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State of the States: Fuel Cells in 2014

5th Edition

Fuel Cell Technologies Office

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About this Report

The information contained in this report was collected from public records and websites, particularly Fuel Cells 2000's ***State Fuel Cell and Hydrogen Database*** and North Carolina Solar Center's ***Database of State Incentives for Renewables & Efficiency*** (DSIRE). Information was also gathered via direct contact with state and industry representatives as of July 31, 2014. This report is a follow-up to Fuel Cells 2000's ***2013***, ***2012***, ***2011*** and ***2010*** reports, State of the States: Fuel Cells in America. If we've missed something in your state, please let us know at ***info@fuelcells.org***. All of the information contained in this report is publicly available.

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About BTI

The ***Breakthrough Technologies Institute*** (BTI) is a non-profit [501(c)(3)] independent, educational organization that identifies and promotes environmental and energy technologies that can improve the human condition. BTI was established in 1993 to ensure that emerging technologies have a voice in environmental and energy policy debates.

Front Cover Photo Credits

A Proterra fuel cell bus in Aiken, South Carolina – source: South Carolina Hydrogen and Fuel Cell Alliance

PlugPower fuel cell forklift refuels at the BMW plant in South Carolina – source: DOE

ReliOn, a Plug Power company, Rail HybridPV-HFC Power System – source: ReliOn

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Acronyms Used in this Report

ARB	California Air Resources Board
ARFVTP	Alternative and Renewable Fuel and Vehicle Technology Program
ARPA-E	Advanced Research Projects Agency-Energy (DOE)
CaFCP	California Fuel Cell Partnership
CEC	California Energy Commission
CEFIA	Clean Energy Finance and Investment Authority (Connecticut)
CHP	Combined Heat and Power
DG	Distributed Generation
DMFC	Direct Methanol Fuel Cell
DOE	U.S. Department of Energy
FCEV	Fuel Cell Electric Vehicle
FTA	Federal Transit Administration
IP	Intellectual Property
kW	Kilowatt
MOU	Memorandum of Understanding
MW	Megawatt
NEESC	Northeast Electrochemical Energy Storage Cluster
NREL	National Renewable Energy Laboratory (DOE)
NYPA	New York Power Authority
NYSERDA	New York State Energy Research and Development Authority
PACE	Property Assessed Clean Energy
PEM	Proton Exchange Membrane Fuel Cell
PV	Solar photovoltaic
R&D	Research and Development
RD&D	Research, Development and Demonstration
RPS	Renewable Portfolio Standard
SBIR/STTR	Small Business Innovation Research and Small Business Technology Transfer
SCRA	South Carolina Research Authority
SGIP	California's Self Generation Incentive Program
SOFC	Solid Oxide Fuel Cell
TRU	Transport Refrigerated Unit
U.S.	United States
ZEV	Zero Emission Vehicle

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Fuel Cells: Localized Energy with Global Reach

Due to fast growing interest worldwide from customers wanting to deploy clean and reliable power, fuel cells are becoming more visible in a wide range of market sectors. With major fuel cell manufacturers and key component suppliers headquartered across the country, cutting-edge university research and partnerships, numerous patents, and the greatest number of fuel cell forklifts and fuel cell backup systems deployed – large or small, **the United States (U.S.) continues to be a world leader in fuel cell technology.**

These successes are due to the forward thinking and efforts from a number of states in the country. States are stepping up to set policies, provide funding and encourage collaboration, both regional and international, and deploying units to continue the momentum and keep the U.S. at the forefront of the fuel cell industry.

This report is the fifth in a series. In 2010, Fuel Cells 2000 published "State of the States: Fuel Cells in America," with follow-up reports in ***2011***, ***2012***, and ***2013***. All provide a comprehensive analysis of state activities supporting fuel cell and hydrogen technology, Top 5 rankings, and a catalog of recent installations and deployments in each state, so that readers can get a sense of just how much is happening around the country and compare their home state to others. The 2012 report provided "Fuel Cell Power Rankings" – nine separate Top 5 lists showcasing activity in the different states and market sectors.

Our 2014 report provides in-depth profiles of policies, initiatives and installations to show why we continue to single out certain states for their contributions to the fuel cell industry in their state, the country and the world. It also provides brief overviews of the progress made since our last report.

Since our last report:

- **California's state government announced it will provide $46.6 million to open 28 new hydrogen fueling stations in the state.[1]**
- **More than 43 MW of stationary fuel cells have been installed or ordered in California, Connecticut, Maryland, Nebraska, New Jersey and New York.[2]**
- **The U.S. Department of Energy awarded more than $75 million to various fuel cell and hydrogen projects across the country.[3]**

Why Fuel Cells?

Fuel cells are not a new technology. First invented in the 1800s, it took more than a century for them to take off – literally, as NASA installed them on its space vehicles to provide electricity (and drinking water!) beginning in the 1960s.

It is only in the past few years, however, that the technology has begun to hit its stride and proved to be a crucial piece of the energy puzzle. The combination

A **fuel cell** is an electrochemical device that combines hydrogen and oxygen to produce electricity, with water and heat as its by-products.

Fuel cells offer a unique combination of benefits that make them a vital technology ideally suited for a number of applications. Fuel cells are complementary, not competitors, to other electricity generation technologies, including renewable ones.

Fuel Cell Benefits

- Fuel flexible - operates on conventional or renewable fuels
- High quality, reliable power
- Exceptionally low/zero emissions
- Modularity/scalability/flexible installation
- Can operate independent of the grid
- Extremely quiet
- Lightweight
- Rugged
- Can be used with or instead of batteries and diesel generators
- Can partner with solar, wind, and other renewable technologies
- Increased productivity
- Cost savings via high electrical and overall efficiency

Fuel cells operate in several market segments today, with major customers making large volume and repeat purchases.

[1] http://www.energy.ca.gov/releases/2014_releases/2014-07-22_hydrogen_Refueling_EV_Charging_Stations_nr.html

[2] See the chart, Stationary Fuel Cell Installations/Orders Since Last Report, on page 53.

[3] Estimate based on the two charts in "Federal Fuel Cell Dollars Flowing to States" section of this report.

U.S. manufacturers are commercializing fuel cell products for a variety of applications. Corporate customers have recognized the technology's value and the customer list continues to grow.

Types of Fuel Cell Applications

- Primary Power
- Backup Power
- Motive Power
- Emergency Power
- Battery/Electronics Charging
- Auxiliary Power Units (APUs)

Examples of Fuel Cell Applications

- **Data Centers** – Apple, eBay, Fujitsu
- **Telecommunications** – AT&T, Verizon, Sprint, T-Mobile/MetroPCS
- **Transit Buses** – AC Transit, SunLine Transit, CTTransit, U. of Delaware
- **Material Handling** – Sysco, Walmart, Coca-Cola, P&G, BMW
- **Grocery/Retail** – Walmart, Whole Foods, Price Chopper, Macy's
- **Hospitality** – Hilton, Sheraton
- **Hospitals/Healthcare** – Kaiser Permanente, St. Francis Hospital
- **Production Facilities** – Coca-Cola, Odwalla, Gills Onions
- **Corporate Headquarters/ Campuses** – Google, Toyota
- **Utilities** – Dominion, Delmarva Power, United Illuminating (UI)
- **Universities** – Univ. of California, Univ. of Connecticut, Univ. of Bridgeport, California State U., San Francisco State U., Western Conn. State U.
- **Military** – U.S. Department of Defense (facilities, motive & soldier power)

of benefits – reliability, efficiency, scalability, ruggedness, low-to-zero emissions, and fuel flexibility – makes fuel cells a good fit for a variety of applications and markets. Customers are taking notice, purchasing fuel cells for a range of applications (see box to the left).

In the vast energy landscape of the U.S., where there is an abundance of natural gas and an existing infrastructure of pipelines to deliver it to homes and businesses, fuel cells utilize fuel more efficiently and with significantly lower emissions than by burning it. Emissions are so low that some areas in the U.S. have even exempted natural gas-fueled fuel cells from air permitting requirements. There are natural gas-fueled fuel cells that have been operating in the U.S. for more than a decade. Fuel cells are also capable of running off hydrogen generated via renewable pathways such as solar and wind, or from methane produced during wastewater treatment, or by anaerobic digestion of waste products from the food, beverage and farming industries.

Fuel cells are also versatile, able to provide primary, backup or auxiliary power, work in tandem with batteries as a range extender, or partner with renewable energy storage systems.

Reliable Power

Fuel cells are not a new technology. First invented in the 1800s, it took more than a century for them to take off – literally, as NASA installed them on its space vehicles to provide electricity (and drinking water!) beginning in the 1960s.

After Hurricane Irene and Superstorm Sandy, many Northeast states resolved to improve grid resiliency and take steps to ensure residents have access to reliable power. Other states are dealing with not only weather-related power outages, but also antiquated infrastructure and transmission lines. To address these challenges, some states encourage the use of distributed generation (DG) to improve energy security and offer grant funding for fuel cells and other DG technologies. New Jersey, for example, has launched the second round of the state's Large Scale Combined Heat and Power (CHP)/Fuel Cell Program to enhance energy efficiency through on-site power generation, providing up to $3 million per project. Connecticut's Microgrid Pilot Program has also committed more than $5 million for two fuel cell projects to help increase power resilience during extreme weather.

Many companies that require critical power – from telecommunication firms to banks, data centers and hospitals – are also turning to fuel cell systems for a highly reliable source of power. The technology's other attributes also prove a selling point: fuel cells take up little space, are virtually silent, and offer no emissions other than useable heat and water, allowing units to be located indoors or outdoors, on the rooftop or in the basement. Fuel cell systems can be configured to operate in tandem with or independent of the electric grid.

Utility Scale

U.S. electric utility companies have begun to deploy megawatt-scale fuel cells at electric power stations to bolster the power grid and generate cleaner and more reliable electricity. Adding fuel cell power generation

also helps energy companies meet clean energy requirements imposed by Renewable Portfolio Standards (RPS) – a regulation in place in many states (and countries) requiring energy companies to acquire a certain percentage of their electricity from renewable sources. Several large-scale installations are already operating at utilities in Connecticut, Delaware and California, including a 14.9-megawatt (MW) Dominion fuel cell power park now in service in Bridgeport, Connecticut,[4] and 30 MW installed at two Delmarva Power substations in Delaware.[5] More are coming soon.

Some energy companies see the long-term potential in adding fuel cells to their portfolios today. In July 2014, Exelon Corporation, an energy provider, announced it would provide equity financing for 21 MW of Bloom Energy fuel cell projects at 75 commercial facilities for two customers in California, Connecticut, New Jersey and New York.[6]

Defending from Drought

Water is a precious resource and in several states, such as California and parts of the Southwest, drought has become all too common. States are reporting less rainfall, less snowpack in the mountains and earlier snowmelt, which equals a lot less water. Generating energy for electricity production, natural gas exploration and farming soaks up this vital commodity. Sandia National Laboratories reports that the electricity industry is second only to agriculture as the largest user of water in the U.S. – electricity production from fossil fuels and nuclear energy requires 190,000 million gallons of water per day, or 39 percent of all U.S. freshwater withdrawals.[7] Fuel cells not only save fuel by their inherent efficiency, but they also can save water. Since one of the byproducts of a fuel cell is water vapor, sufficient water to fulfill the consumption needs of the fuel cell system can be obtained from that exhaust vapor. Fuel cell manufacturers tout this feature, called water balance, in their products, and many customers report saving millions of gallons of water each year.[8]

- Honda's 1-MW fuel cell system, located at its Torrance, California, headquarters, requires no water beyond an injection of 240 gallons at start-up. Compared to the average water demands of California power plants, Honda estimates it will save more than 3.25 million gallons of equivalent water used per year, based on Union of Concerned Scientists' data.[9]

- Delmarva Power's 30 MW of fuel cell installations will use less than 0.002% of the water required by conventional electricity generation, while decreasing carbon dioxide emissions by approximately 50% compared to Delaware's electric grid.[10]

Acquisitions and Expansion

The U.S. is home to leading fuel cell manufacturers in several different market sectors – large-scale power generation, backup power for telecommunications and data centers, primary power for material handling equipment – and many key supply chain companies, from components such as bi-polar plates, membranes and catalysts, to hydrogen fuel, are located here. Several states have realized the potential of fuel cells as a high-growth industry that can bring jobs and economic benefits to their states. There are also many colleges and universities around the country offering fuel cell courses and even degrees, some with high-level research and testing laboratories and centers. Cutting-edge research can attract federal funding (see page 66) and encourage collaboration with other universities both here and abroad. These research centers are also partnering with industry, cultivating and training the next generation of engineers and scientists and providing highly-skilled technical researchers and workers. Collaboration also can lead to the generation of intellectual property (IP), patents and even spin-off companies. All of this U.S. expertise and activity is helping advance the fuel cell industry around the world, while generating jobs and economic investment here at home.

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4 http://fcel.client.shareholder.com/releasedetail.cfm?ReleaseID=816069
5 http://www.bloomenergy.com/customer-fuel-cell/delmarva-power-clean-energy/
6 http://www.bloomenergy.com/newsroom/press-release-07-29-14/
7 http://www.sandia.gov/energy-water/nexus_overview.htm
8 http://www.bloomenergy.com/customer-fuel-cell/
9 http://www.bloomenergy.com/customer-fuel-cell/honda/
10 http://www.bloomenergy.com/customer-fuel-cell/delmarva-power-clean-energy/

Companies are making sales in the U.S. and globally, forming strategic partnerships, and expanding their technology base through acquisitions. Since our last report, there has been consolidation as well as expansion among U.S. companies.

- The South Korean multi-national corporation Doosan Co. Ltd. is acquiring the assets and operating debt of South Windsor, Connecticut's ClearEdge Power for $32.4 million (see page 29) for overview of ClearEdge's activities.) Doosan also acquired FuelCellPower Co. Ltd., which focuses on smaller fuel cells for residential applications. The new company created from merging the two is called Doosan Fuel Cell America and announced plans to hire hundreds of employees to staff the South Windsor facility.[11]

- In April, Spokane, Washington, fuel cell manufacturer ReliOn was acquired by Latham, New York, fuel cell manufacturer Plug Power. The acquisition adds fuel cell stack technology and products which Plug Power plans to integrate into several models of its GenDrive fuel cell systems. The acquisition will also help Plug Power expand into the stationary backup fuel cell market, where ReliOn has sold and installed more than 5.7 MW of fuel cells around the world, including hundreds in the U.S. for major telecommunications companies.[12]

- Port Washington, New York, solid oxide fuel cell (SOFC) manufacturer WATT Fuel Cell Corporation purchased tubular SOFC developer Pittsburgh Electric Engines, Inc., making the company a wholly owned subsidiary of WATT. According to WATT, this will help WATT transition to larger systems for residential power and smaller-scale DG.[13]

- Catacel Corporation was acquired by Johnson Matthey (JM) and will now be part of JM's Process Technologies Division. Catacel opened a new plant and technology center in Ravenna, Ohio, to develop its new methanol steam reforming catalyst. The company reports that its annual growth rate has exceeded 50% over the past three years and that, in the past year, the company has added equipment and employees to keep up with customer demand.[14]

U.S. companies and a military branch also expanded operations and opened new facilities:

- General Electric (GE) opened a fuel cell testing and research facility in Malta, New York, which will focus on developing its SOFC technology. GE currently has a 22-member fuel cell team and expects to begin commercial production of systems, with capacities ranging from 1 MW to 10 MW, in 2017.[15]

- VP Energy, LLC moved manufacturing to its new facility in Brighton, Michigan.[16]

- General Motors (GM) is building a new Fuel Cell Development Laboratory in Pontiac, Michigan, where the majority of the company's fuel cell development work will take place.[17]

- The U.S. Army Tank Automotive Research, Development and Engineering Center (TARDEC) opened a new Ground System Power and Energy Laboratory Fuel Cell Laboratory at the U.S. Army Detroit Arsenal in Warren, Michigan. This state-of-the-art facility enables TARDEC to test and integrate the fuel cell systems it has been developing for military applications for more than a decade. TARDEC will work with GM to test new hydrogen fuel cell-related materials and designs.[18]

GM is also partnering with the U.S. Department of Energy's (DOE) National Renewable Energy Laboratory (NREL) on a multiyear, multimillion dollar joint effort to reduce automotive fuel cell stack costs through material and manufacturing research and development (R&D). NREL and GM will focus on reducing platinum loading, achieving high power densities, understanding the implication of contaminants on fuel cell performance and durability, and accelerating manufacturing processes to achieve the benefits of increased economies of scale. The work will be done

[11] http://globenewswire.com/news-release/2014/08/06/656509/10093302/en/Newly-Formed-Doosan-Fuel-Cell-America-Inc-is-Positioned-to-Become-the-Number-One-Global-Fuel-Cell-Provider-According-to-CEO.html

[12] http://www.plugpower.com/news/pressreleases/14-04-02/PLUG_POWER_ACQUIRES_RELION_INC_BRINGING_INNOVATIVE_FUEL_CELL_STACK_TECHNOLOGY_IN-HOUSE.aspx

[13] http://www.businesswire.com/news/home/20140424006060/en/WATT-Fuel-Cell-Corp.-Acquires-Pittsburgh-Electric#.VFJRuTTF_Ns

[14] http://www.matthey.com/media_and_news/news/2014/johnson-matthey-acquires-catacel

[15] http://www.saratogian.com/general-news/20140723/ge-building-new-facility-in-malta

[16] http://64.9.198.183/company

[17] http://media.gm.com/media/us/en/gm/news.detail.html/content/Pages/news/us/en/2013/Sep/0930-fuel-cell.html

[18] http://media.gm.com/media/us/en/gm/news.detail.html/content/Pages/news/us/en/2013/Sep/0930-fuel-cell.html

under a Cooperative Research and Development Agreement (CRADA) between NREL and GM and takes advantage of NREL's state-of-the-art Energy Systems Integration Facility.[19]

On the investment side, since our last report, the New Zealand Superannuation Fund made an additional $50 million investment in Sunnyvale, California, fuel cell manufacturer Bloom Energy. The Fund made an initial $50 million investment in Bloom in May 2013.[20]

Export Opportunities

Fuel cells are becoming an integral part of the energy mix, leading to international opportunities for U.S. companies. Areas of industry growth include fuel cells for residential power, backup power and grid power, for energy storage, and for material handling equipment, as well as the development of the hydrogen fueling infrastructure for fuel cell-powered passenger vehicles, material handling and buses.

- Japan and Germany are both committed to constructing the hydrogen fueling infrastructure needed to support the first fleets of fuel cell electric vehicles from major auto manufacturers (Toyota, Honda, Daimler and Hyundai), which are entering the market in 2014-2017.
- Europe and Japan are beginning to deploy fuel cell-powered material handling vehicles, a market in which the U.S. is a dominant leader.
- Japan and Germany also have programs to deploy fuel cells to power and heat homes. Japan's Ene-Farm residential fuel cell program has already surpassed 65,000 purchases.
- Places such as India, Indonesia, China, the Middle East, Philippines and South Africa are installing fuel cells to provide crucial power to telecommunications sites.
- Germany and other countries are turning to hydrogen as a means to store the excess energy created from wind turbines and solar arrays.
- In an effort to reduce greenhouse gas (GHG) emissions, South Korea is providing funds for fuel cell power installations. The city of Seoul is planning 190 MW of fuel cell power plants and an additional 40 MW of fuel cells to power buildings in 2014.[21]

Several companies are taking advantage of these opportunities. In addition to their acquisition of ReliOn, Plug Power (Latham, New York) has signed a non-binding memorandum of understanding (MOU) with Korean company Hyundai Hysco Co. Ltd. to create a joint venture partnership to develop and sell hydrogen fuel cells in countries throughout Asia using Hysco's advanced stack and plate technology.[22]

Danbury, Connecticut-based FuelCell Energy and POSCO Energy of Korea have strengthened their strategic relationship with an integrated global supply chain agreement and so far in 2014, 8.4 MW worth of fuel cell orders. FuelCell Energy and POSCO already have installed 56 MW in Korea, at the world's largest fuel cell power park, and have an existing 122 MW order as well as an additional 2.8 MW purchase. POSCO is currently constructing a manufacturing facility which, once operational in mid-2015, will double the global manufacturing capacity of FuelCell Energy's proprietary fuel cell power plants.[23]

GEI Global Energy Corp., a fuel cell company based in Flint, Michigan, entered a joint venture partnership with the Italian firm Associazione Italiana per lo Sviluppo Economico to leverage the expanding global natural gas supply infrastructure to deploy its hybrid fuel cell cogeneration power systems within Italy and Europe. A pilot plant

[19] http://www.nrel.gov/news/press/2014/14370.html

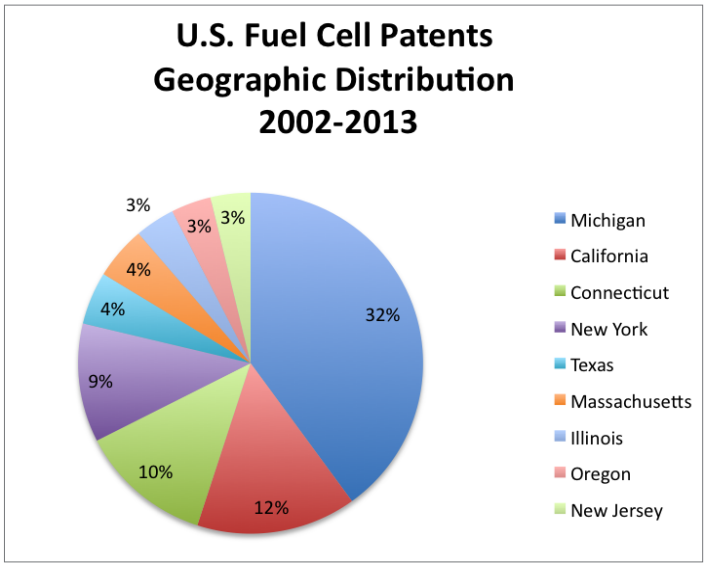
[20] https://www.nzsuperfund.co.nz/news-media/nz-super-fund-increases-stake-bloom-energy

[21] http://cityclimateleadershipawards.com/seoul-hydrogen-fuel-cells/

[22] http://www.plugpower.com/news/pressreleases/14-04-21/PLUG_POWER_AND_HYUNDAI_HYSCO_SIGN_MEMORANDUM_OF_UNDERSTANDING_TO_FORM_FUEL_CELL_JOINT_VENTURE_IN_ASIA.aspx

[23] http://globenewswire.com/news-release/2014/05/13/635825/10081358/en/FuelCell-Energy-Announces-Strengthening-of-Strategic-Relationship-With-POSCO-Energy-Supporting-Global-Market-Development-and-Product-Cost-Reductions.html

and technology showcase will launch in October 2014 providing over 6,000 kilowatt-hours (kW-hr) per month of combined heat and power (CHP) to a small municipality in Northern Italy.[24]



Some U.S. companies are helping to develop the hydrogen fueling infrastructure outside our country's borders. Since our last report:

- Wallingford, Connecticut's Proton OnSite was selected to install its C-Series proton exchange membrane (PEM) electrolyzer at a new hydrogen fueling station in Hamburg, Germany. This will be the second hydrogen generator Proton has supplied to Germany. In 2012, a Proton electrolyzer was installed at Fraunhofer ISE's solar-powered refueling station in Freiburg.[25]
- Air Products and Chemicals, Inc. of Allentown, Pennsylvania, joined with Nippon Steel & Sumkin Pipeline & Engineering Co. Ltd. to work on Japan's developing hydrogen fueling infrastructure market and will develop a long-term marketing and supply agreement.[26]

U.S. Patently Strong in IP

State and local governments want new and established businesses to grow and succeed. Businesses with IP are well-positioned to establish business partnerships, compete competitively, and attract investment.

The Cleantech Group-Heslin Rothenberg Farley & Mesiti P.C., located in upstate New York, publishes the ***Clean Energy Patent Growth Index***, a report that analyzes IP in the clean energy sector, including fuel cells.

The U.S. won back the title from Japan for most fuel cell patents in 2013 with 317 and since 2002, has boasted an impressive 43% of the world's fuel cell patents. GM, based in Michigan, had the most fuel cell patents in 2013, with 128, and the state, also home to several other automaker manufacturing and research divisions, led the country with 139 patents, up 14 from last year. Michigan had more patents than the next four states – California, Connecticut, Massachusetts and Ohio - combined.

[24] http://www.businesswire.com/news/home/20140709005422/en/GEI-Global-Energy-Corp.-Announces-Partnership-Italy#.VFJgUTTF_Ns
[25] http://www.prweb.com/releases/2014/03/prweb11656311.htm
[26] http://www.airproducts.com/company/news-center/2014/02/0227-air-products-and-nippon-steel-sign-agreement-for-hydrogen-fueling-station-work-in-japan.aspx

Top Fuel Cell States

California, Connecticut, New York, Ohio, and **South Carolina** have been singled out as the Top 5 Fuel Cell States in our past reports for their supportive policies and incentives that have proven to encourage fuel cell installations, industry research and development and business expansion. California is by far the leader in the U.S., and arguably the world, with its progressive legislation that may be helping pave the way for fuel cell electric vehicles (FCEVs) and the hydrogen infrastructure, stationary fuel cells running off renewable fuels and large-scale installations to help stabilize the electric grid. New York and Connecticut are home to several of the world's leading fuel cell manufacturers and some of the longest running stationary systems in the country. Each state's public benefit fund has been helping to fund installations for many years now.

What makes these states so successful? It seems that each has in common a combination of "players" working together to develop the state's expertise in fuel cells and hydrogen. These include:

- **State economic development agencies** that believe the state's strengths in fuel cell and hydrogen technologies will lead to innovative research, patents and products. The goal is to develop an expanding and vibrant industry that will bring economic benefits to the state, such as business attraction and growth, and out-of-state investment.
- **State energy and environmental agencies** looking to reduce greenhouse gas and other polluting emissions (often to facilitate compliance with state renewable portfolio standards) and to improve grid energy security. These agencies are often home to funding programs that help to facilitate demonstrations and early market deployments of new and innovate energy technologies, such as fuel cells and hydrogen fueling.
- **State lawmakers**, for the same reasons: to promote low-emission energy technologies and reduce the impact of storms and other interruptions to the energy grid. Lawmakers can set state emission reduction goals, create and fund renewable energy and business development programs, and devise tax incentives for fuel cell and hydrogen technologies.
- **State governors**, who set the stage for state efforts, like the governors from eight states who agreed to a new initiative to put 3.3 million zero-emission vehicles (including fuel cells) on their roadways by 2025.[27]
- **Researchers** at state universities and laboratories, as well as in nascent and established businesses, that are driving fuel cell and hydrogen innovation and product development.
- **Businesses** that are evolving and growing, often with support from state agencies, as they move toward serial production of their fuel cell and hydrogen technology products, or toward further growth within the regional, state, national or international fuel cell industry. These include not only fuel cell manufacturers, but also equipment and material suppliers, installers, and developers of fueling infrastructure.
- **Coalitions or partnerships** comprised of government, industry, and academia, working together on education and outreach, developing vision plans and roadmaps, and representing and promoting the state's fuel cell industry.
- **Willing customers** seeking to achieve sustainability goals by purchasing renewable energy, reducing emissions while ensuring reliable power. Many Fortune 500 companies such as Walmart, AT&T, Apple, Procter & Gamble and others are deploying fuel cells at facilities around the country and helping to sway other stakeholders to follow suit.

There are several policy tools that have been implemented to help support fuel cells. Interconnection standards, net metering, and renewable portfolio standards are examples. Also, Property Assessed Clean Energy (PACE) programs can be used by local governments to finance renewable energy systems or energy efficiency improvements. Local governments finance the cost of the improvements and the property owner pays back the loan over 15-20 years through an additional tax assessment on their property tax bill. The property owner receives immediate benefits from energy improvements via a reduced electric bill. The PACE assessment and lien are tied to the property, not the owner, and are transferred to a new owner upon a sale of the property.

