U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

State of the States: Fuel Cells in America 2015

6th Edition

Fuel Cell Technologies Office

December 2015

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About this Report

The information contained in this report was collected from public records and websites, including 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, 2015. This report is a follow-up to State of the States: Fuel Cells in America 2014, 2013, 2012, 2011 and 2010 editions. If we've missed something in your state, please let us know at jgangi@fchea.org.

Authors and Acknowledgements

This report was written and compiled by Sandra Curtin and Jennifer Gangi of the Fuel Cell and Hydrogen Energy Association (FCHEA) in Washington, DC. Support was provided by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy's Fuel Cell Technologies Office.

Notice

About FCHEA

The Fuel Cell and Hydrogen Energy Association (FCHEA) is the trade association dedicated to the commercialization of fuel cells and hydrogen energy technologies. FCHEA represents the full global supply chain, including automakers, fuel cell materials, components and systems manufacturers, hydrogen producers and fuel distributors, government laboratories and agencies, trade associations, utilities, and other end users.

Front Cover Photo Credits

Top: Fuel cell bus operated by SunLine Transit. Photo courtesy of the California Fuel Cell Partnership. https://www.flickr.com/photos/cafcpmr/

Middle: Doosan fuel cell power plant operating at St. Francis Hospital, Connecticut. Photo courtesy of Doosan Fuel Cell America.

Bottom: Demonstration fuel cell-powered tow tractor operating at Memphis Airport. http://www.energy.gov/articles/leaders-fuel-cell-pack

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Acronyms

ADG	Anaerobic digester gas
ARFVTP	California's Alternative and Renewable Fuel and Vehicle Technology Program
ARPA-E	DOE's Advanced Research Projects Agency -Energy
CaFCP	California Fuel Cell Partnership
CCAT	Connecticut Center for Advanced Technology
CEC	California Energy Commission
CHP	Combined heat and power
DOE	U.S. Department of Energy
EERE FCTO	DOE's Energy Efficiency and Renewable Energy, Fuel Cell Technologies Office
EV	Electric vehicle
FCEV	Fuel cell electric vehicle
FTA	Federal Transit Administration
GSE	Ground support equipment
kW	Kilowatt
MassCEC	Massachusetts Clean Energy Center
MEA	Membrane electrode assembly
MHE	Material handling equipment
MW	Megawatt
NEDO	Japan's New Energy and Industrial Technology Development Organization
NEESC	Northeast Electrochemical Energy Storage Cluster
NREL	National Renewable Energy Laboratory
NYSERDA	New York State Energy Research and Development Authority
OEM	Original equipment manufacturer
OFCC	Ohio Fuel Cell Coalition
P2G	Power-to-Gas
PEM	Proton exchange membrane fuel cell
PPA	Power Purchase Agreement
RD&D	Research, development, and demonstration
RPS	Renewable Portfolio Standard
SBA	U.S. Small Business Administration
SBIR/STTR	Small Business Innovation Research/Small Business Technology Transfer
SOFC	Solid oxide fuel cell
SRNL	Savannah River National Laboratory
TWh	Terawatt-hour
ZEV	Zero emission vehicle

Generating More Than Power: Benefits to States and Businesses

The fuel cell industry—which surpassed $2.2 billion in annual sales in 2014[1]—continues to grow and is generating impressive benefits in a number of ways.

In the U.S., states are promoting their homegrown fuel cell industry to enhance economic growth and job development. The collective industry has produced thousands of jobs, as well as millions of dollars in revenue and investment, in both state and local tax revenues, and in gross state product.[2]

As a technology, fuel cells help to bolster the electric grid, provide reliable and resilient power, reduce emissions, reach remote and rural parts of the country, and utilize domestic sources of energy, including natural gas.

As an industry, fuel cell developers and the supporting supply chain companies are contributing to American manufacturing, exports and job growth.

As a resource, states continue to invest in fuel cell power generation to reduce emissions and to support, or supplant, the aging electric grid. There are many benefits fuel cells offer, but one of the most attractive to states, especially ones in storm-prone areas such as the Northeast, is their resiliency and reliability. Many states are investing in distributed generation and microgrids to keep emergency and other vital services operating when there are power outages, and fuel cells are becoming part of the solution.

In this increasingly connected world, fuel cells are also gaining traction to keep critical communication networks and data centers up and running. The technology is being adopted to provide primary or backup power to ensure constant power through major storms, or other disruptive events.

Fuel cells are showing up in local corporate and retail settings across the U.S., often supported by state funding for low emission, energy efficient, or resilient distributed power generation. The growing customer list for fuel cells includes Fortune 500 companies such as Google, Apple, Coca-Cola and others. Some companies are returning to purchase more fuel cells for multiple sites, or for different applications. For example:

- Walmart is the largest fuel cell customer for material handling equipment (MHE), deploying the technology to power more than 2,800 forklifts at warehouses in Ohio, Pennsylvania, New York, Illinois, Indiana and Minnesota, with more sites on the way. The company also uses stationary fuel cells to generate power for 44 Walmart and Sam's Club retail sites in California and Connecticut.
- Food service product distributor, Sysco, has expanded its fuel cell fleet to more than 800 fuel cell-powered forklifts operating at seven of its warehouses in California, Massachusetts, New York, Texas, Virginia, Pennsylvania, and Michigan.
- Over the last few years, AT&T has deployed fuel cells to provide primary power to almost two dozen data and call centers, as well as backup power to hundreds of cell phone towers in multiple states.

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

Fuel Cell Benefits

- Exceptionally low/zero emissions
- High quality, reliable power
- Modular/scalable
- Quiet
- Rugged
- Efficient:
  - 50%+ electric efficiency
  - 90%+ electric and thermal efficiency (combined heat and power)
- Fuel flexible:
  - Conventional fuels
  - Renewable fuels
- Flexible siting:
  - Indoors or outdoors
  - Lightweight - enables rooftop siting
- Operate in water balance/use very little water in operation

Fuel Cell Capabilities

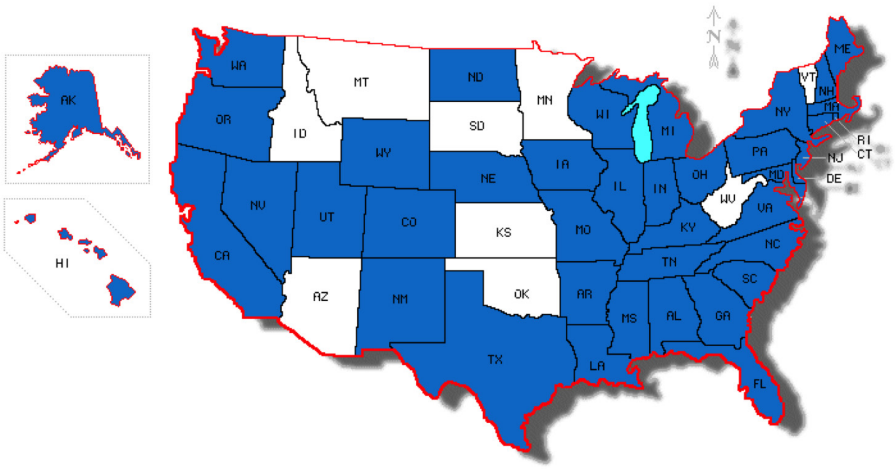
- Scalability to meet any need, ranging from a few watts to multi-megawatt systems
- Able to provide primary, supplemental, or backup power
- Can be grid-tied, or can operate independently from the grid
- Compatible with solar, wind, batteries and other renewable/conventional technologies
- Can be used with, or instead of fossil fuel generators

Fuel cells can improve efficiency and save money for customers. In states with high electricity costs, fuel cells may generate power at a cost lower than grid power, saving money for businesses, and taxpayer dollars for municipalities, which helps to stretch tight budgets. When stationary fuel cells capture by-product heat for facility heating, cooling, and provision of hot water, it offsets the need to purchase natural gas for these services.

In forklift applications, fuel cells are more cost-efficient than using battery power and improve operational efficiency through smaller fueling infrastructure space requirements and faster refueling.

In all applications, fuel cells are a low-to-zero emissions technology that can make a significant contribution to meeting business, state, or local greenhouse gas reduction goals.

Fuel cells now provide clean and reliable power, in stationary or motive applications, in at least 41 states. With the ongoing corporate and municipal adoption of fuel cell power generation, the technology is becoming a part of America's "all of the above" energy strategy.



Note: States marked in blue are home to fuel cells used for stationary and/or forklift power generation

This report is the sixth in a series. All provide a comprehensive analysis of state activities supporting fuel cell and hydrogen technology, profiles of leading states, and a catalog of recent installations, policies, funding and deployments around the country.

To read our past *State of the States: Fuel Cells in America* reports please visit: http://energy.gov/eere/fuelcells/market-analysis-reports.

Compatible, Not Competitive, With Other Energy Resources

The United States' "all of the above" energy portfolio spans a large spectrum, from traditional fossil fuels to renewably-generated power. Fuel cell technology truly adheres to the "all of the above" approach because its main fuel, hydrogen, can be derived from a wide range of resources and feedstocks.

Hydrogen, the most abundant element in the universe, combines readily with other elements and forms compounds. On Earth, hydrogen is chiefly paired with oxygen in the form of water. One method of hydrogen production is via electrolysis – passing electricity through water between two electrodes, breaking it down into its two components, hydrogen and oxygen. This process that can be made extremely clean and emissions-free by using electricity generated by renewable resources, such as solar or wind power.

Hydrogen, generated through renewable electrolysis, is receiving major recognition as an effective method to store excess wind or solar power (called power-to-gas, or P2G) that otherwise would be curtailed. The hydrogen can then be injected into existing natural gas pipeline infrastructure, where it can be widely transported, or stored

and used at a later time to generate electricity in a stationary fuel cell or used to fuel up fuel cell electric vehicles (FCEVs). Hydrogen energy storage offers an unmatched, large-scale storage capacity in the terawatt-hour (TWh) range.

P2G projects are underway around the world, with intense interest in Germany. Closer to home, in April 2015 Southern California Gas Company joined with the U.S. Department of Energy's National Renewable Energy Laboratory (NREL), the University of California, Irvine's National Fuel Cell Research Center, and Wallingford, Connecticut, company Proton OnSite, to launch the first P2G demonstration in the U.S , generating hydrogen from a local photovoltaic source. The produced hydrogen will be injected into a simulated natural gas pipeline system to test grid-scale energy storage.

Hydrocarbon fuels—methanol, ethanol, natural gas, petroleum distillates, liquid propane and gasified coal—also yield hydrogen through a process called reforming. Although the use of reformed hydrogen leads to some carbon dioxide emissions, highly-efficient fuel cell systems operating on this fuel produce significantly lower emissions than burning the same fuels in conventional power plants. In fact, these emissions are so low that some areas of the U.S. have exempted fuel cell power generation from air permitting requirements.

In addition, hydrogen can be extracted from renewable biogases, such as landfill gas produced during natural bacterial decomposition of organic material; anaerobic digester gas (ADG) generated at wastewater treatment plants, breweries and agricultural processing facilities; or from biomass resources such as agricultural or lumber waste. Hydrogen made from these renewable energy resources provides an extremely clean and abundant energy source.

Sites wanting to use biogas, but lacking this resource, may instead be able to use "directed biogas." With this option, an equivalent amount of "scrubbed" (contaminants removed) and pressurized biogas is injected monthly into a natural gas pipeline. While this biogas does not flow directly to the fuel cell – it is instead consumed by other natural gas users—the injection "offsets" the natural gas used by the fuel cell.

Fuel cells can be co-located with other energy resources, such as wind and solar power, batteries, or generators, directly at a site or as part of a community microgrid, which generates power for critical resources when grid power goes down during storms or other disruptive events.

Given these compatibilities, fuel cells are complementary, not competitors to other fuels and technologies, including both conventional and renewable ones. States with plentiful energy resources can benefit from fuel cell and hydrogen technologies—capturing excess solar and wind power, converting waste gases to energy, or utilizing homegrown energy sources.

Growing Awareness of Fuel Cell Benefits

The list of municipal and corporate fuel cell customers is growing as these entities transition from grid power to onsite power production to lower energy costs, improve efficiency, ensure resiliency, and reduce emissions. Commercial fuel cell products are available today to meet a range of power generation needs, whether large or small, primary or backup power, or used in motive, stationary, or off-grid applications. A fuel cell's unique combination of benefits are winning over new users, while a number of established customers, having seen the technology prove itself firsthand, are returning to purchase more. Fuel cells are becoming a go-to technology to provide quality, assured power to both businesses and communities.

State and Local Governments Keep Critical Services Operating

Government agencies must account for expenditures of public funds, showing cost savings or other benefits accruable to the public good, and are finding not only cost, but emissions, fuel and other savings with fuel cells.

Local governments have begun to take advantage of fuel cells to generate continuous or backup power, and by-product heat for heating, cooling, and hot water, for administrative buildings and critical facilities, such as fire and police stations, and detention facilities. In 2014, Santa Clara County, California, installed 2.6 megawatts (MW) of fuel cell systems to power the county's government center, service center, main jail, and correctional facility. In 2013, Hartford, Connecticut, installed a 400-kW fuel cell system to help ensure reliable power the Public Safety

Complex, which includes the city's police, fire, emergency medical services, and 911 dispatch center. The fuel cell's by-product heat is also captured and used to cool the facility via an absorption chiller.

A number of water agencies in California and New York also use fuel cells to generate onsite power, using methane (biogas) generated during the wastewater treatment process as its fuel. This byproduct methane is a greenhouse gas that is often "flared" (burned and emitted to the atmosphere) at the wastewater plants. Fuel cells can take this waste product and turn it into free fuel, yielding zero-emission power generation onsite. The fuel cell's byproduct thermal energy can also be captured for use in the wastewater treatment process.

In New York, four wastewater treatment plants (WWTPs) in the New York City area, and in California, fuel cells operate at the Tulare Regional Wastewater Treatment Facility, Point Loma WWTP and South Bay Water Reclamation Plant (both in San Diego), Inland Empire Utilities Agency WWTP (San Bernardino County), San Jose/Santa Rita Water Quality Control Plant, and Orange County Sanitation District WWTP. Eastern Municipal Water District also has fuel cells operating at two of its wastewater facilities in Perris Valley and Moreno Valley. In addition, the city of Riverside is also planning to add a fuel cell to its Water Quality Control Plant.

"The installation of these fuel cell systems represents a hedge against the rising cost of grid electricity. The new fuel cell system, in combination with the County's 2012 installation of photovoltaic power generating systems at eight County facilities, will help reduce greenhouse gases generated by County operations."

