

State of the States: Fuel Cells in America 2013

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This report was written and compiled by Sandra Curtin and Jennifer Gangi of Fuel Cells 2000, an activity of Breakthrough Technologies Institute in Washington, DC. Support was provided by the U.S. Department of Energy's Energy Efficiency and Renewable Energy Fuel Cell Technologies Office.

About This Report

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

About Fuel Cells 2000

Fuel Cells 2000's mission is to promote the commercialization of fuel cells and hydrogen by supplying accurate, unbiased industry information and developing and disseminating summary materials accessible to a general audience. Fuel Cells 2000 is independent and non-aligned, and supports fuel cells of all types for all applications.

[Fuel Cells 2000](#) is an activity of the [Breakthrough Technologies Institute](#) (BTI), a non-profit [501(c)(3)] independent, educational organization that identifies and promotes environmental and energy technologies that can improve the human condition. BTI was established in 1993 to ensure that emerging technologies have a voice in environmental and energy policy debates.

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Front Cover photo credits

AC Transit (Oakland, California) fuel cell bus fleet, photo by Robert Rose

Credits for all other photos included in report can be found on page 41.

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Appendix 2: Companies Included in the Report .48 State, local and private investment in fuel cell and hydrogen technologies is leading to high-tech job growth and business attraction, as well as supporting a clean energy technology.

ACRONYMS USED IN THIS REPORT

ARPA-E	Advanced Research Projects Agency-Energy (DOE)
CEC	California Energy Commission
CEFIA	Clean Energy Finance and Investment Authority (Connecticut)
CO ₂	Carbon Dioxide
CHP	Combined Heat and Power
DARPA	Defense Advanced Research Projects Agency
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
FCE	FuelCell Energy
FCEV	Fuel Cell Electric Vehicle
GW	Gigawatt
HT-MEA	High Temperature Membrane Electrode Assembly
HT-PEM	High-Temperature PEM Fuel Cell
kW	Kilowatt
MCFC	Molten Carbonate Fuel Cell
MOU	Memorandum of Understanding
MW	Megawatt
NREL	National Renewable Energy Laboratory (DOE)
NYPA	New York Power Authority
NYSERDA	New York State Energy Research and Development Authority
ORNL	Oak Ridge National Laboratory (DOE)
PEM	Proton Exchange Membrane Fuel Cell
PNNL	Pacific Northwest National Laboratory (DOE)

R&D	Research and Development
RD&D	Research, Development and Demonstration
RPS	Renewable Portfolio Standard
SBIR/STTR	Small Business Innovation Research and Small Business Technology Transfer
SCRA	South Carolina Research Authority
SECA	Solid State Energy Conversion Alliance
SGIP	California's Self Generation Incentive Program
SOFC	Solid Oxide Fuel Cell
TRU	Transport Refrigerated Unit
U.S.	United States

FUEL CELLS: POWERING TO PROSPERITY

In the global race towards commercialization, **the United States (U.S.) is a world leader in fuel cell technology**, with major fuel cell manufacturers and key component suppliers headquartered across the country, cutting-edge university research and partnerships, numerous patents, and the greatest number of fuel cell forklifts and fuel cell backup systems deployed.

Across the country, states are stepping up to set policies, provide funding and encourage collaboration, both regional and international, and deploying units to continue industry momentum and keep the U.S. competitive.

Since our last report, in the U.S., there have been:

- **More than 76 megawatts (MW) of stationary fuel cell installations, purchases and orders**
- **1000 fuel cell forklift deployments and orders**
- **49 fuel cell buses, trucks and cars ordered or placed in service**

Along with these impressive numbers, there have been several positive storylines for the U.S. fuel cell industry – new players and markets, larger orders, bigger systems, and name brand repeat customers, helping prove the case that clean, efficient fuel cells are beneficial for the economy and environment.

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

Now we focus on all that has happened since, plus a look at how international investments and collaborations are helping to generate jobs and business growth within the U.S., why our Top 5

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

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

Fuel Cell Benefits

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

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

To learn more about fuel cells, please visit www.fuelcells.org.

remain leaders, and how some other states and even cities are stepping up to move the industry even further.

Worldwide Interest, U.S. Growth

Fuel cells are gaining international attention, due to the need to develop cleaner, more reliable sources of energy. Fuel cells offer multiple benefits. Fuel cells also complement other technologies; they are progressively being partnered with batteries, solar and wind installations, either to provide 100% grid independent capability, or for energy storage. Fuel cells are being offered that operate efficiently on propane, natural gas and liquid hydrocarbons as well as hydrogen. All this is creating opportunities for fuel cells to enter new markets. Since several of the leading fuel cell manufacturers are located in the U.S., export and partnership opportunities are growing, helping advance the industry around the world, while generating jobs here at home.

International Investment

FuelCell Energy (FCE), a fuel cell manufacturer based in **Danbury, Connecticut**, has seen increased sales of its fuel cell system in the U.S., but is also expanding into Korea. The company received a \$181 million, multi-year order from its South Korean partner, POSCO Energy, for 121.8 MW of fuel cell kits and services to be manufactured at the FuelCell Energy production facility in **Torrington, Connecticut**, a follow-on order from a previous 70 MW order completed in April 2013. FCE also created a joint venture company, FuelCell Energy Solutions, GmbH, focused on Germany and Europe, and is working with Abengoa S.A., based in Spain, to sell units in Europe and Latin America.

European energy company E.ON recently invested more than \$120 million in **Sunnyvale, California**'s Bloom Energy to increase its distributed generation capability. Bloom Energy is also partnering with Japanese technology investment firm SoftBank to bring its fuel cells to Japan. The two companies have indicated plans to invest \$10 million each in the joint venture to target Japanese businesses and then potentially expand into China.