Local governments often fund the PACE loans through bonds and via interest paid on the loans, but may also finance PACE programs using municipal funds or bank funding.

Fuel cells are presently funded under PACE programs in California (fuel cells are eligible under the state's 10 local PACE programs) and Connecticut (C-PACE). New York's PACE financing is available for fuel cells using renewable fuels (Energize NY). Colorado and Rhode Island have passed PACE enabling legislation; fuel cells using renewable fuels are eligible in both states once programs are established.

While each of the top fuel cell states in our reports has a unique industry focus – research and development, business and economic development, or technology deployment – the common denominators for growing fuel cell industry success seems to be:

[27] http://www.oregon.gov/deq/docs/MOUzev.pdf

- Collaboration and coordination among the industry's players (business, government, and academia);
- Supportive government policies, created by the legislature and/or governor, which encourage the development and deployment of fuel cells;
- Incentives for fuel cell-related businesses to move to the state and to grow and succeed; and
- Financial support (grants, loans, tax incentives) for end users to encourage fuel cell demonstrations and deployment.

Each of the states highlighted below sees the fuel cell industry as an investment – an industry where the state can be a national leader, and a technology that delivers clean, low emission energy as well as economic benefits to the state.

2014 Top Fuel Cell States

What follows are comprehensive profiles of the top fuel cell states in the U.S., focused on their history of support for fuel cells and current policies and progress toward goals, whether it be for grid security, emissions reductions, or economic development. We show how these states are leading the way – bringing benefits to the state while helping the fuel cell industry grow and the U.S. remain at the top – so that other states and localities can emulate their strategies and successes. We also highlight recent advancements and news since our last report.

CALIFORNIA

Since our last report:

- Hyundai began leasing Tucson Fuel Cell vehicles to customers in Southern California.
- The governor signed Assembly Bill 8, which includes a provision to fund at least 100 hydrogen stations with a commitment of up to $20 million per year.
- The California Energy Commission (CEC) awarded $46.6 million for 28 new hydrogen fueling stations and another $1.2 million for the operation and maintenance of hydrogen refueling stations throughout the state. 51 stations are expected to be operational statewide by the end of 2015, providing up to 9,400 kg/day of hydrogen.
- The California Air Resources Board (ARB) voted to expand incentive funds that help consumers buy zero-emission and plug-in hybrid vehicles (Clean Vehicle Rebate Project).
- 7.3 MWs of stationary fuel cells have been installed, or are on order, from U.S. fuel cell manufacturers.

To address the challenge presented by climate change, vehicle greenhouse gas emissions must be drastically reduced if we are to meet our goal of an 80% reduction by 2050. This 40-year outlook is a far longer time horizon than those employed by the federal agencies under the Clean Air Act, or the requirements to develop the corporate average fuel economy (CAFE) standards. Policies developed under this longer policy timeframe also deliver a continuous policy message to both the manufacturers and consumers that California is committed to significant changes to clean up the cars and light trucks we drive.

– Air Resources Board

Source: ***http://www.arb.ca.gov/msprog/clean_cars/acc%20summary-final.pdf***

California is the nation's leader in fuel cells, home to most of the country's fuel cells for both stationary and transport applications. Fuel cells are funded through many of California's clean transport and DG programs. The state has prioritized the development of a network of hydrogen fueling stations to support the roll out of commercialized fuel cell electric vehicles, which started in 2014 with the delivery of the first Hyundai Fuel Cell vehicles to lease customers.

California is also a national and international leader in the control of air pollution and greenhouse gas (GHG) emissions from mobile and stationary sources. The California Air Resources Board (ARB), founded in 1967, is tasked with protecting the public from exposure to toxic air contaminants and GHGs. The

agency is a key player in providing leadership in implementing and enforcing California's air pollution control rules and regulations – which includes ***AB 32, the California Global Warming Solutions Act of 2006***, which aims to reduce GHG emissions by 25% by 2020 and 80% by 2050 – and providing "innovative approaches for compliance." Fuel cells, which offer a low-to-zero emission approach to both transport and power generation, play a crucial role in this effort.

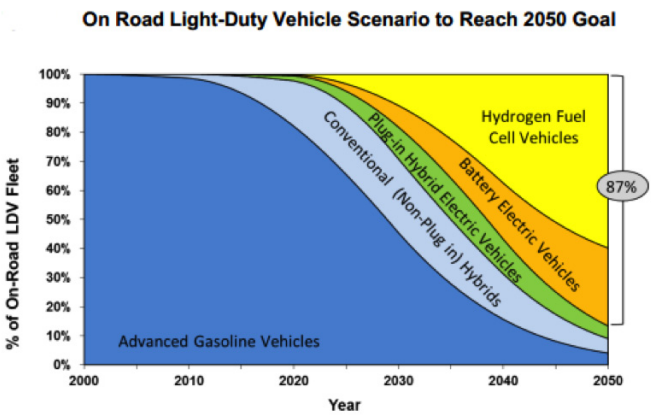
The California Energy Commission (CEC), founded in 1975, is the state's primary energy policy and planning agency. The CEC has invested millions of dollars in its energy research, development and demonstration (RD&D) programs to support technologies to improve energy systems. CEC promotes renewable energy development to meet the goals of the state's Renewable Portfolio Standard (RPS), including funding that support fuel cells for distributed (onsite) power generation. The CEC also develops and deploys alternative and renewable fuels and advanced transportation technologies to help meet the state's goals for reducing greenhouse gas emissions and petroleum dependence in the transportation sector.

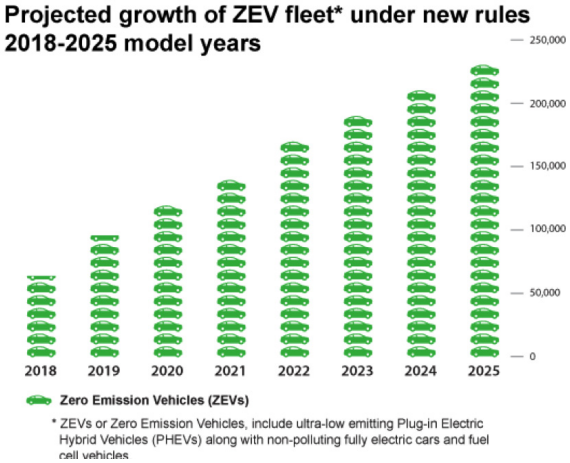
Over the years, California has implemented a number of programs and initiatives that support fuel cells and other alternative power generation technologies. These include ARB's well-known Zero Emission Vehicle (ZEV) regulation and Advanced Clean Cars program, which facilitate deployments of fuel cell passenger vehicles and buses in the state; the CEC's Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP) that is providing funds to establish a state network of 100 hydrogen fueling stations; and the Self-Generation Incentive Program (SGIP), administered by the CEC, which provides generous incentives for distributed (onsite) power generation to help reduce greenhouse gases.

California is now beginning to reap the rewards of these efforts. In 2014, ARB released the California Greenhouse Gas Emissions Inventory for 2012 which shows that the state's gross domestic product (GDP) grew from $1.47 trillion in 2000 to $1.75 trillion in 2012 (2005 dollars), while the carbon intensity – the amount of carbon pollution related to the state's overall economy – fell over the same period, from 316.6 tonnes CO_2e per million dollars in 2000 to 261.9 tonnes per million dollars in 2012.

California's Fuel Cell and Hydrogen Transportation Initiatives

California leads the nation in the deployment of FCEVs and development of hydrogen fueling stations. The state presently has 9 hydrogen stations, with 49 more in development, and 2 stations that support a fleet of





"The latest inventory clearly demonstrates that under AB 32 California is getting more economic development every year for each ton of greenhouse gases emitted overall. That's good news for California and the message is clear: We need to stay the course we're on to continue to grow California's lower carbon economy."

– Mary D. Nichols, Air Resources Board Chairman

Source: ***http://www.arb.ca.gov/newsrel/newsrelease.php?id=612***

"The first few years here in California will be a critical period for hydrogen fuel cell technology, California has stepped up with the offer to invest $200 million dollars to build 100 stations, and through this financial arrangement with FirstElement, Toyota is showing its full commitment to deploy zero emission fuel cell vehicles here in California. Perhaps most importantly, we are showing the future owners of this amazing technology that Toyota is helping to ensure that hydrogen refueling will be available, no matter what car brand is on the hood."

– Bob Carter, senior vice president, Automotive Operations, Toyota Motor Sales, U.S.A., Inc.

Source: ***http://www.reuters.com/article/2014/05/01/toyota-firstelement-idUSnPn3SNTV2+9e+PRN20140501***

fuel cell-powered buses. Many other hydrogen stations have been deployed over the last decade to support on-road FCEV demonstrations, including short-term leases to individual, corporate and government customers who operated the vehicles in real-world driving situations and provided feedback to the manufacturers.

In May 2014, the first serial production Hyundai fuel cell electric vehicle arrived in California and in June, Hyundai handed over the keys to the first commercial Hyundai Tucson Fuel Cell vehicle customer. Hyundai FCEVs are now available to southern California customers through a lease program.

Toyota, which will start serial production of its own FCEV in December 2014, recently announced that it has partnered with California-based hydrogen provider FirstElement Fuel, promising to invest at least $7.2 million to help develop a hydrogen fueling network in the state. In May, FirstElement Fuel won a $27.6 million award from the CEC to install 19 hydrogen fueling stations in the state.

The stage for these events was set by California's efforts over the past decade to bring FCEVs and hydrogen stations to the state. California provides a world-leading example of leadership, innovation and collaboration. The state will be rewarded for these efforts as it becomes the first in the nation to bring significant numbers of commercial fuel cell vehicles to its roadways.

California has supported the deployment of ZEVs for many years, beginning with ARB's Zero Emission Vehicle regulation adopted in 1990 as part of the Low Emission Vehicle (LEV) Program. The program supports the use of ZEVs to improve the state's air quality and to lower emissions from the transport sector. California's goal is to achieve an 80% reduction in GHGs from the transport sector by 2050. The California ZEV rule has been adopted by 10 other states: Connecticut, Maine, Massachusetts, New Jersey, New York, Rhode Island, Vermont, Maryland, New Mexico and Oregon.

The ZEV program became a stand-alone regulation in 1999, "in recognition of the increasing maturity of zero emission technologies and the critical role they can play in achieving California's air quality goals."[28] In 2008, ARB directed staff to strengthen the ZEV requirement and to focus primarily on fuel cell, battery electric and plug-in hybrid electric vehicles for the 2015 and later model years so that these technologies would transition from demonstration to full commercialization.

In 2012, ARB combined the control of smog, soot and global warming gases and requirements into a single package of standards called ***Advanced Clean Cars***. This program includes the LEV and ZEV regulations, and the ***Clean Fuels Outlet*** regulation designed to assure that ultra-clean fuels, including hydrogen, are available to meet growing demand. With

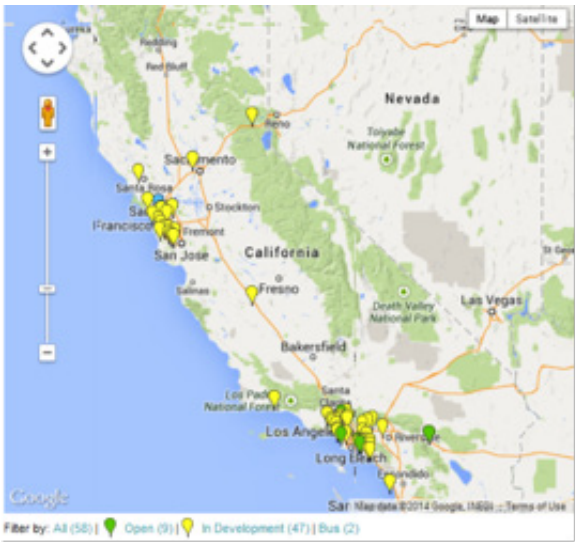
[28] http://www.arb.ca.gov/msprog/clean_cars/acc%20summary-final.pdf

these regulations, zero-emission or plug-in hybrid vehicles will account for one in seven new cars sold in California in 2025, putting California on track to reach its 2050 GHG goal.

In support of these goals, the CEC's Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP) provides grants for hydrogen fueling stations, using funds provided by the California Legislature (Assembly Bill 118 - Nuñez Statutes of 2007).

In September 2013, the governor signed Assembly Bill 8, which includes a provision to fund at least 100 hydrogen stations with a commitment of up to $20 million per year. The bill also requires CEC to design grants, loan incentive programs, revolving loan programs, and other forms of financial assistance to assist in the implementation of the Act's provisions.

The state's Zero Emission Vehicle (ZEV) Action Plan (2013) identified strategies to bring 1.5 million ZEVs to California's roadways by 2025.



California Hydrogen Fueling Station Map

California's governor signed a 2013 MOU between eight states (including Connecticut, Maryland, Massachusetts, New York, Oregon, Rhode Island and Vermont) to put 3.3 million ZEVs on their respective state roadways by 2025. California also joined H_2USA, a public-private partnership to coordinate research and identify cost-effective solutions to deploy infrastructure that can deliver affordable, clean hydrogen fuel in the U.S.

In July 2014, CEC announced $5 million in ARFVTP funding for ARB's Clean Vehicle Rebate Project for qualified electric vehicles, which includes FCEVs. CEC also approved $18.69 million in grants for projects to expand the state's hydrogen fueling infrastructure in 2013, and in July 2014 awarded an additional $46.6 million through the ARFVTP for the development of 28 stations. Thirteen of the new locations will be in Northern California and 15 in Southern California, strategically located to create a hydrogen refueling network along major corridors and in regional centers, and it will also fund a mobile hydrogen refueler that will provide fueling capability when stations are off-line. Six of the stations will provide 100% renewable hydrogen fuel. Adding the new hydrogen stations to the nine existing stations and others already under development, the state will soon boast 56 hydrogen refueling stations – just past the halfway mark in establishing an initial 100-station hydrogen fueling network.

In June 2014, ARB released the Annual Evaluation of Fuel Cell Electric Vehicle Deployment and Hydrogen Fuel Station Network Development, which informs California's decisions for future funding of hydrogen fuel stations, including the number and location of stations as well as minimum technical requirements for those stations. ARB reports that:

- 125 FCEVs are registered with the Department of Motor Vehicles.
- Auto manufacturer projections indicate that California's FCEV fleet will grow to 6,650 by the end of 2017 and 18,500 by the end of 2020.
- A total of 51 stations are expected to be operational statewide by the end of 2015, providing up to 9,400 kg/day of hydrogen.
- The coverage and capacity provided by these stations will be nearly sufficient through 2018 to support the FCEV fleet within that timeframe.

The report also indicates that the hydrogen station coverage and capacity funded under the latest CEC award will not be sufficient for the expected vehicles out to 2020, necessitating up to 49 additional stations. The report recommends that, "CEC should maintain the course – the maximum $20 million allocation and any other potential funding sources identified by ARB and CEC should be utilized in the next CEC funding program for hydrogen fuel stations."

There is still a lot of work to be done, but California is well on its way.

A long-standing fuel cell proponent is the ***California Fuel Cell Partnership (CaFCP)***, formed in 1999 as a public-private partnership to demonstrate and promote the commercialization of FCEVs. The organization operates a FCEV testing and demonstration facility and hydrogen station in West Sacramento, where members maintain a small fleet of demonstration vehicles. Members include many of the major automakers (Chrysler, Daimler, Honda, Hyundai, Nissan, Toyota and Volkswagen), as well as energy and technology companies, and state and federal government agencies. Since its founding, CaFCP has been at the forefront of raising public awareness, supporting hydrogen fueling station implementation, and preparing California for the commercial launch of FCEVs. CaFCP has authored several recent roadmaps including, ***A California Road Map: Bringing Hydrogen Fuel Cell Vehicles to the Golden State*** (2012), which describes the infrastructure (68 stations) needed to successfully launch the early commercial FCEV market, ***Hydrogen Progress, Priorities and Opportunities*** (2014), that reviews progress toward roadmap goals and defines important next steps to create a 100-station hydrogen network in the state, and ***A Road Map for Fuel Cell Electric Buses in California: A Zero-Emission Solution for Public Transit*** (2013) that examines the progress of fuel cell electric buses (FCEBs) and offers recommendations to state and federal policy makers about actions they can take to put FCEBs on the path to full commercial readiness.

CALSTART, a California-based non-profit organization supporting growth of the clean transportation technology industry, has partnered with the Federal Transit Agency (FTA) since the formation of the National Fuel Cell Bus Program in 2006, facilitating the mainstreaming of hydrogen and fuel cell buses in the U.S. and collecting on-road data for fuel economy and emissions for hybrid and zero emission buses. With the CEC's support, CALSTART is also demonstrating both full-sized and shuttle-sized fuel cell and battery buses for both transit and non-transit applications in California. California is home to the largest U.S. fuel cell bus fleet – 12 buses operated by a group of regional transit agencies (AC Transit, Golden Gate Transit, SamTrans, VTA, and Muni) in real-world service throughout northern California's East Bay region. California transit agencies have demonstrated fuel cell-powered transit buses in revenue service for more than a decade, spurred by the state's ***Zero Emission Bus (ZBUS) regulation***.

OVERVIEW OF CALIFORNIA'S FUEL CELL FEHICLE AND HYDROGEN INITIATIVES	
PROGRAM	**DETAILS**
AGENCY: CALIFORNIA ENERGY COMMISSION (CEC)	
Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP)	ARFVTP is a competitive grant program that provides as much as $100 million annually towards innovative transportation and fuel technologies that help California meet its energy, clean air, and climate-change goals. Projects selected for program funding accelerate the development of alternative transportation fuels through the improvement and commercialization of existing and emerging alternative fuel vehicles and infrastructure. Funded projects include commercial vehicle demonstrations and deployment, vehicle manufacturing, fuel production, fuel distribution infrastructure and research of innovative technologies.
AGENCY: CALIFORNIA AIR RESOURCES BOARD (ARB)	
Advanced Clean Cars	In 2012, the ARB approved a new emissions-control program for cars and light trucks for model years 2017 through 2025. The program combines the control of smog, soot and global warming gases and requirements for greater numbers of zero-emission vehicles into a single package of standards called Advanced Clean Cars. The Advanced Clean Cars program is composed of several separate, but related components, including:

	Zero Emission Vehicle (ZEV) Program	Originally part of the Low-Emission Vehicle (LEV) program, ARB established the ZEV program as a stand-alone regulation in 1999. The program has been modified several times to address the pace of development of zero emission technologies. In 2008, the ZEV program requirement for the 2015 and later model years was strengthened to ensure that zero emission technologies (battery electric vehicles, FCEVs, and plug-in hybrid electric vehicles) transition from the demonstration phase to full commercialization in a reasonable timeframe to meet long-term emission reduction goals. The program focuses on both passenger vehicles and urban transit buses (***Zero Emission Bus [ZBus] regulation***).
	Clean Fuels Outlet (CFO)	The CFO regulation is intended to provide outlets of clean fuel to meet the needs of clean, alternative fuel vehicles. The program originally focused on methanol, ethanol and compressed natural gas; amendments to the regulation were made to ensure that ultra-clean fuels such as hydrogen are available to meet vehicle demands brought on by ZEV Program amendments.
Air Quality Improvement Program (AQIP)	Established in 2007 by the California Alternative and Renewable Fuel, Vehicle Technology, Clean Air, and Carbon Reduction Act of 2007 (AB 118), AQIP is a voluntary incentive program to fund clean vehicle and equipment projects, research on biofuels production and the air quality impacts of alternative fuels, and workforce training. AQIP funds have traditionally supported the development and deployment of the advanced technologies needed to meet California's longer-term, post 2020 State Implementation Plan goals, and to fund projects that do not fit within the statutory framework of other ARB incentive programs. AB 118 provides about $200 million annually through 2015 for three new programs to fund air quality improvement projects and to develop and deploy technology and alternative and renewable fuels, including the CVRP.	
	Clean Vehicle Rebate Project (CVRP)	CVRP promotes the purchase of battery electric, plug-in hybrid electric, and FCEVs. Rebates of up to $2,500 per light-duty vehicle are available for the purchase or lease an eligible vehicle, including approved FCEVs.
Low Carbon Fuel Standard (LCFS)	The LCFS, established by the governor's executive order in 2007, uses a market-based cap and trade approach to lowering the greenhouse gas emissions from petroleum-based transportation fuels such as diesel. The LCFS requires producers of petroleum-based fuels to reduce the carbon intensity of their products, culminating in a 10% total reduction in 2020. Petroleum importers, refiners and wholesalers can develop their own low carbon fuel products, or buy LCFS Credits from other companies that develop and sell low carbon alternative fuels, such as biofuels, electricity, natural gas or hydrogen.	
Zero Emission Vehicle (ZEV) MOU	The governors of CA, CT, MD, MA, NY, OR, RI and VT signed a cooperative agreement in 2013 to put 3.3 million ZEVs (fuel cell, battery-electric and plug-in battery electric) on the roads in their states by 2025. The agreement identifies specific actions that will be taken within their states, and joint cooperative actions to be undertaken by the signatory states, to help build a robust national market for electric and hydrogen-powered cars. In May 2014, the states released a collaborative Action Plan.	

California's Stationary Fuel Cell Initiatives

Fuel cells play a major role in California's DG programs that encourage onsite energy production using low emission and renewable resources – through 2012, the state's Self-Generation Incentive Program (SGIP) has funded 195 stationary fuel cells totaling 70 MW of power.

California's Renewables Portfolio Standard (RPS) was established under Senate Bill 1078 in 2002 and presently requires all retail sellers of electricity, including publicly owned utilities, investor-owned utilities, electricity service providers, and community choice aggregators, to acquire 33% of their load from renewable energy by 2020, with an interim target of 25% by the end of 2016. CEC and the California Public Utilities Commission (CPUC) work collaboratively to implement the RPS. Eligible technologies include fuel cells using renewable fuels.

CPUC regulates the state's DG policies and programs for customers and wholesale providers such as utilities. Utilities procure their DG resources through a variety of programs, including the RPS program, competitive solicitations and feed-in tariffs.

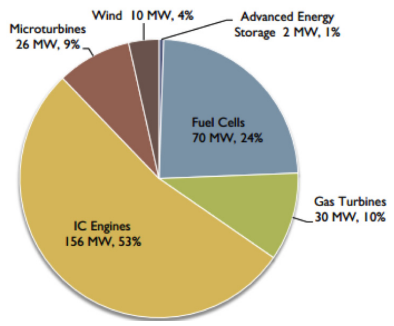
CPUC's customer-side program includes the Self-Generation Incentive Program (SGIP), one of the longest-running and most successful DG incentive programs, with more than 600 systems and over 250 MW of rebated capacity. Eligible technologies include both electric-only and CHP fuel cells, wind turbines, waste heat to power technologies, pressure reduction turbines, internal combustion engines, microturbines, gas turbines and advanced energy storage systems.

SGIP was developed as a peak-load reduction program and designed to complement the CEC's Emerging Renewables Program, which funded smaller systems. Early on the SGIP was composed of a mix of fuel cells, solar photovoltaic (PV) systems, wind turbines, and combustion-based technologies. In 2006, Assembly Bill 2778 directed the CPUC to remove PV technologies from the SGIP (moving incentives instead to CPUC's California Solar Initiative) and limited eligibility of non-PV technologies to fuel cells and wind turbines. This led to a significant growth in fuel cell capacity. A 2009 CPUC decision expanded incentives for fuel cell technologies to include renewable systems using directed biogas; in the next year, 55 new directed biogas systems were added to the SGIP, all using fuel cells. In 2011, CPUC set GHG emission reductions as one of the four primary goals of the SGIP and opened the program to other ultraclean and low-emission DG technologies beyond wind turbines and fuel cells. SGIP participants now receive up-front and performance-based incentives, which apply only to the portion of the generation that serves a project's onsite electric load. SGIP's up-front fuel cell incentive - for both CHP[29] and electric-only fuel cells - is $1.83/watt.

In 2010, CPUC established the Renewable Auction Mechanism (RAM) Program to provide a streamlined process for Pacific Gas & Electric, San Diego Gas & Electric and Southern California Edison to procure energy from new and existing RPS eligible generators that can be applied towards each utility's RPS procurement goals. Utilities are authorized to procure 1,299 MW through RAM by holding four auctions over two years (held in 2011-2013); a fifth auction will be held in 2014. This mechanism is for projects greater than 3 MW and up to 20 MW. While no California fuel cell installations fall within this size range, as yet (fuel cell installations within this size range are presently operating in Connecticut and Delaware) the mechanism would facilitate procurements from future fuel cell systems using renewable fuels that meet the capacity requirement.

Renewable energy producers can also sell Renewable Energy Credits (RECs), which represent the environmental and renewable attributes of renewably-generated electricity. Electric retail sellers must buy eligible renewable energy and

Breakdown of SGIP Technologies by Rebated Capacity (2012)



Project Counts and Capacities by Technology (2012)

Technology Type	*Number of Systems*	*Rebated Capacity (MW)*
Advanced Energy Storage	2	2
Fuel Cells - CHP	103	24
Fuel Cells - Electric Only	92	46
Gas Turbines	9	30
Internal Combustion Engines	256	156
Microturbines	141	26
Wind	14	10
TOTAL	**617**	**294**

[30] These values include Wind and Alternative Energy Storage but do not include PV systems. If PV systems were included, the total system count would equal 1,507 and the total rebated capacity would equal 430 MW.

[29] California is a strong supporter of CHP systems. ARB, under the Global Warming Solutions Act (2006), prepared a Scoping Plan that includes a reduction goal of 6.7 million metric tons (MMT) of carbon dioxide (CO_2) from CHP resources. The governor's Clean Energy Jobs Plan calls for 6,500 MWs of new CHP capacity in the state by 2030.

its associated RECs to comply with the state RPS requirements. RECs can be traded in voluntary trading markets, either "bundled" with the underlying energy or "unbundled" as a separate commodity. CEC tracks the RECs to verify how many RECs each retail seller has procured for compliance with the RPS.

The ***California Stationary Fuel Cell Collaborative (CaSFCC)***, founded in 2001 and administered by ARB and the National Fuel Cell Research Center, works to advance the deployment of stationary fuel cells for DG and other applications in the state. The organization focuses on outreach, education and reports, providing accurate and unbiased evaluation of fuel cell technologies, conducting outreach to policy makers and the public throughout California to provide education on the benefits of fuel cell technology, and maintaining a data base of fuel cell installations and costs in the state. CaSFCC members include state, regional and federal government agencies and private industry.

OVERVIEW OF CALIFORNIA'S STATIONARY FUEL CELL INITIATIVES		
PROGRAM	**DETAILS**	
AGENCIES: THE CALIFORNIA PUBLIC UTILITIES COMMISSION AND THE CALIFORNIA ENERGY COMMISSION JOINTLY IMPLEMENT THE RPS PROGRAM		
Renewables Portfolio Program (RPS)	Established in 2002 under Senate Bill 1078, accelerated in 2006 under Senate Bill 107 and expanded in 2011 under Senate Bill 2, California's RPS is one of the most ambitious renewable energy standards in the country. The RPS program requires investor-owned utilities, electric service providers, and community choice aggregators to increase procurement from eligible renewable energy resources to 33% of total procurement by 2020. Fuel cells operating on renewable fuels are eligible under the RPS.	
AGENCY: CALIFORNIA PUBLIC UTILITIES COMMISSION (CPUC)		
Distributed Generation (DG)	The CPUC regulates DG policies and programs on both the customer and utility (wholesale) side of the electric meter. CPUC oversees incentive programs for customer-side of the meter DG, for customers in the territories of Pacific Gas & Electric, San Diego Gas & Electric, and Southern California Edison.	
	Net Energy Metering (NEM)	Customers who install small fuel cell, solar, wind or biogas generation facilities (1 MW or less) to serve all or a portion of onsite electricity needs are eligible for the state's net metering program. Customer-generators receive a financial credit for power generated by their onsite system and fed back to the utility. The credit is used to offset the customer's electricity bill.
	Self-Generation Incentive Program (SGIP)	SGIP provides incentives (rebates) to support existing, new, and emerging distributed energy resources for qualifying distributed energy systems installed on the customer's side of the utility meter. Eligibility for participation in the SGIP is based on GHG emissions reductions. Technologies that achieve reductions of GHG emissions are eligible for the program, including fuel cells, wind turbines, organic rankine cycle/waste heat capture, pressure reduction turbines, advanced energy storage, and combined heat and power gas turbines, micro-turbines, and internal combustion engines. Participants receive up-front and performance-based incentives. The incentives apply only to the portion of the generation that serves a project's on-site electric load.