Santa Clara County Executive Jeffrey V. Smith, speaking of the 2.6 MW of fuel cells that power four county facilities

After recent devastating storms, localities in the northeastern U.S. are taking advantage of state funding to create reliable microgrids, some of which include fuel cells, to provide power for emergency shelters, first responders, seniors, and public works facilities when grid power goes down. These include several fuel cell microgrids that will be located across Connecticut:

- The town of Woodbridge, Connecticut, will install a 1.6-MW natural gas-powered turbine and a 400-kilowatt (kW) fuel cell to power the Town Hall, library, fire house, police station, public works facility, senior center/emergency shelter, and high school.
- The University of Connecticut, Depot Campus will use a 400-kW fuel cell and a demonstration-scale 6.6- kW photovoltaic solar panel to provide uninterrupted power to a building housing the UConn's Fire Marshal's office, emergency response rooms, and emergency communications; to buildings for secondary command and control support services and serving as warming centers, with access to a kitchen, restrooms, and charging stations for electronic devices; and to electric vehicle (EV) charging stations.
- The University of Bridgeport will add a 1.4-MW fuel cell power plant to provide power to campus buildings including a dining hall, recreation center, student center, police station and two residence halls. The university buildings will be available to house city residents during a power outage or emergency, providing shelter and food service for about 2,700 residents and emergency responders.
- The city of Hartford's Parkville neighborhood, which will deploy a 750-kW fuel cell system to power an elementary school, senior center, library, supermarket, and gas station.[3]

Microgrids are a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that act as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island-mode.

Source: Berkeley Lab, U.S. Department of Energy

In New York, six proposed microgrid projects with fuel cells received funding in July 2015 under the competitive NY Prize program (see page 14 for more details). This Stage 1 award provides funds to conduct detailed engineering assessments to evaluate the feasibility of installing and operating a community microgrid at a proposed site in New York State. Projects moving forward to Stage Two could receive awards for detailed design, and Stage Three winners will receive funds to support build-out of the project.

"Given the weather extremes we have been experiencing, the importance of the microgrid is increasingly evident. It will provide ongoing power for the Town's essential services and security to Woodbridge residents during extended power outages."

Selectman Ellen Scalettar talking about Woodbridge, Connecticut's planned microgrid, which will receive all of its power from a fuel cell system

New Jersey's Energy Resilience Bank, created after Hurricane Sandy using federal Community Development Block Grant-Disaster Recovery funds, is also supporting microgrid and distributed generation projects in the state to enable critical sites to remain operational during future outages. Several fuel cell projects are under consideration in the bank's first tranche of funding, which sought onsite power generation for WWTPs.

State, county, and local governments also benefit from businesses in the fuel cell, hydrogen, and related components industries located within their state. These businesses generate local jobs revenues, as well as public and private investment. Some of this investment includes federal funding awards from the U.S. Department of Energy (DOE) and Federal Transit Administration (FTA) for research, development, and demonstration efforts.

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 500 patents, 45 commercial hydrogen and fuel cell technologies and 65 emerging technologies, as well as significant progress in reducing cost and increasing durability and efficiency. DOE-funded projects have resulted in more than $720 million in revenues in 2013 and 2014 and more than $410 million in private investment in those years. See Appendix 1 for a complete breakdown of DOE funding since the last report.

Businesses Remain Up and Running to Serve Customers

Our everyday lives are intertwined with local businesses (or businesses that we interact with online), so when power goes down and their service or products are not available, we all suffer. These daily interactions include grocery and other retail purchases, cell phone service, online buying and banking processed through data centers and wireless networks.

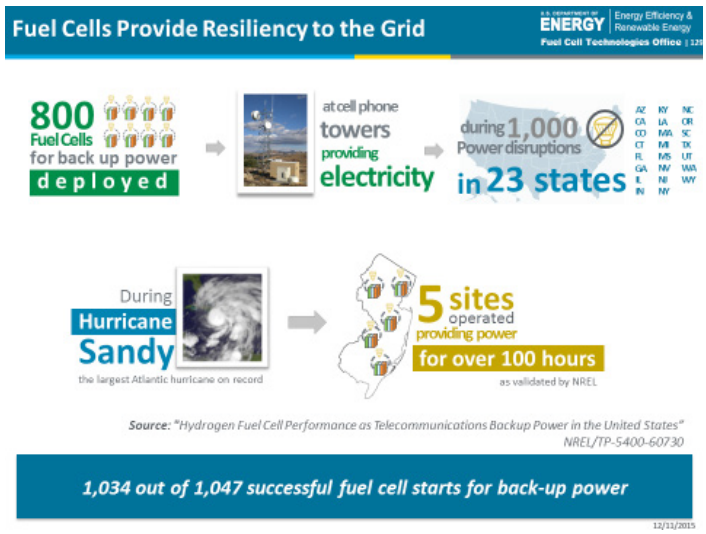
Nearly 10 percent of Fortune 500 companies use fuel cells to generate clean, efficient, and reliable power all across the U.S. When examining the top 100 companies on the Fortune list, the number grows—with almost 25 percent using fuel cells to power data centers, cell phone towers, corporate buildings, retail facilities, or forklifts. Familiar customers include companies such as Apple, AT&T, Verizon, Kroger, JPMorgan Chase, Google, Bank of America, Kaiser Permanente, Target, and Lowe's.

Onsite fuel cell power generation increases reliability and efficiency for operations, while reducing emissions, no matter the fuel source. In retail operations, businesses can stay open during grid power outages and keep refrigerated and frozen items cold, allowing these sites to be a resource to communities hit with prolonged power outages and preventing food spoilage and potential financial losses for company. Fuel cell adopters include grocers, home improvement stores and big box retailers, including Home Depot, Price Chopper, Safeway, Sam's Club, Stop & Shop, Target, Walmart, and Whole Foods Market. In California, a recently-opened IKEA store (San Francisco area) also generates a majority of its power using fuel cells.

Some retailers are deploying a range of efficiency measures and renewable technologies and include fuel cells among them at one or more of their stores. Walmart and Sam's Club have embraced fuel cells and are now powering more than 40 of their retail sites with fuel cell power generation. Because of state fuel cell incentives, most stores with fuel cells are located in California, New York, and Connecticut.

The technology is also in demand for warehouse operations as a cost-effective and zero-emission strategy to power material handling equipment while, at the same time, improving operational efficiency and productivity. With more than 7,500 fuel cell forklifts in daily operation in North America, some of the products we buy everyday may have been moved and stacked by this clean energy technology before making their way to our local stores. These include products from Ace Hardware, Coca-Cola, Carter's, CVS Caremark, Dietz and Watson, Kimberly-Clark, Kroger, Lowe's, Nestlé Waters, Procter & Gamble, Walmart, Wegmans, and Whole Foods Market, who use fuel cell-powered forklifts in a number of their warehouses.

Personal computing and seamless wireless networks are now woven into our daily lives and fuel cells are finding a niche here as well, providing high quality, highly reliable power to data centers. These facilities support business operations and enable financial transactions and online customer purchases. Keeping data centers up and running is critical to today's economy, as businesses can lose millions of dollars for each hour that a data center is without power. As a result, many companies are turning to fuel cell power generation, like Apple at their North Carolina iCloud data center; CenturyLink's California data center powering cloud, managed hosting and colocation services; eBay's Utah data center; First National Bank of Omaha's data center that processes several million banking and credit card transactions daily; and Williams Sonoma's California data center, as well as both Google's and Yahoo!'s California-based global headquarters.



In telecommunication applications, fuel cells deliver power during grid outages, keeping cell phones towers up and running. Adopters include AT&T, T-Mobile/MetroPCS, SouthernLINC, Sprint, and Verizon, who now use fuel cells at thousands of cell towers across more than half of the U.S. In addition, AT&T and Verizon ensure reliability to customers by using fuel cells to power facilities like call centers, data centers, and switching centers.

States Support Fuel Cell Industry / Industry Benefits States

States are recognizing the advantages of attracting fuel cell and hydrogen businesses and related supply chain to their state. There is substantial interest in both fuel cell and hydrogen technologies, both in the U.S. and abroad, providing opportunities for domestic and international sales—generating jobs, local and state tax revenues,

business revenue and investment, and contributing to gross state product. The Northeast Electrochemical Energy Storage Cluster recently analyzed the impact and potential of the fuel cell and hydrogen industries in the northeastern U.S., summarized in chart below.

MAPPING THE FUEL CELL AND HYDROGEN PATH FORWARD

The Northeast Electrochemical Energy Storage Cluster (NEESC), administered by Connecticut Center for Advanced Technology Inc. (CCAT), published the 2015 Hydrogen and Fuel Cell Development Plans for Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont. The plans, updates to ones released in 2012, were produced with support from the U.S. Small Business Administration (SBA) and input from industry stakeholders. The series details the fuel cell and hydrogen industry in each state, assessing the economic impact, including investment, employment and labor income, and highlighting key policies and potential for deployment in a variety of market sectors.

Separately, the Massachusetts Clean Energy Center (MassCEC) published the 2014 Massachusetts Clean Energy Industry Report, which highlights the state's growing renewable energy and energy efficiency markets, estimating it to be a $10 billion industry, responsible for about 2.5 percent of state's gross state product. In 2014, there were 618 workers in Massachusetts' hydrogen generation industry and 178 in the fuel cell industry.

Northeast Electrochemical Energy Storage Cluster (NEESC) 2015 Roadmaps - Analysis of the Fuel Cell and Hydrogen Industry in the Northeast

State	Number of companies in the fuel cell and hydrogen supply chain	Economic Analysis		
		Revenue and investment generated by these companies	State and local tax revenue contributed by these companies	Gross state product generated by these companies
Connecticut	At least 600	Approx. $604.34 million	More than $22 million	More than $211.23 million
	Eight of the Connecticut companies are original equipment manufacturers (OEMs) of hydrogen and/or fuel cell systems and were responsible for supplying 1,010 direct jobs and $311.65 million in direct revenue and investment in 2011.			
Maine	At least 28	Approx. $3.44 million	More than $0.113 million	Approx. $2.9 million
Massachusetts	At least 300	Approx. $184 million	More than $11 million	Approx. $147 million
	Eight of the Massachusetts companies are OEMs of hydrogen and/or fuel cell systems and were responsible for supplying 406 direct jobs and $56.8 million in direct revenue and investment in 2011.			
New Hampshire	At least 25	Approx. $10.7 million	More than $0.428 million	More than $8.5 million
New Jersey	At least 8	More than $32.3 million	More than $1.49 million	Approx. $18.6 million
New York	At least 182	Approx. $332 million	More than $18 million	Approx. $166 million
	Eight of the New York companies are OEMs of hydrogen and/or fuel cell systems and were responsible for supplying 719 direct jobs and $140 million in direct revenue and investment in 2011.			
Rhode Island	At least 15	Approx. $8.4 million	More than $0.329 million	Approx. $6.9 million
Vermont	At least 5	More than $4.1 million	More than $0.183 million	Approx. $3.3 million
TOTALS	**At least 1,163**	**Approx. $1.179 billion**	**More than $53 million**	**Approx. $565 million**

Chart created by FCHEA using NEESC 2015 Road Map data - http://neesc.ccat.us/publications/2015_roadmaps

RECENT STATE FUEL CELL FUNDING AWARDS		
AGENCY/PROGRAM	**AMOUNT**	**AWARDEE/PROJECT DESCRIPTION**
	CALIFORNIA	
Bay Area Air Quality Management District	***$2,200,000***	For the completion of 12 new hydrogen fueling stations in the Bay Area—Berkeley, Campbell, Foster City, Hayward, Los Altos, Mill Valley, Mountain View, Oakland, Redwood City, North First and North Fourth streets in San Jose, San Ramon, Saratoga, South San Francisco and Woodside. The award supplements the cost of the stations, which are mostly being paid for with $50 million from the California Energy Commission and money from three project sponsors.
	CONNECTICUT	
Department of Economic and Community Development (DECD)	***$10,000,000***	For a two-phased expansion of FuelCell Energy's Torrington manufacturing facility. The company will be eligible for $5 million in forgiveness on the first tranche of funding if it creates 165 full-time positions and retains 538 full-time positions, for two consecutive years. The company can earn $5 million in forgiveness on the second tranche of funding if it creates 160 full-time positions and retains 703 full-time positions, for two consecutive years. This expansion project also qualifies for up to $10 million of Urban and Industrial Sites Reinvestment Tax Credits, which the company can monetize over a 10-year period. The expansion project is a $23 million multi-year investment to construct a 90,000-square-foot addition to its Torrington manufacturing facility and add equipment for automation and technology for efficiency and advanced manufacturing implementation. The second phase of the expansion, estimated to cost $42 million, will add manufacturing equipment to expand annual production capacity to at least 200 MW, increase on-site power capabilities with a larger fuel cell power plant, and create a new advanced technology research center.
	MASSACHUSETTS	
Massachusetts Clean Energy Center AmplifyMass program	***$300,000***	AmplifyMass offers awards to Massachusetts-based clean technology companies and university research projects that have been given funding by DOE's ARPA-E (Advanced Research Projects Agency -Energy) program. SiEnergy Systems of Cambridge was awarded $2.65 million from ARPA-E's Reliable Electricity Based on ELectrochemical Systems (REBELS) program in June 2014 to 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. SiEnergy is also developing low temperature thin film solid oxide fuel cell (SOFC) technology from Harvard University.

NEW YORK		
New York State's Economic Development Awards	***$600,000***	$500,000 to American Fuel Cell to further develop membrane electrode assemblies (MEAs). $100,000 to MICROrganic Technologies, Inc. (Albany) to commercialize both its microbial fuel cell technology and to advance the development of original equipment manufacturer production equipment to convert from chemical to electrical energy the organic waste processed at wastewater treatment facilities.
New York State Energy Research and Development Authority (NYSERDA) and New York Battery and Energy Storage Technology (NY-BEST) Consortium	***$250,000***	Awarded to Cornell University to develop and demonstrate a regenerative fuel cell energy storage system, using a Cornell-designed membrane, to produce hydrogen.
	$250,000	American Fuel Cell, LLC (Rochester) to help scale up or demonstrate innovative approaches to energy storage.
	$100,000	Village of Babylon—proposed microgrid would use conventional generation as well as solar, energy storage, and fuel cells. Power from the proposed microgrid would be provided to Babylon Village Hall, the village fire station, highway and sanitation departments, Babylon EMS Response, the Babylon Union Free School District, St. Joseph's Church/School complex, and the American Legion Hall. Partners include: PSEG Long Island, National Grid, Metropolitan Transport Authority, New York State Department of Transportation (DOT), Suffolk County, and Town of Babylon.
	$100,000	Town of Brookhaven—proposed microgrid would provide power to the town hall to enable it to act as an emergency operations center and for two adjacent Sachem schools to function as emergency shelters. Technology would include solar panels and two existing 10-kW wind turbines, fuel cells, battery storage, and/or microturbines powered by the onsite wastewater treatment plant. Partners include: Sachem School District and Brookhaven National Laboratory.
	$100,000	City of Long Beach—proposed microgrid would include combined heat and power (CHP), fuel cell, solar, and energy storage, combined with demand-management technology. Power from the proposed microgrid would be provided to city hall, police/fire headquarters, water/wastewater treatment plants, and affordable housing. Partner include: NRG Energy, Inc., Long Beach Housing Authority, MTA Long Island Railroad, and PSEG Long Island.