Plug Power Inc. of **Latham, New York**, received a \$6.5 million strategic investment from its partner Air Liquide, which includes increased ownership of the companies' HyPulsion joint venture and an engineering services contract. HyPulsion was formed in November 2011 with the stated purpose of meeting the growing demand for fuel cell products in the European material handling market.

Oorja Protonics, of **Fremont, California** entered into a Memorandum of Understanding (MOU) with HySA/Catalysis, one of the three centers of competence for Hydrogen South Africa. As presented in the MOU, the plan involves Oorja granting rights for marketing, selling and distributing its direct methanol fuel cell products in the African market for various applications such as telecommunications towers, material handling and refrigerated trucks. Oorja also entered into a \$4.2 million contract with Genersys Energia Solar Sabre (Genersys ESS) for the marketing, sales and distribution of its fuel cells the Latin American telecom market.

Two international automakers announced major investments in U.S. facilities, expanding technical training centers to prepare for the commercialization of fuel cell electric vehicles (FCEVs).

Toyota began expanding its Technical Training Center in **Glen Burnie, Maryland**. When the expansion is complete, this facility will be Toyota's first technical training center in the United States with the majority of the

required infrastructure in place to train to service its FCEV. Currently, Toyota's fuel cell electric vehicles in the U.S. are serviced by engineering staff out of its engineering and development technical centers. With FCEVs poised to hit the market in the 2015-2017 timeframe, Toyota is training dealership service center technicians to work on fuel cells. Toyota already has several FCEVs in two-year trials around the country.

Honda is spending \$215 million to expand an engine plant and build a new powertrain technology and technical training center in **Anna, Ohio** (\$180 million) and build a technical training center for auto assembly workers and engineers at its **Marysville, Ohio** assembly plant (\$35 million). The Marysville plant will also add office space for Honda North America Services LLC, and a heritage center to document Honda's North American history. The two new training centers in Anna and Marysville will prepare engineers, service technicians and line associates for advanced vehicles such as FCEVs. Honda currently has 13,700 employees in **Ohio** and plans to add 50 more with the investment.

Setting Up Shop

The state of **Connecticut** was successful in attracting Advent Technologies S.A. of Athens, Greece, to relocate its headquarters to **East Hartford**, while maintaining its research and development (R&D) operations in Greece, thanks in part to a \$1 million investment from Connecticut Innovations (CI). The company announced plans to establish a manufacturing and R&D presence in the state for its high temperature proton exchange membranes (HT-PEMs), high temperature membrane electrode assemblies (HT-MEAs) and other HT-PEM fuel cell products and systems.

AlumiFuel Power Corporation is merging its wholly-owned **Philadelphia, Pennsylvania**-based operating subsidiary, AlumiFuel Power Technologies, Inc., (APTI) with Genport srl of Italy, to create a new U.S. corporate entity, NovoFuel, Inc. This merger includes a new lab facility in the Philadelphia area to develop a 5-kilowatt (kW) fuel cell backup power system for the telecommunications market.

Belgium fuel cell component company Borit NV, opened its North American office in **Cleveland, Ohio**. Borit NV supplies hydro-formed sheet metal components and sub-assemblies.

American Acquisitions, Expansions and Investment

There were several major acquisitions and mergers of U.S. fuel cell companies, as well as increased interest from companies outside the industry looking to get involved.

Hillsboro, Oregon-based ClearEdge Power bought **Connecticut** fuel cell powerhouse UTC Power. UTC offered fuel cells for building, transit bus, space, and marine applications. This acquisition expands ClearEdge Power's fuel cell portfolio to include large-scale fuel cell systems and gives the company a manufacturing facility on the East Coast.

FuelCell Energy completed its acquisition of Versa Power Systems, a solid oxide fuel cell (SOFC) manufacturer with engineering and testing facilities located in **Littleton, Colorado**, and research and production facilities located in Calgary, Canada. FuelCell Energy and Versa have been working together on developing and testing a 60 kW SOFC stack with 60 percent electrical efficiency and combined heat and power capability. FuelCell Energy is also using Versa fuel cells in an unmanned submarine project, funded by the U.S. Office of Naval Research, in which a high power density SOFC system is used for large displacement

undersea vehicle propulsion. Versa is also a supplier to The Boeing Co. under a U.S. Defense Advanced Research Projects Agency (DARPA) program to develop long endurance unmanned aircraft.

Las Vegas-based Suja Minerals Corporation acquired **Flint, Michigan** fuel cell company Global Energy Innovations, Inc. (GEI), which spun out of Kettering University in 2007. The new company is called GEI Global Energy Corporation and has indicated that it intends to raise capital to manufacture its GEI X5 HT-PEM fuel cells. Most recently, the company entered into a Letter Of Intent (LOI) with Owl Eco Group, a private developer, to build a 100 MW Power Plant in the natural gas shale fields of Western Pennsylvania. As presented in the LOI, the project will be comprised of 1,000 individual 100 kW natural gas fueled HPEM fuel cell power systems with a project budget of approximately \$470 million.

Cummins Inc., headquartered in **Columbus, Indiana**, made a strategic investment in fuel cell manufacturer ReliOn, located in **Spokane, Washington**. Cummins has multiple business units that design, manufacture, distribute and service engines and related engine related technologies, including fuel systems, controls, air handling, filtration, emission controls and electrical power generation systems.

Global Tungsten & Powders Corp. (GTP) of **Towanda, Pennsylvania** - a manufacturer of tungsten and molybdenum powders and other specialty products - has made a substantial investment in its first manufacturing line of SOFC interconnect plates. In 2011, the company added a 30,000 sq. ft. addition to its production facility to start the manufacture of fuel cell components, and hired 60 additional employees. In 2012, the company announced that it would add a second interconnection plate manufacturing line, scheduled to start operation by May 2013, and would hire about 20 more employees.