Renewable Auction Mechanism (RAM)	In 2010, the CPUC approved a new procurement mechanism called the Renewable Auction Mechanism (RAM) that ordered the investor-owned utilities (IOUs) to procure up to 1,000 MW of system-side renewable DG through a reverse auction using a standard contract. The IOUs held four auctions over two years (2011-2013). A fifth auction is scheduled in 2014. RPS eligible energy projects between 3-20 MW can apply.
AGENCY: CALIFORNIA ENERGY COMMISSION (CEC)	
Renewable Energy Credit (REC)	A REC represents the environmental and renewable attributes of renewable electricity, including the avoided GHG attributes, associated with a REC. A facility owner owns the RECs, and they are not transferred to the utility. This means that a facility owner can make green claims (e.g. "our company is powered by...") if it retains the RECs, or the owner can sell the RECs so another entity can make green claims. The CPUC does not regulate sales of RECs. A REC can be "bundled" with the underlying energy or "unbundled" as a separate commodity from the energy itself, into a separate REC trading market.

Industry/Academia

In addition to being a global leader for its support of fuel cell technologies, California is also home to many companies dedicated to fuel cell and hydrogen products, integration and deployment. A few having a big impact on the global fuel cell industry include the following:

- Bloom Energy is a fuel cell manufacturer, with headquarters in Sunnyvale, California, and a manufacturing facility in Newark, Delaware. Since our last report, the company has installed more than 11 MW of fuel cells in California, Maryland and New York and expanded into Japan with several installations. The company now has more than 100 MW of its Bloom Energy Servers installed in the United States and in July 2014, announced that Exelon Corporation is providing equity financing for 21 MW of Bloom Energy fuel cell projects for two customers (one being AT&T for nine sites) at 75 commercial facilities in California, Connecticut, s.

- Oorja Protonics (Fremont) manufactures direct methanol fuel cells (DMFC) for the material handling, telecommunications backup power and refrigerated transport markets, with several hundred of its fuel cells operating at warehouses across the U.S. Last year the company signed an MOU with HySA/Catalysis to market, sell and distribute Oorja's products in South Africa. In June 2014, Oorja and Los Alamos National Laboratory (LANL) entered into a licensing agreement allowing Oorja to deploy two energy technologies developed by LANL, aimed at improving power density and reducing the cost of DMFCs.

- Altergy Systems (Folsom) manufactures PEM fuel cell backup power solutions for telecom and critical power applications. The company's products have attained more than 20 million hours of field operation.

- US Hybrid Corporation (Torrance) provides electric and hybrid traction drive systems for medium and heavy duty commercial trucks, municipality vehicles, and fuel cell transit buses throughout the world. In January 2014, US Hybrid formed US FuelCell Corporation, a new division, and entered a global licensing agreement with United Technologies Corporation (UTC) to commercialize UTC's PEM fuel cell technologies for the medium and heavy duty commercial vehicle sectors. US FuelCell is located at the former UTC Power plant in Windsor, Connecticut, and the company has taken over all contracts previously awarded to UTC Corporation, including ones from the FTA through its National Fuel Cell Bus Program. US Hybrid is also teaming with the City and County of Honolulu, Department of Environmental Services, Hawaii Center for Advanced Transportation Technologies (HCATT) and Hawaii Natural Energy Institute Hawaii (HNEI) to develop a fuel cell powered refuse truck for operation within the City of Honolulu under award from DOE.

- New fueling companies:
  - Industrial compressed gas distributor IGX Group (Livermore) offers a new hydrogen fueling service for fuel cells in select regions of the U.S. Fueling up to 3600 psi (248 bar) is available for hydrogen fuel cells or vehicles, such as backup power systems for cell towers, emergency generators and lights, and forklifts.
  - FirstElement Fuel (Newport Beach) is partnering with the State of California and Toyota to develop a network of public hydrogen fueling stations in the state. The company received more than $27 million from the CEC in May 2014 to construct 19 hydrogen stations, including two 100% renewable ones.
  - HyGen Industries (Eureka) produces and distributes renewable hydrogen fuel in partnership with station owners. The company received more than $5 million from the CEC in May 2014 to construct three 100% renewable hydrogen stations.

Many of the automakers have headquarters in California. Toyota and Honda, both have their North American headquarters located in Torrance, California. Another similarity is that both facilities have 1 MW stationary fuel cell installations helping to power them.

California is also home to the ***National Fuel Cell Research Center*** at the University of California (UC), Irvine, the UC Davis ***Fuel Cell, Hydrogen, and Hybrid Vehicle (FCH2V) GATE Center of Excellence and the Schatz Energy Research Center*** at Humboldt State University (hydrogen and fuel cell R&D projects). In addition, large stationary fuel cell systems are generating power at a number of universities: the University of California at the San Diego (2.8 MW) and Santa Barbara (200 kW) campuses, with another planned at the Davis campus; San Francisco State University (200 kW and 1.4 MW); and California State University at the Northridge (1 MW), San Bernardino (1.4 MW) and East Bay (1.4 MW) campuses. The Cal State Northridge fuel cell generates base load electricity for the university's facilities and surplus heat for hot water. Exhaust from the heat exchanger is routed into an adjacent greenhouse and arboretum to enhance photosynthesis, boosting plant growth.

CONNECTICUT

Since our last report:

- A 14.9-MW fuel cell facility – the largest in the U.S. – started operation in Bridgeport in December 2013, operated by energy producer and transporter, Dominion. The output of the fuel cell power station is being sold to Connecticut Light & Power (CL&P) under a 15-year fixed power purchase agreement.
- The United Illuminating Company (UI) announced the purchase of 5.6 MW of fuel cells for installation at two sites (Bridgeport and New Haven). The fuel cells will deliver power to the electric grid.
- In October 2013, Connecticut's governor signed a ZEV MOU with seven other state governors, agreeing to individual and joint cooperative actions to help put 3.3 million electric and hydrogen-powered cars onto their roadways by 2025.
- Connecticut-based FuelCell Energy received $6.4 million in funding from DOE to continue research and development on a demonstration sub-megawatt SOFC power plant.
- South Korea's Doosan Co. Ltd. acquired the assets and operating debt of South Windsor-based fuel cell manufacturer, ClearEdge Power. The new company, Doosan Fuel Cell America, plans to add 150 employees to its Connecticut-based operation by the end of 2015.

Connecticut has been a fuel cell leader since the 1950s. The state has a robust fuel cell industry and is home to several major companies that have pioneered fuel cell technologies and hydrogen generation for spacecraft, submarines, stationary power and transport.

The state is home to the ***Connecticut Center for Advanced Technology, Inc. (CCAT)*** and the ***Connecticut Hydrogen-Fuel Cell Coalition (CHFCC)***. CCAT, founded in 2004, is a non-profit economic development organization. CCAT and CHFCC (which is administered by CCAT) actively work with government, industry and other stakeholders to promote fuel cells for stationary and transport applications. CCAT also supports the Northeast Electrochemical Energy Storage Cluster (New York, New Jersey, New England) by helping small businesses that provide the development, production, promotion and deployment of hydrogen fuel and fuel cells for energy storage solutions.

The state's fuel cell vision is driven by the 2008 ***Fuel Cell Economic Development Plan Hydrogen Roadmap***, mandated by Public Act 06-187 and written by CCAT and CHFCC. The report suggests that there are "favorable market conditions for the expansion of the hydrogen and fuel cell industry in Connecticut, that public investment is appropriate and justified, that investment in hydrogen and fuel cell technology would provide a favorable return for the state, and that there are favorable sites for deployment of hydrogen and fuel cell technology in Connecticut to meet pressing energy needs, improve environmental performance, increase economic development, and create new jobs."

Connecticut is home to approximately 600 companies that are part of the growing hydrogen and fuel cell industry supply chain in the Northeast region. Eight of these companies are original equipment manufacturers (OEMs) of hydrogen and/or fuel cell systems, which were responsible for supplying 1,010 direct jobs and $311 million in direct revenue and investment in 2011. Based on a recent Northeast Electrochemical Energy Storage Cluster (NEESC) study,[30] these companies making up the Connecticut hydrogen and fuel cell industry are estimated to have realized approximately $600 million in revenue and investment and contributed more than $26 million in state and local tax revenue from their participation in the Northeast regional energy cluster in 2011.

Connecticut's Stationary Fuel Cell Initiatives

Connecticut's ***RPS***, established in 1998, requires electricity providers to obtain a minimum percentage of their retail load by using renewable energy. By 2020, 20% of the load must be Class I renewable energy sources,[31] which includes fuel cells. Connecticut also requires utilities to enter into 15-year contracts for ***renewable energy certificates (RECs)*** from zero emission Class I renewable energy (ZRECs, up to 1 MW) and low emission Class I renewable energy (LRECs, up to 2 MW) from the customer side of the meter. Fuel cells qualify as a low emission resource. The RECs are tradable in the regional REC market for electric companies to meet their RPS obligations, proving that one megawatt-hour of electricity was generated from a renewable energy source.

The state helps to support clean energy via the ***Clean Energy Finance and Investment Authority (CEFIA)***, which offers incentives and low-cost financing to support renewable energy and energy efficiency installations. CEFIA's program funding comes from a variety of sources including a surcharge on residential and commercial electric bills, Regional Greenhouse Gas Initiative auction allowance proceeds, federal funds and grants, private capital, and other sources. CEFIA is a successor to the Connecticut Clean Energy Fund (CCEF) which was created in 2000 by the Connecticut Legislature and has funded more than $150 million in renewable energy projects, emerging technology investments and education and awareness programs statewide. A number of CEFIA and CCEF programs have supported fuel cells over the years, including:

- **Fuel Cell Initiative** – The Fuel Cell Initiative focused on investments in technology, demonstration sites, deployment and establishment of a fuel cell educational center. CCEF committed $37.5 million to the initiative over five years (2001-2005) and was the first of the nation's 14 deregulated states to launch a fuel cell initiative of this magnitude.
- **On-Site Renewable Distributed Generation (OSDG) Program** – Started in 2005, the OSDG made available nearly $21 million to reduce the cost of clean and renewable energy installations at commercial, industrial and institutional facilities. Fuel cell technology was eligible for funding under the program.

[30] https://www.dropbox.com/s/nnl8b743enj228s/CT2_March2013.pdf

[31] http://www.ct.gov/pura/cwp/view.asp?a=3354&q=415186

- ***Project 150*** – Launched in 2004 as Project 100, the initiative was created by legislation requiring local electric distribution companies to enter into long-term electric purchase agreements (EPAs) with generators of Class I renewable energy to acquire at least 150 MW of power. The legislation aims to address the difficulty of financing large renewable energy projects without long-term contracts.

- ***Operational Demonstration Program*** – The Operational Demonstration Program provides financing to help technology innovators and entrepreneurs advance development and commercialization of emerging clean energy technologies. The goal is to support growth of Connecticut's clean energy industry, resulting in job creation, reduction in clean energy costs, environmental benefits and enhanced energy security. The program funds installation and testing of near-commercial technologies, offering unsecured loans of up to $500,000 with favorable repayment terms and a one-third funding match.

- ***Combined Heat & Power (CHP) Pilot Program*** – Grants, loans, loan enhancements or power purchase incentives are offered to help finance the cost of CHP equipment (which includes fuel cells) for energy-generating projects. CEFIA states that this program is ideal for facilities that have both large electric and thermal load demands such as municipal wastewater treatment plants, hospitals, colleges/universities/schools, grocery stores, manufacturing facilities, hotels, nursing/health care facilities. Individual awards vary based on the specific technology, efficiency and economics of the installation, with a funding maximum of $450 per kW of nameplate rated capacity. Systems must have a capacity rating of 5 MW or less.

In addition, Connecticut offers a property tax exemption for Class I renewable energy systems. Connecticut municipalities are authorized, but not required, to offer a property tax exemption lasting up to 15 years for qualifying cogeneration systems installed on or after July 1, 2007.[32]

In October 2013, CEFIA provided $913,000 in funding under the OSDG program for a 600-kW Bloom Energy fuel cell installation at a Macy's online fulfillment center in Cheshire. Renewable energy credits generated by the fuel cell system will be sold by Bloom to electricity suppliers in order to help the suppliers meet their state-required renewable energy goals.

A 14.9-MW fuel cell power generating facility – the largest in the U.S. – was placed in service in December 2013. The owner, Dominion, will sell the output of the fuel cell power station to Connecticut Light & Power under a 15-year fixed power purchase agreement. The Dominion Bridgeport Fuel Cell facility is part of Project 150. The City of Bridgeport is providing a tax incentive that will be in place for the life of the project.

OVERVIEW OF CONNECTICUT'S STATIONARY FUEL CELL INITIATIVES		
PROGRAM	**DETAILS**	
AGENCY: PUBLIC UTILITIES REGULATORY AGENCY (PURA)		
Renewables Portfolio Program (RPS)	The RPS requires that electricity providers (Connecticut Electric Suppliers and Electric Distribution Company Wholesale Suppliers) obtain a specified minimum percentage of their retail load by using renewable energy. Class I renewable resources, which include fuel cells, must provide 20% of electric generation by 2020.	
	LREC/ZREC Program and Renewable Energy Certificates (RECs)	Public Act 11-80 (2011) requires Connecticut Light & Power (CL&P) and United Illuminating (UI) to launch a 22-year program to promote, fund and expand "behind the meter" (customer-side) renewable generation. Customers who install new, qualifying renewable energy projects can sell the qualified Class I renewable energy credits (RECs) created from their projects to CL&P and UI under a long-term, 15-year contract. The program includes both low-emission renewable energy credits (LRECs, which include generation from fuel cell facilities) and zero-emission renewable energy credits (ZRECS).

[32] http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=CT102F&re=1&ee=1

	Net Metering	CL&P and UI are required to net meter all customer renewable resource generation whose installed generating capacity is less than 500 kW and Class I renewable energy resources whose installed generating capacity is less than or equal to 2 MW. Connecticut also permits the installation of submeters at commercial, industrial, multifamily residential or multiuse buildings where electric power or thermal energy is provided by a Class I renewable energy source.
	Virtual Net Metering	Connecticut permits virtual net metering, allowing customers who operate behind-the-meter Class I and III generation (Customer Host) to assign surplus production from their generator to other metered accounts (Beneficial Accounts) that are not physically connected to the Customer Host's generator.
AGENCY: DEPARTMENT OF ENERGY AND ENVIRONMENTAL PROTECTION (DEEP)		
Microgrid Grant and Loan Pilot Program	Public Act 12-148, "An Act Enhancing Emergency Preparedness and Response," requires DEEP to establish a microgrid grant and loan program to support local distributed energy generation for critical facilities during times of electricity grid outages.	
AGENCY: CLEAN ENERGY FINANCE AND INVESTMENT AUTHORITY (CEFIA)		
Project 150	Project 150 (formerly Project 100) is an initiative to increase Class I renewable energy in Connecticut by at least 150 MWs of installed capacity. This initiative is now fully subscribed. Seven of the 13 supported projects are fuel cell installations.	
Combined Heat & Power Pilot Program	CEFIA offers grants, loans, loan enhancements or power purchase incentives to help finance the cost of CHP equipment for energy-generating projects for facilities that have both large electric and thermal load demands. Fuel cells are included in the program.	
Operational Demonstration Program	The Op Demo program funds installation and testing of near-commercial technologies at representative customer host sites in Connecticut. The Op Demo Program offers unsecured loans of up to $500,000 with favorable repayment terms and requires a one-third funding match.	
TAX INCENTIVES		
Property Tax Exemption for Renewable Energy Systems	Connecticut offers a property tax exemption for "Class I" renewable energy systems that generate electricity for private residential use (farms, single-family homes or multi-family dwellings limited to four units). Beginning in October 2014, commercial and industrial systems are also eligible for the property tax exemption.	

Connecticut's Fuel Cell and Hydrogen Transportation Initiatives

Hartford-based CTTRANSIT has operated demonstration fuel cell buses for many years under FTA National Fuel Cell Bus Program and the agency's ***Hydrogen Fuel Cell Bus Program***. Their first prototype fuel cell bus was placed in regular transit service in 2007 and (like the California fuel cell buses) the agency gathered operational and performance data for analysis by NREL to help improve successive generations of fuel cell buses. Four new fuel cell buses were introduced onto local bus routes in 2010 and a next generation fuel cell bus will be deployed in 2015. CTTRANSIT is the process of building a hydrogen fueling station onsite that will generate hydrogen by electrolysis, partially powered by an existing solar array located on the CTTRANSIT bus garage. In addition, the agency uses a 400-kW stationary fuel cell to help power the agency's headquarters.

The Greater New Haven Transit District (GNHTD) in Hamden is undertaking an innovative program to explore the performance and commercial viability of hydrogen fueled transit bus technology in south central Connecticut. Led by GNHTD and backed by the FTA, this project (known as HyRide), consists of a 22-foot plug-in hybrid hydrogen fuel cell transit bus that will be operating in the greater New Haven area. This vehicle will operate in regular revenue operations, including shuttle and paratransit modes. The GNHTD is also developing a hydrogen refueling station with a capacity of approximately 10 Kg/day to provide fuel for the paratransit bus. It is anticipated that the hydrogen refueling station will be operational in late 2014 or 2015.

In 2010, Toyota Motor Sales, USA, Inc. (TMS) provided Connecticut hydrogen fueling developer SunHydro with 10 of its Advanced Fuel Cell Hybrid Vehicles (FCHV-adv) for testing. The vehicles fuel at the SunHydro solar-powered hydrogen fueling station, located at its partner Proton OnSite's headquarters in Wallingford.

Connecticut is also one of the eight signatory states to the ZEV MOU.

OVERVIEW OF CONNECTICUT'S FUEL CELL VEHICLE AND HYDROGEN INITIATIVES	
PROGRAM	**DETAILS**
CTTRANSIT Hydrogen Fuel Cell Bus Program	The Hartford-based transit agency has operated fuel cell buses in transit service since 2007 as part of the FTA's National Fuel Cell Bus Program.
Zero Emission Vehicle (ZEV) Memorandum of Understanding	The governors of CA, CT, MD, MA, NY, OR, RI and VT signed a cooperative agreement in 2013 to put 3.3 million zero-emission vehicles (fuel cell, battery-electric and plug-in battery electric) on the roads in their states within a dozen years. In May 2014, the states released a collaborative ***Action Plan***.

Industry/Academia

Connecticut is home to a number of key players in the fuel cell industry.

- FuelCell Energy (Danbury and Torrington) provides baseload distributed molten carbonate fuel cell power plants to electric utilities, commercial and industrial companies, universities, municipalities, governments and other customers around the world. The company's systems can operate using a range of fuels including renewable biogas from wastewater treatment and food processing, as well as clean natural gas, directed biogas and propane. FuelCell Energy's first commercial power plant was installed in 2003. Since then, the company has grown significantly; the company's power plants have to date generated more than 2.5 billion kWh of electricity. By the end of fiscal year 2012, FuelCell Energy's Connecticut manufacturing plant was producing at an annual run-rate of 56 MW with a total annual facility production capacity of 90 MW.
  - In 2007 FuelCell Energy began to expand globally, partnering with Korea's POSCO Energy to target markets in Southeast Asia (the company now has the largest fuel cell system in the world – a 59-MW system operated in South Korea). POSCO Energy is also licensed to manufacture FuelCell Energy's Direct FuelCell® power plants in South Korea and has begun construction of a manufacturing facility.
  - In 2012, FuelCell Energy also established a European manufacturing, sales and service unit, FuelCell Energy Solutions GmbH (FCES), which has already installed units in the UK and Germany. In June 2014, FCES received nearly €5 million (US$6.7 million) in awards by Germany's Federal Ministry for Economic Affairs and Energy to support a three-year research and development project between FCES and its partner Fraunhofer IKTS.
- Proton Onsite (Wallingford), founded in 1996, manufactures hydrogen generators, using PEM electrolysis, and has installed its C-Series electrolyzer in hydrogen refueling stations in Flint, Michigan, Emeryville, California,

and multiple locations in Hawaii and internationally, including several in Germany. The company recently expanded into hydrogen control systems.

- Advent Technologies (East Hartford) designs, develops and produces polymers, membranes, and membrane electrode assemblies (MEAs) for high temperature PEM fuel cells.

- Other companies in the state include: Infinity Fuel cell and Hydrogen, Inc. (Windsor), which has leveraged NASA Phase III SBIR funding to develop an Advanced Passive Water Removal fuel cell, which was recognized for innovation in 2011; Precision Combustion, Inc. (North Haven), developing and manufacturing fuel processors to convert conventional liquid and gaseous fuels to hydrogen-rich reformate for fuel cells and hydrogen production; Sustainable Innovations (Glastonbury), developing hydrogen energy systems, large-scale hydrogen energy storage products and technologies for hydrogen processing/compression for both industrial and transportation markets; and Treadwell Corporation (Thomaston), developing hydrogen and oxygen generators.

United Technologies Corporation (UTC), headquartered in South Windsor, started its fuel cell program through its aerospace subsidiary Pratt & Whitney back in 1954. Starting in the 1960s, the company supplied fuel cells to NASA for the various space missions, which provided electric power as well as drinking water for the astronauts. In 1985, a wholly-owned subsidiary, International Fuel Cells, was formed to focus on the fuel cell business. Over the years, the company saw several name changes before becoming UTC Power in 2001. UTC's main market was large-scale phosphoric acid (PAFC) stationary fuel cell systems, installing hundreds around the world at wastewater treatment plants, hospitals, universities, corporate facilities, grocery stores and many other sites. UTC Power also had divisions focused on fuel cells for buses and automobiles.

In March 2013, UTC Power was sold to ClearEdge Power, a fuel cell manufacturer based in Oregon with facilities in California. In 2014, UTC, which maintains fuel cell capabilities outside the UTC Power unit, also entered into various deals with other fuel cell companies for its IP and technology in other fuel cell market sectors.

- In January 2014, US Hybrid Corporation, located in Torrance, California, formed US FuelCell Corporation, a new division, and entered a global licensing agreement with UTC to commercialize UTC's PEM fuel cell technologies, focusing on the medium and heavy duty commercial vehicle sectors. US FuelCell is located at the former UTC Power plant in Windsor, Connecticut, and the company has taken over all contracts previously awarded to UTC Corporation, including ones from the FTA through its National Fuel Cell Bus Program.

- In April 2014, Ballard Power Systems, a fuel cell manufacturer based in Canada, acquired UTC's IP assets related to its PEM transportation- and stationary-related fuel cell technology, including approximately 800 patents and patent applications.

Other divisions within UTC are still active in fuel cells and are attracting federal investment in various research and development programs. United Technologies Research Center (UTRC), operating in East Hartford, was awarded $3.2 million in June 2014 from the Advanced Research Projects Agency-Energy (ARPA-E) for its project Metal Supported Proton Conducting Solid Oxide Fuel Cell Stack. UTCR will develop an intermediate-temperature fuel cell for residential applications that will combine a building's heating and power systems into one unit.

UTC Aerospace Systems was selected by the Office of Naval Research (ONR) to proceed with the next phases of the Long Endurance Undersea Vehicle Propulsion (LEUVP) energy program. UTC Aerospace Systems is designing and developing a PEM-based fuel cell energy system for a 21-inch diameter unmanned undersea vehicle (UUV). In the previous phase, the system operated successfully for over 30 hours using an integrated cryogenic reactant system and fuel cell power plant to provide 42 kWh of total energy over a power range of 100 to 3800 watts.

After ClearEdge took over UTC Power's Connecticut facility in 2013, the company made sales in U.S. and Korea. ClearEdge also raised investment dollars from venture companies and the state of Connecticut. Despite that, in May 2014, ClearEdge eliminated the workforce at two Connecticut operations and announced that the company intended to file for bankruptcy. In June 2014, South Korean company Doosan Co. Ltd. entered into an asset purchase agreement to acquire substantially all assets of ClearEdge Power, Inc. for $32.4 million. Doosan also acquired

FuelCellPower Co. Ltd., which focuses on smaller fuel cells for residential applications. The new company created from merging the two is now Doosan Fuel Cell America, and is operating out of the South Windsor facility.

Connecticut is also home to research centers. The ***Center for Clean Energy Engineering (C2E2)*** at the University of Connecticut, formerly the Connecticut Global Fuel Cell Center, is a research, education and outreach center that focuses on sustainable energy engineering, particularly on fuel cells, hydrogen generation and fuel reforming. The Center also assists in the validation of fuel cell systems for partnering organizations such as FuelCell Energy. The University of Connecticut also hosts the ***Fraunhofer Center for Energy Innovation***, with research in the areas of fuel cells, energy storage, in-stream hydro, and power management and distribution. This new center was created by Fraunhofer USA, Inc., the Fraunhofer Institute for Ceramic Technologies and Systems IKTS in Germany, the State of Connecticut DEEP, and is now the seventh Fraunhofer USA research center.

NEW YORK

Since our last report:

- In July 2014, the Governor announced the availability of $250 million to invest in renewable energy projects, including fuel cells and wind farms.
- Latham-based fuel cell manufacturer Plug Power received separate funding awards from DOE and NYSERDA to demonstrate fuel cell-powered transport refrigeration units; Plug Power also received an order from Walmart for 2,000+ fuel cells to power its forklifts at seven facilities, providing the hydrogen fueling stations as well.
- NYSERDA is supporting more than 11 new fuel cell installations, including five Verizon office buildings and three AT&T facilities.

New York has been a pioneer in stationary fuel cell development since as far back as the late 1960s, with Brooklyn Union Gas leading the way with research on phosphoric acid fuel cells. The state is still home to some of the world's longest running fuel cell installations and boasts a growing industry.

Unlike other states with fuel cell-focused industry associations or partnerships, New York's fuel cell support comes mainly from two organizations – the New York State Energy Research and Development Authority (NYSERDA), a public benefit corporation, and the New York Power Authority (NYPA), a state-run utility.

NYSERDA

In 1975, the state legislature established the NYSERDA, a public benefit corporation, to focus on reducing petroleum use in New York. That mission holds true today, with an increasing focus on achieving that goal via renewable resources, including fuel cells.

NYSERDA is primarily funded by state rate payers through a System Benefits Charge (SBC) that was established in 1996. The SBC has been extended regularly, most recently until December 2016, with an annual average budget of $98.8 million. The money is used by NYSERDA to finance energy efficiency programs, research and development initiatives, low-income energy programs and other initiatives.

NYSERDA is governed by a 13-member board that includes a variety of Commissioners and Chairs of state agencies as well as appointees, who are required by law to include an engineer or research scientist, an economist, an environmentalist, a consumer advocate, an officer of a gas utility, an officer of an electric utility, and three at-large members.

NYPA

NYPA is America's largest state power organization, with 16 generating facilities and more than 1,400 circuit-miles of transmission lines. NYPA finances construction of its projects through bond sales to private investors, repaying bondholders with proceeds from its operations.