	$100,000	Town of Hempstead—proposed microgrid will include wind, solar, hydrogen station assets in the Town's Energy Park, battery storage, additional generators, fuel cells, and/or cogeneration. The microgrid would provide power to critical community facilities including the Point Lookout/Lido Beach Fire Station, the Town's Water District Well #1 & #2 Main Treatment Plant, and the Town's Department of Conservation and Waterways Administration and Marina facilities, which serve as an off-base hub for the Nassau County Police Department and Bay Constables, along with providing support and staging for incoming emergency support teams. Partners include: Hempstead's Department of Conservation and Waterways, Department of Water, and the Lido and Point Lookout Fire District.
	$100,000	Village of Freeport—proposed microgrid would, in addition to repowering the municipal electric utility's existing power plant, will seek to deploy solar, wind, fuel cell CHP, and battery storage. Power will be distributed to the village's railroad station, telecommunications system, police and fire operations, four public schools, as well as more than 250 commercial and 150 residential parcels. Partners include: Freeport Electric, Anbaric Transmission, Arup, and National Grid.
	$$100,000	Eighth Avenue Microgrid (NYC)—project includes a 2.9 million-square-foot building located in the Chelsea area of Manhattan between Eighth and Ninth Avenues and 15th and 16th Streets. It is owned by Google and includes medical facilities as well as critical telecommunications equipment. The proposed microgrid would include solar, CHP, fuel cell, and energy storage technology to serve the building's diverse tenant base. Partners include: Energy & Resource Solutions, City of New York, One City Block, New York Power Authority, Beth Israel Medical Center, Schneider Electric, and Con Edison.
OHIO		
Ohio Controlling Board - Edison Advanced Manufacturing Program	***$297,056***	Approved state funding to help develop and promote local advanced manufacturing projects in fuel cell technology. The Ohio Fuel Cell Coalition will provide $335,154 in matching funds.
PENNSYLVANIA		
Commonwealth Financing Authority - Alternative and Clean Energy Program	***$300,000 grant, $370,000 loan***	WATT Fuel Cell Inc., an SOFC fuel cell developer based in Port Washington, NY, expanded its manufacturing operation of specialized fuel cells in a 39,000-square-foot space within the Mount Pleasant Glass Centre in Westmoreland Township, a $2.27 million project that is expected to result in 33 jobs during the next three years. WATT has committed to investing more than $1.4 million at the site.

Existing companies are seeing opportunities in the fuel cell industry and are moving into related markets, benefitting not only themselves, but also the states in which they are located. Recently:

- UQM Technologies Inc., located in Longmont, Colorado, expanded its business into fuel cells by acquiring the fuel cell compressor module business from Roush Performance Products.[4] In addition to taking over Roush's client base, UQM received its first purchase order for fuel cell compressor systems from Ballard Power Systems for fuel cell electric buses. The deal totals $600,000 with potential for follow-on orders.[5]

- Cleveland, Ohio-based Hyster-Yale Materials Handling announced that its parent company, NACCO Materials Handling Group, Inc., had acquired Nuvera Fuel Cells. Hyster-Yale, a forklift manufacturing company, plans to integrate Nuvera's fuel cell technology across large parts of the company's lift truck product range, as well as fuel cell aftermarket solutions to fit most any electric powered lift truck brand in the market today.[6]

- Korean multinational conglomerate, Doosan, purchased the assets of Connecticut-based fuel cell manufacturer ClearEdge Power (formerly UTC Power) out of bankruptcy and began operations at its corporate headquarters outside of Hartford, Connecticut, in 2014. Operating as a Doosan subsidiary company, Doosan Fuel Cell America has, in one year, built a sales pipeline of more than 50 MW across the globe, has increased production levels, and anticipates employing about 300 people by the end of 2015.

Start-up businesses are often spin-offs from university research, and are making progress on the path toward product commercialization:

- Parajito Powder, LLC, based in Albuquerque, New Mexico, was approved for $100,000 in funding from STC. UNM (formerly known as the Science & Technology Corporation @ UNM). This early-stage investment will help the company move its technology, which was developed at the University of New Mexico, toward product development and expansion of markets.[7]

- In March 2015, Waste2Watergy, based in Corvallis, Oregon, was awarded a $225,000 Small Business Technology Transfer (STTR) Phase I grant from the National Science Foundation (NSF).[8] The startup company, formed at Oregon State University, has developed a microbial fuel cell capable of cleaning wastewater at breweries and other food and beverage processors while generating electricity. The new NSF funding will help demonstrate the scalability of its proprietary cathode material in the fuel cell, as well as performance, durability and feasibility of the overall design. For the past 18 months, funded in part by $150,000 from Oregon BEST, Waste2Watergy has been partnering with Portland-based Widmer Brothers Brewing to test its technology.

- Microsoft is working on an ARPA-E funded project with Maryland-based Redox Power Systems, a start-up SOFC company from the University of Maryland. Redox received $5 million in 2014 to develop a low-temperature SOFC.

> *"Growing Wyoming's technology sector has been a priority and Wyoming is seeing results. This alternative energy project is not only a zero-carbon data center, it is more. It is a laboratory for biogas and fuel cell research. Wyoming is on the cutting edge."*
>
> Governor Matt Mead, Wyoming

In addition, Microsoft Corporation is expanding its data center west of Cheyenne, Wyoming, investing an additional $200 million.[9] Microsoft is powering this data center with a FuelCell Energy 300-kW fuel cell that utilizes biogas from a nearby wastewater treatment plant. The project came together with the assistance of a coalition comprised of local and state groups, including the Wyoming Business Council, Cheyenne LEADS, Cheyenne Board of Public Utilities, the University of Wyoming, Western Research Institute, and state and local government, with $1.5 million in state funding provided by a Wyoming Business Council Business Ready Community grant. Microsoft covered the remaining $6.1 million cost of the fuel cell power plant.

Global automakers are also boosting state economies, investing in manufacturing facilities across the country and providing thousands of jobs, not just in the plant, but for the supply chain as well.

- General Motors (GM) is investing an additional $245 million into its Orion, Michigan, assembly plant, boosting the company's total investment in the Orion plant to $962 million since it reopened in 2010.[10] The Orion facility focuses on several of GM's electric and next-generation vehicles, and the investment, as well as GM's projected addition of 300 new jobs, could also benefit its FCEV program.

- Honda has established a large footprint in Ohio, with 11 state-of-the-art plants in six communities that employ more than 13,700 people. The automaker has invested $9 billion in its Ohio facilities and has purchased more than $9.5 billion in parts from 156 Ohio-based parts suppliers. The largest Honda manufacturing facility is located in Marysville, which is 4 million-square-feet and employs 4,200 workers. The Marysville plant also has 51 fuel cell-powered forklifts and hydrogen fueling. More than 50 years ago, the automaker created a Transportation Research Center with Ohio State University (OSU) and donates more than $2.3 million a year to OSU's College of Engineering.

- BMW's only U.S. presence is in Greer, South Carolina. The 4 million-square-foot manufacturing facility boasts one of the largest fleets of fuel cell-powered forklifts in the world. BMW also participated in a DOE-funded "Landfill Gas-to-Hydrogen Pilot Project" which focused on methane-to-hydrogen conversion at a nearby landfill for use in its forklifts. In 2014, BMW invested an additional $1 billion investment in the facility that made it the automaker's largest factory in the world.[11]

Realizing the economic benefits of an automotive manufacturing presence in the region, states are vying to attract automakers with generous incentive packages.

- To encourage Daimler AG to move its Mercedes-Benz USA's headquarters from New Jersey to Atlanta, the state of Georgia offered the automaker an approximately $23 million package of state job-tax credits, exemptions and development funding, combined with lower corporate-tax rates.[12] More than $17.3 million will come from five-year tax credits for each new job brought to Georgia – the company's state corporate tax bill will be reduced by as much as $4,000, every year for up to five years for each new job. The state also provided $6 million in development funds, and a partial tax exemption for construction materials to help build the new headquarters. Daimler has FCEVs on the road around the world in demonstration and pilot programs, including in San Francisco and Los Angeles, California. The company also has more than 270 fuel cell-powered forklifts at its Vance, Alabama, production facility.

Military Facilities Using Fuel Cells

The U.S. military is also adopting the use of alternative energy technologies at military facilities and in the field. Fuel cells are among these technologies and the potential for wider-scale adoption could benefit businesses producing these systems. Recently:

- Proton OnSite (Wallingford, Connecticut) received follow-on orders from UTC Aerospace Systems for 17 of its proton exchange membrane (PEM) electrolyzer stacks that will provide oxygen generation for new submarines in the American, British and French Navy fleets.[13] Proton is the only U.S. supplier of stacks for international submarine fleets. The multi-million dollar orders will be supporting U.S. Virginia Class, U.K. Vanguard and Astute classes, and French Barracuda Class submarine oxygen production, and supplement previous deliveries for these boats going back to 2008.

- In September 2014, WATT Fuel Cell Corp. (Port Washington, New York) received a 20-month, $2.1 million contract from the U.S. Army Communications-Electronics Research, Development and Engineering Center (CERDEC) to design and build a commercial-grade additive manufacturing line, as well as demonstrate and evaluate the line's increased capacity for production of tubular cell components for SOFC systems, resulting in the delivery of a 1-kW SOFC system incorporating these components.[14]

Research Moving Industry Forward at State Universities & Laboratories

Across the country, a number of universities are focused on crucial cutting-edge research helping advance the fuel cell and hydrogen industry. In the classroom, many offer fuel cell specific courses or degrees, training the

engineers and technicians to enter the workforce as the industry grows. As showcased in the table below, universities are also part of the patent generation universe which can potentially evolve into spin-off or start-up companies.

Some research at the university level is funded by DOE to help achieve cost reduction as well as increases in performance, durability and efficiency in various components of the fuel cell, including catalysts, membranes, and balance of plant and others. Projects include hydrogen storage, production and delivery.

Since our last report, universities in 13 states have received funding from DOE, totaling more than $12.7 million. See Appendix 1 for a detailed chart outlining the individual award amounts and project specifics.

DOE FUNDING AWARDS FOR UNIVERSITY-LEVEL FUEL CELL AND HYDROGEN RESEARCH		
STATE	**TOTOAL AMOUNT**	**UNIVERSITY RECIPIENT**
California	***$4,500,000***	California Institute of Technology, University of California, Irvine, University of California, San Diego
Delaware	***$500,000***	University of Delaware
Georgia	***$200,000***	Georgia Institute of Technology
Maryland	***$200,000***	University of Maryland
Massachusetts	***$1,400,000***	Boston University, Massachusetts Institute of Technology, Northeastern University
Michigan	***$2,054,343***	Kettering University, Michigan State University, University of Michigan
Montana	***$200,000***	Montana State University
New Mexico	***$1,000,000***	University of New Mexico
South Carolina	***$200,000***	University of South Carolina
Tennessee	***$200,000***	Tennessee Technological University
Texas	***$1,200,000***	Texas A&M University
Virginia	***$1,000,000***	Virginia Tech
West Virginia	***$199,999***	West Virginia University
Total	**$12,854,342**	

Several universities have dedicated research centers on their campus, specifically for fuel cell development or incorporating fuel cells as part of a broader energy or engineering focus. Two in New York are constructing new facilities that will not only include fuel cells in the scope of research conducted there, but are also seeking to install fuel cells to help power the laboratories.

- Binghamton University is constructing a new $70 million, 114,000-square-foot Smart Energy Research and Development Facility at the campus' Innovative Technologies Complex that is scheduled to be completed in 2017.[15] Plans include installing a fuel cell to produce electricity, heating and cooling to the building and the fuel cell will also be used in research. The LEED Platinum facility is estimated to bring a direct economic impact of $78.5 million to local counties during its construction phase, supporting more than 500 jobs, including about 200 construction jobs. After construction, new employees will generate $2.5 million of economic impact annually to the local economy.

- As part of its new $191 million Zero Energy Nanotechnology (ZEN) Building, SUNY Polytechnic Institute in Albany, will install a 100-kW fuel cell.[16] The facility is entering many partnerships with energy companies opening offices and creating jobs in the building, as well as with groups such as Japan's New Energy and Industrial Technology Development Organization (NEDO) for research and testing (see page 16 for more details).

Research centers, either part of a university, a National Laboratory or business development incubator are becoming bastions of critical industry R&D, as well as actively involved in creating community partnerships and conducting education and outreach to stakeholders key to moving fuel cell and hydrogen technologies into the mainstream.

The Applied Research Center (ARC) in Aiken, South Carolina, is a great example. ARC was established as a hydrogen energy research facility in 2006, and its 60,000-square-foot campus houses state-of-the-art laboratories and research organizations. This includes DOE's Savannah River National Laboratory (SRNL) Energy Materials Research Laboratory (EMRL) and other hydrogen research activities. ARC is also working with several private companies in the evaluation of novel hydrogen storage technology for fuel cell-powered forklifts.