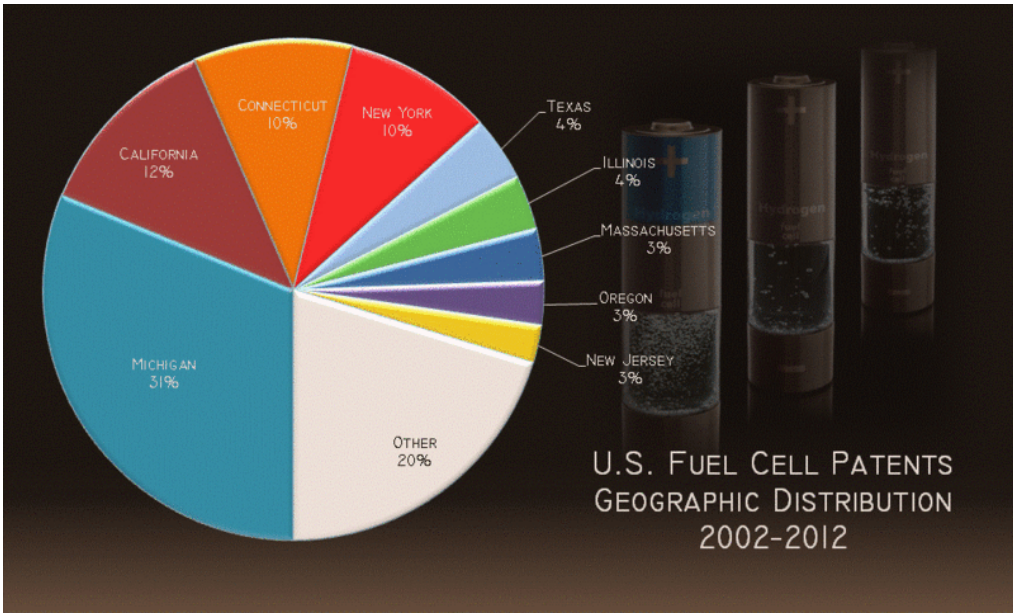
Wilimington, Massachusetts fuel cell manufacturer Lilliputian Systems, Inc. joined with nationwide specialty retailer Brookstone (headquartered in **New Hampshire**) to launch Nectar™, a solid oxide fuel cell-based portable electronics charger. Nectar™ won the prestigious Consumer Electronics Show (CES) Innovations Award for Design and Engineering in the Portable Power category and is approved for carry-on and use for regular commercial aircraft by the UN International Civil Aviation Organization and the U.S. Department of Transportation.

Patent Leader

Fuel cells have been the leading clean technology with regards to patents, surpassing solar, wind and hybrid/electric patents for more than a decade now, according to the Clean Energy Patent Growth Index put out by the Cleantech Group at the law firm of Heslin Rothenberg Farley & Mesiti P.C.¹

The 2012 report also shows that for the first time since 2009, the U.S. trailed Japan in fuel cell patents, with Korea in third. The report delves into individual state patents, and with most automakers and component suppliers headquartered there, Michigan was America's patent leader, with 126 patents. The next states on the list are California (55), Connecticut (26) and New Jersey (13). The rest of the top ten include Minnesota, Oregon, Florida, New York, Ohio and Massachusetts.

¹ http://cepgi.typepad.com/heslin_rothenberg_farley_/





TOP 5 STATES


The Top 5 states of our past reports - **California, Connecticut, New York, Ohio, and South Carolina** - remain the U.S. leaders, with continued and expanded support for fuel cell and hydrogen technologies. Each state differs in its focus. California, for example, strongly supports fuel cell transport and large stationary fuel cell power generation, while Ohio is attracting and promoting a robust fuel cell industry and R&D base.

We also recognize three additional states – **Delaware, New Jersey and Texas** – which are promoting fuel cells to reduce polluting emissions, improve energy efficiency, and promote high-tech job growth.

2013 Top 5 Fuel Cell States



CALIFORNIA



- California has been an early and strong supporter of fuel cell buses and passenger vehicles, deploying buses in regular transit service for more than a decade (AC Transit, SCVTA, SunLine Transit, BurbankBus) and testing fuel cell vehicles in trials and early customer leasing programs. In 2012-2013 the state redoubled efforts to expand hydrogen fueling station deployments in preparation for anticipated fuel cell vehicles commercialization by major auto manufacturers starting in 2015-2017.
- California is the U.S. leader in large stationary fuel cell deployments due to generous credits offered through the California Public Utilities Commission's [Self-Generation Incentive Program \(SGIP\)](#), which provides incentives to support existing, new, and emerging distributed energy resources. The program reports a steady increase in the amount of funding for fuel cells during 2011 and 2012.
- The city of San Diego has developed unique fuel cell applications that include a directed biogas project that involves three fuel cells (see City Spotlight section).



CONNECTICUT



- Connecticut's [New Comprehensive Energy Strategy](#) indicates that fuel cells are an important element of the state's renewable resources strategy, as the technology can help Connecticut meet its renewable portfolio standard (RPS) goals and provide a highly reliable source of distributed generation that can be the power source for local microgrids. The report recommends better integration and support of fuel cell usage into the state's homes, industrial facilities, and cars.
- The same report notes that in 2010 the fuel cell industry contributed \$267 million to Connecticut's gross state product and more than \$22 million in state and local tax revenue, while supporting about 1,000 jobs among approximately 600 companies that play a supporting role to the state's hydrogen and fuel cell industry.
- In the first round of Connecticut's Low Emission Renewable Energy Credit (LREC) program, Connecticut Light & Power (CL&P) and United Illuminating (UI) awarded more than \$52 million to fuel cell projects totaling over 6.3 MW of power.
- CTTRANSIT (New Haven, Hartford) has operated fuel cell buses since 2007. The city of New Haven is also home to a number of fuel cell installations, including a fuel cell powering the City Hall (see City Spotlight section).