Programs and Policies

NYSERDA, NYPA and the Long Island Power Authority (LIPA) were all early advocates for fuel cell technology and often worked together on programs and funding for installations. Both NYSERDA and NYPA have been funding installations since the 1990s and LIPA installed fuel cells at sites all around Long Island – including a McDonald's, several houses, an animal shelter, and an airport. In 2001, LIPA commissioned 75 fuel cells at a 3-acre site at its substation in West Babylon. In 2004, NYSERDA and NYPA proposed $1.5 million for hydrogen technology demonstration projects and in 2005, all three agencies sponsored the ***New York State Hydrogen Energy Roadmap***, a survey of state resources and strengths, as well as a phased strategy for developing a hydrogen economy for New York.

Over the years NYSERDA has had several energy efficiency programs that funded fuel cell evaluations, field testing and business development. In 2002-2003, NYSERDA's Combined Heat and Power (CHP) program provided $5.5 million for fuel cell CHP demonstration projects and almost $3 million for fuel cell product development. These early programs provided valuable data that helped fuel cell manufacturers improve the technology and familiarize the public with fuel cell technology.

New York State, through regulations adopted by the Public Service Commission (PSC), first enacted its RPS in 2004 with the goal of increasing the amount of renewable electricity used by consumers to 25% by 2013. In an Order issued in January 2010, following a comprehensive mid-course review, the Commission expanded the RPS target from 25% to 30% and extended the terminal year of the program from 2013 to 2015.

Unlike most states with an RPS, New York State uses a central procurement model whereby NYSERDA administers programs which are responsible for the majority of the RPS goals. Specifically, NYSERDA is responsible for obtaining the Main Tier (larger utility scale resources) and Customer-Sited Tier (smaller, behind the meter resources) targets with the remainder to be made up by the Voluntary Market, purchases made by State agencies under Executive Order 111, and purchases made by the Long Island Power Authority. In an April 2, 2010 Order, the Commission established static NYSERDA Main Tier and Customer-Sited Tier program targets for supporting the production of approximately 10.4 million megawatt-hours (MWh) of renewable energy annually by 2015. NYSERDA's current target consists of approximately 9.5 million MWh from the Main Tier and 0.9 million MWh from the Customer-Sited Tier.

The Main Tier consists primarily of medium to large- scale electric generation facilities that deliver their electrical output into the wholesale power market administered by the NYISO with a wide range of eligible technologies including fuel cells. The Commission established the Customer-Sited Tier because of the importance of accelerating the development of emerging technologies, associated environmental benefits, and ability to site technologies in urban, heavily-loaded areas. The Customer-Sited Tier consists of smaller, "behind-the-meter" resources, such as photovoltaic systems, fuels cells, customer-sited wind facilities, anaerobic digester gas, and similar technologies that for the most part produce electricity for use onsite. Although the Main Tier and Competitive PV program currently operate through the issuance of periodic competitive solicitations, all other Customer-Sited Tier resources are supported through first-come/first-served open enrollment programs that provide a combination of standard offer incentives for the "buy-down" of capital costs and/or energy production.

NYSERDA receives funds collected from ratepayers by the State's major privately-owned electric utilities such as National Grid or New York State Electric and Gas. These funds, collected as part of a transparent "System Benefits/ RPS Charge," on the delivery portion of electricity bills help to pay for energy efficiency, low income assistance, and the RPS.

The RPS ***Customer-Sited Tier Fuel Cell Program (CST Fuel Cell Program) – Large Fuel Cell*** and the ***CST Fuel Cell Program – Small Fuel Cell*** supports the installation and operationof continuous duty and large-scale fuel cell systems, with up to $1 million available for fuel cell systems rated larger than 25 kW. Funding is available on a

first-come, first-served basis until the end of 2015, or until all funding ($3.5 million per year, $21 million total) has been fully committed.

Fuel cells also qualify as renewable in New York's RPS Main Tier program. NYSERDA has conducted eight competitive Main Tier solicitations and released a 9th Main Tier solicitation in July 2014 in pursuit of the Main Tier target. Wind power is the predominant generating technology in the Main Tier, representing 1,696 MW of new renewable capacity under contract, of which 1,657 MW was in operation at the end of 2013. The balance of new capacity is comprised of hydroelectric upgrades, biogas (landfill gas to electricity), anaerobic digestion to electricity, fuel cells and biomass (direct and co-fired) facilities.

Over the next 20 years, the direct benefits from the projects currently within the RPS program are expected to approach $2.4 billion, and the effects on the broader economy are estimated at more than $4.9 billion.[33]

NYSERDA also oversees the ***NY Green Bank***, a state-sponsored investment fund dedicated to overcoming current obstacles in clean energy financing markets and increasing overall capital availability through various forms of financial support such as credit enhancement, project aggregation, and securitization. The NY Green Bank was established on December 19, 2013, by the New York State PSC which provided $165.6 million for initial capitalization. By collaborating with the private sector, NY Green Bank leverages its funds with private capital to facilitate the transition to New York State's clean energy future.

The New York PSC oversees the state's RPS, interconnection standards and net-metering regulations. There is pending legislation (***Bill No. S06485/A008800***), which would change the combined rated capacity of fuel cell electric generating equipment for net energy metering for non-residential customers from 1,500 kW to 2,000 kW. It passed the Ways and Means Committee at the end of May, 2014 and was returned to the NY State Senate for action.

Supporting Stationary Fuel Cells

Both NYPA and NYSERDA have a long history of supporting stationary fuel cell installations. In the late 1990s and early 2000s, the Department of Defense (DOD) installed fuel cells in New York as part of its PAFC Demonstration and Climate Change Rebate programs, which were both designed to test large-scale fuel cells at both military and corporate sites to test and improve the technology. NYSERDA contributed funding to several NY locations.

In 1997, NYPA installed a fuel cell power plant at the Westchester County Wastewater Treatment Plant in Yonkers, the world's first commercial fuel cell to use anaerobic digester gas (ADG) to produce electricity. Because of the success of the Yonkers plant, NYPA joined with NYSERDA and purchased eight more fuel cells in 2001, and installed them at four New York City Department of Environmental Protection (NYC DEP) Water Pollution Control Plants in Brooklyn, Bronx and Staten Island. These fuel cells are still operating today and NYPA continues to invest in them, procuring equipment in 2010 and 2012 to extend the life of the systems.

NYPA also installed fuel cells at the New York City Aquarium, the Bronx Zoo, the North Central Bronx Hospital and at its White Plains office. One of the country's longest running installations is located at the New York Police Department Central Park station, operating since 1999. This NYPA-funded installation was one of the only places with power during the August 2003 blackout because the fuel cell is not connected to the electric grid.

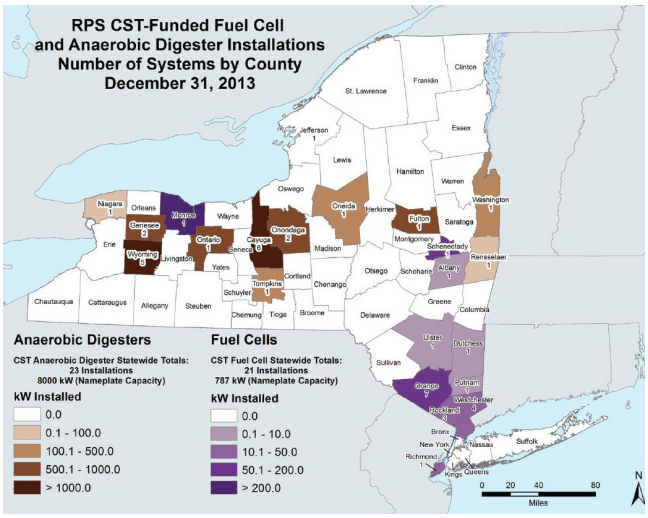
Most recently, NYPA worked with the Port Authority of New York and New Jersey to install a 1.2-MW fuel cell at 1 World Trade Center to reduce the building's demand for electricity from the grid and help power critical building systems, improving energy security.

NYSERDA funding has helped bring fuel cells to locations such as a Price Chopper supermarket, a Coca-Cola Refreshments facility, the Octagon Park apartment complex, the NY Hilton, Sheraton Hotel New York, and Verizon's Call and Communications Center in Garden City, where seven fuel cells totaling 1.4 MW were installed in 2005, making it the largest U.S. installation at the time.

400 kW fuel cell at Rochester Institute of Technology

[33] http://www.nyserda.ny.gov/About/Newsroom/2012-Announcements/2012-12-24-Governor-Cuomo-Announces-250-Million-Dollars-for-Renewable-Energy-Projects.aspx

Since 2007 when NYSERDA's CST Fuel Cell Program was launched, until the end of 2013, 19 fuel cells were installed, 17 as emergency backup power devices (187 kW total installed capacity) and two for power generation (600 kW of installed capacity.) NYSERDA reported that its early program support for emergency backup power devices played a very positive role in the aftermath of Superstorm Sandy, keeping lines of communications open for many New York State residents and emergency responders.[34]



In 2013, NYSERDA helped fund six installations in the state that met the requirement of the CST Fuel Cell Program.[35] All six of these sites are utilizing fuel cells from ClearEdge Power and qualify for the maximum capacity incentive of $200,000 apiece. Additionally each site qualifies for performance payments for three years post installation with a maximum total incentive of $1,000,000 per site.

These include five Verizon office buildings in Brooklyn (3 sites totaling 1.6 MW), Staten Island (400 kW) and Queens (800 kW) and one at the Rochester Institute of Technology (400 kW).

Most recently, NYSERDA, through the Main Tier, awarded subsidies for five fuel cell projects. Bloom Energy will install fuel cells at AT&T facilities in White Plains and Rego Park, Queens, as well as a Stop & Shop grocery store in Mount Vernon.

Facility	Resource Type	Location	County	New Renewable Capacity (MW)	Bid Capacity (MW)	Maximum Annual Contract Quantity (MWh)	Contract Duration (years)	Project Status
8th Main Tier Solicitation								
401 Fieldcrest Dr. Elmsford, NY 10523	Fuel Cell	NY	Westchester	0.8	0.8	6,325	10	Under Construction
Stop and Shop Clean Energy Project - Mt. Vernon	Fuel Cell	NY	Westchester	0.26	0.3	2,112	10	Under Construction
ATT Clean Energy Project - 400 Hamilton B	Fuel Cell	NY	Westchester	1.05	1.0	8,432	10	Under Construction
ATT Clean Energy Project - Rego Park	Fuel Cell	NY	Queens	0.53	0.5	4,216	10	Under Construction
ATT Clean Energy Project - 400 Hamilton A	Fuel Cell	NY	Westchester	0.53	0.5	4,216	10	Under Construction

Transportation

There have been several FCEV demonstrations in New York, and a handful of hydrogen fueling stations built to support them. The state, like many in the Northeast, only recently is trying to show automakers that California shouldn't be the only destination for FCEVs when they are introduced commercially in the next few years. The state has joined with seven others on the ZEV MOU and Action Plan and, via the Northeast States for Coordinated Air Use Management (NESCAUM), is now participating in H_2USA, a public-private partnership organized by DOE and others to promote the commercial introduction and widespread adoption of FCEVs and hydrogen fueling infrastructure.

On the transportation side, NYSERDA's focus has mostly been on electric vehicles and charging stations, but in November 2013, the agency awarded Latham-based fuel cell manufacturer Plug Power $500,000 to demonstrate the viability of replacing diesel generators with hydrogen fuel cells for powering transport refrigeration units (TRUs) on trailers hauled by trucks that deliver perishable goods. Plug Power also received $650,000 from DOE for a similar project.

For the projects, Plug Power is developing a fuel cell and interconnect hardware to provide connection to refrigeration unit equipment based on its GenDrive® fuel cell architecture. The fuel cell will power a Carrier Transicold refrigeration unit that will service a Sysco Corporation distribution center on Long Island for 12 months. That Long

[34] http://www.nyserda.ny.gov/-/media/Files/Publications/PPSER/NYSERDA/2014-RPS-annual-report.pdf
[35] http://chp.nyserda.ny.gov/facilities/index.cfm?Filter=Fuel+Cell

Island Sysco location already has a hydrogen refueling system installed to fuel its 50 fuel cell-powered forklifts (using Plug Power fuel cells) that have been operating for several years now.

In 2007, NYSERDA and NYPA funded a study on the performance of hydrogen fuel cells powering Raymond (headquarted in Greene) forklifts and to demonstrate the safety of a hydrogen fueled forklift environment. The project installed one of the first indoor hydrogen fueling systems in the country, installed various OEM fuel cells in the forklifts for performance testing at typical forklift duty cycles, and documented best practices for the design and application of indoor refueling systems.

Fuel cell-powered forklifts from Oorja Protonics (powered by methanol, not hydrogen) are also operating at a Baldor Specialty Foods distribution center in the Bronx.

Industry

According to the ***New York Hydrogen and Fuel Cell Deployment Plan*** published in 2012 by NEESC, New York has more than 180 companies that are part of the hydrogen and fuel cell industry supply chain in the Northeast. An update to that report[36] estimates that these companies are providing more than 1,700 direct and indirect jobs and have realized approximately $331 million in revenue and investment while contributing millions of dollars in state and local tax revenue.

Plug Power Inc., located in Latham, has 85% of the fuel cell material handling equipment market. Customers include Walmart, Coca-Cola, BMW, Sysco and many others. The company also has several demonstration projects underway with DOE in addition to the TRU mentioned above, involving airport baggage vehicles and backup CHP units. Plug Power recently acquired Spokane, Washington, fuel cell manufacturer ReliOn to expand into the backup power market; ReliOn has installed hundreds of fuel cell units for telecommunications customers around the world, including AT&T, Sprint and Verizon here in the U.S.

To expand to international markets, Plug Power received a $6.5 million strategic investment from its partner Air Liquide in 2013, to focus on the European material handling market. Plug recently signed a non-binding MOU with Hyundai Hysco Co. Ltd. to jointly develop and sell hydrogen fuel cells in Asia.

Port Washington SOFC manufacturer WATT Fuel Cell Corp., is a relative newcomer to the industry, but recently teamed up with another company, Parker Hannifin, to showcase portable fuel cell generators and installed a fuel cell on a boat. WATT also purchased tubular SOFC developer Pittsburgh Electric Engines, Inc. to eventually transition to larger systems for residential power and small-scale DG.

Solid Cell, which has a manufacturing facility in Rochester, is also developing SOFCs and has received $511,000 in grants from NYSERDA. In 2013, NYSERDA awarded SolidCell $200,000 to continue commercialization of its NTN Composite Interconnect for SOFCs. That grant was matched by Solid Cell and its partners: RocCera, Alfred University and the NanoMaterials Innovation Center at Alfred, Allegany County.

In 2014, General Electric announced the creation of a new, internal start-up, GE Fuel Cells, and plans to open a fuel cell pilot development and manufacturing plant in Malta.[37]

New York is also home to many universities involved in critical fuel cell research, including several (Cornell University, Rochester Institute of Technology, University of Albany) with dedicated fuel cell centers or laboratories. Fuel cells have been installed at a few as well, including Hofstra University and the State University of New York (SUNY), College of Environment Science and Forestry.

Energy Storage

Energy storage as a means to stabilize the electric grid and provide reliable power for customers at any time, in any weather, has been an area of increasing interest in the Northeast. Hydrogen as an energy carrier, and fuel cells as a means to store the hydrogen and provide electricity, are also gaining attention, particularly generation of hydrogen via solar and wind, making it a renewable system. New York is active in energy storage, a member of NEESC, and supports various projects around the state.

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[36] https://www.dropbox.com/s/oanpy0s5b77x5rp/NY2_March2013.pdf

[37] http://www.bizjournals.com/albany/news/2014/07/22/general-electric-is-building-a-fuel-cell-pilot.html

In March 2014, the New York Battery and Energy Storage Technology Consortium (NY-BEST), an organization of more than 130 industry, academic and government partners, awarded $250,000 to Cornell University to develop and demonstrate a regenerative fuel cell energy storage system, using a Cornell-designed membrane, to produce hydrogen.

In April, NY-BEST and partner DNV GL (formerly DNV KEMA), a global company with extensive energy advisory, testing, inspection and certification expertise, opened a new $23 million Battery and Energy Storage Technology Test and Commercialization Center at the Eastman Business Park in Rochester. The Center offers product development services that are essential for researchers and companies to test the viability and performance of innovative energy storage technologies, including fuel cells, before they are introduced to the marketplace as new commercial products. The Center received a $5.9 million investment from NYSERDA, $1 million from Empire State Development, with DNV GL investing up to $16 million. As part of its investment, DNV GL also plans to move its existing energy storage testing capabilities from Pennsylvania to New York.

OVERVIEW OF NEW YORK'S STATIONARY FUEL CELL INITIATIVES		
PROGRAM	**DETAILS**	
AGENCY: NEW YORK STATE ENERGY RESEARCH AND DEVELOPMENT AUTHORITY (NYSERDA)		
RPS Main Tier	The Main Tier operates through the issuance of periodic competitive solicitations. Please review ***eligibility requirements*** for more information.	
RPS Customer – Sited Tier Fuel Cell Program	Capacity incentive - Supports the installation and operation of continuous duty and large-scale fuel cell systems, with basic incentive of $1,000/kW + possible $500/kW bonus for systems that provide standalone capability to serve essential services. Maximum: $200,000 for basic capacity incentive, $100,000 for bonus capacity incentive. Funding is available on a first-come, first-served basis until the end of 2015, or until all funding ($3.5 million per year, $21 million total) has been fully committed.	
RPS Customer-Sited Tier Fuel Cell Program - Small Fuel Cell	Financial incentives are available to support the installation and operation of continuous duty fuel cell systems in New York State, with up to $50,000 available for fuel cell systems rated at 25 kW or less. Funding is on a first-come, first-served basis until the end of 2015 or until all funding ($100,000 per year, $600,000 total) has been fully committed, whichever comes first.	
	Performance Incentives	Performance incentives can be received for up to 3 years for systems with an annual capacity factor of 50% or greater. $0.15 per net kWh, up to $20,000 per project site per year for small systems and $300,000 per project site per year for large systems. The total value of incentives is capped at $50,000 for systems of up to 25 kW and at $1 million for larger systems.
Various PONs and RFPs	NYSERDA's various programs (such as residential, commercial, transportation, environmental) outline broad energy and environmental challenges, and then publicly request proposals, from any private or institutional entity, for project plans. Fuel cells are often included as eligible technologies.	
AGENCY: NEW YORK PUBLIC SERVICE COMMISSION (PSC)		
Renewable Portfolio Standard (RPS)	The PSC adopted an RPS in 2004 with a renewables target of 25% of state electricity consumption by 2013; it was expanded in January 2010 to 30% by 2015. Of this 30%, 20.7% will be derived from existing renewable energy facilities and one percent (1%) of the target is expected to be met through voluntary green power sales in 2015.	
Net Metering	Fuel Cells: 10 kW for residential; 1.5 MW for non-residential.	

Interconnection Standards	Applies to systems up to 2 MW in capacity located in the service area of one of New York's six investor-owned local electric utilities: Central Hudson Gas and Electric, Consolidated Edison (Con Edison), New York State Electric & Gas, Niagara Mohawk (d/b/a National Grid), Orange and Rockland Utilities, and Rochester Gas and Electric.

OHIO

Since our last report:

- Ohio's Controlling Board approved an award of $297,056 to the Ohio Fuel Cell Coalition to further advance fuel cell manufacturing technologies and the regional fuel cell supply chain. Funding is provided through the Advanced Manufacturing Program, a competitive grant program administered by the Ohio Development Services Agency to support work to develop advanced manufacturing technologies for Ohio manufacturers, particularly small and medium-sized firms. The Ohio Fuel Cell Coalition will provide $335,154 in matching funds.
- The Stark Area Regional Transit Authority (SARTA) is partnering with CALSTART for two fuel cell buses to be delivered in 2015. The Ohio Department of Transportation (ODOT) granted SARTA $500,000 to construct a hydrogen station to fuel the bus
- Ace Hardware announced it plans to deploy more than 60 fuel cell-powered forklifts at a distribution center currently under construction in West Jefferson, Ohio.

Ohio has developed a niche for itself as a leader in fuel cell supply chain technologies. The state is home to a growing network of fuel cell and component manufacturers, as well as universities conducting leading research into fuel cell and hydrogen technologies. This did not happen by accident. The state has prioritized advanced technology development to create globally competitive products and fosters the development and relocation of new companies in emerging industry sectors. The state's ***Third Frontier Program***, a $2.1 billion initiative started in 2002, provided funding to Ohio technology-based companies, universities, nonprofit research institutions and other organizations to create new technology-based products, companies, industries, and jobs.

Industry

One of the Third Frontier's focus areas was fuel cell technologies. From 2002 through fiscal year 2012, the ***Third Frontier Fuel Cell Program*** provided direct financial support to R&D efforts that addressed technical and cost barriers to commercialization of fuel cell and other advanced energy components and systems, and promoted the development of fuel cell related materials, components, systems, and advances in the full value-chain associated with fuel cell commercialization.

The Third Frontier Fuel Cell Program is no longer active; however, the Third Frontier ***Edison Advanced Manufacturing Program***, a competitive grant program, recently awarded funding to the ***Ohio Fuel Cell Coalition (OFCC)*** to continue support of advanced fuel cell manufacturing technology projects in the state. OFCC – an organization comprised of industry, academia, and government leaders – works to strengthen and expand Ohio's fuel cell industry and actively promotes the state's fuel cell-related industry cluster, the "***Fuel Cell Corridor***," comprised of fuel cell stack and system integrators; component and materials suppliers; balance of plant, equipment and direct service suppliers; academia (fuel cell and hydrogen study and research); and government, technology and non-profit customers. OFCC reports that in 2010, Ohio employed 9.8% of all U.S.

residents who work in the fuel cell/hydrogen industry and that the industry has leveraged more than $300 million federal dollars in support of fuel cells.[38]

The Ohio Development Services Agency (ODSA) offers a variety of bonds, grants, loans and tax credits to assist Ohio companies as they grow and create jobs within the state.

The ***Advanced Energy Job Stimulus Program***, active during 2009-2011 as a part of the bipartisan Ohio Job Stimulus Plan, provided financing through conduit bonds for a broad range of projects involving the purchase, construction and/or installation of air quality facilities by businesses and other entities, as well as offering lifetime exemption from state income tax, real property, sales and use taxes. SOFC developer, Technology Management Inc. (Cleveland) was awarded $2.5 million to acquire fixed assets (machinery and equipment); the loan will be forgiven if job commitment (42 new jobs and 14 jobs retained) is met within three years from the closing date of the loan.

Today, ODSA's ***Qualified Energy Project Tax Exemption*** provides owners or lessees of renewable, clean coal, advanced nuclear, and cogeneration energy projects with an exemption from the public utility tangible personal property tax. Projects certified as a "Qualified Energy Project" are exempt from taxation so long as the project is completed within the statutory deadlines, meets the "Ohio Jobs Requirement," and continues to meet several ongoing obligations.

ODSA also oversees an ***Energy Loan Fund*** that provides low-cost financing to small businesses, manufacturers, nonprofits, and public entities for energy improvements that reduce energy usage and associated costs, reduce fossil fuel emissions, and/or create or retain jobs. Eligible activities include energy retrofits, energy distribution technologies and renewable energy technologies. Funding is provided through the Advanced Energy Fund and the federal State Energy Program and the American Recovery and Reinvestment Act (ARRA).

OVERVIEW OF OHIO'S ENERGY-RELATED BUSINESS SUPPORT INITIATIVES	
PROGRAM	**DETAILS**
AGENCY: OHIO DEVELOPMENT SERVICES AGENCY (ODSA)	
Qualified Energy Project Tax Exemption	Provides owners or lessees of renewable, clean coal, advanced nuclear, and cogeneration energy projects with an exemption from the public utility tangible personal property tax. Fuel cells are eligible. For projects over 250 kW, a payment is made to the county where the renewable energy facility is located in lieu of taxes. Payments range from $6,000-$8,000 depending upon the percentage of Ohio-based employees used during construction.
Energy Loan Fund	Provides low-cost financing to small businesses, manufacturers, nonprofits, and public entities for energy improvements that reduce energy usage and associated costs, reduce fossil fuel emissions, and/or create or retain jobs. Funding is provided through the Advanced Energy Fund and federal State Energy Program and American Recovery and Reinvestment Act. Eligible activities include energy retrofits, energy distribution technologies and renewable energy technologies. Projects must achieve 15% reduction in energy usage, demonstrate economic and environmental impacts and be included within a long-term energy strategy of the community served.
Edison Advanced Manufacturing Program	A competitive grant program supporting the adoption and extension of, or assistance with, existing advanced manufacturing technologies to Ohio companies. The program, which focuses on small and medium-sized firms aligned and collaborating with an Edison Center or other eligible nonprofit entities, such as Ohio universities. The program has awarded funding to the Ohio Fuel Cell Coalition to advance fuel cell manufacturing and the regional fuel cell supply chain.

[38] http://www.hydrogen.energy.gov/pdfs/htac_apr13_5_valente.pdf

Renewable Portfolio Standard

2008 electric industry restructuring legislation created the ***Renewable and Advanced Energy Portfolio Standard*** which requires that Ohio's electric distribution utilities and electric services companies acquire 25% of the electricity sold from alternative energy sources by 2025. At least 12.5% must come from renewable energy resources, including wind, hydro, or biomass and at least 0.5% solar, and the remainder may be generated from advanced energy resources, including nuclear, clean coal and fuel cells. The annual benchmark obligations may be met through the purchase of qualified RECs, with at least half of the renewable energy used generated at facilities located in Ohio. One of the RPS-compliant facilities located in the state is a 1-MW Ballard ClearGEN PEM fuel cell system located at FirstEnergy Corp's Eastlake Power Plant near Cleveland. The fuel cell, installed in 2010, is activated during hours of peak demand to reduce the strain on the power grid.

New legislation (***SB 310***, 2014) signed by Ohio's governor freezes RPS targets at the 2014 level for two years while an Energy Mandates Study Committee examines the state's renewable energy, energy efficiency, and peak demand reduction mandates. The committee will make recommendations based on a cost-benefit analysis and will develop an opt-in and opt-out systems for the mandates. SB 310 also states that the General Assembly intends to enact legislation, taking into account the recommendations of the Energy Mandates Study Committee, to reduce the state's renewable energy, energy efficiency, and peak demand reduction mandates. If the committee takes no action, the RPS will be reinstated with the renewable targets rolled back by two years.

OVERVIEW OF OHIO'S STATIONARY FUEL CELL INITIATIVES		
PROGRAM	**DETAILS**	
AGENCY: PUBLIC UTILITIES COMMISSION OF OHIO (PUCO)		
Renewable and Advanced Enery Portfolio Standard	As originally enacted, Ohio law requires electric distribution utilities and electric services companies to secure a portion of their electricity supplies from alternative energy resources, which include fuel cells (an "advanced energy resource"). All companies must meet annual energy benchmarks that increase as a percentage of electric supply each year. By 2025, 25% of the state's energy supply must come from alternative energy sources: at least 12.5% from renewable energy resources (including wind, hydro, and biomass) and at least 0.5% solar, with the remainder generated from advanced energy resources, including nuclear, clean coal and fuel cells. At least half of the renewable energy used must be generated at facilities located in Ohio. 2014 legislation suspended the RPS for two years while a legislative panel studies the renewable standards. If the panel takes no action, the RPS will be reinstated and compliance schedule will be rolled back by two years (ultimately requiring 25% renewable energy supply by 2027).	
	Renewable Energy Credits (RECs)	Electric distribution utilities and electric services companies can meet their annual RPS benchmark obligations through the purchase of qualified RECs, which have a lifetime of five years following their acquisition.
	Net Metering	Each electric utility is required to develop a tariff for net metering for qualifying customer generators upon request. A qualifying customer generator is one whose generating facilities are: fueled by solar, wind, biomass, landfill gas, or hydropower, or use a microturbine or a fuel cell.