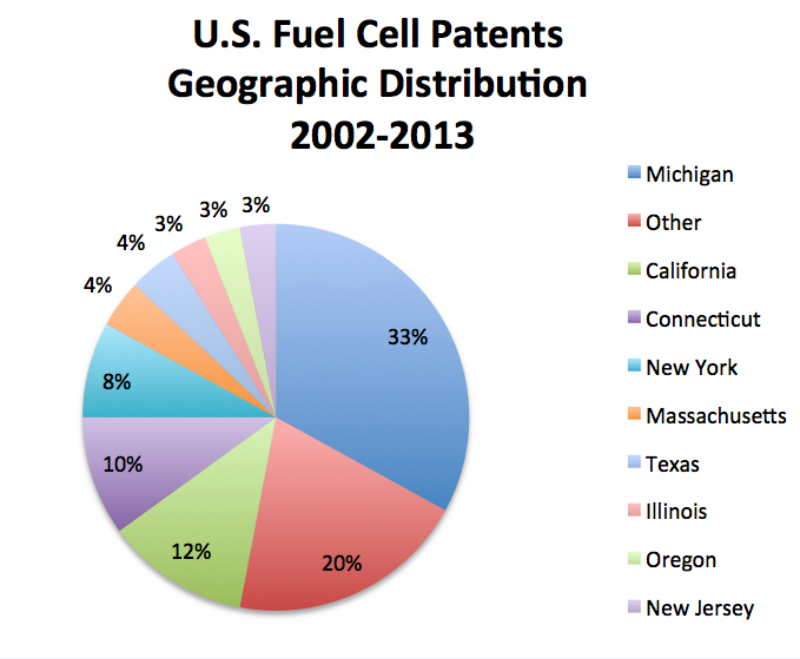
"These successful energy programs—like the Stark State Fuel Cell Prototyping Center—are critical to Ohio's economic development and in aiding our nation's energy independence. Fuel cell and hydrogen technologies are on the cusp of revolutionizing the way we use energy in Ohio and it's critical that we encourage our state's manufacturers, private sector investors, suppliers, and potential customers to embrace this promising new technology."

Sen. Sherrod Brown (OH), during at 2013 visit to the Stark State Fuel Cell Prototyping Center

MAPPING THE FUEL CELL AND HYDROGEN PATH FORWARD

In the clean energy sector, fuel cells are among the top technologies in the intellectual property (IP) and patent space. Cleantech Group-Heslin Rothenberg Farley & Mesiti P.C. tracks clean energy IP in its Clean Energy Patent Growth Index report.

In 2014, the U.S. was bumped by Japan to second place. At the state level, Michigan was again the top patent generator with 99 fuel cell patents, driven in part by automaker R&D located in that state. California (44) and Connecticut (18) round out the top three, home to many fuel cell companies and universities between the two states.



In addition to ongoing public outreach in Aiken and neighboring counties, ARC has recently worked with Aiken County Technical College on STEM Training Camps to provide education and training to more than 150 K-12 teachers about hydrogen, fuel cells and other renewable energy sources.

Stark State College (North Canton, Ohio) was awarded $3.35 million in state Third Frontier funds to construct a Fuel Cell Prototyping Center for fuel cell development on the campus, helping Ohio to create and retain high quality jobs. The Center functions as a pre-production facility to serve as a bridge between research and the marketplace. In 2012, Korean corporation, LG, invested $45 million in Rolls-Royce Fuel Cell Systems, a charter tenant at the center, renaming the company LG Fuel Cell Systems, Inc., and has consolidated its fuel cell research and development activities at this facility.

International Investment and Opportunity

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,[1] and 30 MW installed.

The U.S. is home to some of the world's major fuel cell manufacturers, hydrogen generation and supply chain companies – leading the industry with commercial products in the market, resulting in growing sales and global export opportunities which help create jobs and increase manufacturing here at home. Since our last report, there have been some exciting new developments of U.S.-based companies expanding their global reach.

Connecticut is home to several companies finding success exporting products around the world. Wallingford-based Proton OnSite was even recognized for it in May 2015, winning one of President Obama's "E" Awards for Exports.[17]

Korea

Connecticut-based fuel cell manufacturers have successful partnerships in Korea, exporting a big chunk of unit sales, the majority being multi-MW orders.

- FuelCell Energy, a fuel cell manufacturer based in Danbury, has been working with Korean company POSCO Energy for several years now. Currently, the companies have installed more than 140 MW of fuel cells in Korea, consisting of 18 fuel cell parks in 13 different South Korean cities.[18] This includes the world's largest at 58.8 MW, installed in Hwasung City, which provides power to 70,000 homes.
- Doosan Fuel Cell America, headquartered in South Windsor and formed when South Korean company Doosan acquired ClearEdge Power, now has 35 fuel cells operating in Korea, totaling more than 15 MW. This includes 2.6 MW from six units that began operating at a Korea South East Power Co. Ltd.'s (KOSEP) facility in May 2015.[19] The number will increase to 48 fuel cells totaling 21 MW once an additional 5.6 MW that was ordered in June 2015 is installed by KOSEP by the end of the year.[20]
- Also in June, Doosan announced its first major supply deal, worth $25 million, with an additional $36 million long-term service agreement, with KOSEP to deliver a combined cycle power plant to be constructed in Bundang, just south of Seoul.[21]

Japan

In September 2014, Japan's NEDO launched a $25 million clean-tech research partnership with SUNY Polytechnic Institute in Albany, New York.[22] NEDO will be testing equipment such as solar panels, fuel cells and advanced lighting technologies at SUNY Poly's ZEN building currently under construction. The ZEN building will be a

[1] http://fcel.client.shareholder.com/releasedetail.cfm?ReleaseID=816069

> *"Our pipeline of projects is creating the type of production scale that will promote efficient and cost-effective manufacturing. Equally exciting is that our manufacturing will further stimulate job creation and expansion domestically, as the RUBICON™ is manufactured and supported by a robust supply-chain in the U.S."*
>
> Emilio De Jesus, President of Dominovas Energy's Africa Division

"zero-energy" building that uses a 100-kW fuel cell to generate electricity, helping offset what it takes from the electric grid.[23]

California-headquartered Bloom Energy, through Bloom Energy Japan Limited, installed a 1.2 MW fuel cell at the Osaka Prefectural Central Wholesale Market in Ibaraki City, Osaka Prefecture.[24] The system provides 50% of the buildings' overall electricity needs. This is Bloom's third installation in Japan.

Air Products, based in Allentown, Pennsylvania, signed an Alliance Agreement with Suzuki Shokan Co., Ltd. to work together on the design, construction and operation of hydrogen fueling stations for the material handling vehicle market in Japan.[25]

China

Verde LLC, based in Braintree, Massachusetts, began a renewable energy storage project in China in early 2015, funded through the "Chinese 863 Program," a State High-Tech Development Plan focused on the development of advanced technologies.[26] Verde is working with partners to convert excess wind into hydrogen for storage. The hydrogen will also be utilized in a fuel cell to provide electricity to the grid and potentially for FCEVs.

Africa

In June 2015, Dominovas Energy, based in Atlanta, Georgia with manufacturing in Dearborn, Michigan, was named a Private Sector Partner to President Barack Obama's *Power Africa Initiative*, a multi-stakeholder partnership comprised of private sector participants, the United States government and governments of several African countries, including but not limited to Ethiopia, Ghana, Kenya, Liberia, Nigeria and Tanzania.[27] Dominovas was the first and only fuel cell company included.

This is in addition to three multi-MW, multi-year, and potentially multi-million, even billion, dollar power provider agreements (PPA) Dominovas entered in recent months with African entities, which include:

- A multi-year PPA for 200 MW to the South Kivu Province, in the Democratic Republic of the Congo, via its proprietary RUBICON™ SOFC system. This is expected to yield more than $1 billion in guaranteed revenue to Dominovas Energy over the multi-year term PPA.[28]
- A multi-year PPA for 3 MW to the Somico Mine in the SANKURU/LUSAMBO region of the Democratic Republic of the Congo (DRC), home to one of the largest certified concentrations of diamonds, gold and iron ore in Africa. This deal is valued at more than $107 million.[29]
- A multi-year PPA for 3 MW to the City of David, in the DRC, which will comprise 3,000 homes, a hospital, health clinics, schools, malls, parks, food markets, sports centers, police stations, and waste treatment facilities across 8,000 hectares. This deal is valued at more than $100 million.[30]

Air Products, working with Anglo American Platinum, conducted feasibility assessments, constructed hydrogen storage facilities and installed 5 kW fuel cell units at three Eastern Cape high schools in South Africa.[31] The fuel cells, installed in September 2014 as part of South Africa's Rural Education Development Initiative, provide backup power for lighting and to charge computers, tablets and other equipment.

India

Air Products also opened India's first solar-powered renewable fuelling station in June 2015, the company's third in the country.[32] The solar-hydrogen station is located at the Solar Energy Center near Delhi and was funded by the Government of India's Ministry of New and Renewable Energy. Partners include India's National Institute of Solar Energy and the University of Petroleum and Energy Studies.

Europe

In July, New York-based Plug Power entered into a definitive agreement with Axane, S.A., a subsidiary of Air Liquide S.A. to acquire the remaining 80 percent of HyPulsion, its European joint venture, for $11.47 million. Plug Power will now own 100% of HyPulsion to focus on its growth strategy within Europe. Air Liquide will support this effort as a hydrogen supplier.

Also in July 2015, two Air Products projects were awarded funding from the Office for Low Emissions Vehicles' (OLEV) Hydrogen Refueling Stations Infrastructure Grants Scheme,[i] which aims to provide up to £5.5 million (US$8.5 million) in capital grant funding over two years (2015-17) for infrastructure projects seeding development of hydrogen for road transport in the U.K. The funding will be used to upgrade two Air Products SmartFuel® stations in Heathrow and Hendon, as well as an upgrade to a mobile refueling station.

Israel

U.K. company Cella Energy opened a U.S. facility at the NASA Kennedy Space Center in Florida in 2011. In October 2013, Space Florida, the state's aerospace and spaceport development authority, and the Israeli Office of the Chief Scientist through its Industrial Center for Research and Development, created a $2 million recurring joint fund that supports aerospace and technology RD&D projects that benefit them both. In July 2015, Cella Energy and partner Israel Aerospace Industries (IAI) were selected for a second-round award to develop hydrogen power systems for IAI's Unmanned Aircraft System platform based on Cella's unique pelleted hydrogen system.[33]

The Leaders: State Policies and Funding Promote Fuel Cells, Hydrogen Infrastructure, and Businesses

In determining the leading states that support fuel cells and hydrogen, several criteria come into play:

- First, these states have set in place state policies, programs and funding to promote the technology.
- Second, these efforts have proven successful in encouraging fuel cell installations and/or the development of hydrogen fueling infrastructure.
- Third, support is provided to fuel cell and hydrogen-related businesses in the state.
- Fourth, the states' support for fuel cells and hydrogen has been recognized not only at the corporate level, but also at the municipal level. Local governments are taking advantage of state programs and funding to adopt fuel cell power generation at local facilities, such as city halls, administrative buildings, law enforcement and fire/EMS facilities, jails, and wastewater treatment plants, in order to ensure resilient power generation for their communities.

Three states meet this criterion. Once again, the "Top 3" fuel cell leaders are California, Connecticut, and New York.

These states are not resting on their laurels. They continue to provide innovative programs and funding opportunities to support low-emission power generation, zero-emission transport, and growing industries that provide economic benefits to the state, such as jobs, revenue and investment, state and local tax revenue, gross state product and, in some cases, state exports to foreign markets.

California is the undisputed and long-time leader, recognized worldwide for its efforts to reduce greenhouse gas emissions. These efforts include the promotion of FCEVs, fuel cell buses, hydrogen fueling infrastructure, and generous grants to encourage the installation of stationary fuel cell power generation.

Connecticut and New York, two of several northeastern states impacted in the past few years by severe storms and power outages, support the deployment of fuel cells and other distributed generation technologies to improve

[a] To qualify for the low-income rebate, buyers must make no more than 300% of the federal poverty level - about $73,000 for a four-person family, or $48,000 for a two-person household.

power resiliency, ensuring that critical services are available when power goes down. These states also support fuel cells as a means to reduce greenhouse gas emissions, helping to meet Renewable Portfolio Standard (RPS) goals to increase the proportion of renewable energy delivered to customers by electric utilities.

In addition, these three states are home to many of the world's leading fuel cell manufacturers.

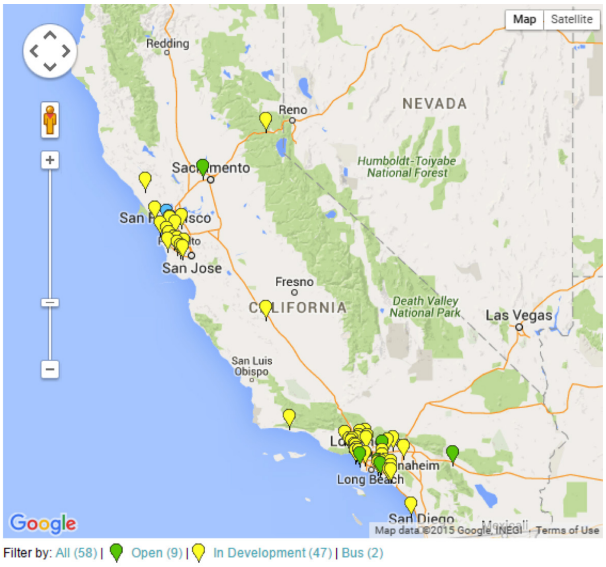
For a comprehensive overview of the leading states' fuel cell and hydrogen programs and policies, and their implementation history, see our last report: State of the States: Fuel Cells in America 2014.

California

FCEVs and Hydrogen Stations

California has long been a world leader in supporting the deployment of fuel cells vehicles and hydrogen stations. The state has made a commitment to provide at least $20 million in funding annually until an initial 100 hydrogen stations have been built and offers a $5,000 rebate through the Clean Vehicle Rebate Program (CVRP) for new FCEVs. In 2015, California regulators boosted this rebate for low-income FCEV purchasers,[a] who will be able to receive a $6,500 state rebate, $1,500 more than the $5,000 rebate available to others.

This commitment to policies and programs incorporating FCEVs and providing the financial foundation to construct the hydrogen infrastructure to support them is a key reason major automakers are targeting California as one of the first locations in the world for FCEV commercial deployment. In 2015 alone, California has awarded more than $7 million in grants for hydrogen fueling station operation and maintenance, and for fuel cell technology demonstrations for medium- and heavy-duty trucks.



CaFCP Hydrogen Station Map, curtesy of Google

According to the California Fuel Cell Partnership (CaFCP), several hundred fuel cell passenger vehicles and transit buses now operate on California roadways. Some vehicles are leased directly to customers, while others are deployed in fleet programs. Three transit agencies also operate fuel cell-powered buses in daily revenue service, including AC Transit in Oakland and SunLine Transit in Thousand Palms , with fuel cell buses also planned for Burbank and San Francisco. The CaFCP maintains a map of current and planned hydrogen stations in the state.