NEW YORK



- New York is home to a number of fuel cell and component companies that have recently attracted notable federal and international R&D funding awards to develop fuel cell tow tractors and transport refrigerated units, and to use fuel cells for energy storage.
- The New York State Energy and Research Development Authority (NYSERDA) and New York Power Authority (NYPA) have helped to fund fuel cell R&D and installations for more than a decade. NYSERDA offers generous funding incentives for the installation and operation of continuous duty fuel cell systems (with up to \$1 million available for fuel cell systems rated larger than 25 kW and up to \$50,000 available for fuel cell systems rated at 25 kW or less) and NYSERDA also recently announced a R&D funding award for SOFC R&D.
- New York City hosts an array of fuel cells that date back to the 1990s, including fuel cells providing power to a range of sites including the Central Park Police Precinct, the NASDAQ sign, News Corp's TV studios, and the Bronx Zoo's Lion House (see City Spotlight section).



OHIO



- Ohio has chosen to support fuel cells as part of the state's manufacturing base and has awarded \$90 million in grants to the fuel cell industry and to R&D efforts. The Ohio Fuel Cell Coalition (OFCC) has helped to build a strong competency in the industry, and Ohio can rightfully boast that, "there is not a fuel cell manufactured in the U.S. that does not have Ohio components." Ohio has an impressive Fuel Cell Supply Chain.
- Ohio's R&D capabilities have attracted federal research dollars and the state has leveraged more than \$300 million of federal dollars in support of fuel cells.
- By the end of 2012, Ohio forklift manufacturer Crown Equipment Corp. has placed more than 1500 fuel cell forklifts into the U.S. market.
- The OFCC has hosted several annual Ohio-focused fuel cell and supply chain symposiums and Columbus will be the 2013 host of the Fuel Cell Seminar and Energy Exposition, the largest U.S. industry conference.



SOUTH CAROLINA



- DOE's Savannah River National Laboratory (SRNL) and EngenuitySC have recently partnered to bring new innovations out from the lab and into the marketplace. As part of the project, SRNL will provide technical expertise on hydrogen innovation to the Fuel Cell Collaborative for select projects.
- The City of Columbia Fuel Cell Collaborative was formed in 2006 and is comprised of the South Carolina Research Authority (SCRA), the city of Columbia, University of South Carolina, Midlands Technical College, and EngenuitySC. The group's mission is to make the Columbia region a leader in fuel cell innovation and technology, attracting private sector partners, fuel cell scientists, entrepreneurs and innovators to the Columbia region and collaborating with private sector leaders for fuel cell deployments in city, university and commercial applications throughout the region.
- South Carolina is home to one of North America's largest fuel cell material handling fleets (BMW in Spartanburg), which was expanded to 275 forklifts in June. (see City Spotlight section)

Three to Watch



DELAWARE

- Delaware officials successfully attracted SOFC fuel cell manufacturer, Bloom Energy, to the state in 2012 and Bloom installed a 3 MW fuel cell system at Delmarva Power's Brookside Substation during the same year. In July 2013, Bloom's new manufacturing facility, which is still partially under construction, began manufacturing and delivering fuel cell units (Newark). Fifty new jobs have been created to date.
- The University of Delaware's Department of Mechanical Engineering built and deployed two fuel cell hybrid buses (2007, 2009) that shuttle students around campus. Two new fuel cell buses will join the university's fleet in 2013-2014.



NEW JERSEY

- In 2012, New Jersey started its Clean Energy Solutions Combined Heat and Power/Fuel Cell Program to fund large and small fuel cell and CHP projects. The program's goal is to enhance energy efficiency through onsite power generation with recovery and productive use of waste heat, and to reduce existing and new demands to the electric power grid. In 2013, the New Jersey Economic Development Authority (EDA) and the New Jersey Board of Public Utilities (BPU) launched a second round of the Large Scale Combined Heat and Power/Fuel Cell Program.
- The New Jersey Clean Energy Program reports that the CORE Rebate Program had funded eight fuel cell installations totaling more than 1.5 MW of power (as of October 2012).



TEXAS

- The Houston Galveston Area Council has been awarded grant funding from the U.S. Department of Energy (DOE) for a deployment of 20 heavy duty fuel cell-electric trucks at the Port of Houston. The Texas Emission Reduction Program (TERP) is providing \$500,000 to fund a hydrogen station that will support the vehicles.
- Several Texas-based companies have deployed fuel cell forklifts, including H-E-B (San Antonio), Sysco (Houston and San Antonio), and Ace Hardware (Wilmer). Sysco and H-E-B will also conduct a demonstration of fuel cells to power transport refrigerated units (TRUs) on tractor trailers that deliver produce and frozen foods to supermarkets. The project partnership includes DOE, Pacific Northwest National Laboratory, and transport temperature control system manufacturer, Thermo King.

CITY SPOTLIGHT

Within our Top 5 states and others, **cities and towns are showing growing support for fuel cells** and becoming catalysts for the fuel cell industry. Here are five that are making headlines and headway.

San Diego, California

San Diego is turning a waste problem into a revenue stream through a directed-biogas project that utilizes 2.4 MW of fuel cells. Three FuelCell Energy power plants (2.8 MW, 1.4 MW, and 300 kW) are installed at three different locations in the city and use purified biogas from the Point Loma wastewater treatment plant as the primary fuel source for the generation of clean electricity. The city estimates that the project will generate \$2.6 million of revenue over 10 years from payments made by BioFuels Energy for the biogas. In addition, San

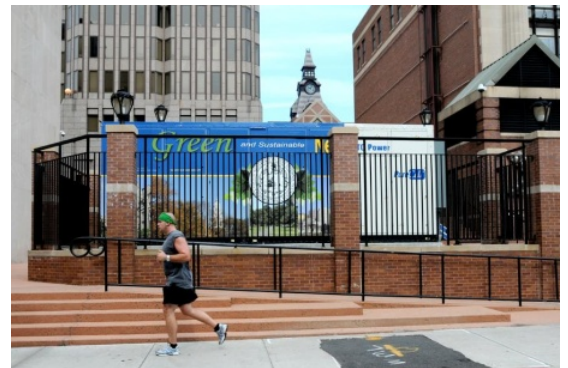


Diego anticipates that it will save \$780,000 in electricity costs to power the South Bay Water Reclamation Plant under a 10-year power purchase agreement with BioFuels Energy.