Transportation

The Stark Area Regional Transit Authority (SARTA) is also looking to deploy fuel cell buses through its No Emissions Bus Program. The transit authority is partnering with CALSTART for two fuel cell buses, tentatively scheduled for production in February 2015 for the first bus and July 2015 for the second. Delivery will be August 2015 and December 2015.[39] The FTA provided funding for this project and the Ohio Department of Transportation (ODOT) granted SARTA $500,000 to construct a hydrogen station to fuel the bus.[40]

Walmart has had more than 200 fuel cell-powered forklifts operating at a food distribution center in Washington Court House since 2007 and in June 2014, Ace Hardware announced plans to deploy units at its distribution center now under construction in West Jefferson.

Industry/Academia

Ohio has found its niche as an industry leader in the fuel cell supply chain. The state is home to a number of businesses focused on the automotive and aerospace industry that have subsequently expanded into the fuel cell markets – OFCC director Pat Valente says, "these are businesses that were dealing with many fluctuations in their industries. Diversifying (into fuel cells) helped flatten those ups and downs."[41]

For example Catacel (Ravenna), formed in 2001, designs and manufactures catalytic reformers and heat exchanging technology for the fuel cell, industrial gas, and gas reforming industries. Catacel now supplies more than $2 million in fuel cell and related components annually, which comprises more than 70 percent of the company's business.[42]

Forklift manufacturer Crown Equipment Corp. (New Bremen) diversified its product fleet by adding fuel cell-powered models, with the help of $1 million grant in 2009 from the Third Frontier Fuel Cell Program to develop fuel cell forklifts. The company's forklifts comprise 40% of Plug Power's fuel cell material handling fleet.

The state is also home to SOFC developer LG Fuel Cell Systems (North Canton), which is co-owned by LG (60% ownership) and Rolls Royce (40%). LG Fuel Cell Systems is headquartered at a research facility on the Stark State University campus and also works with researchers at Case Western Reserve University (CWRU). During its decade as Rolls Royce Fuel Cell Systems, the Ohio Third Frontier program awarded the company more than $5 million in funding for its work. Rolls Royce was attracted to Ohio over other states because of Ohio's competitive advantage in fuel cells including grants provided through Third Frontier.[43]

Other Ohio companies include:

- NexTech Materials (Lewis Center) – manufacturer of high performance complex oxides for the SOFC and catalysis markets.
- Technology Management Inc. (Cleveland) – provider of SOFC systems designed to generate power from diesel, bio and jet fuel.
- GrafTech International (Parma) – produces graphite flow field plates used in 75% of FCEVs, as well as in fuel cell buses and forklifts.[44]

OFCC maintains a complete ***database*** of Ohio's fuel cell, components and balance of plant manufacturers on its website.

Ohio is also very strong on university-based fuel cell and hydrogen R&D, with more than 85 fuel cell projects underway at universities.[45] The state has funded fuel cell project development and testing facilities at CWRU, the Ohio State University, the University of Toledo, Cleveland State University, and Stark State College of Technology that can help companies with fuel cell and hydrogen research.

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[39] http://www.sartaonline.com/Content/uploads/5-28-14-2843.pdf
[40] http://www.midwestenergynews.com/2014/05/20/ohio-looks-to-fuel-cells-as-economic-catalyst
[41] http://www.midwestenergynews.com/2014/05/20/ohio-looks-to-fuel-cells-as-economic-catalyst
[42] http://www.midwestenergynews.com/2014/05/20/ohio-looks-to-fuel-cells-as-economic-catalyst
[43] http://www.cleveland.com/business/index.ssf/2012/06/rolls-royce_sells_51_percent_o.html
[44] http://energy.gov/sites/prod/files/gcprod/documents/WA_07_040_GRAFTECH_INTERNATIONAL_LTD_Waiver_of_Patent_Rights.pdf
[45] http://www.crainscleveland.com/article/20131115/BLOGS05/311189999/fuel-cells-are-energized-and-here-to-stay

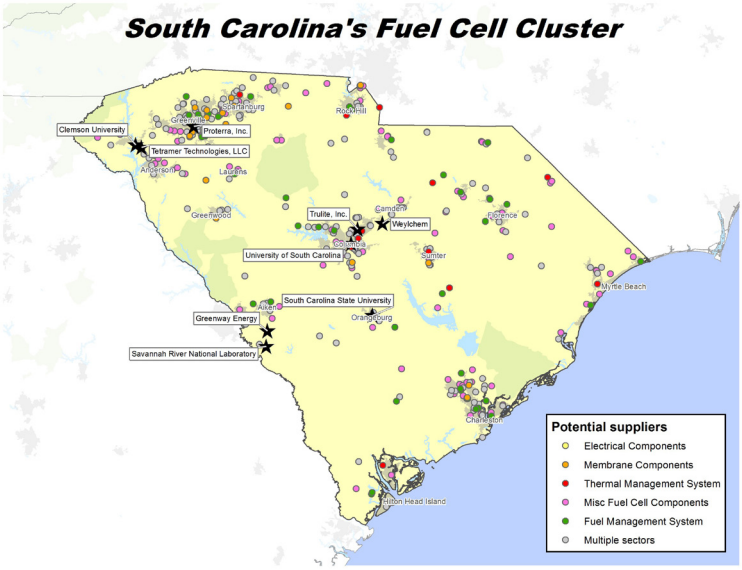
SOUTH CAROLINA

Since our last report:

- The University of South Carolina's Solid Oxide Fuel Cell Center was ranked #1 in total funding ($54 million) out of the state's 51 SmartState Centers. The SmartState Program, established in 2002, authorizes South Carolina's three public research institutions (Clemson University, Medical University of South Carolina, and University of South Carolina) to create Centers of Economic Excellence in research areas that will advance the state's economy. The SmartState Program has attracted more than $1.2 billion in non-state investment and has created more than 7,000 jobs. Funding comes from the state lottery. In June 2014, the University was awarded $3.2 million from the federal ARPA-E program.
- The South Carolina Hydrogen and Fuel Cell Alliance issued a report, *Economic Development: South Carolina's Hydrogen and Fuel Cell Cluster* (Feb. 2014), with an Action Plan for continued growth of the industry.
- South Carolina legislature created a Distributed Energy Resource Program to increase distributed energy resources in the state. Energy utilities may choose to participate in the program, which will include resources up to 20 kW for residential and 1 MW for nonresidential DG. Hydrogen from renewable resources is defined as an eligible renewable generation resource under the program. New interconnection and net metering rules will be established.

Almost a decade ago, South Carolina identified its strong capabilities in hydrogen and fuel cells technologies and began–through partnerships of government, business and academia – to nurture a growing fuel cell industry in the state.

In 2005, several studies (*SCH2 - The South Carolina Hydrogen Economy: Capitalizing on the State's R&D Assets and South Carolina Hydrogen & Fuel Cell Economy Strategy Final Report*) found that South Carolina has the infrastructure, technology, and resources to be competitive in a hydrogen economy and that it should exploit these capabilities.[46] The state began to implement a cluster strategy that creates a closely knit concentration of producers, suppliers and institutions focused on emerging industries that the state expects to grow and achieve competitiveness.[47] The Hydrogen and Fuel Cell Cluster (part of the Future Fuels Cluster) is recognized as one of South Carolina's important economic clusters.



Also in 2005, the South Carolina Hydrogen and Fuel Alliance (SCHFCA) was formed to oversee the state's fuel cell strategy and promote the state's hydrogen and fuel cell cluster. Members include federal and state government offices (Savannah River National Lab, the South Carolina Department of Commerce, Energy Office, Fire Marshal's Office, and Department of Minority Affairs), private companies, coalitions and partnerships, and university and research facilities in the state. SCHFCA's report, *Economic Development: South Carolina's Hydrogen and Fuel Cell Cluster* (2014), proposes a "Hydrogen and Fuel Cell Cluster Action Plan" for continued growth of the industry in the state. South Carolina

[46] http://www.sunycnse.com/download/Anthony_Boccanfuso_New_Energy_Symposium.pdf

[47] http://www.schydrogen.org/documents/2005%20Next%20Energy%20Initiative%20study.pdf

has completed mapping of its fuel cell and hydrogen supply chain, the first in the country to do so using the North American Industry Classification System (NAICS) code.

The ***South Carolina Innovation Plan 2013***, a roadmap to strengthen the development of the state's "innovative econo¬my," also recommends that efforts and resources should focus on advancing growth in high-tech firms in industries that have the most high-growth potential – which includes the fuel cell and hydrogen cluster.

Additionally, the state's General Assembly recently ***amended Section 12-6-3588*** of the 1976 Code to enact the South Carolina Clean Energy Tax Incentive Program, "to encourage business investment that will produce high quality employment opportunities and enhance this state's position as a center for production and use of clean energy products. The program accomplishes this goal by providing tax incentives to companies in the solar, wind, geothermal, and other clean energy industries which are expanding or locating in South Carolina."

University of South Carolina and City of Columbia

The ***South Carolina Research Innovation Centers Act of 2005*** directed the ***South Carolina Research Authority (SCRA)*** to create three "innovation centers" within the state, and specified eleven technology domains, including hydrogen and fuel cell technology, where the state should concentrate its economic development efforts. The ***Industry Partners Act of 2006*** further directed SCRA to stand up a "target program of excellence" in hydrogen and fuel cell technology through collaboration between the University of South Carolina and the Savannah River National Laboratory (SRNL). The comprehensive, state-wide innovation program, called SC Launch, is run by SCRA.

In 2006, the University of South Carolina (USC) and City of Columbia formed the ***Fuel Cell Collaborative***, (along with partners EngenuitySC, Midlands Technical College and the SCRA) to position Columbia and the Midlands region as a leader in hydrogen and fuel cell innovation and technology. In 2006, Columbia's city council unanimously passed a resolution supporting the city's objective to become a leader in fuel cell innovation. The council also created the ***Columbia Fuel Cell District*** in downtown Columbia, which integrates research, education and outreach, hydrogen production and fueling, and multiple end-use applications. In 2014, SRNL also joined the Fuel Cell Collaborative.

The ***Greater Columbia Fuel Cell Challenge*** was also launched in 2006 to accelerate the commercialization of ideas and discoveries, from discovery and development, to fuel cell demonstrations and deployments. Over its history, the Challenge has funded a wide array of projects including the development and testing of fuel cell prototypes, various demonstrations of fuel cell technologies (e.g. fuel cell forklifts trialed at multiple Columbia-area companies, fuel cell backup power units installed at three Columbia radio communications sites and at the Northeast Campus of Midlands Technical College, portable power fuel cell prototypes for multiple manufacturers, "repurposing" a 5-kW fuel cell system for powering the scoreboard at USC's baseball stadium, etc.).

In June 2009, the Fuel Cell Collaborative was selected to receive the "Innovator Award" from the Southern Growth Policies Board. The citation accompanying this award noted the group's "collaborative partnership with the public, private, university, government and nonprofit sectors" as the basis for the award.

In September 2011, the Collaborative received recognition from the International Economic Development Council as a recipient of its "Excellence in Economic Development Award," citing the group's "innovative use of technologies to promote energy efficiency; promotion of cross-industry collaboration; commercialization/technology transfer; preparation of workers for green collar jobs; and its replicability to other organizations or geographic areas."

South Carolina is home to two hydrogen fueling stations, located in downtown Columbia and in Aiken. Both were opened in 2009. The two stations are located about 50 miles apart, creating a "SC Hydrogen Freeway" along Interstate 20.

The Columbia station was developed when the FTA's National Fuel Cell Bus Program selected Columbia as a site for a prototype fuel cell bus demonstration. The bus serviced routes for the Central Midlands Regional Transit Authority (CMRTA) and for the USC campus starting in the fall of 2009, before moving to a follow-on

demonstration site (Austin, TX) in 2012. The hydrogen station continues to service a small fleet of FCEVs in the area.

The Aiken Sage Mill Industrial Park hydrogen station, developed by the Aiken-Edgefield Economic Development Partnership (EDP), along with partners DOE, GENCO, Kimberly-Clark Corporation, Plug Power Inc., and Air Products, is the nation's first multi-use industrial park fueling station to supply hydrogen directly for industrial, commercial, and government use.

The EDP, the Applied Research Center (ARC), and the city of North Augusta also partnered to obtain a fuel cell bus, which began operation in the city in 2014. The city, which has been working on ways to become more environmentally friendly, obtained the bus through a competitive process.

USC, located in Columbia, plays a major role in the state's fuel cell and hydrogen cluster. The university is home to the ***Solid Oxide Fuel Cells Center of Excellence***, which has partnered with the Boeing, ExxonMobil, SRNL, DOE, NASA, Department of the Navy, and the Air Force Office of Scientific Research, among others. The SOFC Center has added $31.2 million in research support and more than 270 jobs to South Carolina since 2008. USC also hosted the Center for Fuel Cells (which sunsetted at the end of 2013), a National Science Foundation Industry/University Cooperative Research Center that worked with industry partners such as BASF, Boeing, Dow Corning, DuPont, FuelCell Energy, GM, LG Electronics, Plug Power, and Proton Onsite.

USC's Center for Electrochemical Engineering (CEE) is also conducting crucial fuel cell research and has received millions in federal dollars from DOE and NSF over the years for research in fuel cell contaminants and electrolyzers. Dr. Branko Popov, Director of the CEE, was recognized by Thomson Reuters as one of the most "Highly Cited Researchers 2014" for his work on batteries and fuel cells. Dr. Popov has received DOE funding to develop novel non precious metal catalysts for fuel cells and currently is using funding from DOE and NSF to develop ultra-low loading platinum catalysts for PEM fuel cells. He has also received funding from NASA for the development of advanced regenerative fuel cells.

USC has been involved in many fuel cell demonstrations and deployments. USC's Green Quad dormitory installed a 5-kW fuel cell that powered the lights and hot water for the Center for Sustainability, funded by $100,000 from DOE and $50,000 from the South Carolina Energy Office. The University also leased two Ford hydrogen fuel cell buses, owns two fuel cell-powered Segways, and powers its baseball stadium scoreboard using a fuel cell.

Other Industry/Academia

Midlands Technical College (MTC), located in Columbia, offers fuel cell technology training programs and has devoted two full-scale labs to the design and fabrication of fuel cell technology. The MTC Enterprise Campus also serves as a business accelerator, and is currently home to TruLite, a manufacturer of fuel cell power generators for backup and off-grid applications.

Fuel cell research is also conducted at Clemson University's International Center for Automotive Research.

The Applied Research Center (ARC), located at the Savannah River Research Campus in Aiken, was initially established as a center for hydrogen fuel and fuel cell R&D. The facility has since broadened its research efforts beyond hydrogen, but it still remains one of the facility's primary research initiatives. ARC researchers work in collaboration with SRNL and the facility is home to SRNL's Hydrogen Technology Research Laboratory (HTRL). ARC: Hydrogen projects have included the development of a Chevrolet Silverado 4X4 truck with a hydrogen-powered internal combustion engine and the Sage Mill Industrial Park hydrogen refueling station in Aiken. The ARC initiatives are programs of the Aiken-Edgefield Economic Development Partnership. In addition, ARC: Hydrogen is partnering with SRNL and the AIST (Advanced Institute of Science and Technology) of Japan on renewable hydrogen systems.

Several major corporations with facilities in South Carolina have taken advantage of fuel cell power.

BMW operates 350+ fuel cell-powered forklifts, tuggers and stackers at its Spartanburg manufacturing plant and a 700 kg/day hydrogen fueling pump. The company also has used methane gas-to-power part of the plant's total energy requirements, earning the company the #4 spot on EPA's "Top 20 Onsite Generation" list. The gas is collected

from the local Palmetto landfill and is cleaned, compressed and delivered to the plant via a 9.5-mile pipeline. BMW, the South Carolina Research Authority, the Gas Technology Institute, Ameresco Inc., and the South Carolina Hydrogen and Fuel Cell Alliance are working together to develop a method to convert some of this methane gas onsite into hydrogen for the fuel cell forklifts. This effort is funded, in part, by a grant from DOE.

Kimberly-Clark operates a fuel cell-powered forklift fleet at its Aiken facility. Bridgestone-Firestone (also located in Aiken) also demonstrated fuel cell forklifts at its manufacturing plant for several years, placing them in service in 2008/2009.

Proterra, a manufacturer of electric and fuel cell buses located in Greenville, is working on several projects, and recently demonstrated the driving range of their hydrogen fuel cell bus as part of the Federal Transportation Administration fuel cell bus program. The bus was driven to the Sage Mill Hydrogen Station in Aiken, SC, approximately 109 miles, for refueling. The Sage Mill Hydrogen Station is the only station in a several state area with the 5,000 psi capability needed to fuel the bus.

OVERVIEW OF SOUTH CAROLINA'S FUEL CELL AND HYDROGEN INITIATIVES	
PROGRAM	**DETAILS**
AGENCY: SOUTH CAROLINA RESEARCH AUTHORITY (SCRA)	
SC Research Innovation Centers Act (2005)	Directed SCRA to create three "innovation centers" and specified 11 technology domains, including hydrogen and fuel cell technology, where the state should concentrate its economic development efforts.
Industry Partners Act (2006)	The Act further directed SCRA to establish a "target program of excellence" within each of the three research innovation centers and to focus on the application, development, and commercialization of the basic research being undertaken by the centers. This includes a target program of excellence in hydrogen and fuel cell technology through collaboration between the University of South Carolina and SRNL. An Industry Partnership Fund was established by the Act to carry out the program's objectives. Taxpayers received a state income tax credit (or other form of credit) for voluntary contributions to the fund. The fund sunsetted in mid-2012.
AGENCY: PUBLIC SERVICE COMMISSION (PSC)	
Hydrogen Permitting Act	The bill establishes a South Carolina Hydrogen Permitting Program within the Office of the State Fire Marshal. The bill also states that only the state fire marshal may permit a hydrogen facility in the state and that the fire marshal may delegate that authority to a county or municipal official.
Sales Tax Exemption for Hydrogen Fuel Cells	Exempts from sales tax any device, equipment, or machinery operated by hydrogen or fuel cells, any device, equipment, or machinery used to generate, produce, or distribute hydrogen and designated specifically for hydrogen applications or for fuel cell applications, and any device, equipment, or machinery used predominantly for the manufacturing of, or research and development involving hydrogen or fuel cell technologies.

South Carolina Distributed Energy Resource Program	The goal of the voluntary program is to promote the establishment of a reliable, efficient, and diversified portfolio of distributed energy resources for the state. Any distributed energy resource program proposed by an electrical utility must, at a minimum, result in development by 2021 of renewable energy facilities located in South Carolina in an aggregated amount of installed nameplate generation capacity equal to at least 2% of the previous five-year average of the electrical utility's South Carolina retail peak demand. Eligible facilities must be 20 kW or less (residential customers) or 1 MW or less (nonresidential customers). Hydrogen fuel derived from renewable resources qualifies as a renewable generation source.
Net Metering	The 2014 Distributed Energy Resource Program Act creates new net metering rules. Residential customers can net meter renewable systems of 20 kW or less. Nonresidential customers can net meter systems that are 1 MW or less, or 100% of contract demand. The net metering rules do not permit meter aggregation, group/joint billing projects, and/or virtual net metering.
Interconnection Guidelines	In 2006, the PSC adopted simplified interconnection guidelines for small renewable energy systems and other forms of DG – up to 20 kW for residential systems and up to 100 kW for non-residential systems. The interconnection guidelines apply to Progress Energy, Duke Energy, and South Carolina Electric and Gas. The 2014 Distributed Energy Resource Program Act directs PSC to promulgate standards for interconnection of renewable energy facilities and other non-utility owned generation with a generation capacity of 2 MW or less to an electrical utility's distribution system.

Gaining Ground

There are several other states, some with long-standing and others with new-found fuel cell support, that are making a tremendous difference in helping move the U.S. fuel cell industry forward. These states see the benefits and potential for fuel cells to reduce GHG emissions while strengthening the electric grid to provide reliable power to residents and businesses.

HAWAII

Hawaii depends heavily on petroleum for its electricity generation, relying on oil for 71% and on coal for 15%.[48] Electricity prices are three times higher than the U.S. average.[49]

Hawaii can potentially meet 60% to 70% of its future energy needs from renewable energy sources and is working to transition to greater energy independence through locally-produced renewable energy and energy efficiency. The state and DOE established an ***MOU*** in 2008 to work together to transform the financial, regulatory, legal, and institutional systems that govern energy planning and delivery (DOE-Hawaii Clean Energy Partnership).

The state has been actively involved in hydrogen and fuel cell research, development and deployment (RD&D) for a number of years. In 2001, Hawaii enacted an ***RPS*** with the goal of 15 percent clean energy by 2015, 25 percent by 2020, and 40 percent by 2030. The RPS definition of "renewable energy" includes hydrogen produced from renewable fuels.

In 2002, the Hawaii Department of Business, Economic Development, and Tourism (DBEDT) released, Nurturing a Clean Energy Future in Hawaii: Assessing the Feasibility of the Large-Scale Utilization of Hydrogen and Fuel Cells in Hawaii.

In 2006, Hawaii's legislature created the hydrogen investment capital special fund to provide seed capital for venture capital investments in private sector and federal projects for research, development, testing and

[48] http://energy.hawaii.gov/wp-content/uploads/2011/08/HI-Energy-FactsFigures_May2014_2r.pdf

[49] http://energy.hawaii.gov/wp-content/uploads/2011/08/HI-Energy-FactsFigures_May2014_2r.pdf

implementation of the ***Hawaii Renewable Hydrogen Program***, located within the Hawaii Department of Business, Economic Development, and Tourism (DBEDT). The program is tasked with designing, implementing, and administering activities that focus on Hawaii's renewable energy resources. This includes fostering strategic partnerships, demonstration projects, investment and education and outreach focusing on renewable hydrogen, for applications such as electric grid reliability and security and infrastructure for the production, storage, and refueling of hydrogen vehicles.

DBEDT and the Hawaii Natural Energy Institute released Analysis of Geothermally Produced Hydrogen on the Big Island of Hawaii: A Roadmap for the Way Forward in 2008.

Since 2010, Hawaii's state and county agencies have been required to comply with the ***alternative and advanced light-duty vehicle acquisition requirements***. Priority for purchase is: 1) plug-in electric vehicles, 2) hydrogen or FCEVs, 3) other alternative fuel vehicles, 4) hybrid vehicles, 5) top performers for fuel economy in EPA's annual Fuel Economy Leaders report.

Hawaii's ***Green Energy Market Securitization (GEMS) program***, facilitated by DBEDT via the Hawaii State Energy Office, was passed via legislation in 2013. The program issues Green Infrastructure Bonds to secure low-cost financing for clean energy installations with loan payments for the devices made over time through the customer's electricity bill. In its initial phase, GEMS targets distributed solar, but will be flexible and deployed in a phased approach to make financing available for many clean energy and energy efficient technologies that provide energy cost savings.

The ***Hawaii Center for Advanced Transportation Technologies (HCATT)***, established in 1993, has been involved in joint federal-industry fuel cell RD&D partnerships for many years. The organization, which focuses on development of advanced low emission and zero emission electric drive vehicles, has been awarded more than $40 million in federal funds, matched by $23 million from private partners. HCATT is managed by the High Technology Development Corporation (HTDC), a state agency established by the Hawaii State Legislature in 1983 to facilitate the development and growth of Hawaii's commercial high technology industry.

HCATT'S FUEL CELL AND HYDROGEN PROJECTS	
YEAR	**DETAILS**
2004-2009	Developed a battery-dominant hybrid fuel cell shuttle bus demonstrated at Hickam Air Force Base, Hawaii. Additional FCEVs: Step Van, MB-4 Aircraft Towing Vehicle, Ford Ranger Electric Pick-Up Truck, Light Cart.
2006	Developed and installed a modular/deployable hydrogen production and dispensing station at Hickam.
2009	Installed a 146-kW photovoltaic array to power the hydrogen station.
2010	Partnered with the Army to evaluate a fleet of 10 hydrogen internal combustion engine Ford Escapes, and GM hydrogen fuel cell-powered SUVs.
2011	Tested five 10-kW vertical axis wind turbines to supplement the PV array in powering the hydrogen station. The turbines failed in high winds and the project was halted in 2012. Entered into a partnership with the Hawaii Natural Energy Institute and The U.S. National Park Service to demonstrate fuel cell-powered shuttle buses in Hawaii Volcanoes National Park. The two busses will be zero emission, hydrogen fuel cell/battery powered hybrid electric buses designed to operate in potentially damaging sulfur laden air (harmful to fuel cell technology) to demonstrate viability of environmentally friendly tours for the park.

2013	Delivered a hydrogen fuel cell-powered R-12 refueling truck to Joint Base Pearl Harbor–Hickam (JBPHH) to demonstrate the viability of complex fuel cell technology on the flight line. HCATT and US Hybrid delivered a 25 passenger fuel cell powered Crew Bus to JBPHH to showcase hydrogen fuel cell technology to aircrew and visitors transiting JBPHH. HCATT is working on a hydrogen-powered C-17 tug to demonstrate the high torque of hybrid electric hydrogen fuel cell flight line technology, a hydrogen powered Weapons Loader for the Fifth Generation F-22 Raptor fighter along with advanced medium sized wind turbine technologies supporting renewable energy infrastructure at JBPHH.

The ***Hawaii Natural Energy Institute (HNEI)***, a research unit of the School of Ocean and Earth Science and Technology of the University of Hawai‘i at Mānoa, was established by the Legislature in 1974, to seek new forms of energy to reduce dependence on fossil fuels. HNEI established a major fuel cell R&D program, built on its successful research on hydrogen production from renewable resources. HNEI R&D activities include testing of individual PEM fuel cells, development of bio-fuel cells and biocarbon fuel cells, studies concerned on the use of fuel cells in support of electrical grid stability, and use of fuel cells for helium recovery from rocket test systems.

HNEI'S FUEL CELL AND HYDROGEN PROJECTS	
PROJECT	**DETAILS**
Grid Management Using Hydrogen	Ongoing project sponsored by the Naval Research Laboratory with funding from DOE, with project partners Puna Geothermal Venture and the County of Hawaii Mass Transit Agency. The project objective is to assess the use of a hydrogen production and storage system as a grid management tool to mitigate adverse impacts of renewable energy sources on the electric grid system of the Big Island. The stored hydrogen could be used to run fuel cells and generate electricity as needed. The hydrogen produced could also be used for transportation fuel by the island's Mass Transit Agency (MTA) buses, fuel for stationary fuel cells, and chemical feedstock for producing ammonia.
Hydrogen for GM Equinox Fuel Cell Electric Vehicles	Supported in part by DOE, Office of Naval Research, and the State of Hawaii Hydrogen Fund. Project partners include HCATT and Marine Corps Base (MCB) Hawaii. The project involved the installation of a hydrogen production, storage, and dispensing system for fueling 16 General Motors Equinox FCEVs at MCB Hawaii. The vehicles were paid for by the Army Tank Automotive Research Development Engineering Center (TARDEC), Office of Naval Research and Air Force Research Laboratories (ONR) and Air Force Research Laboratories (AFRL).
Hydrogen for Hawaii Volcanoes National Park Vehicles	Funded by DOE and DBEDT, project elements include hydrogen production at the Puna Geothermal Venture (PGV) plant on the Big Island of Hawaii, hydrogen transport to a dispensing station at the Kilauea Military Camp, located within the Hawaii Volcanoes National Park (HAVO), and fueling of plug-in hybrid electric shuttle buses used for visitors to HAVO. Important benefits of this project are the validation of fuel cell vehicle operation, help in reducing barriers to the introduction of hydrogen infrastructure, and benefits to visitors to the HAVO facility.

Hawaii is home to the Joint Base Pearl Harbor-Hickam, home to both the U.S. Air Force and U.S. Navy. The base has been active in helping demonstrate and validate hydrogen and fuel cell technologies for various military (and civilian) applications. At the base's National Demonstration Center, established with the State of Hawaii, a variety of vehicles have been tested: a battery dominant fuel cell hybrid bus, fuel cell hybrid step van, fuel cell hybrid aircraft tow vehicle, flightline maintenance support vehicle with a fuel cell auxiliary power unit, a fuel cell-powered light cart, fuel cell hybrid flightline sweeper, and FCEVs from General Motors. The base has a renewable hydrogen fueling station powered by a 146 kW PV array that can produce up to 12kg/day of hydrogen. When the station isn't in operation, the excess solar energy is used by the grid.