CaSFCC Fuel Cell Installation Map, curtesy of Google

Stationary Power

California supports the deployment of large stationary fuel cells, with several state agencies actively funding these installations to help the state meet its RPS, greenhouse gas (GHG) reduction, and sustainability goals. Many of these deployments are supported by

the state's Self Generation Incentive Program (SGIP) funding, which offers an incentive $1.65/watt for both CHP and electric-only fuel cells.

The California Stationary Fuel Cell Collaborative (CaSFCC) reports that, as of October 1, 2014:

- There were active or publicly announced stationary fuel cell installations in more than half of California's 58 counties and in more than 100 cities.
- These installations represent more than 100 MW of installed capacity, enough to provide electricity to 100,000 homes.

Some of the installations are from repeat customers that deploy fuel cells at multiple sites.

CaSFCC maintains a map of the state's stationary fuel cell installations.

Fuel cell customers with stationary installations in California include:			
Adobe	FedEx	Nokia	St. Helena Hospital
Aerojet Rocketdyne	Fireman's Fund	Norco College	Staples
Albertson's Supermarket	Franklin Templeton	NTT America	Sutter Home Winery
Altera Innovation	Fujitsu	Odwalla	Sutter Santa Rosa Hospital
Apple	Gills Onions	Owens Corning	Target
AT&T	Google	Pacific Cheese Company	Taylor Farms
Baker Hughes	Honda	Panasonic Avionics	TaylorMade-adidas
Bank of America	Honda Center	Pixar Animation Studios	The Ratkovich Co.
BD	IKEA	Pratt & Whitney Rocketdyne	Toyota Motor Sales
Blue Lake Rancheria	Intuit	Ramar Foods International	University of California
California Institute of Tech.	J&D Soft Gel Labs	Roche Molecular Diagnostics	Verizon
California State University	JMB Realty	Roll Global	VersaCold
CBS Studios	Johnson & Johnson	Safeway	Walmart
CenturyLink	Juniper Networks	Sam's Club	Whole Foods Market
Chino Valley Medical Center	Kaiser Permanente	San Francisco State Univ.	Williams Sonoma
Coca-Cola	Kellogg's	SAP Pavilion	Xilinx
Cox Communications	Life Technologies	Shark's Ice	Yahoo!
Cyprus Semiconductor	Lockheed Martin	Sheraton	
Dreamworks Animation	LPL Financial/Hines	Sierra Nevada Brewing Co.	
eBay Inc.	Medtronic	Silverman & Light	

"The benefits of this fuel cell project are that we avoid the flaring of the biogas, we remove future compliance obligations from the South Coast Air Quality Management District regulations due to the emission of only water vapor from the fuel cells, and we obtain carbon credits from the California Air Resources Board. Fuel cells operating on renewable biogas solve a number of our issues and concerns about permitting and sustainability that are not easily or completely addressed by other forms of on-site power generation."

Ernest Marquez, Jr., Principal Engineer, City of Riverside, speaking of the city's planned fuel cell planned at the Regional Water Quality Control Plant

"We are doing the right thing to ensure cleaner air for our residents to breathe as we power critical facilities within a framework that saves the city money. The opportunity to further clean our air without significant investments in equipment, while also obtaining cost savings, is a win-win."

Mayor Rusty Bailey speaking of the new 1.4-MW fuel cell system planned at Riverside California's Regional Water Quality Control Plant

In addition, a number of California's municipalities are adopting fuel cells for low-emission, efficient, and reliable power generation, and sometimes byproduct heat for heating, cooling, and hot water, at government facilities. Some of these sites employ renewable biogas to power their fuel cells, using either biogas produced onsite at wastewater treatment plants, or directed biogas.

Stationary fuel cells at California municipal sites include:	
Facility	**City**
AC Transit	Oakland
Orange County Sanitation District Wastewater Treatment Plant	Fountain Valley
Eastern Municipal Water District Wastewater Treatment Plant	Moreno Valley
Eastern Municipal Water District Wastewater Treatment Plant	Perris Valley
Inland Empire Utilities Agency Wastewater Treatment Plant	Ontario
Point Loma Wastewater Treatment Plant	San Diego
Riverside Water Quality Control Plant (planned)	Riverside
San Jose/Santa Rita Water Quality Control Plant	San Jose
Santa Clara County Berger Service Center	San Jose
Santa Clara County Elmwood Correctional Facility	Milpitas
Santa Clara County Government Center	San Jose
Santa Clara County Main Jail North	San Jose
Santa Rita Jail	Dublin
Sonoma County Administration Campus and County Jail	Santa Rosa
South Bay Water Reclamation Plant	San Diego
South Coast Air Quality Management District	Diamond Bar
Tulare Water Reclamation Plant	Tulare

California has developed an Energy Storage Roadmap to support the advancement of energy storage, including the possible use of hydrogen energy storage, also known P2G, as a grid resource. Widely adopted in Germany, P2G is a method of storing and transporting energy that can help to resolve barriers to the large-scale adoption of renewable energy, such as off-grid wind and solar power, offering energy storage capacity in the TWh range. P2G converts electrical power into a gaseous fuel by means of electrolysis, using electricity to split water into its component parts of hydrogen and oxygen. The hydrogen is stored in caverns for later use, or into injected a natural gas pipeline. America's first P2G demonstration will be conducted by Southern California Gas and its partners, generating renewable hydrogen from a local photovoltaic source and injecting it into a simulated natural gas grid.

Connecticut

FCEVs and Hydrogen Stations

In May 2015, Connecticut's Department of Energy and Environmental Protection (DEEP) launched the Connecticut Hydrogen and Electric Automobile Purchase Rebate Program (CHEAPR). It offers a cash rebate of up to $3,000 to Connecticut residents, businesses, and municipalities who purchase or lease an FCEV. CHEAPR also provides bonuses to the dealers selling the vehicles. In all, $800,000 will be used for cash rebates, while $200,000 is set aside for dealer bonuses.

Following that, in June, EVConnecticut, a partnership between DEEP and the CT DOT announced a Hydrogen Fueling Station Grant, called H2Fuels. Administered by the Connecticut Center for Advanced Technology,

H2Fuels will provide grants up to $450,000 to develop and operate two public hydrogen fueling stations in the greater Hartford area.

The state-operated transit agency, CTtransit, has operated fuel cell buses since 2007.

> *"Connecticut is a hub of innovation and, in particular, we are consistently ranked among the top states leading the U.S. fuel cell industry which, in our state alone, employs thousands of workers and generates millions of dollars in economic activity and tax revenue. The fuel cell industry is simply too important not to be part of our long-term energy goals to implement cleaner, cheaper, and more reliable energy sources for Connecticut's residents and businesses."*
>
> Governor Dannel P. Malloy

Stationary Power

The state's Microgrid Grant and Loan Program has awarded more than $7 million in funding to two fuel cell projects in the pilot round and one in round 2. This includes:

- $2,144,234 to the University of Connecticut Depot Campus/Storrs Campus for a 400-kW fuel cell and a 6.6-kW demonstrator photovoltaic system;
- $3,000,000 to the Town of Woodbridge for a microgrid that will support Woodbridge police stations, fire station, Department of Public Works, town hall, high school, and library. The system will include a 1.6-MW natural gas-powered turbine and a 400-kW fuel cell;
- $2,180,898 to the University of Bridgeport for a microgrid that will support the dining hall, recreation center, student center, police station and two residence halls, using a 1.4-MW fuel cell system.

> *"Bridgeport has North America's largest fuel cell. These projects aren't just good for the environment. They are good for our economy. They create jobs. They help reduce asthma and breathing ailment rates for kids. They grow our tax base. And, it's proof that our city can heal from the sins of our past and move toward a cleaner and more prosperous future."*
>
> Bill Finch, Mayor of Bridgeport, Connecticut

A proposed project would build a 63.3-MW fuel cell power plant in Beacon Falls on a 23.8-acre brownfield site that was a former sand mine. The project would produce enough power for 60,000 homes and could generate up to $90 million in local property taxes over the project's life.

> *"Returning a former sand mine site to the tax rolls is solid economic policy, and doing so with unobtrusive fuel cells that are clean and quiet and built in Connecticut is very compelling. This project is advancing rapidly as the right companies are involved and time and money is being invested to bring this project to fruition."*
>
> William Corvo, President of CT Energy & Technology, LLC.

All of the companies involved in the project are based in Connecticut - CT Energy & Technology, LLC, O&G Industries, and FuelCell Energy – with more than 1,500 employees between them living in the state. Construction would be done in three phases over three years and is tentatively scheduled for the beginning of 2016.

The state is already home to a 14.9-MW fuel cell power park in Bridgeport, owned by Dominion, and Connecticut Light & Power purchases the electricity for the local grid. Another fuel cell and solar system will be located at Seaside Park, a former landfill site, generating power for United Illumination (UI).

Sketch of the proposed 63.3 MW Beacon Falls fuel cell power park

In addition, a number of Connecticut businesses, universities and local governments operate fuel cells, or are planning new fuel cell installations. The state is also home to two multi-use, residential high rise buildings with fuel cells.

Fuel cell customers with stationary installations in Connecticut include:			
AT&T	Connecticut Science Center	Macy's	Univ. of Bridgeport (planned)
Becker + Becker (two residential high-rise buildings)	CT Energy & Technology (planning)	Pepperidge Farm Bakery	Univ. of Connecticut
Cabela's Sporting Goods	Danbury Fair Mall	Saint Francis Hospital	Western Connecticut State Univ.
Carla's Pasta	Dominion	Stop & Shop	Whole Foods Market
Central Connecticut State Univ.	Eastern Connecticut State Univ.	UIL Holdings (planned)	Yale University
Coca-Cola	Hartford Hospital	United Illuminating	

Stationary fuel cells at Connecticut municipal sites include:	
Facility	**City**
City of New Haven Town Hall	New Haven
Connecticut Juvenile Training School	Middletown
CTtransit Headquarters	Hartford
CTtransit maintenance facilities (planned)	Hamden
Hamden High School	Hamden
Hartford/Parkville microgrid (planned)	Hartford
Hartford/Rosedale microgrid	Hartford
Hartford Public Safety Complex	Hartford
Middletown High School & Vocational Agricultural Center	Middletown
Greater New Haven Water Pollution Control Authority Facility	New Haven
Roberto Clemente Leadership Academy and Hill Central School	New Haven
South Windsor High School	South Windsor
Town of Woodbridge microgrid (planned)	Woodbridge

The interest in fuel cells continues to grow. Redding, Connecticut, recently created a task force to examine the feasibility of bringing a fuel cell to the town to help improve air quality.[34]

Business Development/Partnerships

Connecticut is actively promoting its state's energy sector, including its fuel cell industry, to encourage business development and partnerships.

New York

Stationary Power

New York has long invested in fuel cell technology, home to some of the longest-running stationary installations in the world. Projects are partially funded through various program supported by NYSERDA. One is a dedicated, open enrollment fuel cell funding program, available through December 31, 2015. The RPS Customer-Sited Tier Fuel Cell Program has separate tracks – one for a fuel cell system rated 25 kW or less, and another for systems over 25 kW – and provides as much as $300,000 per site.

For every $1 invested in RPS Main Tier projects, New York realizes $3 in economic benefits.[35] More than $3 billion of direct investment in New York State is expected as a result of existing Main Tier projects in the form of jobs, payments to public entities, in-state purchase of goods and services and land leases.

In December 2014, a new law increased the combined rated capacity of fuel cell electric generating equipment for net energy metering for non-residential customers from 1.5 MW to 2 MW.[36]

In April 2015, Governor Andrew Cuomo announced up to $160 million to grow large-scale clean energy across New York as part of the State's *Reforming the Energy Vision* (REV) strategy.[37] This funding will support significant private investment in renewable energy sources, including fuel cells. Recognizing the maturation of fuel cell equipment, for the first time ever, fuel cell projects are now eligible for 20-year contracts, expanding on the previous 10-year term coverage.

Also part of REV, NY-Prize, a $40 million competition to help communities create microgrids, with goals of reducing costs, promoting clean energy, and building reliability and resiliency into the electric grid, was launched.

In July 2015, $8.3 million was awarded to 83 projects ($100,000 each) to assess the technical, operational and financial feasibility of their proposed community microgrid.[38] Six of the communities have identified fuel cells as part of their proposed technology mix, including the Village of Babylon, Town of Brookhaven, City of Long Beach, Town of Hempstead, Village of Freeport, and Eighth Avenue Microgrid in Manhattan. The next stage of the project will identify approximately 10 projects to develop detailed project designs, with awards of up to $1 million each, while the final stage will approve up to $7 million each for approximately five projects for final build and construction.

Current New York fuel cell customers include a range of users, such as businesses, a university, a residential high-rise building, wastewater treatment plants, the new World Trade Center, and City Hall.

Fuel cell customers with stationary installations in New York include:		
AT&T	News Corp.	Rochester Institute of Tech.
Becker + Becker – residential high rise building	New York Aquarium	Sheraton Hotel
Coca-Cola	Port Authority of NY & NJ - World Trade Center	Stop & Shop
Morgan Stanley	Price Chopper	Verizon

Stationary fuel cells at New York municipal sites include:	
Facility	**City**
Hunt's Point Water Pollution Control Plant	Bronx
New York City Hall	New York City
New York Power Authority (NYPA) Office Building	White Plains
Oakwood Beach Water Pollution Control Plant	New York City
Red Hook Waste Water Treatment Plant	Brooklyn

Rising States

Beyond the Top 3, there are several other states interested in funding and supporting fuel cells as part of an overall energy and economic strategy—to boost resiliency and energy efficiency, jobs, manufacturing and exports, and meet sustainability and climate goals.

These include Colorado, Hawaii, Massachusetts, New Jersey, Ohio, and Pennsylvania. We've highlighted some of the recent exciting efforts and advancements in the fuel cell and hydrogen space that these states have achieved since our last report.

Colorado

Colorado is a newcomer to our list—fast becoming a hot bed of energy and clean technology industries, including fuel cells and hydrogen.

Business Development/Partnerships

The Colorado Hydrogen Coalition was formed in 2014 to focus on accelerating the development of the hydrogen fuel cell technologies market in Colorado, and promoting collaborative stakeholder engagement across sectors. There is a growing industry in the state, with several companies winning DOE funding awards for R&D and product development. Colorado also offers several business development incentives and resources to expand business into the hydrogen and fuel cell sector.