San Diego is home to several other fuel cell installations including 1.8 MW of fuel cells installed at three Cox Communications facilities and 1.5 MW installed at the Sheraton San Diego Hotel and Marina's East and West Towers. The fuel cells are quiet enough to be located next to the hotel's tennis courts and supply both base load electricity for the 1,044-room hotel and byproduct heat to warm the water for the hotel's pool.

New Haven, Connecticut

Connecticut has many fuel cell installations, due to support from the Connecticut Clean Energy Finance & Investment Authority (formerly the Connecticut Clean Energy Fund) and being the home state of fuel cell manufacturers FuelCell Energy and ClearEdge Power. Within the state, New Haven stands out, boasting several high profile fuel cells, including a 400-kW fuel cell at its City Hall that powers both the City Hall and the Hall of Records. In 2003 the city of New Haven installed two fuel cells, a 200-kW unit at the New Haven Water Pollution Control Authority (WPCA) and a 250-kW system at Yale University's Environmental Science Center and Peabody Museum. New Haven also has fuel cells installed at the Clemente Leadership Academy and Hill Central Music Academy (sharing the fuel cell) and at 360 State Street, a LEED-Platinum certified, 32-story, 500-unit apartment building.



Connecticut Transit (CTTRANSIT) received \$5.7 million federal funding to install a stationary fuel cell at its New Haven Division bus maintenance facility.

New York City, New York

New York City has long been home to a large number of fuel cell installations, which started back in 1990s when a fuel cell was installed at the off-grid Central Park Police Precinct. As people bustle about the city, few realize that fuel cells have been humming quietly about them for years – powering the NASDAQ sign at 4 Times Square, generating power for the Madagascar Building at the Bronx Zoo, and producing electricity and hot water for the Hilton New York hotel and for News Corp’s newsroom, among others.

The New York Power Authority (NYPA) and the New York City’s Department of Environmental Protection jointly installed fuel cells at four of the City’s water pollution control plants that have been running for years and were instrumental to proving the benefits to other states following suit. The New York State Research and Development Authority (NYSERDA) and NYPA have both been crucial partners in promoting and helping to finance fuel cell installations around the state.



New installations are planned all around the city, including 4.8 MW of fuel cells for the new **Freedom Tower** building under construction at the former World Trade Center site, several MWs for Verizon sites and a 100 kW fuel cell system for New York’s City Hall.

Cleveland, Ohio

Ohio is home to many of the fuel cell industry’s component suppliers and integrators, as well as several universities, community and technical colleges that offer courses, advanced research and even fuel cell degrees. Although there are several clusters in the state where major activity is happening, Cleveland is becoming an important hub for fuel cell research and demonstration.

Stemming from a funding award from the U.S. Department of Transportation (DOT) to the Northeast Advanced Vehicle Consortium, the Greater Cleveland Regional Transit Authority (RTA) now has a 40-foot fuel cell bus operating in daily revenue service. The RTA worked with the National Aeronautics and Space Administration (NASA) John H. Glenn Research Center, the Cleveland Foundation, the Ohio Aerospace Institute, and Air Products to become the first transit system in Ohio — and one of the few in the nation — to produce its own hydrogen fuel using electrolysis. RTA is leasing the bus at no cost, and only has to pay for the electrolyzer, hydrogen fueling equipment and bus maintenance and operation.

In addition to assisting the RTA with the fuel cell bus program, NASA engineers at the Glenn Research Center in Cleveland have been developing a fuel cell for planetary rovers to provide longer operation in dark areas, such as the shaded regions of Mars.



Cleveland-based company Technology Management Inc. (TMI) is partnering with a neighbor in Akron, Lockheed Martin, on a \$3 million contract with the Office of Naval Research for the design and development of solid oxide fuel cell generator sets integrated with solar panels to power battlefield equipment.

The university system in Cleveland is also a huge contributor to the fuel cell industry, in Ohio, the U.S. and the world, with one of the first modern fuel cells built at Case Western Reserve University (CWRU) in the early 1950s. CWRU is home to the Great Lakes Energy Institute and most recently, CWRU teamed up with researchers from Texas and Korea on catalyst research. In 2011, a CWRU engineering professor and his team were awarded a 5-year, \$7 million from the U.S. Department of Defense to produce new materials for a range of technologies, including fuel cells and hydrogen storage devices. That team also includes additional staff from CWRU, as well as researchers from the Georgia Institute of Technology, North Texas University, Purdue University, Wright Patterson Air Force Base, Pacific Northwest National Laboratory and GrafTech Inc., a private company in Cleveland. In the 2013 Ohio Clean Energy Challenge, a team from CWRU received a wild card berth for designing a programmable electric bike with a low-cost fuel cell that runs on recyclable liquid fuel.

Spartanburg, South Carolina

BMW's Spartanburg, South Carolina facility hosts one of the world's largest fuel cell material handling fleets at a single location.

This manufacturer's fleet recently added 175 more fuel cell pallet trucks and forklifts, boosting its fleet to 275, but the company isn't stopping there. Currently the lift trucks are fueled with hydrogen provided by Linde, but the automaker is also working with the South Carolina Research Authority (SCRA) on a two-year Landfill Gas-to-Hydrogen Pilot Project. Methane gas piped 9.5 miles from Palmetto Landfill in Wellford supplies half of the plant's electricity and heating needs, and the project is testing to see if hydrogen produced from that stream can be cleansed sufficiently for use in the plant's materials-handling equipment. The final phase of this project is scheduled to begin later this year, when BMW will conduct side-by-side trials of its material handling equipment fueled by the hydrogen generated at the landfill versus commercially sourced and delivered hydrogen. If the experiment works, weekly liquid-hydrogen tanker visits will no longer be required. SCRA has been a leading funding and implementation partner, with cost share from DOE. Project partners include the Gas Technology Institute, Ameresco, Inc., and the South Carolina Hydrogen and Fuel Cell Alliance.