In 2012, HTDC, HCATT and the U.S. Air Force Advanced Power Technology Office selected Hydrogenics Corporation to develop, fabricate and deliver a 100 kW outdoor containerized hydrogen power system for the base.

So far in 2014, Hawaii has seen an increase in state fuel cell activities. Three fuel cell buses could hit the roads of the Big Island within less than a year, two operating at Hawaii Volcanoes National Park and one operated by the Hawaii County Mass Transit Agency (called Hele-On). HCATT recently awarded $707,500 to US Hybrid to convert a 25-passenger shuttle for the transit agency.[50] HNEI has $5 million for the bus project as well as a project using hydrogen to stabilize the electric grid, sourced from DOE, Office of Naval Research, and state hydrogen fund and fuel taxes.[51] A 20 kilogram hydrogen storage and delivery system will be integrated at US Hybrid's Honolulu facility.

In addition, the federal Maritime Administration (MARAD) announced a $700,000 project to deploy a 100 kW portable fuel cell power system at the Port of Honolulu. Researchers will examine the potential cost savings and emissions reductions using fuel cells to provide electrical power to ships at berths, using the fuel cell to help power vessel on-board systems pier side for ships, tugs, and barges operating between the Hawaiian Islands. The project will be led by Sandia National Laboratories and funded by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) and the U.S. Department of Transportation's Maritime Administration (MARAD).

MASSACHUSETTS

Massachusetts is moving quickly up the ladder to become one of the most fuel cell-friendly states in the U.S.

Massachusetts had two of the earliest fuel cell installations at municipal facilities - at the Braintree Municipal Landfill (1999) and the Deer Island Sewage Treatment Plant (1997). Both were initially installed to run off ADG but the Deer Island facility didn't produce enough of the gas to run the unit for extended periods of time, so after four and a half years, the fuel cell was decommissioned. At Braintree, the landfill gas produced contained too much nitrogen to use in the fuel cell, so the system was modified to operate using natural gas and the electricity was then fed into the town's power grid. Despite the inability to power the fuel cells with ADG as initially intended, these early installations at waste facilities helped the fuel cell manufacturers improve on the technology and led to additional installations at landfills and wastewater treatment plants in New York, Connecticut and California that successfully operate on ADG.

Also in the late 1990s, the Department of Defense installed several fuel cells in the state as part of its PAFC Demonstration and the Climate Change Rebate program, which were both designed to test large-scale fuel cells at both military and corporate sites to test and improve the technology.

In 2001, the Verizon Engineering Facility in Woburn boasted the first fuel cell-powered telecommunications site in the U.S. , a 5-kW natural gas-powered fuel cell system, developed by Cambridge -based Nuvera Fuel Cells. The fuel cell provided primary power to the facility as part of a 500-hour demonstration, with the electric grid and batteries used as backup if needed. This demonstration was successful and there are now hundreds of fuel cells installed across the country at cellular towers and switching stations by Verizon as well as other major telecommunications companies including Sprint, AT&T and T-Mobile/MetroPCS.

The Massachusetts Technology Collaborative, a public agency established in 1982 by the Massachusetts legislature to advance the growth of the technology sector of the state's economy, provided financial support via its Renewable Energy Trust Fund. The fund is supported by a non-bypassable surcharge of $0.0005 per kWh (0.5 mill/kWh),

[50] http://westhawaiitoday.com/news/local-news/hydrogen-powered-buses-coming-big-island#sthash.CWFF4OOb.dpuf

[51] http://westhawaiitoday.com/news/local-news/hydrogen-powered-buses-coming-big-island#sthash.CWFF4OOb.dpuf

imposed on customers of all investor-owned electric utilities and competitive municipal utilities in Massachusetts; $150 million was allocated over a five-year period (1998-2002), and then set at $25 million per year from 2003-2010 and last set at $23 million in 2011. The Fund does not have an expiration date. In 2009, the Massachusetts Clean Energy Center (MassCEC), an organization dedicated to accelerating the success of clean energy technologies, companies and projects in the state, became the administrator of the Renewable Energy Trust Fund.

Massachusetts' ***RPS*** was one of the first programs in the nation that required a certain percentage of the state's electricity to come from renewable energy. Eligible Class I resources include fuel cells utilizing renewable fuels. Fuel cells and fuel cells utilizing renewable fuels are both eligible in the state's ***net metering*** rules.

Massachusetts created and administers the ***Green Communities Program*** which fosters the adoption of energy technologies that serve to increase energy efficiency, reduce energy footprints and lower emissions. The program provides technical assistance and financial support for municipal initiatives to improve energy efficiency and increase the use of renewable energy in public buildings, facilities and schools.

One city, Boston, has taken major steps to make itself greener and more efficient. Greenovate Boston is a community-driven movement to get citizens involved in reducing the city's GHG emissions 25% by 2020 and 80% by 2050, as outlined in the City's Climate Action Plan. In April 2014, the Greenovate Boston Mayor's Carbon Cup was announced, a voluntary recognition program for large hospitals, universities, and commercial building portfolios committed to reducing their GHG emissions intensity by 35% by 2020. Fuel cells could play a role in this effort, as the technology has been installed in all three of those market segments in other states.

In addition to overseeing the Renewable Energy Trust Fund, MassCEC encourages energy technology development and early stage market adoption via a range of programs.

The Massachusetts Hydrogen Coalition was formed in 2004 to develop and expand Massachusetts' electrochemical, hydrogen, fuel cell and related technology industries. The group has more than 30 members and works with several organizations in the state including MassCEC, Massachusetts Electric Vehicle Initiative Task Force, Massachusetts Clean Cities, Massachusetts Clean Energy Council, and Massachusetts Global CleanTech MeetUp.

In 2010, MassCEC joined with MassDevelopment, the state's finance and development authority, to provide Lilliputian Systems, a developer of fuel cell portable power products for consumer electronic devices based in Wilmington, with a $5 million loan to expand its manufacturing plant. Each organization provided $2.5 million, with MassDevelopment tapping its ***Emerging Technology Fund*** which targets technology companies that are starting up or expanding manufacturing in Massachusetts by providing financing for working capital, manufacturing facilities, and equipment.

According to the ***2013 Massachusetts Clean Energy Industry Report*** from MassCEC, fuel cells make up 1% of the clean energy industry (8,400 reported jobs) in the state, with hydrogen generation contributing 0.3%. Despite this seemingly small percentage of overall energy jobs, Massachusetts boasts an impressive cluster of fuel cell and hydrogen companies, and is home to several fuel cell manufacturers finding success in niche market sectors such as material handling, hydrogen fueling, remote and backup power, and military applications such as portable soldier power and unmanned air and ground vehicles used in surveillance.

The ***Massachusetts Hydrogen and Fuel Cell Deployment Plan***, published in 2012 by the Northeast Electrochemical Energy Storage Cluster (Massachusetts is a participating state), reported that Massachusetts is home to more than 300 companies that are part of the Northeast hydrogen and fuel cell supply chain. An update to that report[52] estimates that these companies have generated more than $184 million in revenue and provide more than 1,100 jobs.

Several of the companies have attracted the attention and financial support from DOE through its Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) awards. Giner, of Newton, recently received more than $1.2 million to develop its hydrogen electrolyzer, including a first-of-its-kind award under a new EERE SBIR technology-to-market topic "Technology Transfer Opportunity: EERE/LAN" that moves existing inventions developed at DOE's national laboratories to the marketplace and accelerates the pace of commercialization.

[52] https://www.dropbox.com/s/mymuwij59wk7eam/MA2_March2013.pdf

The state has many other companies making waves in the industry, including:

- ElecroChem of Woburn, one of the longest existing fuel cell companies, with 70% of sales overseas, has a wide range of products in the marketplace, from fuel cells to components and testing equipment.
- Acumentrics SOFC Corporation of Westwood, which develops Remote Power Stations for the oil and gas industry, as well as other applications.
- Protonex of Southborough, which develops fuel cells for military use – portable soldier power, unmanned vehicles, etc., and has received millions of dollars in funding from various branches of the U.S. military.
- Nuvera Fuel Cells of Billerica, which manufactures fuel cells for the material handling and industrial vehicle market as well as steam methane hydrogen generators and compact hydrogen stations. The company is currently involved in several DOE demonstration projects.

Boston University, Harvard, Massachusetts Institute of Technology (MIT), Northeastern University, University of Massachusetts Amherst, UMass Lowell, Worcester Polytechnic Institute (WPI) are all conducting fuel cell and hydrogen research. In 2008, WPI's Fuel Cell Center was designated by the Massachusetts legislature as the official state Hydrogen and Fuel Cell Institute and authorized $10 million to spearhead research.

Massachusetts universities are also attracting federal investment from DOE. MIT of Cambridge was awarded $547,289 by DOE's ARPA-E to develop a reformer that converts natural gas to liquid fuel. A professor of mechanical and industrial engineering at the University of Massachusetts was awarded a five-year $750,000 grant from DOE to study the nanoscale materials inside fuel cells.

The state has several fuel cell installations currently operating, including two grocery stores – a Whole Foods in Dedham and a Star Market in Newtown. Both were installed in 2009. The Whole Foods fuel cell works in tandem with the store's 460 solar panels (80 kW total) generates approximately 90% of the facility's electric needs. That installation received $400,000 from the Massachusetts Renewable Energy Trust's Large Onsite Renewables Initiative.

On the transportation side, Massachusetts is moving to become a target for automakers once FCEVs are commercialized in the marketplace. To help achieve this, Massachusetts was one of the eight states to sign the ZEV MOU in October 2013. To respond to points of the MOU, the Massachusetts Electric Vehicle Initiative Task Force was formed using representatives from industry, automakers and government to create a response plan. The plan will include a package of incentives for both EV and FCEV use.

The Massachusetts Hydrogen Coalition chairs the Massachusetts Fuel Cell Electric Vehicle Working Group, working on developing a fleet-to-retail FCEV launch program complete with infrastructure. The Coalition is also a member of H_2USA.

In 2013, Nuvera Fuel Cells received two Toyota FCHV-adv fuel cell vehicles from Toyota Motor Sales, USA, Inc. to operate and maintain at its Billerica headquarters for two years.

Nuvera Fuel Cells also received $650,000 from DOE to demonstrate its Orion™ fuel cell to power TRUs on tractor trailers used to deliver frozen foods and fresh produce to supermarkets. The company is working with Thermo King to integrate fuel cells in a refrigerated trailer that will run for at least 400 hours while supporting two sites, making deliveries for a Sysco food distribution facility in Riverside, California, and for H-E-B's food distribution center in San Antonio, Texas. The Sysco and H-E-B facilities have fuel cell forklifts in operation with hydrogen infrastructure already in place, provided by Nuvera's PowerTap™ hydrogen generator and refueling system.

Nuvera is also involved with the Massachusetts Hydrogen Fuel Cell Bus program, which received a $7.7 million grant from the FTA to demonstrate a "Total Transit Solution" consisting of one

fuel cell bus and one hydrogen refueling station at the Massachusetts Bay Transportation Authority (MBTA) in Boston. The bus and hydrogen station are expected to be in service by the end of 2014. Nuvera's program partners include MBTA, BAE Systems, ElDorado National, Ballard Power Systems, and the Northeast Advanced Vehicle Consortium (NAVC).

MassCEC, as part of the InnovateMass program, which seeks to advance deployment of innovative clean energy technology in the Commonwealth, awarded Nuvera (and partners Toyota Motor Sales, AvCarb and Northeast Electrochemical Storage Cluster) $150,000 in April 2014 to develop Massachusetts' first public hydrogen refueling station at Nuvera's Billerica headquarters. The companies will match the grant with $830,740.

Global goods distributor Sysco has been running its entire Boston warehouse facility forklift fleet on hydrogen-powered fuel cells (170 in total) since 2012.

Massachusetts also has one of the most active energy storage development markets in North America, a field that is a growing opportunity for hydrogen and fuel cells and is a member of NEESC.

NEW JERSEY

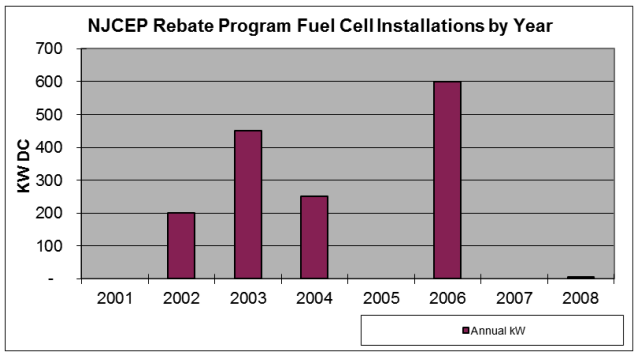
New Jersey's goals include enhancing energy efficiency in the state through DG with recovery and productive use of waste heat, and reducing existing and new demands to the electric power grid. The Board of Public Utilities (BPU) encourages DG by providing financial incentives for installations through its ***Combined Heat & Power and Fuel Cell (CHP-FC) Program***. Incentives are available for onsite commercial and industrial CHP and fuel cell systems fueled by non-renewable sources, such as natural gas. Incentives range from $1.50 to $4.00/Watt, depending upon capacity and waste heat recovery, with additional performance-based bonus payments of $0.25/Watt for "Pay for Performance" participants. Incentives are capped at $2 million/60% of project costs for systems 1 MW or under and $3 million/45% of project costs for systems above 1 MW.

NEW JERSEY – CHP-FC PROGRAM: INCENTIVES FOR FUEL CELLS					
ELIGIBLE TECHNOLOGY	Size (Installed Rated Capacity)	Incentive ($/Watt)	P4P Bonus ($/Watt) (cap $250,000)	% of Total Cost Cap per project	$ Cap per project
Fuel Cells powered by non-renewable fuel source. Incentives are available for systems both with and without waste heat recovery	≤1 MW w/ waste heat	$4.00	$0.25	60%	$2 million
	≤1 MW	$3.00			
	>1 MW w/ waste heat	$2.00		45%	$3 million
	>1 MW	$1.50			

NJCEP Wind, Biopower and Fuel Cell Installations by Program Type

As of 7/31/2014

Technology	Wind	Biopower	Fuel Cell	Total
Rebate Programs				
Project Qty	42	14	8	64
Total kW	4,734	8,505	1,505	14,744
Total $ Amount	$4,432,100	$7,359,120	$4,707,312	$16,498,533



Prior to implementation of the CHP-FC program, BPU's Clean Energy Partnership (NJCEP) ***Rebate programs*** helped fund eight fuel cell projects in the state. The fuel cells were installed between 2002-2008 at several colleges, a hotel, and a Merck production plant.

New Jersey also hopes to improve the resiliency of its power grid. In January 2014, the state issued a ***Substantial Amendment*** to its Action Plan describing how the U.S. Department of Housing and Urban Development's (HUD) second allocation of Community Development Block Grant-Disaster Recovery (CDBG-DR) funds will be used to satisfy overall unmet Superstorm Sandy-related needs. In this Amendment, among other recovery-related efforts, the state is requesting $210 million to create an Energy Resilience Bank (ERB) to allow critical facilities to invest in fuel cells, combined heat and power, solar with storage, and other technology that will better prepare water and wastewater facilities, schools and hospitals, police and fire stations, and other key community infrastructure for future weather events. New Jersey's planned ERB will differ from other U.S. Green Energy Banks in that it would be the first to focus specifically on energy resiliency. In July 2014, the state took steps to establish the bank, announcing that the BPU and the state's Economic Development Authority (EDA) ***will work jointly in the establish and operate the ERB***.

New Jersey includes fuel cells using renewable fuels (defined as a Class I renewable energy resource) in the following regulations, incentives and programs:

- New Jersey's ***RPS*** requires power providers serving retail customers in the state to procure electricity from qualifying renewable energy sources. The requirements increase each year, growing to 22.5% renewable energy of the by 2021, including 17.88% sourced from Class I renewable resources.
- ***Net Metering*** rules apply to customers of New Jersey's investor-owned utilities and energy suppliers, and to customers of certain competitive municipal utilities and electric cooperatives. All Class I renewable energy technologies under the state RPS are eligible. The BPU has not set an aggregate limit, but may allow utilities to limit net metering if statewide enrolled capacity exceeds 2.5% of peak electric demand.
- The ***Edison Innovation Clean Energy Manufacturing Fund (CEMF) and Edison Innovation Green Growth Fund (EIGGF)***, administered by the EDA, provides funding assists to -profit companies developing Class I renewable energy.
- A ***Property Tax Exemption*** from local property taxes is available for renewable energy systems used to meet onsite electricity, heating, cooling, or general energy needs.

New Jersey was an early site for the deployment of fuel cells. In 1995, Jersey Central Power and Light Company installed a 200-kW fuel cell at the site of one of its customers, AT&T Research Center in Holmdell. This fuel cell provided base load electric service as well as heat to AT&T. A number of demonstration fuel cells followed, deployed with funding through the Department of Defense fuel cell and climate change programs: Ramapo College (installed in 2000), Merck & Co. (2002), Ocean County College (2003), Sheraton hotels located in Parsippany and Edison, (2003), Johnson & Johnson (2003), Richard Stockton College (2003), and The College of New Jersey (2004).

New Jersey's Office of Research and Technology in the New Jersey Department of Transportation has developed and demonstrated several FCEVs and fuel cell-powered variable message signs, with leadership from Project Engineer Mike Strizki. In 2006, Strizki converted his home in Hopewell to run exclusively on solar-hydrogen power and has a home-based hydrogen vehicle fueling station.

More recently, Sprint Nextel deployed 260 fuel cells at cell tower sites in New Jersey, with funding provided through the ARRA. ACuPowder International Metal's processing facility in Union is participating in a DOE project as an industrial user of hydrogen – hosting a combined heat, hydrogen and power (CHHP) fuel cell system. Owens Corning (Kearny) received $1.2 million in funding through the New Jersey CHP-Fuel Cell Program for its 2012 installation of a 525-kW fuel cell (this is Owens Corning's second fuel cell installation; the first is located in Compton, California). In 2013, Verizon deployed a 2-MW solar and fuel cell system at its operations headquarters located in Basking Ridge.

The Linde Group, an industrial gas company, is involved in developing the hydrogen infrastructure around the world, for light duty vehicles and buses as well as for material handling. The company's North American headquarters are located in Murray Hill.

Also Noteworthy

PENNSYLVANIA

The Pennsylvania Energy Development Authority (PEDA) is now offering an estimated ***$12.5 million in grants and loans for energy projects*** and anticipates awarding approximately $10 million specifically for alternative and renewable energy projects. Funding is also available for clean alternative fuels, alternative energy manufacturing and alternative energy research. Fuel cells are included.

Pennsylvania is also home to companies helping advance the hydrogen infrastructure for fuel cell vehicles all around the world.

Air Products and Chemicals, Inc., based in Allentown, is an industrial gas company that has taken its expertise with hydrogen into vehicle fueling markets, deploying its first hydrogen fueling station in 1993. The company has been involved in more than 150 hydrogen fueling projects in the U.S. and 20 countries worldwide, averaging more than 800,000 hydrogen fill-ups per year. In January 2014, Air Products received $900,000 from DOE to develop a tube trailer for hydrogen delivery and storage and in March 2014, opened a new SmartFuel® branded station at Honda's R&D headquarters in Torrance, California, in just seven months.

The company also received a $209,046 Alternative Fuel Incentive Grant (AFIG) from Pennsylvania's Department of Environmental Protection (DEP) in December 2013 to deploy a next phase pilot demonstration of its hydrogen fueling technology in Lehigh County.

PDC Machines, based in Warminster, is a second generation family owned and operated business that manufactures hydrogen compressors. PDC's technology is a key component of more than 110 hydrogen fueling stations and dispensers around the world.

Johnson Matthey Fuel Cells, a global business dedicated to the supply of high quality fuel cell components, has its North American headquarters in West Chester.

Also of note, the city of Pottsville boasts two facilities with fuel cell-powered forklifts in operation. Wegman's has had 136 fuel cell vehicles in operation at its Pottsville warehouse since 2010 and a Walmart site has had almost 300 Plug Power fuel cells operating in its class-2 and class-3 electric lift trucks since mid-2014, already accumulated more than 100,000 hours of run-time and more than 9,900 kg of hydrogen dispensed.

RHODE ISLAND

In February 2014, Rhode Island's governor created an Executive Climate Change Council to reduce the state's GHG emissions and prepare for the impacts of climate change. In June, the Council issued its ***climate change report***, which recommends increasing the use of renewable energy and clean fuels by passing legislation to allow greater procurement of regional renewable energy; updating licensing laws to remove barriers for local installations; and extending and expanding Rhode Island's DG growth program.

The Rhode Island Office of Energy Resources (OER), which is conducting a period review of the state's energy plan, recommends that the state pursue an "all of the above clean energy strategy."

While fuel cells are not presently eligible for DG financing through OER's Renewable Energy Fund, fuel cells using renewable fuels are classified as an eligible renewable energy source under the state's renewable energy standard.

Rhode Island is part of the eight-state alliance to put 3.3 million zero-emission vehicles (battery and fuel cell) on the roads in their states within a dozen years and is also part of a ten-state Regional Greenhouse Gas Initiative, the first market-based regulatory program in the United States to reduce GHG emissions.

Multi-State Efforts

There are several policy initiatives and organizations that join states together towards the common goal of advocating and encouraging fuel cell and hydrogen infrastructure development as part of a comprehensive energy strategy.

What our members have accomplished since 1998

- Invested nearly $3.4 billion of public funds in renewable energy projects
- Leveraged $12.5 billion in outside funds
- Supported installation of 3.9 gigawatts of clean energy generation capacity
- Generated 10.7 gigawatt hours of clean, renewable energy
- Avoided 8.1 million tons of carbon dioxide emissions, the equivalent of taking about 1.4 million cars off the road

Clean Energy States Alliance (CESA)

The ***Clean Energy States Alliance (CESA)*** is a national nonprofit organization that works with state leaders, federal agencies, industry players, and other stakeholders to advance policies that effectively address financing challenges, drive technological innovation, grow green jobs and industry development, and raise public support and demand for renewable energy and energy efficiency. CESA's members include state and municipal clean energy programs and public benefit funds. The group has 15 core members and ten affiliate members and since 1998, CESA members have invested nearly $3.4 billion that has led to more than 130,000 renewable energy projects.

In 2010, CESA was funded by the DOE's Fuel Cell Technologies Office to create a series of briefing papers on fuel cells and hydrogen technologies. The papers were compiled into one report, ***Fuel Cells: Briefing Papers for State Policymakers***, published in August 2011, and although a few years old, they still provide relevant information about fuel cells and their benefits and applications, with a focus on how state legislators and stakeholders can implement policies to support fuel cells, and includes several successful examples.

With many countries looking to strengthen the electric grid and harvest renewable resources such as wind and solar, energy storage is becoming a hot topic around the world. To address this, CESA also has partnered with the Connecticut Center for Advanced Technologies (CCAT) and other regional organizations to promote the NEESC.

Northeast Electrochemical Energy Storage Cluster (NEESC)

Fuel cells are electrochemical devices. In 2010 the U.S. Small Business Administration provided funding to CCAT to create the NEESC, a network of industry, academic, government and non-governmental organizations to support the electrochemical energy industry in the Northeast United States. The states involved include **Maine, New Hampshire, Vermont, Connecticut, Rhode Island, New York** and **New Jersey**. CCAT is working with other state partners including Maine's Hydrogen Energy Center, New Energy New York, CESA, and the Massachusetts Industry Stakeholders. The cluster is focused on businesses that provide the innovative development, production, promotion and deployment of hydrogen fuels and fuel cells to meet the demand for energy storage solutions.

	ME	NH	VT	MA	RI	CT	NY	NJ
Energy Policy for Fuel Cells								
Mandatory Renewable Portfolio Standard (RPS)	Eligible	Eligible		Eligible	Eligible if renewable	Eligible	Eligible	Eligible if renewable
Net Metering	Eligible	Eligible	Eligible if renewable	Eligible	Eligible if renewable	Eligible	Eligible	Eligible if renewable
Public Benefits Fund	Eligible		Eligible if renewable	Eligible	Eligible if renewable	Eligible	Eligible	Eligible if renewable
State Incentives for Fuel Cells								
Performance-Based Power Purchase	Eligible				Eligible if renewable	Eligible	Eligible	
State Grant Program		Eligible if renewable	Eligible if renewable		Eligible	Eligible		Eligible
State Loan Program			Eligible if renewable		Eligible if renewable	Eligible		
Property Tax Incentive (Commercial)			Eligible if renewable			Eligible		Eligible
Sales Tax Incentive			Eligible if renewable			Eligible	Eligible	
Property-Assessed Clean Energy (PACE) Financing						Eligible	Eligible	Eligible if renewable
State Incentives for Hydrogen Fuel								
Zero Emission Vehicle Program (FCEV/H_2 Infrastructure)			Eligible	Eligible	Eligible	Eligible	Eligible	

Eligible Eligible if renewable

NEESC also supports the development of fuel cells and hydrogen Infrastructure, and deployment of FCEVs.

The states involved in NEESC are some of the leaders with regards to fuel cell installations, industry and support.

The NEESC has completed several fuel cell-focused projects. In 2012, they published extensive ***Hydrogen and Fuel cell Development Plans***, and ***updated monographs*** for each of its states that provides localized data on key target markets for both stationary and transportation applications to help stakeholders realize the energy, economic, and environmental potential in the region. They also highlight each state's fuel cell, hydrogen and related supply chain industry to show current economic impacts on the state, generating millions of dollars in revenues, investment, taxes and product exports as well as helping increase direct and indirect job growth.

To help stakeholders utilize the information in the reports, NEESC also developed an online ***Supply Chain Database*** that allows searches by major category, by state, key words, geographic radius search.

Zero Emission Vehicle States

In October 2013, the governors of **California, Connecticut, Massachusetts, Maryland, New York, Oregon, Rhode Island,** and **Vermont** signed a ***MOU*** agreeing to coordinate actions to support and ensure the successful implementation of their state's ZEV programs that support battery and fuel cell vehicles. Collectively these states committed to having at least 3.3 million ZEVs operating on their roadways by 2025.

In May 2014, the collaboration's Program Implementation Task Force published a ***Multi-State ZEV Action Plan*** to develop infrastructure, coordinated policies, codes and standards and a consumer market primed to put 3.3 million ZEVs on the road by 2025.

Actions include:

- Providing consumer incentives to enhance the ZEV ownership experience.
- Leading by example through increasing ZEVs in state, municipal, and other public fleets.
- Encouraging private fleets to purchase, lease, or rent ZEVs.
- Promoting ZEV infrastructure planning and investment by public and private entities.
- Removing barriers to ZEV charging and fueling stations.
- Removing barriers to the retail sale of electricity and hydrogen as transportation fuels.

The coalition is facilitated by the Northeast States for Coordinated Air Use Management (NESCAUM), a nonprofit association of state environmental agencies in the Northeast. NESCAUM recently joined H_2USA, a public-private partnership organized by DOE and others to promote the commercial introduction and widespread adoption of FCEVs and hydrogen fueling infrastructure, in support of the coalition and its member states.

Pacific Coast Action Plan on Climate and Energy

In October 2013, Governors from **California, Oregon** and **Washington** joined with the British Columbia, Canada, Premier to sign the ***Pacific Coast Action Plan*** on Climate and Energy, a regional agreement to strategically align policies to reduce GHGs and promote clean energy. The agreement specifically mentions expanding the use of ZEVs, aiming for 10 percent of new public and private fleet vehicle purchases by 2016.