FCEVs and Hydrogen Stations

Located in the western part of the U.S., between the two coasts and the eight states that signed the ZEV memorandum of understanding, Colorado has a $6,000 state tax credit for ZEVs, one of the most generous in the nation, in place through 2021.

In 2013, Toyota delivered four FCEV-adv fuel cell vehicles to NREL, located in Golden, on a two-year loan program. There currently are two still in use at the NREL, along with a Daimler B-Class FCEV. NREL currently operates a 350 bar renewable H2 fueling station at its National Wind Technology Center (Wind2H2), just south of Boulder, and a new state-of-the-art 700 bar hydrogen fueling station has opened up at the Energy Systems Integration Facility (ESIF), located on its main campus in Golden, connected with DOE's H2FIRST activities focused on improving hydrogen fueling infrastructure.

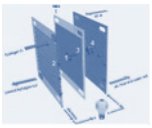
Stationary Power

In 2004, Colorado became the first state in the U.S. to enact a RPS by ballot initiative. The RPS, as well as the state's interconnection standards and net metering, include fuel cells using hydrogen derived from eligible renewables as an eligible energy resource.

There are a few stationary fuel cell installations currently operating in Colorado, including an 8-kW fuel cell backup system operating at the CableLabs headquarters in Louisville, a fuel cell backup system at a Colorado Springs Federal Aviation Administration (FAA) site, powering a remote transmitter/receiver, and fuel cells are also powering chemical injection pumps at multi-wellhead head sites in Western Colorado.

Material Handling

Retail food chain Kroger operates 120 fuel cell-powered forklifts operating at its Stapleton warehouse.



R&D

NREL's ESIF includes a state-of-the-art Fuel Cell Development and Test Laboratory and was named R&D Magazine's 2014 "Laboratory of the Year" as a first-of-its kind facility that merges an ultra-energy efficient workplace, one of the world's most energy-efficient, high-performance computing data centers, and sophisticated high-bay laboratory spaces with outdoor test areas. The facility's hydrogen and fuel cell research focuses on developing, integrating, and demonstrating hydrogen production and delivery, hydrogen storage, and fuel cell technologies for transportation, stationary, and portable applications.

Hawaii

Hydrogen Energy Policy

Hawaii has one of the highest electricity prices in the U.S., and has to import a majority of its energy, so the state is committed to finding new, local sources of energy. Hawaii's governor signed an energy bill that strengthens Hawaii's commitment to clean energy by directing the state's utilities to generate 100 percent of electricity sales from renewable energy resources by 2045. In addition, a new state hydrogen implementation coordinator position was created by the Legislature to facilitate the establishment of infrastructure and policies across all agencies of the State to promote the expansion of hydrogen-based energy in Hawaii. That position was filled in July 2015.[39]

Ocean Vessels and Ports

There are several ongoing fuel cell and hydrogen projects in Hawaii, including one at the Port of Honolulu, testing fuel cells to power ships at berth. That demonstration received $3 million in DOE funding.

FCEVs and Hydrogen Stations

DOE, with the Office of Naval Research and the state of Hawaii, and the Hawaii Natural Energy Institute (HNEI) helped fund a new "fast-fill" high-pressure hydrogen fueling station at the Marine Corps Base Hawaii that opened in November 2014.[40] This state-of-the-art station supports a fleet of General Motors Equinox FCEVs leased by the Office of Naval Research (ONR) for use by Marine Corps and Navy personnel on Oahu and is certified for unattended operation, just like at a gas station.

Massachusetts


FCEVs and Hydrogen Stations

In April 2015, an additional $2 million was allocated to the Massachusetts Offers Rebates for Electric Vehicles (MOR-EV) program, administered by the Department of Energy Resources (DOER). MOR-EV offers rebates of up to $2,500 to Massachusetts residents who buy or lease electric vehicles, including FCEVs. Qualifying fuel cell models include the Honda FCX Clarity, Hyundai Tucson Fuel Cell, and Mercedes-Benz B-Class F-Cell. The program was initially funded using $2 million in Regional Greenhouse Gas Initiative auction proceeds, which also finances the new funding.

Stationary Power

DOER also oversees the Community Clean Energy Resiliency Initiative grant program. In September 2014, DOER awarded $7.4 million in grants, and have since amended the solicitation documents to not only include natural gas CHP fuel cells but to also permit CHP and district energy systems utilizing natural gas and renewable energy fuels. CHP or fuel cell systems with waste heat utilization must achieve annual system efficiency of at least 65 percent; and high efficiency (at least 50 percent) fuel cells.

New Jersey

Stationary Power

As a state hit hard by Superstorm Sandy, New Jersey is increasingly turning to fuel cells as part of the solution to provide resilient and reliable power, particularly in the face of strong weather events.

In November 2014, New Jersey launched the Energy Resilience Bank (ERB) the first public infrastructure bank in the nation to focus on energy resilience, with $200 million allocated through a Community Development Block Grant-Disaster Recovery (CDBG-DR) fund. The ERB supports the development of distributed energy resources at critical facilities throughout the state that will enable them to remain operational during future outages. Fuel cells are an eligible technology, either fueled with fossil fuel natural gas or renewable fuels such as biogas, methane from landfills or digesters, or hydrogen generated from a renewable source.

The first round of funding focused on waste water treatment plants. This is an area of concern because nearly one-third of the state's public water systems lost power during Hurricane Sandy.[41] The next round will focus on hospitals, as more than half of New Jersey's hospitals lost power during the storm.[42] Future funding priorities will also include transit, education, and public housing.

New Jersey is also looking to enhance energy efficiency through on-site power generation with recovery and productive use of waste heat, and to reduce existing and new demands to the electric power grid. The Board of Public Utilities seeks to accomplish this goal by providing generous financial incentives for CHP and fuel cell installations, via its CHP-FC Program.

The state's Clean Energy Partnership Large Energy Users Program (LEUP) is designed to promote self-investment in energy efficiency and CHP projects, offering incentives up to $4 million on a first-come, first-served basis for eligible entities in New Jersey's largest commercial and industrial facilities. The installation of a CHP or fuel cell system can be included as part of the LEUP work scope for incentive consideration.

Ohio

Business Development/Partnerships

Home to many automotive and aerospace companies, and the supply chain supporting them, Ohio has an existing support network that lends itself perfectly to the fuel cell industry. In December 2014, DOE awarded the Ohio Fuel Cell Coalition (OFCC) $450,000 to establish an integrated network of four Regional Technical Exchange Centers to increase communication between OEMs and hydrogen and fuel cell component suppliers and to establish a nationwide, web-accessible database containing inputs from suppliers and OEMs along with a supplier contact list. OFCC will also assemble a working group to tackle component and subsystem standardization.

The state's budget was signed by the Governor in July 2015 and contained a five-year extension of the "payment in lieu of taxes" (PILOT) program that was scheduled to end at the end of the year. PILOT lowers tangible personal property tax rates for renewable and advanced energy technologies, including fuel cells. This extension adds certainty to developers and offers a revenue stream to local communities willing to host an eligible project.

The Ohio Third Frontier Technology Validation and Start-up Fund, administered by the Ohio Development Services Agency, includes fuel cells in its scope and has $4.5 million available for calendar year 2015.

FCEVs and Hydrogen Stations

Ohio's Stark Area Regional Transit Authority (SARTA) received an $8.9 million grant from the Federal Transit Administration to deploy fuel cell buses. The first two buses will begin operation in 2016, with five more slated for delivery in 2017.

Material Handling

In December 2014, NACCO Materials Handling Group Inc., the operating company for Cleveland-based lift truck manufacturer Hyster-Yale Materials Handling Inc. acquired Billerica, Massachusetts, fuel cell manufacturer and hydrogen fuel generation company Nuvera Fuel Cells, Inc. Hyster-Yale plans to integrate fuel cells into its product lines and offer factory-fitted fuel cell applications in addition to hydrogen generation and delivery capabilities. The company said it will also offer aftermarket solutions designed to fit most electric-powered lift trucks currently on the market.

Pennsylvania

FCEVs

Pennsylvania's Department of Environmental Protection elected to continue its six-year-old Alternative Fuel Vehicle Rebate Program until December 31, 2015.[43] FCEVs and hydrogen vehicles are eligible for $1,000 rebates.

Business Development

In 2014, WATT Fuel Cell Corporation, based in Port Washington, New York, purchased Pittsburgh Electric Engines, Inc. and opened a 39,000 square foot manufacturing facility in Mount Pleasant in October that year. WATT was also awarded a grant and a loan from the state's Commonwealth Financing Authority - Alternative and Clean Energy Program (see page 15 for more details on the funding award).

Also in 2014, J.V. Manufacturing, a stamping dies and components company located in Natrona Heights, received a $500,000 grant from the Pennsylvania Energy Development Authority to o buy additional processing equipment to produce fuel cell components.[44]

Material Handling

There are more than 850 fuel cell-powered material handling vehicles operating in warehouses around Pennsylvania. In May 2015, family-owned and operated Dietz & Watson, one of the largest preparers of premium deli meats and artisan cheeses, deployed 25 at its new Philadelphia warehouse. Walmart has been operating almost 300 fuel cell-powered forklifts at its Pottsville facility since mid-2014. Other customers include Procter & Gamble (Mehoopany), Sysco (Philadelphia), and Wegman's (Pottsville).

Expanding the Fuel Cell Reach: Summaries of Recent Sales, Installations and Deployments

Stationary Fuel Cells

In addition to the many MWs either installed or ordered for our Top 3 states since our last report, with Plug Power's deal with SouthernLINC, its ReliOn fuel cells will soon be installed at sites in the Gulf region of the U.S., including Alabama, Georgia, Mississippi and Florida.[45] Wyoming is now also home to a FuelCell Energy fuel cell power plant, through a demonstration by Microsoft.

Other interesting standouts since our last report include the Blue Lake Rancheria Tribe in California which is using locally-grown timber as the Ballard Power Systems' fuel cell hydrogen source; and a Bloom Energy fuel cell system now installed at a mall in Connecticut.

Repeat customers include Walmart, Pepperidge Farm, AT&T, and Becker & Becker.

STATIONARY FUEL CELL INSTALLATIONS/ORDERS SINCE LAST REPORT (ALPHABETICAL BY STATE)				
LOCATION	CUSTOMER	PROVIDER	POWER	DETAILS
		CALIFORNIA		
Apple Valley	*Walmart*	*Bloom Energy*	*200 kW*	Provides 40-60% of store's electricity.
Emeryville	*Disney Pixar Animation Studios*	*Bloom Energy*	*1 MW*	The fuel cell helps supplement electricity use throughout the campus.
	IKEA	*Bloom Energy*	*300 kW*	Retail store – combined with solar.
Fairfield	*AT&T*	*Bloom Energy*	*1 MW*	N/a
Gardena			*400 kW*	N/a
Hayward	*Pacific Cheese*	*Bloom Energy*	*300 kW*	N/a
Humboldt County	*Blue Lake Rancheria Tribe Hotel & Casino*	*Ballard Power Systems*	*175 kW*	Will be integrated with a biomass gasifier and syngas purification unit to convert locally-grown timber by-product feedstock into hydrogen-rich syngas. The fuel cell will provide base load power for the Tribe's commercial enterprises and byproduct heat will warm the swimming pool in an adjacent hotel.
Irvine	*CenturyLink*	*Bloom Energy*	*500 kW*	The fuel cells, expected to produce nearly 4.4-million kW-hr of annual electricity, help power cloud-managed hosting and co-location services housed within the data center.
	Johnson & Johnson Advanced Sterilization Products (ASP)	*Bloom Energy*	*500 kW*	The fuel cells, along with uninterruptible power modules provide 25% of the ASP daily energy consumption and a 22% reduction in CO2 emissions as compared to the electric grid currently in use in Irvine.
Lake Forest	*Panasonic Avionics*	*Bloom Energy*	*750 kW*	Installed in September 2014 at Panasonic Avionics' global headquarters. The fuel cells generate enough power to provide 85% of the facility's energy load.
Norco	*Norco College*	*Doosan Fuel Cell America*	*400 kW*	N/a
Palm Desert	*Walmart*	*Bloom Energy*	*200 kW*	Provides 40-60% of store's electricity.
Palm Springs			*200 kW*	Provides 40-60% of store's electricity.

Riverside	*City of Riverside. Riverside Regional Water Quality Control Plant*	*FuelCell Energy*	*1.4 MW*	Will convert approximately one half of the biogas from the wastewater treatment process into a continuous supply of clean electricity to provide about half of the power needs for the facility. The fuel cell will also power two EV charging stations, as well as provide thermal energy for the water treatment process.
San Jose	*Equinix*	*Bloom Energy*	*1 MW*	Fuel cell will use biogas to power data center.
Santa Rosa	*Medtronic*	*Bloom Energy*	*400 kW*	Installed November 2014. The fuel cell system provides 96% of the electrical requirements for one of largest buildings on campus, and increases the percentage of on-site electrical generation from approximately 13% to more than 85%. The system also saves 3 million gallons of water annually.
		CONNECTICUT		
Baltic	*Amgraph Packaging*	*Doosan Fuel Cell America*	*800 kW*	Amgraph will install two 400 kW fuel cells to provide CHP to its plant. This project was awarded a grant under the Connecticut Low and Zero Emissions Renewable Energy Credit (LREC) program, which distributes renewable energy credit payments for each MWh of power produced.
Berlin	*Comcast*	*Bloom Energy*	*400 kW*	Comcast's Western New England Regional Headquarters
Bloomfield	*Pepperidge Farm*	*FuelCell Energy*	*1.4 MW*	This project was awarded a grant under the LREC program and is Pepperidge Farm's second fuel cell installation.
Danbury	*Danbury Fair Mall/Macerich (mall owner)*	*Bloom Energy*	*750 kW*	Produces 36% of power used by the 1.3 million- sq.-ft. mall. The project was financed in partnership with Washington Gas Energy Services and the Connecticut LREC Program.
Glastonbury	*Connecticut Natural Gas Corp. Pressure Reduction Facility*	*FuelCell Energy*	*2.8 MW*	A 3.4-MW DFC® Energy Recovery Generator (DFC-ERG®) plant will be installed at a gate station owned by UIL subsidiary Connecticut Natural Gas Corporation, where natural gas is converted from high to low pressure.
Hamden	*CTtransit*	*Doosan Fuel Cell America*	*400 kW*	The fuel cell will power a maintenance and storage facility.