BMW is also participating in two hydrogen storage projects with the DOE.



Houston, Texas

Long known for oil and gas production, Texas is quickly becoming recognized in the fuel cell world as a state to watch. The city of Houston - Texas' largest city and the fourth most populous in the U.S. - is helping with that, with some interesting recent deployments.

The Port of Houston is one of the busiest ports in the country, with hundreds of millions of tons of cargo moved per year. To help alleviate harmful emissions and test and demonstrate new technology, the DOE awarded the Houston Galveston Area Council (HGAC) \$3.4 million to operate 20 heavy duty hydrogen fuel cell electric hybrid trucks around the port. The TYRANO™ hydrogen fuel cell-electric trucks are made by California-based Vision Industries and will fuel up at a new hydrogen station, the first public one in the state of Texas (and one of only a handful in U.S.) that will be installed at the port. The Texas Emission Reduction Program (TERP) is providing \$500,000 to help fund the station, which will use hydrogen from an existing pipeline and eventually be available to fuel other hydrogen-powered vehicles besides the trucks.



There are several fuel cell material handling deployments around Texas, but Houston has one of the biggest, with 102 fuel cell-powered forklifts at a Sysco distribution center. With cost-share funding from the DOE's American Recovery and Reinvestment Act (ARRA), Sysco Houston was able to secure 98 - 26 class-2, 47 class-3, and 25 Class-3 Cold Temperature power units at the facility. Since the initial ARRA purchase, the company has added four more (102) and claims they are saving nearly \$100,000 per year in man hours spent on refueling fuel cells versus swapping batteries and have created 5.5 jobs from the switch. The experience of Sysco Houston's deployment has led to additional purchases of fuel cells for fleets at other Sysco warehouses (including San Antonio) and now the company has 700 deployed at seven facilities around the country.

H₂ USA

DOE, along with industry partners, recently launched H₂USA - a public-private partnership focused on advancing hydrogen infrastructure to support more transportation energy options for U.S. consumers, including fuel cell electric vehicles (FCEVs). The new partnership brings together automakers, government agencies, state coalitions, gas suppliers, and the hydrogen and fuel cell industries to coordinate research and identify cost-effective solutions to deploy infrastructure that can deliver affordable, clean hydrogen fuel in the United States.

Current members of the H₂USA partnership include:

- American Honda Motor Company (CA)
- California Fuel Cell Partnership (CA)
- Hyundai Motor America (CA)
- Toyota Motor North America (CA)
- National Renewable Energy Laboratory (CO)
- Proton OnSite (CT)
- American Gas Association (DC)
- Association of Global Automakers (DC)
- Electric Drive Transportation Association (DC)
- Fuel Cell and Hydrogen Energy Association (DC)
- U.S. Department of Energy (DC)
- Argonne National Laboratory (IL)
- Massachusetts Hydrogen Coalition (MA)
- Nuvera Fuel Cells (MA)
- Chrysler Group LLC (MI)
- General Motors Holding (MI)
- Mercedes-Benz USA (NJ)
- Sandia National Laboratories (NM)
- Plug Power (NY)
- ARC: Hydrogen (SC)
- South Carolina Research Authority (SC)
- Nissan North America Research and Development (TN)
- Air Liquide (TX)
- Hydrogenics (Canada)
- ITM Power (U.K.)

STATE FUEL CELL AND HYDROGEN ACTIVITIES

The following section profiles recent (2013) state fuel cell and hydrogen activities, organized by policies, funding, deployments (by type), university activity, DOE-funded R&D, and military activity. For more extensive descriptions, or to see other active installations and polices in all states, or where decommissioned fuel cells once operated, please visit Fuel Cells 2000's [State Fuel Cell and Hydrogen Database](#). You can also contact us at info@fuelcells.org for help connecting to industry and potential collaborators as well as for general fuel cell information.

Your State at Your Fingertips Fuel Cell and Hydrogen Activities Guide									
State	H2/FC Policy	H2/FC Funding	Stationary Fuel Cells	Material Handling	Transportation	Hydrogen Fueling	University Activity	DOE-Funded H2/FC R&D	Military
AL				p. 26					
CA	p. 17	p. 18	p. 20	p. 26	p. 28	p. 31		p. 36	p. 40
CO					p. 28	p. 31	p. 33	p. 36	
CT	p. 17	p. 18	p. 22		p. 28		p. 33	p. 37	p. 40
DE			p. 24		p. 29				
FL		p. 19						p. 37	p. 40
GA				p. 26	p.29				
HI									p. 40
IL			p. 24					p. 37	
LA				p. 26					
MA				p. 26	p. 29	p. 32		p. 37	
MD							p.33		
MI			p. 24				p.34		p. 41
MN								p. 38	
MO				p. 27					
NC			p. 24				p. 34	p. 38	
NE		p. 19							
NH							p. 34		

NJ		p. 19	p. 24					p. 38	
NY		p. 19	p. 24	p. 27	p. 29				
OH					p. 29		p. 33	p. 38	p. 41
OR		p. 20					p. 33		
PA			p. 25	p. 27	p.30				
SC				p. 27		p. 32			
TN								p. 38	
TX				p. 27	p. 30	p. 32	p. 33	p. 38	
UT							p. 33	p. 39	
VA							p. 34	p. 39	
WA			p. 25		p. 30		p. 34		p. 41
WI								p. 39	
WV								p. 39	
WY		p. 20	p. 25						

FUEL CELL ACTIVITIES - KEY



Fuel Cell Policy/Roadmaps – Includes all recent state legislation, policy, or roadmaps that focus on the deployment of hydrogen and fuel cells.



