



## Quadrennial Energy Review

### Summary of Hydrogen and Fuel Cells in the report

#### Background

The Department of Energy's first installment of the Quadrennial Energy Review (QER) identifies areas of the national transmission, storage and distribution (TS&D) that are vital to promote economic competitiveness, and energy and environmental responsibility. It focuses on the network of pipelines, wires, storage, waterways, railroads, and other facilities that are vital to our energy system. The QER seeks to identify systemic vulnerabilities and proposes major policy recommendations and investments to replace, expand, and when appropriate, modernize infrastructure.

#### Hydrogen and Fuel Cells

Hydrogen is specifically mentioned four times in the document, and fuel cells are mentioned twice. While we expect the second installment of the QER to focus on specific technologies in detail, the acknowledgement of hydrogen and fuel cells is limited to energy storage, alternative fuels, infrastructure corridors, and distributed power options for the grid.

Below are the sections and page numbers where the hydrogen and fuel cells are mentioned. The full report can be found here: [http://energy.gov/sites/prod/files/2015/04/f22/QER-ALL%20FINAL\\_0.pdf](http://energy.gov/sites/prod/files/2015/04/f22/QER-ALL%20FINAL_0.pdf)

#### ***Energy Storage***

Energy storage technologies, including pumped hydro storage, thermal storage, **hydrogen storage**, and batteries provide valuable system flexibility. Storage is unique because it can take energy or power from the grid, add energy or power to the grid, and supply a wide range of grid services on short (sub-second) and long (hours) timescales. It can supply a variety of services simultaneously. For example, concentrating solar power paired with highly efficient thermal storage becomes a dispatchable resource (meaning grid operators can control the power output) available throughout the day. Many storage technologies (e.g., batteries, flywheels, and supercapacitors) have fast response rates (seconds to minutes) available over a short time frame; other storage technologies, such as compressed air energy storage, are better suited to offer flexibility in the time frame of hours to days. **(p. 3-10)**

#### ***Biofuels and TS&D Infrastructure Issues***

Other biofuels have chemical properties more similar to gasoline and other hydrocarbons, enabling more ready distribution through existing TS&D infrastructure. Upstream biofuels involve biofuels that could be blended into the petroleum product supply chain at the refinery and then transported with the petroleum product through its normal infrastructure. These alternatives include oil from the pyrolysis of biomass, hydrocarbons derived from applying the Fischer-Tropsch process to mixtures of carbon

monoxide and **hydrogen** produced in biomass gasifiers, oil derived from algae, and fatty acid methyl esters. (p. 4-12)

### ***Department of Energy (DOE) alternative fuels programs***

DOE has supported research and development on the compatibility of higher-level ethanol blends with distribution infrastructure and vehicles. DOE grants and loans helped initial commercial cellulosic ethanol refineries come online. DOE has active research programs on drop-in fuels, and small amounts are already entering the commercial markets.<sup>1</sup> DOE also has robust research, development, demonstration, and deployment programs using electricity and **hydrogen** in vehicles, and use of these fuels in transportation is increasing. (p. 4-12)

### ***Designating Corridors for Pipelines, Electric Transmission Lines, and Related Infrastructure***

Section 368 of the Energy Policy Act of 2005 required the Departments of Interior, Agriculture, Commerce, Defense, and Energy—in consultation with FERC and tribal entities—to work together to designate energy rights-of-way corridors for oil, gas, and **hydrogen** pipelines and electricity transmission and distribution facilities on Federal lands—first in 11 Western contiguous states (Section 368(a)) and later, if warranted, in the remaining states (Section 368(b)). The Departments of Interior and Agriculture designated more than 6,000 miles of these corridors in 2009 for 11 Western states and are currently undertaking a periodic corridor review for the Western states that may lead to revised or new corridor designations. While their use is voluntary, project developers and relevant Federal agencies have, to varying extents, used portions of the Western energy transport corridors for projects since 2009. Unless funding resources are provided to the Federal agencies to continue this work, it is likely any new corridor decisions will be delayed. (p. 9-15)

### ***Appropriate Valuation of New Services, Technologies, and Energy Efficiency***

Ultimately, the electric system exists to serve load—or the demand for electric services—from the residential, commercial, industrial, and transportation sectors. There is a suite of services that the grid provides to meet real-time changes in load and supply, among other things. A better understanding of the full costs and benefits of those services would allow regulators, utilities, and customers to develop more fair and equitable pricing structures. These services and a range of other important societal goals are enabled by new technologies. Distributed energy and smart grid technologies offer the potential to help meet America’s changing energy needs, minimize the environmental impact of electricity generation, strengthen economic growth, and improve the reliability of the Nation’s electrical infrastructure. As noted, the full spectrum of existing and emerging technologies includes new intelligent grid (smart grid) delivery technologies, energy efficiency, combined heat and power, **fuel cells**, gas turbines, rooftop PV, distributed wind, plug-in hybrid and all-electric vehicles, distributed storage, demand response, and transactive building controls. (p. 3-17)

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<sup>1</sup> Department of Energy. “Bioenergy Frequently Asked Questions.” <http://www.energy.gov/eere/bioenergy/bioenergyfrequently-asked-questions>. Accessed February 25, 2015.

### ***A Vision for the Grid of the Future***

Today's grid—where power typically flows from central station power plants in one direction to consumers—is fundamentally different from the grid of the future, where two-way power flow will be common on both long distance, high-voltage transmission lines and the local distribution network. The grid of the future will be an essential element in achieving the broad goals of promoting affordable, reliable, clean electricity and doing so in a manner that minimizes further human contributions to climate change. To do this, the grid of the future will have to accommodate and rely on an increasingly wide mix of resources, including central station and distributed generation<sup>2</sup> (some of it variable in nature), energy storage, and responsive load. **(p. 3-5)**

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<sup>2</sup> There are a variety of options for distributed generation, including photovoltaics, wind, low-head hydropower, combined heat and power, and **fuel cells**.