Hartford	*777 Main Street/Becker & Becker*	*Doosan Fuel Cell America*	*400 kW*	The building renovation incorporates 285 apartments and will be downtown Hartford's largest apartment building. It also includes six retail shops, a gym, club room, library and 250-car parking garage. The fuel cell helped the project reach LEED Platinum certification.
New Haven	*Walmart*	*Bloom Energy*	*N/a*	Business continuity site—fuel cell provides portion of power during outages. Final commissioning in 2015.
Waterford	*Walmart*	*Bloom Energy*	*N/a*	Business continuity site—fuel cell provides portion of power during outages. Final commissioning in 2015.
		NEW YORK		
Purchase	*Morgan Stanley*	*Bloom Energy*	*250 kW*	Fuel cell and solar field expected to produce approximately 3 million kWh of energy/yr. During peak energy consumption times, they can supply up to 30% of the building's demand. The fuel cell will also supply grid-independent electricity to power portions of the building's critical load during grid outages.
		WYOMING		
Cheyenne	*Microsoft*	*FuelCell Energy*	*300 kW*	Data center pilot project. The fuel cell runs on biogas generated from a nearby Water Reclamation Facility and operates independent of the grid to provide continuous power to the data center. Any excess power is provided to the water reclamation facility to offset their electric costs.
		MULTIPLE LOCATIONS		
Major metro and rural areas of Alabama, Georgia, southeast Mississippi and northwest Florida	*Southern Company/ SouthernLINC Wireless*	*Plug Power*	*N/a*	Southern Company and Plug Power entered a multi-year contract to provide ReliOn integrated fuel cell solutions and GenFuel hydrogen services to SouthernLINC Wireless, for 500 of its wireless network long-term evolution (LTE) sites.
		TOTAL 13.7 MW		

This chart includes publically announced sales and installations since our last report, including previously undisclosed locations. N/a = information is not available.

Material Handling

The business case for fuel cell-powered forklift equipment is being successfully made in warehouses around the U.S. and a DOE study finding that fuel cell-powered MHE can have a lower total cost of ownership than comparable battery lifts supports it as well.[46] The U.S. is leading the world in fuel cell material handling deployments, with more than 7,500 fuel cells deployed across the country. The customer lists keeps getting longer as well as growing laterally, with companies ordering more units for additional facilities. The MHE market is also expanding to include ground service equipment (GSE) vehicles at airports and utility vehicles operating at ports and other municipal facilities.

FUEL CELL MATERIAL HANDLING ORDERS/DEPLOYMENTS SINCE LAST REPORT (ALPHABETICAL BY STATE)				
LOCATION	**CUSTOMER**	**PROVIDER**	**POWER**	**DETAILS**
		FLORIDA		
Sarasota	***United Natural Foods, Inc. (UNFI)***	***Plug Power***	***6***	UNFI, which has had 65 fuel cell-powered forklifts operating at its Sarasota distribution facility since 2010, became the first company to receive new Raymond® Model 5500 fuel cell-compatible orderpickers.
		ILLINOIS		
Chicago	***Golden State Foods***	***Plug Power***	***39***	The 158,300 square-foot regional headquarters and logistics center built on a 15-acre parcel west of Chicago, will serve more than 460 McDonald's in the Midwest region.
		NEW JERSEY		
Carteret	***FreezPak Logistics***	***Plug Power***	***25***	For new cold storage distribution center freezer warehouse under construction.
Newark	***Newark Farmers Market***	***Plug Power***	***110***	For new refrigerated meat warehouse. Already had 96 operating since 2011.
		OHIO		
Marysville	***Honda***	***Plug Power***	***51***	Honda has two hydrogen stations onsite to fuel the forklfts.
Troy Township	***Unnamed***	***Plug Power***	***177***	For a mix of class-2 and class-3 lift and reach trucks, a GenFuel hydrogen fuel supply and storage infrastructure, and a GenCare maintenance contract.

PENNSYLVANIA				
Philadelphia	*Dietz & Watson*	*Plug Power*	*N/a*	A newly constructed 200,000-square-foot warehouse and distribution center is located on 20 acres next to the company's Philadelphia headquarters and manufacturing plant. This new facility will distribute Dietz & Watson products to supermarket retailers, food service suppliers, and medium and small delicatessens throughout the U.S. and the company will integrate fuel cells into its entire fleet of class-2 and class-3 lift trucks.
TENNESSEE				
Chattanooga	*Volkswagen*	*Plug Power*	*46*	N/a
Memphis	*FedEx*	*Plug Power*	*15*	As part of a DOE-sponsored project, 15 fuel cell GSE cargo tractors and supporting hydrogen infrastructure went into service April 2015 at Memphis International Airport.
WISCONSIN				
Pleasant Prairie	*Uline*	*Plug Power*	*21 (130+)*	Uline is a distributor of shipping, industrial and packaging materials to businesses throughout North America. The initial deployment of 21 fuel cells will power the forklift fleet at one of Uline's distribution centers in Pleasant Prairie. Uline will deploy a second fleet of fuel cell-powered lift trucks into a newly constructed facility, bringing the total to more than 130 between the two facilities.
This chart includes publically announced sales and installations since our last report, including previously undisclosed locations.				

Hydrogen Fueling Stations

With FCEVs beginning to hit the road in California, and plans being made for rollouts in other states in the coming years, ensuring the fueling infrastructure is there to support them is crucial. Constructing hydrogen stations and adding dispensing capabilities to existing gasoline stations are a top priority for automakers and other stakeholders. These companies are partnering together, and with state agencies and other organizations, to keep the momentum going forward.

In addition to fueling cars and buses, with each fleet of fuel cell-powered MHE, a hydrogen fueling/dispenser system is installed, helping increase awareness about properties of hydrogen and hydrogen safety, as well as advancing component technologies and products that can be adapted to larger pressures, capacities and storage for FCEVs and buses.

Last year, we reported on the California Energy Commission's (CEC) funding award of $46.6 million for 28 new and upgraded stations through its Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP). Since our last report, several of these California stations have opened:

- In January, the first station to be certified to sell hydrogen to public was opened at California State University, Los Angeles. The station produces renewable hydrogen on site and can provide 65 kilograms (kg) of hydrogen per day via an electrolyzer, enough to fuel 13 cars a day.[47]
- In March 2015, a station originally installed in 2004 at the South Coast Air Quality Management District (SCAQMD) headquarters in Diamond Bar, was replaced with a new state-of-the-art publicly accessible hydrogen fueling station.[48] The upgraded station allows for both low- and high-pressure hydrogen refueling and has a 100 kg per day capacity, which can fuel 20 to 25 cars a day. The station is the first in Southern California to accept payment by credit card. In addition to the CEC funding this site received, additional funding came from SCAQMD's Clean Fuels fund.
- In July 2015, a Ramos Oil hydrogen station in West Sacramento completed the formal commissioning process and officially opened. This includes a list of criteria including inspections, permitting, testing by a range of organizations, including automakers, hydrogen supplier, city officials and state agencies.[49]

The CEC also announced many new funding awards, including several focused on the operation and maintenance of previously announced hydrogen stations. Awards through its other programs included the Medium- and Heavy-Duty Advanced Vehicle Technology Demonstration and the Zero Emission Readiness Program.

CALIFORNIA ENERGY COMMISSION (CEC) FUEL CELL/HYDROGEN FUNDING AWARDS SINCE LAST REPORT		
COMPANY	**AMOUNT**	**PROJECT**
Air Products and Chemicals	***$1,200,000***	CEC awarded $1.2 million to Air Products for the operation and maintenance of hydrogen refueling stations in the state. Air Products will receive $300,000 for stations in Diamond Bar, Woodland Hills, Santa Monica, Los Angeles (2), and Irvine.
CALSTART	***$900,000***	To develop and demonstrate an innovative, battery/fuel cell hybrid zero-emission transit bus that could reduce the price of fuel cell hybrid buses by up to 7%.
	$2,998,948	Via ARFVTP Medium- and Heavy-Duty Advanced Vehicle Technology Demonstration "H2Ride Hydrogen Shuttle Bus Demonstration Project."
City and County of San Francisco	***$111,495***	Via ARFVTP ZEV Readiness program for "Fuel Cell Electric Vehicle Fleet and Infrastructure Planning for San Francisco."
Hydrogenics USA, Inc.	***$2,679,417***	Via ARFVTP Medium- and Heavy-Duty Advanced Vehicle Technology Demonstration for "Hydrogenics Advanced Fuel Cell Vehicle Technology Demonstration for Drayage Truck."
	$2,148,177	Via ARFVTP Medium- and Heavy-Duty Advanced Vehicle Technology Demonstration for "New Flyer Advanced Fuel Cell Vehicle Technology Demonstration for Bus."
Linde LLC	***$300,000***	For operation and maintenance costs and data collection for a new hydrogen refueling station that opened in West Sacramento in December 2014.

Redwood Coast Energy Authority	***$169,000***	Via ARFVTP Zero Emission Vehicle Readiness program for "North Coast and Upstate Fuel Cell Vehicle Readiness Project."

To supplement CEC funding, in July 2015, the Bay Area Air Quality Management District approved $2.2 million to complete 12 hydrogen refueling stations in Berkeley, Campbell, Foster City, Hayward, Los Altos, Mill Valley, Mountain View, Oakland, Redwood City, North First and North Fourth streets in San Jose, San Ramon, Saratoga, South San Francisco and Woodside.[50]

On the other side of the U.S., in November 2014, Air Liquide announced a partnership with Toyota to develop the hydrogen infrastructure in the Northeast part of the country. Initially, the two companies will construct 12 hydrogen fueling stations in New York, New Jersey, Massachusetts, Connecticut and Rhode Island.[51]

In South Carolina, the National Institute of Standards and Technology (NIST), part of the U.S. Department of Commerce, used a hydrogen field-test standard at the Sage Mill Industrial Park hydrogen fueling station in Aiken to measure how much hydrogen is being pumped into tanks.

Appendix 1: Federal Funding By State

DOE's FCTO funding is 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.

The following chart showcases the range of states and the companies, universities and organizations located there, that have received DOE funding from FY2013-2015.

FY13-FY15 Funding by State (FCTO)

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State	FY13-FY15 Total Funding	Industry, National Laboratories, Universities, and Government Entities	
California	$34.7M	California Air Resources Board California State University, Los Angeles CalTech Lawrence Berkeley National Laboratory Lawrence Livermore National Laboratory NASA Jet Propulsion Laboratory Sandia National Laboratory Stanford University University of California, Davis University of California, Berkeley	Ardica Electricore H2 Technology Consulting HRL Laboratories J. Craig Venter Institute Materia Mercedes-Benz Research and Development, NA Quantum Technologies
Colorado	$43.8M	Colorado School of Mines National Renewable Energy Laboratory	University of Colorado, Boulder TDA Research
Connecticut	$7.6M	Fuel Cell Energy Proton OnSite	United Technologies Research Center
District of Columbia	$0.04M	U.S. Department of Transportation	
Delaware	$0.1M	Ion Power	
Georgia	$1.5M	CTE	
Hawaii	$4.3M	University of Hawaii	
Idaho	$2.2M	Idaho National Laboratory	
Illinois	$22.3M	Argonne National Laboratory Illinois Institute of Technology	Gas Technology Institute Northwestern University
Massachusetts	$5.2M	Ballard, now Avcarb Boston College Northeastern University	Giner Nuvera Fuel Cells
Maryland	$4.6M	National Institute of Standards and Technology (NIST) EnergyWorks	RedOx Fuel Cells W. L. Gore & Associates
Michigan	$4.1M	Eaton Ford	General Motors
Minnesota	$4.0M	3M	
Missouri	$0.4M	University of Missouri, Columbia	
Nebraska	$0.8M	Hexagon Lincoln	
New Jersey	$0.2M	BASF	
New Mexico	$20.7M	Los Alamos National Laboratory NASA	Sandia National Laboratory

FY13-FY15 Funding by State (FCTO)

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State	FY13-FY15 Total Funding	Industry, National Laboratories, Universities, and Government Entities	
New York	$10.1M	Brookhaven National Laboratory General Motors	H2Pump Mohawk Innovative Technologies
North Carolina	$0.5M	PPG	
Ohio	$1.3M	Battelle	Midwest Optoelectronics
Oregon	$0.7M	Oregon State University	
Pennsylvania	$1.6M	Penn State University Air Products and Chemicals Arkema	Dynalene PPG
South Carolina	$10.1M	Savannah River National Laboratory	University of South Carolina
Tennessee	$18.5M	Oak Ridge National Laboratory ORISE	FedEx Express
Texas	$1.8M	Southwest Research Institute	
Virginia	$5.2M	Nanosonic Sprint	Strategic Analysis Wiretough Cylinders
Washington	$12.7M	Pacific Northwest National Laboratory	Innovatek

Since our last report, the FCTO has selected projects for more than $39 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 FCTO FUNDING AWARDS SINCE LAST REPORT			
COMPANY	CITY	AMOUNT	PROJECT
CALIFORNIA			
Aerojet Rocketdyne, Inc. (formerly Pratt & Whitney Rocketdyne)	*Canoga Park*	*$750,000*	To demonstrate a one-step hydrogen production process exhibiting substantial energy benefits compared with the conventional hydrogen production method. Researchers will conduct studies to optimize performance while soliciting interest among companies in adopting the process.
California Institute of Technology	*Pasadena*	*$1,000,000*	To develop novel new high-capacity hydrogen sorbents based on high surface area graphene.
University of California	*Irvine*	*$1,000,000*	To develop a novel photocatalyst particle-based slurry reactor with the potential for low-cost renewable hydrogen production via solar water splitting.

US Hybrid Corporation	***Torrance***	***$148,393***	SBIR/STTR Phase I Release 2 Award to develop and demonstrate PEM fuel cell-battery electric hybrid trucks for medium-duty or heavy-duty bucket trucks with drivetrain-integrated electric power take-off systems. US Hybrid will help establish a business case, mitigate the cost of hydrogen fuel infrastructure, supplement utility industry evaluations of introducing hydrogen generation on their grids, and demonstrate fuel cell-battery electric hybrid truck technologies.
COLORADO			
Versa Power Systems	***Littleton***	***$1,000,000***	To develop hydrogen production technologies using high temperature solid oxide electrolysis capable of operating at high current densities (i.e., high hydrogen production rates) and high efficiencies.
CONNECTICUT			
Advent Technologies, Inc.	***East Hartford***	***$1,000,000***	To advance liquid-fueled and higher temperature fuel cell technology at the catalyst, gas diffusion electrode, and membrane electrode assembly levels for stationary and auxiliary power unit applications.
FuelCell Energy	***Danbury***	***$2,800,000***	Continuation of an award from DOE's Advanced Manufacturing Office to install a DFC-H2 fuel cell at its manufacturing facility in Torrington, Connecticut, to generate hydrogen, electricity and heat.
		$3,200,000	For advanced material development to enhance power density and performance of the next generation of the company's DFC products.
		$7,500,000	To enhance the performance and durability of the company's solid oxide fuel cell technology to attain market expectations.
Proton Energy Systems/Proton OnSite	***Wallingford***	***$1,000,000***	To advance alkaline exchange membrane-based electrolysis technology by developing durable and efficient platinum-group metals-free electrolysis cells.
		$150,000	SBIR/STTR Phase I Release 1 Award to develop a non-precious metal catalyst based on doped cobalt oxides.
Sustainable Innovations, LLC	***East Hartford***	***$149,255***	SBIR/STTR Phase I Release 1 Award to team with the University of Connecticut to develop an innovative multi-channel hydrogen fuel quality monitor to detect multiple hydrogen impurities at the refueling station.