Funding Opportunities/Business Attraction – Includes state funding, loans, grants, or other incentives geared towards increasing fuel cell and hydrogen business, installations, or presence in the state. This section also includes any funding from foundations, venture capital companies or other stakeholders.



Stationary Power – Includes both large-scale (>200 kW) and small scale (5-100 kW) systems, both installed and announced (planned) since last report. Stationary power also encompasses fuel cell units used for telecommunications backup (1-20 kW).



Fuel Cell Forklifts – Includes material handling vehicles being deployed at warehouses around the country. The U.S. is currently the world leader in fuel cell forklifts, with more than 4,000 units deployed and hundreds more on order.



Transportation – Includes fuel cell-powered automobiles, buses, trucks or other utility vehicles deployed, announced or funded in the last year.



Hydrogen Fueling – Includes hydrogen stations and dispensers that are being installed around the U.S. to fuel cars, buses, and forklifts powered by fuel cells. In some Transportation entries, the fueling information is included, rather than in a separate entry.



University Activity – Includes all non-DOE funded university activity, research or accolades from the past year.



DOE-Sponsored R&D – Includes all DOE funded numerous research and development projects at universities and companies throughout the U.S.



Military – Includes fuel cell research, demonstration and deployments all around the country funded by various branches of the U.S. military.



FUEL CELL POLICY

State policies have been shown to foster fuel cell installations, company relocations and growth to help keep the U.S. at the forefront of fuel cell commercialization.

California

- The California Fuel Cell Partnership released [A Road Map for Fuel Cell Electric Buses in California: A zero-emission solution for public transit](#) which looks at the progress of fuel cell electric buses (FCEBs) in California and around the world, and offers recommendations to state and federal policy makers about actions they can take to put FCEBs on the path to full commercial readiness.
- In May 2013, the California Energy Commission unanimously adopted the *2013-2014 Investment Plan Update* to support the development and use of green vehicles and alternative fuels. The update sets funding priorities for the approximately \$100 million in annual state funds under the Commission's Alternative and Renewable Fuels and Vehicle Technology (ARFVT) Program, created by Assembly Bill 118. Twenty million dollars were allocated for hydrogen fueling infrastructure and in July 2013, more than \$18 million was awarded.

Connecticut

- Connecticut released its 2013 Comprehensive Energy Strategy (the “Strategy”) in February, which outlines strategies for the state to meet its ongoing energy needs in a cleaner, more reliable way. To meet its 20% by 2020 renewable portfolio standard, the state will have to increase its Class I resources (fuel cells, solar, and wind) by 3 gigawatts (GW). The Strategy includes recommendations to expand the state’s hydrogen filling station network as demand for fuel cell-powered vehicles grows, as well as a recommendation to promote more distributed generation of power. It also creates a new Advanced Energy Innovation Hub at the University of Connecticut, which will focus on fuel cells, microgrid engineering and small-scale hydropower.

Other initiatives proposed include “tax equity financing for fuel cell technology in partnership with private sector investors, Department of Energy & Environmental Protection (DEEP), and the electric distribution companies” to help attract private capital to the state’s fuel cell industry, and interagency coordination to promote adoption of a broad platform of Zero and Low Emission Vehicles, including hydrogen powered vehicles. Also, the Strategy seeks to promote Combined Heat and Power (CHP), for both industrial and residential uses, not only for the energy savings, but also to give a boost to the state’s fuel cell companies.

The Strategy recommends fuel cell applications in particular, as they provide a triple benefit: offering clean energy (including heat) for customers, promoting reliability as they can operate in island mode during power

outages, and enhancing the State's capacity for economic growth to the extent that in-state fuel cell manufacturers compete successfully for new projects.

- In July 2013, Public Act No. 13-298 (An Act Concerning Implementation of Connecticut's Comprehensive Energy Strategy and Various Revisions to the Energy Statutes) directs each electric company or electric distribution company to allow the installation of submeters at commercial, industrial, multifamily residential or multiuse buildings where the electric power or thermal energy is provided by a Class I renewable energy source (which includes fuel cells), or in any other location as approved by the authority [and] where submetering promotes the state's energy goals. This is an addendum to earlier policy which permits submetering at (1) recreational campgrounds, (2) individual slips at marinas.



FUEL CELL FUNDING

State, local and private investment in fuel cell and hydrogen technologies is supporting a clean energy technology.

California

- In July 2013, the California Energy Commission (CEC) awarded more than \$18 million for hydrogen station projects (see Hydrogen Fueling section for more details).
- The Southern California Gas Company (SoCalGas) recently established a \$1 million innovation fund with the Los Angeles Cleantech Incubator (LACI) to speed the development of clean technologies in three key areas, including fuel cells.
- Scientist Orianna Bretschger, Ph.D, of the J. Craig Venter Institute (JCVI) in San Diego, a non-profit genomic research organization, has received a \$5 million grant from the Roddenberry Foundation to continue her research into new wastewater treatment technologies. The five year grant will support the development of Bretschger's BioElectrochemical Sanitation Technology (BEST), which uses microbial fuel cells (MFCs) to clean wastewater and improve sanitation and water accessibility in developing world applications.

