrogen and fuel cells. Such communication is especially important in light of prior perceptions that the Department was not supportive of these technologies.

Contrary to these perceptions, hydrogen and fuel cells are an important part of the Department's portfolio. In fact, the President's FY 2014 budget request was 25 percent higher than the FY 2013 request ($100M vs $80M), demonstrating continued support. In addition, the FY 2014 enacted appropriation was $92.9M in EERE and $25M in FE, which also were consistent with the FY 2013 continuing resolution and FY 2012 appropriation. DOE officials have also made announcements regarding hydrogen and fuel cells on multiple occasions, including the kick-off the H_2USA Partnership in May 2013, when a formal press release was issued and public statements were made by Dr. David Danielson, DOE's Assistant Secretary for Energy Efficiency and Renewable Energy.

Recommendation

"We feel that it is important for you to recognize publicly the reality of international competition and the potential that it will permanently erode the U.S. leadership position in the market for fuel cells."

Response

The Department is aware of international competition in the emerging area of hydrogen and fuel cells. In fact, the Department spearheaded the formation of (and has supported the continuation of) a critical global partnership, the *International Partnership for Hydrogen and Fuel Cells in the Economy,* to help monitor global activities and track progress in various countries. The Department also conducts various market and technology analyses to benchmark that status of various industry sectors and identify areas where key technologies, such as hydrogen and fuel cells, are becoming competitive.

By leveraging key early market opportunities, the Department's efforts have already resulted in strong U.S. leadership, paving the way for a robust domestic industry across multiple sectors. For example, DOE's cost-shared deployments of fuel cell forklifts and backup power units have led—either directly or indirectly—to a nearly seven-fold increase in sales. And as a result, more than 90 percent of the global sales of fuel cell powered forklifts are from U.S. companies.

To bolster this leadership, the Department continues to invest in hydrogen and fuel cell technologies across the research spectrum—from basic science to applied research and development, as well as technology demonstration, early market deployments, and other efforts to overcome market barriers. The Department also tracks the progress and impact of taxpayer dollars, identifying a substantial number of new hydrogen and fuel cell technologies and products directly resulting from DOE funding—including more than 440 patents, 40 commercial technologies already on the market, and another 65 emerging technologies expected to be on the market in the next three years.

Recommendation

> *"We suggest you make positive efforts to support the rollout of a retail infrastructure for hydrogen fueling by intermediating with the multiple interested parties. A special conference in the coming months to review and discuss infrastructure issues and opportunities could be an extraordinary opportunity to learn, decide, and lead the next steps to progress and success. Such an event could also build upon and reinforce the efforts of H_2USA and important state initiatives such as those developing in California, Hawaii, and the Northeast."*

Response

The Department agrees that it is an appropriate and potentially high-impact role for DOE to serve as an intermediary and convene stakeholders to address the challenge of hydrogen infrastructure. Department representatives, including the Assistant Secretary for Energy Efficiency and Renewable Energy, have participated in H_2USA meetings to jump-start efforts to launch the initiative. On August 8, 2013, the H_2USA Partnership conducted its formal kickoff meeting, which was attended by several senior DOE officials, including Assistant Secretary Danielson.

Furthermore, the Department continues to work closely with states that have announced plans to support the rollout of hydrogen infrastructure, including California, Hawaii, and others. California recently announced a plan to install additional hydrogen fueling stations to achieve a total of 70 stations by 2016, and the California legislature passed a bill (Assembly Bill 8[9]) that requires the California Energy Commission (CEC) to allocate $20 million annually (not to exceed

[9] California Assembly Bill No. 8 – Alternative Fuel and Vehicle Technologies Funding Program, http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140AB8

20 percent of available funds) until 2024 to fund at least 100 publicly available hydrogen fueling stations.

The bill also requires CEC and the California Air Resources Board to jointly review and report on the progress toward establishing a hydrogen fueling network that provides the coverage and capacity to fuel vehicles. DOE is an active member of the California Fuel Cell Partnership and coordinates closely with its efforts. DOE is also an active member of the Hawaii Hydrogen Initiative ("H2I"), along with numerous other partners, including General Motors, DOD, the Hawaii Gas Company, the National Renewable Energy Laboratory, the University of Hawaii, the University of California at Irvine, and FuelCell Energy. The Department supports this initiative by conducting testing, validation, and analysis of hydrogen infrastructure technologies, including the process of injecting hydrogen into existing natural gas pipelines as well as long term renewable approaches in Hawaii.

Recommendation

> *"We would be pleased if you would request a review of both the work of HTAC and its Subcommittees later this year or early next year, where you and your leadership team will hear and see firsthand how this committee of citizen volunteers, a well-functioning group of energy technology and energy policy experts, is helping to shape the nation's transportation and technology future in support of the ongoing efforts of the Program Office."*

Response

The Department values the advice and commitment of HTAC in its efforts to continue to improve the Department's programs and activities related to hydrogen and fuel cells. While a formal review of HTAC is not considered necessary or appropriate given the role of a Federal advisory committee, further engagement of HTAC members may be solicited in the coming year to strengthen coordination between HTAC and senior leadership at DOE. Specifically, given the restructuring of the Office of Energy Efficiency and Renewable Energy, the new Deputy Assistant Secretary for Sustainable Transportation is anticipated to engage with HTAC more regularly.

Recommendation

> *"Despite the challenging funding environment, please include this work among your funded priorities."*

Response

Hydrogen and Fuel Cells remain a high priority in the Administration's "all-of-the-above" energy strategy. The FY 2014 increase in the EERE budget request (25 percent) over the FY 2013 request is consistent with the Administration's "all-of-the above" energy strategy and is aligned with automakers' plans for commercial fuel cell electric vehicles in the 2015 timeframe and

beyond. In addition, the fiscal year 2014 appropriation provides reasonably stable funding for hydrogen and fuel cells with $92.9M for EERE and $25M for FE—in line with the FY 2012 appropriation and the FY 2013 continuing resolution.