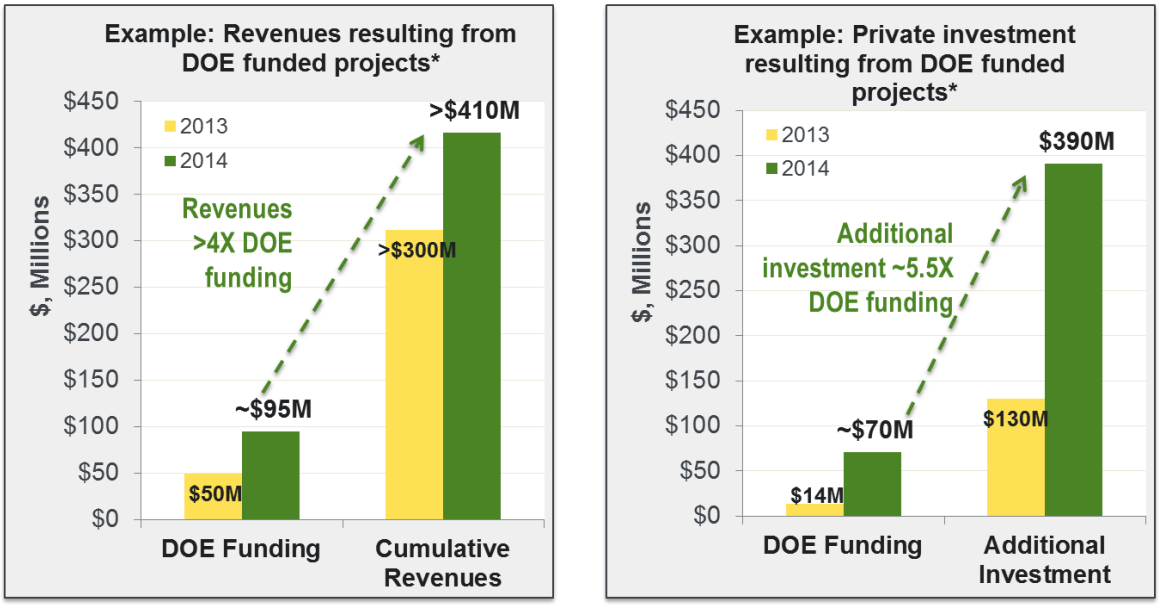
Regional Greenhouse Gas Initiative

The Regional Greenhouse Gas Initiative (RGGI) is a ten-state effort to cap and reduce CO_2 emissions from the power sector. States involved include **Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island,** and **Vermont** and according to RGGI's 2012 Program Review, the goal is to stabilize and cap CO_2 emissions at 91 million short tons in 2014. The cap then declines 2.5% each year from

2015 to 2020. The states sell nearly all emission allowances through auctions and invest proceeds in energy efficiency, renewable energy, and other consumer benefit programs.

Federal Fuel Cell Dollars Flowing to States

DOE's EERE Fuel Cell Technologies Office (FCTO) supports hundreds of RD&D projects with fuel cell companies, universities, national laboratories and other stakeholders around the United States. This support has led to more than 450 patents, 42 commercial hydrogen and fuel cell technologies and 65 emerging technologies, as



Source: U.S. Department of Energy

well as significant progress in reducing cost and increasing durability and efficiency. DOE-funded projects have resulted in more than $700 million in revenues in 2013 and 2014 and more than $500 million in private investment in those years.

Funds are awarded through formal requests for proposals and solicitations on specific topics and via the Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) program.

Since our last report, the FCTO has selected projects for more than $42 million in funding to support RD&D projects around the country focused on hydrogen production, storage and delivery, including composite materials and components and fuel cell industrial vehicle demonstrations. Many of these projects have been awarded and others are in the award recognition phase, anticipated to be awarded within the next few months.

U.S. DOE Funding Awards Since Last Report (Alphabetical by State)			
Company	City/State	Funding Amount	Project
Arizona			
Amsen Technologies, LLC	Tucson	$150,000	FY 2014 SBIR/STTR Phase 1 Release 1 - High-performance proton exchange membranes for electrolysis cells.

California			
Ardica	San Francisco	$1.2 million	To transition and scale-up a low-cost production process for the production of aluminum hydride, a potential high-capacity hydrogen storage material.
HRL Laboratories	Malibu	$1 million	To develop high capacity reversible hydrogen storage materials that have properties needed for practical hydrogen storage applications.
Lawrence Livermore National Laboratory	Livermore	$1.2 million	To develop a reversible, high-capacity storage material that can bond to and release hydrogen in a vehicle, reducing the amount of hydrogen that needs to be pumped in the tank.
Materia	Pasadena	$2 million	To reduce the cost of compressed hydrogen storage systems. The project will demonstrate a novel resin system that reduces the use of expensive carbon fiber composites for high pressure storage tanks.
Sandia National Laboratory	Livermore	$1.2 million	To systematically screen low cost alternative materials for use in hydrogen storage systems.
		$2.2 million	To develop a high-efficiency solar thermochemical reactor for solar hydrogen production.
US Hybrid	Torrance	$149,562	FY 2014 SBIR/STTR Phase 1 Release 2 - to develop a proof-of-concept design approach for a fuel cell-battery electric hybrid truck for waste transportation.
Vision Industries Corporation	Long Beach	$148,746	FY 2014 SBIR/STTR Phase 1 Release 2 awards to also develop a proof-of-concept design approach for a fuel cell electric truck for waste transportation.
Colorado			
Composite Technology Development, Inc.	Lafayette	$999,927	FY 2014 SBIR Phase II Release 3 - Optimizing the Cost and Performance of Composite Cylinders for H2 Storage using a Graded Construction.
National Renewable Energy Laboratory	Golden	$3 million	To develop high-efficiency tandem absorbers based on novel semiconductor materials that can produce hydrogen from water using solar energy.
University of Colorado, Boulder	Boulder	$2 million	To develop a novel solar-thermal reactor to split water with concentrated sunlight.
Connecticut			
FuelCell Energy	Danbury	$3 million	To increase U.S. competitiveness in the fuel cell market by enhancing the performance, increasing the lifespan, and decreasing the cost of stationary fuel cells being used for DG and CHP applications
		$900,000	To develop a novel hybrid system for low-cost, low greenhouse gas hydrogen production.
Georgia			
Center for Transportation and the Environment (CTE)	Atlanta	$3 million	To develop a fuel cell hybrid electric walk-in delivery van with a 150-mile range per fueling. The project will also retrofit 15 UPS delivery vans with fuel cell hybrid power trains and test them at UPS distribution facilities across California.

Hawaii			
University of Hawaii	Honolulu	$3 million	To develop photoelectrodes for direct solar water splitting.
Massachusetts			
Giner, Inc.	Newton	$1,149,984	FY 2014 SBIR/STTR Phase I Release 1 - developing a water electrolysis process that can provide high-pressure hydrogen straight to storage tanks or vehicles.
		$149,949	FY 2014 SBIR/STTR Phase I Release 2 - Ionomer Dispersion Impact on Advanced Fuel Cell and Electrolyzer Performance and Durability. This was the first-of-its-kind award under a new EERE SBIR technology-to-market topic "Technology Transfer Opportunity: EERE/LAN" that moves existing inventions developed at DOE's national laboratories to the marketplace.
GVD Corp.	Cambridge	$149,830	FY 2014 SBIR/STTR Phase I Release 1 - developing improved plastic and elastomer seal coatings to enable reliable performance of hydrogen systems.
Nuvera Fuel Cells, Inc.	Billerica	$1.5 million	To design and demonstrate a high-pressure hydrogen dispenser for fuel cell electric vehicle fueling.
New Jersey			
Treadstone Technologies	Princeton	$991,774	DOE FY2014 SBIR Phase II Release 3 - Novel Structured Metal Bipolar Plates for Low Cost Manufacturing.
North Carolina			
PPG Industries	Greensboro	$1.2 million	To demonstrate a novel high strength glass fiber that is stronger than the carbon fibers used today at half of the cost.
Pennsylvania			
Air Products and Chemicals, Inc.	Lehigh	$900,000	To develop a cost-effective tube trailer for hydrogen delivery and storage that can withstand high pressures and test it at hydrogen fueling stations in southern California.
South Carolina			
Tetramer Technologies, LLC	Pendleton	$150,000	FY 2014 SBIR/STTR Phase I Release 1 - leveraging membrane technology developed through a previous EERE membrane humidifier project to design improved PEM electrolyzer ion exchange membranes.
Tennessee			
FedEx Express	Memphis	$3 million	To develop a hydrogen fuel cell delivery truck with a range of up to 150 miles per fueling and to test 20 of these trucks at FedEx facilities in Tennessee and California.
Oak Ridge National Laboratory	Oak Ridge	$2 million	To demonstrate a low cost, steel concrete composite vessel for high pressure hydrogen storage.
Texas			
Southwest Research Institute	San Antonio	$1.8 million	To demonstrate a hydrogen compression system.
Virginia			
Wiretough Cylinders LLC	Bristol	$2 million	To demonstrate a low cost, high pressure hydrogen storage vessel using a steel wire overtrap.

Washington			
Pacific Northwest National Laboratory	Richland	$2.2 million	To develop a reactor for hydrogen production from bio-derived liquids.

Last year, DOE led the launch of H2USA, a public-private partnership focused on advancing hydrogen infrastructure to support more transportation energy options for U.S. consumers, including FCEVs. In April 2014, to help support H2USA activities, the FCTO also established the Hydrogen Fueling Infrastructure Research and Station Technology (H2FIRST) project, a collaborative effort between Sandia National Laboratories (SNL) and the National Renewable Energy Laboratory (NREL) to demonstrate hydrogen refueling technologies and infrastructure, reduce the cost and time of new fueling station construction and improve the stations' availability and reliability. Two research facilities, Sandia's Center for Infrastructure Research and Innovation and NREL's Energy Systems Integration Facility, will serve as hubs for H2FIRST.

As part of a DOE-supported project, Massachusetts fuel cell manufacturer Acumentrics tested two of its 250 watt SOFCs to power some of the remote broadcast cameras and two 1 kW SOFCs to power lights in pit row at the 2014 ***Daytona 500***, the first race in the NASCAR Sprint Cup series. The fuel cells ran on propane, which can be bought easily at most gas stations, home improvement stores and other outlets, and run a lot longer than a conventional gasoline-powered generator on a comparable amount of fuel. NASCAR estimates it could save more than $2,000 per race weekend by replacing gasoline-powered generators with fuel cells - a savings of $77,000 over the course of the season.

In July 2014, the U.S. Department of Commerce's National Institute of Standards (NIST) awarded $100,000 to the Rochester Institute of Technology's Golisano Institute for Sustainability to fund the final phase of fuel cell research designed to create a prototype residential power system.

ARPA-E Advancing DG

The Advanced Research Projects Agency-Energy (ARPA-E) was formally established at DOE in 2009. It advances high-potential, high-impact energy technologies that are too early for private-sector investment. The program has funded various fuel cell research projects over the years and in June 2014, awarded $33 million in funding for 13 new projects under its Reliable Electricity Based on ELectrochemical Systems (REBELS) program which is aimed at developing transformational fuel cell technologies for low-cost distributed power generation.[53] The projects, highlighted in the chart below, are focused on improving grid stability, balancing intermittent renewable technologies, and reducing CO_2 emissions using electrochemical distributed power generation systems.

U.S. DOE ARPA-E June 2014 REBELS Program Awards (Alphabetical by State)			
Company	**City/State**	**Funding Amount**	**Project**
California			
Palo Alto Research Center	Palo Alto	$1.5 million	*Reformer-less Fuel Cell* - develop an intermediate-temperature fuel cell capable of utilizing a wide variety of carbon-based input fuels.
SAFCell	Pasadena	$3.7 million	*Solid Acid Fuel Cell Stack* - develop solid acid fuel cells that will operate at 250°C and use new catalysts based on carbon nanotubes and metal organic frameworks.
University of California Los Angeles	Los Angeles	$1 million	*Fuel Cells with Dynamic Research Capability* - develop a low-cost, intermediate-temperature fuel cell that will use new metal-oxide electrode materials.
Colorado			
Colorado School of Mines	Golden	$1 million	*Fuel-Flexible Protonic Ceramic Fuel Cell Stack* - develop a mixed proton and oxygen ion conducting electrolyte that allows a fuel cell to operate at temperatures less than 500°C.

[53] http://arpa-e.energy.gov/sites/default/files/documents/files/REBELS%20project%20descriptions_FINAL%20AS%20ISSUED_06172014.pdf

Connecticut			
FuelCell Energy	Danbury	$3.5 million	*Liquid Fuels and Electricity from Intermediate-Temperature Fuel Cells* - develop an intermediate-temperature fuel cell that will directly convert methane to methanol and other liquid fuels using advanced metal catalysts.
United Technologies Research Center	East Hartford	$3.2 million	*Metal Supported Proton Conducting Solid Oxide Fuel Cell Stack* - develop an intermediate-temperature fuel cell for residential applications that will combine a building's heating and power systems into one unit.
Georgia			
Georgia Tech Research Corporation	Atlanta	$1 million	*Fuel Cell Tailored for Efficient Utilization of Methane* - develop a fuel cell that operates at temperatures less than 500°C by integrating nanostructured materials into all cell components.
Illinois			
Argonne National Laboratory	Argonne	$2 million	*Hybrid Fuel Cell System for Converting Natural Gas to Electricity and Liquid Fuels* - develop a hybrid fuel cell technology that will both generate electricity and produce liquid fuel.
Maryland			
Redox Power Systems	Fulton	$5 million	*Low-Temperature Solid Oxide Fuel Cells* - develop a fuel cell with a mid-temperature operating target of 400°C while maintaining high power density and enabling faster cycling.
Massachusetts			
SiEnergy Systems	Cambridge	$2.65 million	*Hybrid Fuel Cell-Battery Electrochemical System* - develop a hybrid electrochemical system that uses a multi-functional electrode to allow the cell to perform as both a fuel cell and a battery.
South Carolina			
University of South Carolina	Columbia	$3.2 million	*Bi-functional Ceramic Fuel Cell Energy System* - develop an intermediate-temperature, ceramic-based fuel cell, that will incorporate a newly discovered ceramic electrolyte and nanostructured electrodes that enable it to operate at temperatures lower than 500˚C.
Tennessee			
Oak Ridge National Laboratory	Oak Ridge	$2.75 million	*Nanocomposite Electrodes for a Solid Acid Fuel Cell Stack* - redesign a fuel cell electrode that operates at 250°C using highly porous carbon nanostructures that dramatically increase the amount of surface area, lowering the amount of expensive platinum catalysts used in the cell.
Utah			
Materials & Systems Research, Inc.	Salt Lake City	$2.8 million	*Electrogenerative Cells for Flexible Cogeneration of Power and Liquid Fuel* - develop an intermediate-temperature fuel cell capable of electrochemically converting natural gas into electricity or liquid fuel in a single step.

Stationary Fuel Cells Strengthen Grid, Reduce Emissions

Fuel cells are powering businesses, data centers, universities, power stations, telecommunications towers and switching stations, around the country. Since our last report, more than 43 MW of fuel cells have been installed or ordered in California, Connecticut, Maryland, Nebraska, New Jersey and New York.

Stationary Fuel Cell Installations/Orders Since Last Report (Alphabetical by State)				
Location	**Customer**	**Fuel Cell Provider**	**Size/# of Units**	**Notes**
California				
Chino	Chino Valley Medical Center	Bloom Energy	600 kW	Installed in March 2014, the fuel cell system reduces the facility's carbon footprint by 22%.
Irvine	University of California, Irvine Medical Center	FuelCell Energy	1.4 MW	Ordered June 2014, the fuel cell will generate about 30% of facility power needs; excess heat produced will be used in a direct exhaust absorption chiller to produce 200 tons of cooling for an office building and associated institutional requirements.
Pittsburg	Ramar Foods	Bloom Energy	200 kW	Provides 65% of electricity needs for the food-manufacturing plant.
San Diego	Hines/LPL Financial	Bloom Energy	500 kW	Largest net-zero energy commercial office building in the U.S. The surplus power generated is delivered back to the grid through San Diego Gas & Electric.
San Jose	Kellogg	Bloom Energy	1 MW	Installed at Eggo® bakery.
Santa Clara County	Washington Gas Energy Systems/WGL Holdings	Bloom Energy	2.6 MW	WGES will finance, build, own and operate the fuel cell system and sell all energy generated to SCC under a 20-year power purchase agreement.
Sunnyvale	Yahoo!	Bloom Energy	1 MW	Provides one-third of the electricity for Yahoo!'s campus.
Connecticut				
Bridgeport	United Illuminating	FuelCell Energy	Two 2.8 MW units	Part of a distributed renewable power generation project that also includes a solar array.
Bridgeport	University of Bridgeport	FuelCell Energy	1.4 MW	Will supply about 80% of the campus power needs.
New Haven	United Illuminating	FuelCell Energy	Two 2.8 MW units	Will be located in the port area of the city near an electrical substation owned by UI and will provide continuous power to the substation.
Delaware				
Newark	JPMorgan Chase	Bloom Energy	500 kW	Provides support power to its data centers.
Maryland				
Fort Meade	NSA Campus	Bloom Energy	1.6 MW	Installed at NSA Campus located at Fort Meade.

Nebraska				
Omaha	First National Bank of Omaha	ClearEdge Power	400 kW	Replaces one of the longest running fuel cell installations (since 1999) with a next generation unit. FNBO was the first data center in the world to generate power via fuel cells. The fuel cell is installed in the main floor of the building.
New Jersey				
Basking Ridge	Verizon	ClearEdge Power	2 MW	5 fuel cells and solar panels provide 66% of the energy used at Verizon's flagship operations center.
New York				
Brooklyn	Verizon	ClearEdge Power	1.6 MW total	400 kW at 2 Verizon office buildings (Clinton Ave., Rockaway Ave.) and 800 kW at another (Meserole St.) Qualifies for NYSERDA's maximum capacity $200,000 incentive. Also qualifies for performance payments for three years post installation with a maximum total incentive of $1,000,000 per site.
Elmsford		N/A	800 kW	Awarded NYSERDA funding in 2013.
Jamaica	Verizon	ClearEdge Power	800 kW	Office building. Qualifies for NYSERDA's maximum capacity $200,000 incentive. Also qualifies for performance payments for three years post installation with a maximum total incentive of $1,000,000.
Mt. Vernon	Stop & Shop	Bloom Energy	300 kW	Bloom was awarded NYSERDA funding in 2013.
Rego Park	AT&T	Bloom Energy	500 kW	Bloom was awarded NYSERDA funding in 2013.
Rochester	Rochester Institute of Technology	ClearEdge Power	400 kW	Qualifies for NYSERDA's maximum capacity $200,000 incentive. Also qualifies for performance payments for three years post installation with a maximum total incentive of $1,000,000.
Staten Island	Verizon	ClearEdge Power	400 kW	Office building. Qualifies for NYSERDA's maximum capacity $200,000 incentive. Also qualifies for performance payments for three years post installation with a maximum total incentive of $1,000,000.
White Plains	AT&T	Bloom Energy	1.5 MW total	Bloom was awarded NYSERDA funding in 2013 for two AT&T buildings.
Various Locations				
California, Connecticut, New Jersey, New York	Exelon	Bloom Energy	21 MW	Exelon plans to fund the deployment of 21 MW of Bloom Energy fuel cells (more than 100 individual fuel cell units) for two customers across 75 commercial locations. One customer has been identified as AT&T.
N/A	Sprint	Altergy Systems, CommScope Inc., First Element Energy LLC, and ReliOn Inc.	N/A	Sprint received $250,000 from DOE to deploy fuel cell-powered backup power systems for rooftop telecommunications equipment.

Transportation Helping Drive Industry Growth

Fuel cells are powering cars, buses, ships, planes, trains, forklifts, and other transport technologies. Since our last report, the first commercial FCEVs were placed in the hands of customers in April 2014 with Hyundai beginning to lease its FCEV in Southern California. Toyota and Honda will start small-scale rollouts in Japan, Germany and California in 2015. Fuel cell bus demonstrations are continuing with many buses operating in revenue service in states around the country.

Alabama's Birmingham-Jefferson County Transit Metro Area Express (MAX) in Birmingham received a fuel cell bus from the Center for Transportation and the Environment (CTE) for regular daily use as part of a two year demonstration project. The bus was funded by the FTA's National Fuel Cell Bus Program.

In California, CALSTART signed an agreement with fuel cell manufacturer Ballard Power Systems to deploy a fuel cell hybrid bus in 2015 at the University of California campus in Irvine, together with partners BAE Systems, ElDorado National and the University of California, Irvine.

The CEC approved a $1.1 million grant to CTE to develop and deploy fuel cell hybrid electric walk-in delivery vans. This grant will supplement the $3 million CTE is receiving from DOE for the project, which will develop a fuel cell hybrid electric walk-in delivery van with a 150-mile range per fueling and also retrofit 15 UPS delivery vans with fuel cell hybrid power trains and test them at UPS distribution facilities across California. CTE is working with the University of Texas Center for Electromechanics, Electric Vehicles International of Stockton, California, Hydrogenics USA, located in San Diego, California, and Valence Technology of Austin, Texas.

DOE is also funding FedEx Express, headquartered in Memphis, Tennessee, on a similar project, providing $3 million to develop a hydrogen fuel cell delivery truck with a range of up to 150 miles per fueling. FedEx will test 20 of these trucks at its facilities in Tennessee and California and is partnering with Plug Power and Smith Electric Vehicles of Kansas City, Missouri, on the project.

US Hybrid was awarded a contract by the HCATT to design, integrate, and deliver its H2Ride™ Fuel Cell Plug-In Shuttle Bus for operation by the County of Hawaii MTA's HELE-ON Big Island bus service. The project is funded by the State of Hawaii and the Office of Naval Research via the HHNEI. Integrated at US Hybrid's Honolulu facility, the 25-passenger shuttle bus utilizes a 30-kW fuel cell fueled by a 20-kg hydrogen storage and delivery system.

The city of North Augusta, South Carolina, obtained a fuel cell bus that started operation in January 2014.

Material Handling Lifting U.S.

The U.S. is still by far the leader with regards to fuel cell-powered material handling vehicles. Major corporations such as Sysco, Walmart, BMW, Coca-Cola, FedEx and others are adding to and in some cases, replacing their battery forklift and lift truck fleets around the country with fuel cells. Since our last report, there have been only three public announcements but for more than 2,300 units, bringing the total of fuel cell forklifts deployed or on order in the U.S. to more than 8,000.[54]

Fuel Cell Forklift Deployments/Orders Since Last Report				
Location	Customer	Fuel Cell Provider	Size/# of Units	Notes
Joliet, IL	Central Grocers	Plug Power	182	Replacing original fleet of fuel cell-powered forklifts after operating for >2 million hours

[54] http://hydrogen.energy.gov/pdfs/14010_industry_lift_truck_deployments.pdf

Various locations, including Johnstown, NY, Pottsville, PA and Sterling, IL	Walmart	Plug Power	2,069	For fuel cell-forklifts to be deployed over two years at 7 North American distribution centers.
West Jefferson, OH	Ace Hardware	Plug Power	60+	For new distribution center currently under construction.

In our 2013 report, we covered Ace Hardware's purchase of 65 GenDrive® fuel cell units from Plug Power for class-2 and class-3 lift and reach trucks to operate at its newest Retail Support Center, then under construction in Wilmer, Texas. As of June 2014, the fuel cell-powered vehicles have been operating at the recently completed 450,000 square-foot (sq-ft) building for three months. The company has been so pleased with the way the fuel cells have performed that Ace has decided to deploy additional fuel cell forklifts at another new 534,000 sq-ft distribution center being built in West Jefferson, Ohio. Once that facility is completed, Ace Hardware will have more than 130 fuel cell-powered material handling vehicles in its fleet.

Fueling Infrastructure Support

The hydrogen infrastructure to support FCEVs is starting to emerge. To fuel material handling vehicles at warehouses and distribution centers, companies are installing hydrogen dispensers throughout the facilities. There are several DOE demonstration projects of various vehicles (see above) that are utilizing mobile hydrogen refuelers or installing stations to support them.

All of the hydrogen fueling stations for FCEVs opened or funded since our last report have been located in California. The CEC awarded $46.6 million via the ARFVTP for 28 new public hydrogen stations and one mobile refueler. This will add 13 new stations in Northern California and 15 in Southern California, with six of the stations offering 100% renewable hydrogen.

Hydrogen Fueling Stations Opened or Funded in California Since Last Report			
Location	**Hydrogen Provider**	**CEC Funding (if applicable)**	**Notes**
Campbell	FirstElement Fuel, Inc.	$1,451,000	Part of CEC's May 2014 Hydrogen Refueling Station Development Grants – planned operational date is October 31, 2015.
Coalinga	FirstElement Fuel, Inc.	$1,451,000	Part of CEC's May 2014 Hydrogen Refueling Station Development Grants – planned operational date is October 31, 2015.
Costa Mesa	FirstElement Fuel, Inc.	$1,451,000	Part of CEC's May 2014 Hydrogen Refueling Station Development Grants – planned operational date is October 31, 2015.
Hayward	FirstElement Fuel, Inc.	$1,451,000	Part of CEC's May 2014 Hydrogen Refueling Station Development Grants – planned operational date is October 31, 2015.
Laguna Niguel	FirstElement Fuel, Inc.	$1,451,000	Part of CEC's May 2014 Hydrogen Refueling Station Development Grants – planned operational date is October 31, 2015.
Lake Forest	FirstElement Fuel, Inc.	$1,451,000	Part of CEC's May 2014 Hydrogen Refueling Station Development Grants – planned operational date is October 31, 2015.
La Canada Flintridge	FirstElement Fuel, Inc.	$1,451,000	Part of CEC's May 2014 Hydrogen Refueling Station Development Grants – planned operational date is October 31, 2015.
Long Beach	FirstElement Fuel, Inc.	$1,451,000	Part of CEC's May 2014 Hydrogen Refueling Station Development Grants – planned operational date is October 31, 2015.

Los Angeles (Cal State)	Hydrogenics	N/A	Opened May 2014 at the University's Hydrogen Research and Fueling Facility, the largest university-operated hydrogen station of its kind in the U.S. Financial backing came from the California Air Resources Board, DOE, the CA South Coast Air Quality Management District, the Mobile Sources Air Pollution Reduction Review Committee, the Ahmanson Foundation, and the Automobile Club of Southern California.
Los Angeles (Hollywood Boulevard)	FirstElement Fuel, Inc.	$1,451,000	Part of CEC's May 2014 Hydrogen Refueling Station Development Grants – planned operational date is October 31, 2015. Station will be 100% renewable.
Los Angeles (Lincoln Boulevard)	FirstElement Fuel, Inc.	$1,451,000	Part of CEC's May 2014 Hydrogen Refueling Station Development Grants – planned operational date is October 31, 2015. Station will be 100% renewable.
Oakland	Linde LLC	$2,125,000	Part of CEC's May 2014 Hydrogen Refueling Station Development Grants – planned operational date is October 31, 2015.
Ontario	Ontario CNG Station, Inc.	$2,125,000	Part of CEC's May 2014 Hydrogen Refueling Station Development Grants – planned operational date is October 31, 2015.
Orange	HyGen Industries, LLC	$1,768,938	Part of CEC's May 2014 Hydrogen Refueling Station Development Grants – planned operational date is October 31, 2015. Station will be 100% renewable.
Pacific Palisades	HyGen Industries, LLC	$1,768,938	Part of CEC's May 2014 Hydrogen Refueling Station Development Grants – planned operational date is October 31, 2015. Station will be 100% renewable.
Palo Alto	Air Liquide Industrial US LP	$2,125,000	Part of CEC's May 2014 Hydrogen Refueling Station Development Grants – planned operational date is October 31, 2015. Station will be 100% renewable.
Redwood City	FirstElement Fuel, Inc.	$1,451,000	Part of CEC's May 2014 Hydrogen Refueling Station Development Grants – planned operational date is October 31, 2015.
Riverside	ITM Power, Inc.	$2,125,000	Part of CEC's May 2014 Hydrogen Refueling Station Development Grants – planned operational date is October 31, 2015.
Rohnert Park	HyGen Industries, LLC	$1,768,938	Part of CEC's May 2014 Hydrogen Refueling Station Development Grants – planned operational date is October 31, 2015. Station will be 100% renewable.
San Diego	FirstElement Fuel, Inc.	$1,451,000	Part of CEC's May 2014 Hydrogen Refueling Station Development Grants – planned operational date is October 31, 2015.
San Jose	FirstElement Fuel, Inc.	$1,451,000	Part of CEC's May 2014 Hydrogen Refueling Station Development Grants – planned operational date is October 31, 2015.
San Ramon	Linde LLC	$2,125,000	Part of CEC's May 2014 Hydrogen Refueling Station Development Grants – planned operational date is October 31, 2015.
Santa Barbara	FirstElement Fuel, Inc.	$1,451,000	Part of CEC's May 2014 Hydrogen Refueling Station Development Grants – planned operational date is October 31, 2015.
Saratoga	FirstElement Fuel, Inc.	$1,451,000	Part of CEC's May 2014 Hydrogen Refueling Station Development Grants – planned operational date is October 31, 2015.
South Pasadena	FirstElement Fuel, Inc.	$1,451,000	Part of CEC's May 2014 Hydrogen Refueling Station Development Grants – planned operational date is October 31, 2015.
South San Francisco	FirstElement Fuel, Inc.	$1,451,000	Part of CEC's May 2014 Hydrogen Refueling Station Development Grants – planned operational date is October 31, 2015.