DELAWARE			
University of Delaware	*Newark*	*$500,000*	To develop a new class of anion exchange membranes with high oxidative-stability for use in cerium redox-flow batteries and with potential for use in fuel cell applications.
FLORIDA			
Mainstream Engineering Corporation	*Rockledge*	*$149,871*	SBIR/STTR Phase I Release 2 Award to develop a real-time, in-line optical detector for the measurement of fuel cell membrane thickness. Previously, the FCTO funded the NREL to develop non-destructive in-line quality control techniques for MEA components production. Mainstream Engineering's project involves technical transfer of NREL intellectual property on optical techniques. Mainstream will design and fabricate a quality control device that is readily implementable in a roll-to-roll production line for the production of one or more MEA component materials. Their quality control device will help to drive down the costs of fuel cells by reducing waste and improving the process efficiency of roll-to-roll manufacturing of PEMs.
GEORGIA			
Center for Transportation and the Environment	*Atlanta*	*$1,000,000*	To develop 700 bar conformable hydrogen storage systems based on novel pressure vessel designs developed by the founder of High Energy Coil Reservoirs.
ILLINOIS			
Gas Technology Institute	*Des Plaines*	*$500,000*	To assess the technical and economic feasibility of thermal compression for cost-effective pressurization of hydrogen to 700 bar for hydrogen fueling stations, as well as demonstrate the concept in a small-scale test system.
IOWA			
Ames Laboratory	*Ames*	*$1,200,000*	To investigate the development of novel high-capacity silicon-based borohydride/graphene composite hydrogen storage materials produced through mechanochemical processes.

MASSACHUSETTS			
Giner, Inc.	*Newton*	*$999,926*	SBIR/STTR Phase II Release 1 Award to address the high capital and operating costs of electrolysis by working to commercialize advanced water electrolysis catalysts that are more active and require a significantly less amount of precious metal than those used in conventional PEM electrolyzers.
		$999,989	SBIR/STTR Phase II Release 2 Award to develop advanced membrane and electrode components to significantly enhance the durability and performance of fuel cells and electrolyzers.
		$1,000,000	To develop reversible fuel cells for energy storage applications based on alkaline exchange membrane technology.
GVD Corp.	*Cambridge*	*$998,834*	SBIR/STTR Phase II Release 1 Award to develop improved plastic and elastomer seals coatings to enable reliable performance of hydrogen systems supporting FCEVs.
Northeastern University	*Boston*	*$1,000,000*	To develop non-PGM, anion poisoning-resistant, oxygen reduction reaction electrocatalysts to replace high platinum loadings in phosphoric acid-based fuel cells for CHP stationary applications.
MICHIGAN			
Michigan State University, College of Engineering	*Lansing*	*$694,000*	To develop the technology needed to improve solid oxide fuel cells and design new brazing alloys.
University of Michigan	*Ann Arbor*	*$1,200,000*	To explore more efficient materials for hydrogen fuel cells, specifically man-made compounds called metal-organic frameworks, and to isolate and develop "best-in-class" hydrogen storage technology.
NEW MEXICO			
Southwest Sciences, Inc.	*Santa Fe*	*$155,000*	SBIR/STTR Phase I Release 1 Award to develop a diode laser sensor for detection of typical impurities found in hydrogen fuel at the refueling station.
University of New Mexico	*Albuquerque*	*$1,000,000*	To address a major challenge for anion exchange membrane fuel cells - the absence of a reliable anode catalyst for the hydrogen oxidation reaction.
OHIO			
Ohio Fuel Cell Coalition	*Elyria*	*$450,000*	To develop a robust supply chain for fuel cell and hydrogen systems that will accelerate mass production, reduce cost, and improve performance and durability.

pH Matter, LLC	***Columbus***	***$150,000***	SBIR/STTR Phase I Release 1 Award to develop a non-precious metal catalyst based on phosphorus-doped carbon-nitrogen materials.
Westside Industrial Retention & Expansion Network's GLWN	***Cleveland***	***$695,000***	To complete detailed manufacturing analysis of fuel cell systems (automotive and stationary), high pressure hydrogen storage systems, and key high value hydrogen and fuel cell subsystems and components.
SOUTH CAROLINA			
Tetramer Technologies, Inc.	***Pendleton***	***$1,000,000***	SBIR/STTR Phase II Release 1 Award to improve PEM electrolyzer ion exchange membranes to develop a lower cost, higher performance method of commercially generating on-site hydrogen by electrolyzing water.
		$999,994	SBIR/STTR Phase II Release 2 Award to develop new high performance water vapor membranes to improve fuel cell balance-of-plant components, reducing cost and improving performance.
TEXAS			
Texas A&M University	***College Station***	***$1,200,000***	To develop new low-cost hydrogen sorbents that have high hydrogen sorption capacities that exceed the "Chahine rule" or the expected hydrogen adsorption per unit of surface area.
VIRGINIA			
Virginia Clean Cities at James Madison University	***Harrisonburg***	***$450,000***	To develop a nationwide Fuel Cell and Hydrogen Opportunity Center consisting of an innovative internet-based resource to grow the domestic fuel cell and hydrogen industry.
Virginia Tech	***Blacksburg***	***$1,000,000***	To develop biological hydrogen production technology based on an in vitro synthetic biosystem composed of numerous thermoenzymes and biomimetic coenzymes.
TOTAL $36,905,262			

DOE's National Energy Technology Laboratory (NETL) also funds fuel cell RD&D, primarily through its Solid Oxide Fuel Cell Program. In July 2015, funding for 16 projects was announced.

U.S. DOE NETL FUNDING AWARDS SINCE LAST REPORT (ALPHABETICAL BY STATE)			
COMPANY	**CITY**	**AMOUNT**	**PROJECT**
		CALIFORNIA	
University of California, San Diego	***La Jolla***	***$2,500,000***	To conduct a three-year project to evaluate and demonstrate an innovative, versatile, and cost-competitive SOFC stack concept suitable for a broad range of power generation applications. Researchers will evaluate and select appropriate materials, designs, and fabrication processes to produce metal-supported interconnects with the desired microstructure and operating characteristics.
		CONNECTICUT	
FuelCell Energy	***Danbury***	***$2,500,000***	With its subsidiary will develop a low-cost method for manufacturing the anode support layer for SOFCs. The team will investigate advanced manufacturing of the cell components and explore a technique to reduce the thickness of the barrier layer and decrease imperfections. Additionally, the team will develop an innovative stack technology for better thermal management, material reduction, better packaging within stack modules, and ease of installation.
		$6,000,000	With its subsidiary will design, fabricate, and test a state-of-the-art, 400-kW, thermally self-sustaining atmospheric-pressure SOFC prototype system.
		DELAWARE	
University of Delaware	***Newark***	***$500,000***	To develop a new class of anion exchange membranes with high oxidative-stability for use in cerium redox-flow batteries and with potential for use in fuel cell applications.
		GEORGIA	
Georgia Institute of Technology	***Atlanta***	***$200,000***	With partner will develop innovative, robust and durable cathode materials and structures with high tolerance to common contaminants encountered under realistic operating conditions. The team will use model cells with carefully designed electrodes to probe and map contaminants on different sites of electrode surfaces in order to correlate the electrochemical performance with the structure and composition evolution of the cathodes over time.

MARYLAND			
Redox Power Systems	***College Park***	***$2,500,000***	Redox will head a partnership to improve the performance and reduce the stack costs of Redox's high power density, natural gas fueled, SOFCs. The project specifically emphasizes the systematic investigation of SOFC degradation mechanisms for the Redox technology from the cells to the stack, as well as the development of relevant solutions. The project team will also demonstrate a 20% reduction in the current DOE cost target through a detailed cost analysis based on Redox's cell technology and its proven manufacturing processes.
University of Maryland	***College Park***	***$200,000***	To investigate cathode composition and structure under applied voltage/current using real ambient gas contaminants to determine their effects on SOFC cathode oxygen reduction reactions.
MASSACHUSETTS			
Acumentrics	***Westwood***	***$199,545***	Acumentrics and partner will support an SOFC industry goal to rate fuel cells at constant operational performance for more than 40,000 hrs. and will provide valuable insights into improving material selection and designs for the next generation of SOFC stacks.
Boston University	***Boston***	***$200,000***	To design SOFC anodes that are functional at intermediate temperatures and maintain high power densities at high fuel utilizations. By depositing nano-sized nickel catalyst particles through infiltration into porous scaffolds, this project will produce fuel cells with optimized anode microstructures. The resulting SOFC cells will demonstrate a 50% improvement in performance at intermediate temperatures and high fuel utilization rates when compared conventionally processed cell anodes.
Massachusetts Institute of Technology	***Cambridge***	***$200,000***	To develop SOFC electrodes that are tolerant to two of the most prevalent cathode electrode impurities: chromium and silicon. In an effort to minimize the cost and complexity of cathodes, this research will focus on creating self-cleaning electrode materials that trap impurities before they block the electrodes active sites.

MICHIGAN			
Kettering University	*Flint*	*$160,343*	To improve SOFC cathodes by fabricating and evaluating novel composite materials to enhance the performance, reliability, robustness, and endurance of commercial SOFC systems. The team will then characterize and electrically test composite cathodes to quantify the improvements in SOFC electrical performance.
MONTANA			
Montana State University	*Bozeman*	*$200,000*	To develop, characterize, and refine electrode preparation methods for SOFCs to mechanically strengthen the anode support structure and facilitate the binding of metal catalysts to ion-conducting ceramic scaffolds.
NEW YORK			
GE Global Research	*Niskayuna*	*$2,481,141*	GE and partners will develop a thermal-spray, redox stable, ceramic anode that will enable robust, large scale, metal-supported SOFCs. The project team will tailor the thermal spray process and engineer the powder microstructure to produce high performing SOFC. The project will culminate in the assembly of a 5-kW stack that will be tested for at least 1000 hrs using natural gas or simulated natural gas fuel.
OHIO			
LG Fuel Cell Systems, Inc.	*North Canton*	*$2,500,000*	To qualify a material and process solution for selected metallic components of an advanced integrated stack block. This entry-into-service product will significantly reduce component cost and increase the reliability and endurance of LG's cell and stack technology.
SOUTH CAROLINA			
University of South Carolina	*Columbia*	*$200,000*	To develop accelerated test protocols to establish common approaches for determining and projecting the durability of SOFC cathodes under simulated operation conditions.
TENNESSEE			
Tennessee Technological University	*Cookesville*	*$200,000*	To develop and demonstrate a cobalt-free nickel iron oxide spinel – a type of hard mineral – for SOFC cathode-side contact application. This spinel contact structure is expected to provide superior performance compared to the current contact materials due to good electrical conductivity and chemical compatibility to the different components.

WEST VIRGINIA			
West Virginia University	***Harrisonburg***	***$199,999***	Will use an atomic layer deposition coating and thermal treatment process on commercial SOFCs to tailor the nanostructure on anode surfaces. Optimizing the design of the surface nanostructure could produce a 50% greater power density for commercial SOFC, as well as increase long-term cell durability.
TOTAL $17,941,028			

Other Agencies

The U.S. Department of Transportation's Maritime Administration (MARAD) announced in July 2015 that it is providing $500,000 to support a feasibility study for the design, construction, and operation of a high-speed fuel cell passenger ferry and a hydrogen refueling station in San Francisco, California.[52] The project, San Francisco Bay Renewable Energy Electric vessel with Zero Emissions (SF-BREEZE), includes design, construction and operation of the ferry and a hydrogen fueling station with the capacity to produce about 1,500 kg of hydrogen a day, making it the world's largest. MARAD is working with Sandia National Laboratories on the feasibility study in partnership with Red and White Fleet, the American Bureau of Shipping, the U.S. Coast Guard and naval architect Elliott Bay Design Group. Other contributors include the California Environmental Protection Agency's Air Resources Board and the California Governor's Office of Business and Economic Development.

In February 2015, the Federal Transit Administration (FTA) announced projects selected for Fiscal Year 2013 and Fiscal Year 2014 funding under the Low and No Emission Vehicle Deployment Program. The The LoNo Program provides funding for transit agencies for capital acquisitions and leases of U.S.-made zero emission and low-emission transit buses, including acquisition, construction, and leasing of required supporting facilities such as recharging, refueling, and maintenance facilities. Two projects focused on fuel cell buses.

U.S. FTA LOW OR NO EMISSION VEHICLE DEPLOYMENT PROGRAM FUEL CELL PROJECT SELECTIONS (ALPHABETICAL BY STATE)			
PROJECT SPONSOR	**CITY**	**AMOUNT**	**PROJECT**
CALIFORNIA			
SunLine Transit Agency, in partnership with Southern California Association of Governments	***Thousand Palms***	***$9,803,860***	SunLine Transit Agency, in partnership with the Southern California Association of Governments, will receive funding to build and deploy five hydrogen electric hybrid fuel cell buses. BAE Systems, Ballard Power Systems and ElDorado National will team up to build the new zero-emission buses. This project will increase SunLine's current fleet of hydrogen electric hybrid fuel cell buses and allow the agency to offer expanded transit service in the Coachella Valley area of Southern California.

OHIO			
Stark Area Regional Transit Authority (SARTA)	*Canton*	*$8,877,405*	SARTA will receive funding to purchase and deploy five hydrogen fuel cell buses from the Integrated Product Team of Ballard Power Systems, BAE Systems, and ElDorado National. The agency will use the new zero-emission buses in a variety of operating conditions, including congested downtown streets, major urban roads and rural highways. SARTA provides more than 2.7 million rides per year throughout Stark County, Ohio.
TOTAL $18,681,265			

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