Torrance	Air Products and Chemicals, Inc.	N/A	Opened in March 2014 at Honda's R&D headquarters. This SmartFuel® branded station was completed in just seven months.
Truckee	FirstElement Fuel, Inc.	$1,451,000	Part of CEC's May 2014 Hydrogen Refueling Station Development Grants – planned operational date is October 31, 2015.
Woodside	Hydrogen Technology & Energy Corporation (HTEC)	$2,125,000	Part of CEC's May 2014 Hydrogen Refueling Station Development Grants – planned operational date is October 31, 2015.
Various (mobile refueler)	Institute of Gas Technology	$999,677	Part of CEC's May 2014 Hydrogen Refueling Station Development Grants – planned operational date is August 2015.

FirstElement Fuel, which received the lion's share of the funding, and HyGen Industries, are both California-grown startup companies. Rather than build an entirely new station from the ground up, both companies select existing gas station locations and co-locate hydrogen fueling equipment there.

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Page 46 (graphic): Northeast Electrochemical Energy Storage Cluster
Page 48 (graphic): U.S. Department of Energy

Appendix 1 – State Summary Chart

The following is a quick reference guide to current state fuel cell and hydrogen activity. For the purposes of this chart, the headings refer to:

Supportive Policies: Active RPS, net-metering, interconnection standards, funding, tax credits, etc.

Vehicles: Light duty vehicles, buses, material handling vehicles deployed or on order

Installations: Large and small stationary installations currently in operation or on order

DOE-Funding: Any 2013/2014 funding from DOE for fuel cell/hydrogen research, demonstration and deployment to industry or universities in that state

Collaboration: Working with any other state or region to advance fuel cells and hydrogen in the U.S.

States at a Glance – Fuel Cell & Hydrogen Support					
State	Policies	Vehicles	Installations	DOE-Funding	Collaboration
Alabama		X			
Alaska					
Arizona				X	
Arkansas					
California	X	X	X	X	X
Colorado		X		X	
Connecticut	X	X	X	X	X
Delaware		X	X		X
Florida		X		X	
Georgia		X		X	
Hawaii		X		X	
Idaho					
Illinois		X		X	
Indiana					
Iowa					
Kansas		X			
Kentucky		X			
Louisiana		X			
Maine					X
Maryland		X	X	X	X
Massachusetts	X	X		X	X
Michigan		X			
Minnesota				X	
Mississippi					
Missouri		X			
Montana					
Nebraska			X		
Nevada					
New Hampshire					X
New Jersey	X	X	X	X	X

New Mexico					
New York		X	X		X
North Carolina		X		X	
North Dakota					
Ohio		X		X	
Oklahoma					
Oregon	X				X
Pennsylvania	X	X		X	
Rhode Island	X	X			X
South Carolina	X	X		X	
South Dakota					
Tennessee		X		X	
Texas		X		X	
Utah			X	X	
Vermont	X				X
Virginia		X	X	X	
Washington			X		X
West Virginia				X	
Wisconsin			X		
Wyoming			X		

Appendix 2 – Additional Resources

Database of State Incentives for Renewables & Efficiency (DSIRE)

DSIRE is a comprehensive source of information on state, local, utility and federal incentives and policies that promote renewable energy and energy efficiency. Established in 1995 and funded by the U.S. Department of Energy (DOE), DSIRE is an ongoing project of the N.C. Solar Center and the Interstate Renewable Energy Council. ***www.dsireusa.org***.

State and Regional Fuel Cell and Hydrogen Associations/Coalitions

California Fuel Cell Partnership – ***www.cafcp.org***
California Hydrogen Business Council – ***www.californiahydrogen.org***
California Stationary Fuel Cell Collaborative – ***www.casfcc.org***
CT Hydrogen-Fuel Cell Coalition – ***www.chfcc.org***
Fuel Cell and Hydrogen Energy Association – ***www.fchea.org***
Massachusetts Hydrogen Coalition – ***http://massh2.org***
Ohio Fuel Cell Coalition – ***www.fuelcellcorridor.com***
South Carolina Hydrogen and Fuel Cell Alliance – ***www.schydrogen.org***

Clean Energy States Alliance (CESA)

CESA Core Members

Alaska Energy Authority (AEA)
California Energy Commission (CEC)
Clean Energy Finance and Investment Authority (CEFIA) (Connecticut)
District Department of the Environment, Energy Administration - D.C. (DDOE)
Energy Trust of Oregon
Long Island Power Authority (LIPA)
Maryland Energy Administration (MEA)
Massachusetts Clean Energy Center (MassCEC)
New Hampshire Public Utilities Commission - Sustainable Energy Division
New Jersey Clean Energy Program (NJCEP)
New York State Energy Research & Development Authority (NYSERDA)
Ohio Development Services Agency - Office of Energy
Rhode Island Office of Energy Resources
Sacramento Municipal Utility District (SMUD)
Vermont Public Service Department - Clean Energy Development Fund

CESA Affiliate Members

Alaska Center for Energy and Power
Connecticut Department of Energy and Environmental Protection
Maryland Clean Energy Center
Maryland Department of the Environment
Massachusetts Department of Energy Resources
Massachusetts Department of Environmental Protection
New Mexico State Energy Office- Energy Conservation and Management Division
Oregon Department of Energy
Rhode Island Commerce Corporation
TRF Sustainable Development Fund

DOE Efficiency and Renewable Energy Fuel Cell Technologies Office

The U.S. Department of Energy (DOE) Fuel Cell Technologies Office in the Office of Energy Efficiency & Renewable Energy conducts comprehensive efforts to overcome the technological, economic, and institutional obstacles to the widespread commercialization of fuel cells and related technologies.

http://www1.eere.energy.gov/hydrogenandfuelcells

For more information about any of the information included in this report, please contact Breakthrough Technologies Institute at ***info@fuelcells.org***.

Appendix 3 – Companies Included in the Report

The following is a list of all the companies mentioned in this report with their websites.

Automakers

General Motors – ***www.gm.com/vision/greener_vehicles.html***
Honda – ***http://world.honda.com/FuelCell***
Hyundai – ***www.hyundaiusa.com/tucsonfuelcell***
Toyota – ***www.toyota.com/fuelcell***

Fuel Cell Manufacturers

Acumentrics – ***www.acumentrics.com***
Altergy Systems – ***www.altergysystems.com***
Ballard Power Systems – ***www.ballard.com***
Bloom Energy – ***www.bloomenergy.com***
CommScope – ***www.commscope.com***
ElectroChem – ***www.fuelcell.com***
Electro Power Systems – ***www.electropowersystems.com***
First Element Energy LLC – ***www.firstelementenergy.com***
FuelCell Energy – ***www.fuelcellenergy.com***
Genport srl – ***www.genport.it/our-mission***
Global Energy Innovations – ***http://geifuelcells.com***
Hydrogenics – ***www.hydrogenics.com***
Materials & Systems Research, Inc. – ***http://msrihome.com***
Nuvera Fuel Cells – ***www.nuvera.com***
Oorja Protonics – ***www.oorjaprotonics.com***
Parker Hannifin – ***www.parker.com***
Plug Power – ***www.plugpower.com***
Protonex – ***www.protonex.com***
Redox Power Systems, LLC – ***www.redoxpowersystems.com***
ReliOn – ***www.relion-inc.com***
SAFCell – ***http://safcell.com***
SiEnergy Systems – ***http://sienergysystems.com***
Solid Cell – ***http://solidcell.com***
Technology Management Inc. – ***http://tmi-anywherenergy.com***
Vision Industries Corporation – ***www.visionmotorcorp.com***
VP Energy, LLC – ***http://vpenergy.com***
Watt Fuel Cell Corporation – ***http://wattfuelcell.com***

Hydrogen Generation/Fueling

Air Liquide – ***www.us.airliquide.com***
Air Products and Chemicals, Inc. – ***www.airproducts.com***
FirstElement Fuel, Inc. – ***www.firstelementfuel.com***
HyGen Industries, LLC – ***www.hygen.com***
IGX Group – ***www.igxgroup.com***
Linde North America LLC – ***www.linde.com***
Nuvera Fuel Cells – ***www.nuvera.com***
PDC Machines – ***www.pdcmachines.com***
Proton OnSite – ***www.protononsite.com***

Supply Chain

Ardica – ***www.ardica.com***
Catacel Corp. – ***www.catacel.com***
Composite Technology Development – ***www.ctd-materials.com***
Gas Technology Institute - ***www.gastechnology.org***
Giner, Inc. – ***www.ginerinc.com***
GVD Corp. – ***www.gvdcorp.com***
HRL Laboratories – ***www.hrl.com***
Materia – ***www.materia-inc.com***
NexTech Materials – ***www.nextechmaterials.com/energy/***
PPG Industries – ***www.ppg.com***
Tetramer Technologies – ***www.tetramer.com***
Treadstone Technologies, Inc. – ***www.treadstone-technologies.com***
Wiretough Cylinders LLC – ***www.wiretough.com***

Appendix 4 – Glossary of Energy Regulatory Terms

Definitions courtesy of ***DSIRE*** unless noted.

Distributed Generation (DG)

Small-scale power generation technologies (typically in the range of 3 to 10,000 kilowatts) located close to where electricity is used (for example, a home or business) to provide an alternative to or an enhancement of the traditional electric power system.[55]

Interconnection Standard

Interconnection standards specify the technical and procedural process by which a customer connects an electricity-generating to the grid. Such standards include the technical and contractual terms that system owners and utilities must abide by. State public utilities commissions typically establish standards for interconnection to the distribution grid, while the Federal Energy Regulatory Commission (FERC) has adopted standards for interconnection to the transmission level. While many states have adopted interconnection standards, some states' standards apply only to investor-owned utilities (and not to municipal utilities or electric cooperatives).

Net Metering

For electric customers who generate their own electricity, net metering allows for the flow of electricity both to and from the customer – typically through a single, bi-directional meter. When a customer's generation exceeds the customer's use, electricity from the customer flows back to the grid, offsetting electricity consumed by the customer at a different time during the same billing cycle. In effect, the customer uses excess generation to offset electricity that the customer otherwise would have to purchase at the utility's full retail rate. Net metering is required by law in most U.S. states, but state policies vary widely.

Renewable Portfolio Standard (RPS)

Renewable portfolio standards (RPSs) require utilities to use or procure renewable energy or renewable energy credits (RECs) to account for a certain percentage of their retail electricity sales – or a certain amount of generating capacity – according to a specified schedule. Renewable portfolio goals are similar to RPS policies, but goals are not legally binding. Most U.S. states have established an RPS. 26 states (AZ, CA, CO, CT, DE, HI, IN, KS, ME, MD, MO, MT, NH, NJ, NM, NY, OH, OK, PA, RI, SC, VT WV, WI) and the District of Columbia include hydrogen and/or fuel cells in their RPS.

[55] http://www.energy.ca.gov/glossary/glossary-d.html

Appendix 5 – State Industry Group Survey Responses

California Stationary Fuel Cell Collaborative (CaSFCC)

What motivated the formation of the CaSFCC?

The Collaborative was founded to advance the deployment of stationary fuel cells for distributed generation (DG) and other applications throughout California. Fuel cells facilitate a foundation of clean, efficient, reliable and sustainable power.

What are the organization's missions and goals?

The Collaborative promotes the deployment of fuel cell technologies as a means of reducing or eliminating air pollutants and GHG emissions, increasing energy efficiency, promoting energy reliability and independence, and helping the state of California move closer to realizing a sustainable energy future.

What sort of activities does the CaSFCC engage in?

Outreach, education, reports

What are California's strengths relating to fuel cells and hydrogen?

- California has a long standing history in addressing environmental quality, and establishing the regulation of emissions to this end.
- Environmental focus:
  - Many regions of California are in non-attainment for criteria pollutants like NOx (nitrogen oxides) and PM (particulate matter).
  - Water conservation.
- Electricity is relatively expensive in California. DG is more cost effective in California than in other states.
- State policies promote clean technology like fuel cells.
- Diverse population and high tech universities provide a substantial job pool for technology companies.

Name California's supportive policies or legislation that help the fuel cell industry.

Renewable Electricity Standard, cap and trade, ease of permitting fuel cells versus traditional generation, Self-Generation Incentive Program (SGIP).

Name one or two of CaSFCC's most successful projects

Orange County Sanitation District's renewable Tri-Generation Fuel Cell Project

- Public-Private Partnership
- 27 members (academia, business, government)
- Founded in 2001
- Supported by Industry Advisory Panel member dues

What obstacles or challenges do you face at the state or local level?

- Uncertainty with future regulations and incentives
- Interconnection issues
- Viable natural gas and bio gas feed-in tariffs

What other state or regional groups does the CaSFCC work closely with?

In addition to our Core group members, we work closely with other fuel cell related industry groups including the Fuel Cell Hydrogen and Energy Association, California Fuel Cell Partnership, and California Hydrogen Business Council.

What are the CaSFCC's future plans and strategies to move industry and state forward?

- Provide accurate and unbiased evaluation of fuel cell technologies.
- Outreach to policy makers and the public throughout California to provide education on the benefits of fuel cell technology.
- Provide and maintain a data base of fuel cell installations and costs in California.

Connecticut Hydrogen-Fuel Cell Coalition (CHFCC)

What motivated the formation of the CHFCC?

Clean, reliable, and domestically made fuel cells and an emerging industry poised to grow.

What are the organization's mission and goals?

Advancement of the hydrogen fuel cell industry.

What sort of activities does the CHFCC engage in?

Information dissemination, outreach, technical analysis, financial analysis, planning with state supported Roadmap documents

What are Connecticut's strengths relating to fuel cells and hydrogen?

Supply chain, supportive policy, progressive attitude to support clean and efficient energy.

Name Connecticut's supportive policies or legislation that help the fuel cell industry.

LREC – Performance Based Purchase, Mandatory RPS, ZEV MOU, Net Metering, Virtual Net Metering, Public Benefits Fund, Project 150, Green Bank, State Loan Program, Property Tax Incentive, Sales Tax Incentive, Commercial Property Assessed Financing, Utility Based Financing, Microgrid Program.

Name one or two of the CHFCC's most successful projects.

A Hydrogen Fuel Cell Roadmap for the state.

What obstacles or challenges do you face at the state or local level?

Administrative funding, consistent long term incentives, cost of product

What other state or regional groups does the CHFCC work closely with?

Ohio, South Carolina, California

What are the CHFCC's future plans and strategies to move the industry and state forward?

A Revised Roadmap - comprehensive strategy for stationary and vehicle programs.

- Non-profit organization
- Approximately 40 members (industry, academia, government)
- Founded in 2005
- Supported by the State of Connecticut and member dues

Massachusetts Hydrogen Coalition

What motivated the formation of the Massachusetts Hydrogen Coalition?

Recognition of the role that fuel cells and hydrogen would play as global energy needs increased as society started to address climate energy issue. The Massachusetts Hydrogen Coalition was created to provide support for the early stage development and later the refinement of these energy technologies to insure they reach the market in a package enabling market adoption. Fuel cells were viewed as a cross cutting energy technology that had application in transportation, stand-by power, combined heat and power, and energy storage.

What are the organization's mission and goals?

The mission of the Massachusetts Hydrogen Coalition is to accelerate the success of Massachusetts companies and organizations developing and deploying hydrogen, fuel cell and related technologies, and to significantly increase the scale and scope of hydrogen and fuel cell related activities in Massachusetts. The Coalition's core emphasis is to expand the level of industrial activity associated with hydrogen and fuel cells in Massachusetts through funding, research and development, demonstration programs, education, partnering and incentives.

What sort of activities does the Massachusetts Hydrogen Coalition engage in?

The Massachusetts Hydrogen Coalition Chairs the Massachusetts Fuel Cell Electric Vehicle Working Group developing a fleet to retail FCEV launch program complete with infrastructure. The Coalition is a member of H_2USA. We provide members with industry news, information on market opportunities, matchmaking with potential investors or strategic partners, lobbying, letters of support usable with various opportunities that present themselves, as an interface with the Massachusetts Clean Energy Center and other state groups. We represent the Massachusetts fuel cell and hydrogen industry cluster at domestic and international shows, conventions and forums. We participate in demonstrations, offer code approval support and provide educational seminars when requested by members.

What are Massachusetts' strengths relating to fuel cells and hydrogen?

1. Massachusetts has the largest base of fuel cell & hydrogen developers and manufacturers of any state in the U.S.
2. Massachusetts has an outstanding university system for energy and allied technology research with these as examples - Boston University, Harvard, Massachusetts Institute of Technology (MIT), Northeastern University, University of Massachusetts Amherst, UMass Lowell, Worcester Polytechnic Institute (WPI).
3. The Massachusetts Clean Energy Center programs foster energy technology development and early stage market adoption. Examples – Catalyst Awards Program, Innovate Awards Program, Solarize Mass Program adoption example.
4. Massachusetts is home to a large number of strategic investor partners allied to the energy market.

Name Massachusetts' supportive policies or legislation that help the fuel cell industry.

1. Massachusetts is one of only eight states that signed the **Zero Emission Vehicle Memorandum of Understanding**. To respond to points of the MOU, the Massachusetts Electric Vehicle Initiative Task Force was

Massachusetts Hydrogen Coalition

- Non-profit industry association
- More than 30 members that include fuel cell and hydrogen developers, manufacturers and support companies, integrators, academia, local and state government.
- Founded in 2004
- Supported by member dues, donations and grants

formed using representatives from industry, automakers and government to create a response plan. The plan will include a package of incentives for both EV and FCEV use.

2. Massachusetts created and administers the **Green Communities Program** which fosters the adoption of energy technologies that serve to increase energy efficiency, reduce energy footprints and lower emissions. The Green Communities Program is a shining example how to quickly demonstrate a new energy technology to a broad geography of retail and consumer markets.

3. Massachusetts participates in the **Massachusetts Fuel Cell Electric Vehicle Working Group** alongside industry, fleet users and automakers developing a fleet based FCEV launch program targeting vehicle deployments in late 2015.

4. Massachusetts actively supports businesses and industry in the pursuit of international opportunities using both trade missions and the Global CleanTech MeetUp event for this purpose.

Name one or two of the Massachusetts Hydrogen Coalition's most successful projects.

1. Development of a viable fleet based hydrogen infrastructure funding program from which the Commonwealth and region can build FCEV critical mass for a consumer launch with minimal use of government funding.

2. Growth of the New England Clean Energy Conference into the Global CleanTech MeetUp. This event showcases early stage companies and those that need to fund a special project to the investment community and strategic partners.

What obstacles or challenges do you face at the state or local level?

Massachusetts, like other smaller states, is faced with tight state resources. Competition for scarce dollars is always a challenge, as it should be.

The Commonwealth welcomes partnering opportunities with industry and strategic partners. Access to legislators at the state and local level is relatively easy in Massachusetts. They are all willing to listen. But fuel cell companies are still not reporting profits making it difficult to pitch them. Time to market with a product remains longer than that required for other technologies. The industry needs more success stories.

What other state or regional groups does the Massachusetts Hydrogen Coalition work closely with?

In the Commonwealth – Massachusetts Clean Energy Center, Massachusetts Electric Vehicle Initiative Task Force, Massachusetts Clean Cities, Massachusetts Clean Energy Council, Massachusetts Global CleanTech MeetUp. In the Region – Northeast Electrochemical Storage Cluster (NEESC), Connecticut Center for Advanced Technology (CCAT), Maine Hydrogen Center, Rhode Island Clean Cities, NYSERDA, California Fuel Cell Partnership. The Massachusetts Hydrogen Coalition is a member of the H_2USA program.

What are the Massachusetts Hydrogen Coalition's future plans and strategies to move the industry and state forward?

Short term our focus is a successful launch of FCEVs in the Commonwealth. We view a successful FCEV launch as validation of fuel cell and hydrogen energy technology and the birth of a new industry that will bring additional dollars into play and the application of the technology into other applications.

We will work to finalize the fleet HPA concepts, facilitate fleet discussions, develop H2 fueling infrastructure, seek code & standards approvals as required, educate as required and continue to push for legislation as needed for success.

Our FCEV activities will be integrated with our neighboring Northeast states to insure a smooth regional rollout.

On completion of the FCEV program, our efforts will shift to Energy Storage and to Combined Heat & Power applications.

We will continue to hold our CEO Roundtable Breakfasts with invited guests to provide networking opportunities, introduction of strategic partners and provide a listening board to learn what needs our industry has.

Northeast Electrochemical Energy Storage Cluster (NEESC)

What motivated the formation of the NEESC?

Clean, reliable, and domestically made with emerging industry poised to grow. Economic development and job growth.

What are the organization's mission and goals?

Support the electrochemical energy industry in the Northeast US (ME, NH, VT, MA, CT, RI, NY, and NJ) for economic development and job growth. Development of fuel cells and hydrogen Infrastructure, and deployment of fuel cell electric vehicles (FCEVs).

What sort of activities does the NEESC engage in?

- Tradeshow(s) Participation
- Export Readiness
- Business Planning
- Roadmap Planning
- Supply Chain Management
- Market Development
- Incubator Assistance
- Education/Awareness
- Economic/Financial Guidance

What are the Northeast U.S. strengths relating to fuel cells and hydrogen?

Supply chain, supportive policy, increasing job opportunities, progressive attitude to support clean and efficient energy.

Name the supportive policies or legislation in the Northeast U.S. that help the fuel cell industry.

	ME	NH	VT	MA	RI	CT	NY	NJ
Energy Policy for Fuel Cells								
Mandatory Renewable Portfolio Standard (RPS)	Eligible	Eligible		Eligible	Eligible if renewable	Eligible	Eligible	Eligible if renewable
Net Metering	Eligible	Eligible	Eligible if renewable	Eligible	Eligible if renewable	Eligible	Eligible	Eligible if renewable
Public Benefits Fund	Eligible		Eligible if renewable	Eligible	Eligible if renewable	Eligible	Eligible	Eligible if renewable
State Incentives for Fuel Cells								
Performance-Based Power Purchase	Eligible				Eligible if renewable	Eligible	Eligible	
State Grant Program		Eligible if renewable	Eligible if renewable		Eligible	Eligible		Eligible
State Loan Program			Eligible if renewable		Eligible if renewable	Eligible		
Property Tax Incentive (Commercial)			Eligible if renewable			Eligible		Eligible
Sales Tax Incentive			Eligible if renewable			Eligible	Eligible	
Property-Assessed Clean Energy (PACE) Financing						Eligible	Eligible	Eligible if renewable
State Incentives for Hydrogen Fuel								
Zero Emission Vehicle Program (FCEV/H_2 Infrastructure)			Eligible	Eligible	Eligible	Eligible	Eligible	

Eligible | Eligible if renewable

- Non-profit organization
- 1,179 supply chain members; members include industry, academia, government
- Founded in 2010
- Supported by the Small Business Administration

Name one or two of the NEESC's most successful projects.

2012 – Hydrogen and Fuel Cell Development Plans, development of an online ***Supply Chain Database for the electrochemical energy industry***.

What obstacles or challenges do you face at the state or local level?

- Official recognition of the Hydrogen and Fuel Cell Development "Roadmap" Plans by government officials.
- Wide-spread engagement difficult to coordinate for region policy.
- Communications
- State/Regional engagement

What other state or regional groups does the NEESC work closely with?

The cluster spans an area in the northeastern United States from New Jersey to Maine. NEESC is administered by the Connecticut Center for Advanced Technology, Inc. (CCAT) and its state partners including Maine's Hydrogen Energy Center (HEC), New Energy New York (NENY), the Clean Energy State's Alliance (CESA), and the Massachusetts Industry Stakeholders. NEESC is funded by the SBA as one of seven Regional Innovation Clusters (RICs).

What are the NEESC's future plans and strategies to move the industry and state forward?

- Economic analyses/modeling
- Geographic analysis: energy users, fleets, refueling, other markets
- Coordination for deployment
- Administration of regional cluster
- Execution of State and Regional "Roadmap" deployment plans

Ohio Fuel Cell Coalition (OFCC)

What motivated the formation of the OFCC?

In 2001 the State of Ohio evaluated the fuel cell industry in the State and was pleasantly surprised to find a robust fuel cell supply chain with top-level research & development talent and hands on technology research. Soon after the evaluation the State held a fuel cell conference and almost 200 people attended, because of the response it was determined that a "Coalition" was needed to keep the momentum, this became the beginning of the Ohio Fuel Cell Coalition. Finally, Ohio Governor Bob Taft announced an Ohio Fuel Cell initiative which included a series of incentives for fuel cell researchers and fuel cell companies.

THE FUEL CELL CORRIDOR™
Global Center of the Fuel Cell Industry

- Non-profit industry association
- More than 30 members that include fuel cell and hydrogen developers, manufacturers and support companies, integrators, academia, local and state government.
- Founded in 2004
- Supported by member dues, donations and grants

What are the organization's mission and goals?

The Ohio Fuel Cell is a united group of industry, academic and government leaders working collectively to strengthen Ohio's fuel cell industry and to accelerate the transformation of the region to global leadership in fuel cells.

What sort of activities does the OFCC engage in?

Newsletters, outreach and education, lobbying, reports, facilitating demonstrations

What are Ohio's strengths relating to fuel cells and hydrogen?

SOFC (solid oxide fuel cell), access to supply chain, R&D, manufacturing & innovation infrastructure, skilled workforce, and central logistics

Name Ohio's supportive policies or legislation that help the fuel cell industry.

Ohio Tax Reform and Renewable Portfolio Standard

Name one or two of the OFCC's most successful projects.

The Ohio Third Frontier Project invested over $100 million in fuel cells over a five-year period, which has enabled over $350 million of Federal dollars in support of fuel cells, also the Ohio Fuel Cell Supply Chain initiative, presented four supply chain exchange events which we are leveraging for additional State and potentially Federal support.

What obstacles or challenges do you face at the state or local level?

Time

What other state and regional groups does the OFCC work closely with?

Lorain County Community College, NorTech, TeamNeo, Connecticut Center for Advanced Technology, South Carolina Hydrogen Fuel Cell Alliance

What are the OFCC's future plans and strategies to move the industry and state forward?

The Ohio and U.S. fuel cell industry needs a technical exchange center to coordinate and accelerate the development of low cost BOP (balance of plant) components through information exchanged between the fuel cell OEM's (original equipment manufacturers) and the Ohio fuel cell BOP manufacturers, this is an initiative that the Ohio Fuel Cell Coalition is currently implementing.

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