Connecticut

- In response to power and system outages due to storms like Superstorm Sandy and others, Connecticut's DEEP Microgrid Pilot Program, passed under Public Act 12-148, awarded \$18 million to nine microgrid projects, including two involving fuel cells. The city of Storrs will receive \$2.14 million for a project including a fuel cell and solar power for the University of Connecticut Depot campus, and the city of Woodbridge is slated for \$3 million for a project including a natural gas turbine and a fuel cell for the police station, fire station, Department of Public Works, town hall and high school. Partners in the first round of the program include DEEP, the state Department of Emergency Management and Homeland Security and the U.S. Department of Defense.
- The Connecticut Light & Power Company (CL&P) and the United Illuminating Company (UI) jointly issued a Request for Proposals (RFP) for the Low and Zero Emissions Renewable Energy Credit Program. More than \$52 million was awarded to 14 Connecticut-based fuel cell projects totaling more than 6.3 MW of power.
- Sustainable Innovations, LLC, of Glastonbury, and its partner, ICL Industrial Products, an Israeli company with U.S. headquarters in New York, have received a \$900,000 grant from the U.S.-Israel Binational Industrial Research and Development (BIRD) organization to develop a regenerative fuel cell for energy storage. BIRD provides funding for research projects conducted by Israeli and U.S. firms.

Florida

In July 2013, the Florida Governor signed H.B. 705 which expands the Florida Institute for the Commercialization of Public Research by creating the Florida Capital Technology Seed Fund as a corporate

subsidiary of the Institute. The purpose of this fund is to foster greater private-sector investment funding, encourage investments in start-up companies and advise companies on how to restructure their organizations in order to attract greater business opportunities. In April 2013, the Institute provided \$300,000 in funding to Bing Energy, based in Tallahassee, to develop its manufacturing technology and a new 3-kW fuel cell backup power system. Bing has about a dozen employees in Tallahassee but the company plans to expand its workforce significantly over the next five years and is on track to add about 200 workers by 2017, including mechanical and electrical engineers and support staff.

Nebraska

The Nebraska Energy Office and the state's lending institutions offer Nebraska Dollar and Energy Saving Loans which include a 2.5% interest rate on loans for projects involving fuel cells.

New Jersey

The New Jersey Economic Development Authority (EDA) and the New Jersey Board of Public Utilities (BPU) launched a second round of the [Large Scale Combined Heat and Power/Fuel Cell Program](#), which supports CHP and standalone fuel cell projects with a generating capacity of greater than one megawatt, with up to \$3 million available per project. As of July 1, 2013 New Jersey's [small CHP-FC](#) program (for projects 1 MW and below) and the large CHP-FC program (for large scale projects) were combined into a single program.

New York

- Solid Cell, which has a manufacturing facility in Rochester, has won a fourth grant from NYSERDA to help develop its solid oxide fuel cell from prototype to commercialization. The \$200,000 grant will be matched by Solid Cell and its partners: RocCera, Alfred University and the NanoMaterials Innovation Center at Alfred, Allegany County. Since 2010, NYSERDA has provided a total of \$511,000 in grants to assist Solid Cell set up the manufacturing facility at Rochester Technology Park.
- NYSERDA also recently issued a Program Opportunity Notice (PON) seeking proposals to support development, demonstration, and commercialization of innovative transportation products, systems and services. \$2,500,000 is available. \$500,000 of this PON's funding is reserved for "electrified transportation" projects - technologies that interact with the electric power grid and that use electricity to displace petroleum, or that improve operation of the grid, or that produce other benefits in New York State.

Oregon

Oregon Built Environment & Sustainable Technologies (OregonBEST), an independent nonprofit established by the Oregon Legislature, provided a \$150,000 grant to Widmer Brothers Brewing for a new pilot project to install a small-scale fuel cell at Widmer's Portland brewery, which is expected to treat about 1,000 gallons of wastewater a day while generating electricity. Widmer pays the city of Portland to treat its wastewater, so recycling and reusing the water will help the company save money. The fuel cell was developed by Professor Hong Liu and researcher Yanzhen Fan from Oregon State University's Department of Biological and Ecological Engineering. The team launched a startup company, Waste2Watergy to market the fuel cells.

Wyoming

The Wyoming State Loan and Investment Board (SLIB) approved a \$1.5 million Community Readiness grant to the city of Cheyenne to install the required infrastructure for a FuelCell Energy fuel cell at a Microsoft DataPlant on a site located on the city of Cheyenne's Dry Creek Water Reclamation Facility. The project is testing the integration of a fuel cell with a modular IT container powered from available biogas methane created from the treatment process at the Dry Creek facility.



STATIONARY POWER

The U.S. is the leader in large-scale fuel cell installations, and is home to major fuel cell manufacturers, components suppliers, and integrators.

California

Once again, California leads the country, and in terms of customers, the world, with stationary fuel cell installations, both large-scale and smaller backup systems for telecommunications and other network sites. Since our last report, there have been tens of MWs sold or installed in California.

Bloom Energy, headquartered in Sunnyvale, has deployed 11.4 MW in 35 projects of installations at Walmart stores in California. The company recently announced a new leasing program with Bank of America (BofA) Merrill Lynch that plans to assist businesses with financing fuel cell installations. The following is a chart of Bloom Energy public installations and order announcements in California since our last report:

Bloom Energy California Installations Since 2012 Report

Customer	Location	Size	Notes
AC Transit	Oakland	400 kW	Electricity from the fuel cell will also power an electrolyzer to produce carbon-neutral hydrogen for the AC Transit's fuel cell buses.
Altera	San Jose	1 MW	Installed two 500 kW fuel cell systems at corporate headquarters, reducing overall CO ₂ emissions, from 2011 levels, by 2%.
American Honda Motor Co., Inc.	Torrance	1 MW	1.13 million sq. ft., 101 acre campus.
AT&T	Various sites	9.6 MW	AT&T ordered an additional 9.6 MW of Bloom Energy fuel cell systems, making AT&T Bloom Energy's largest non-utility customer. Once completed, AT&T will have 17.1 MW of fuel cells helping to power 28 sites in California and Connecticut.
Baker Hughes	Shafter	300 kW	Supplies 60% of the power required to operate the company's main office, laboratories, and vehicle maintenance workshop at its new 70-acre integrated campus.
Honda Center	Anaheim	750 kW	Home to the National Hockey League's Anaheim Ducks. Financing is coming from new leasing program with Bank of America Merrill Lynch.

Intuit	Woodland Hills	500 kW	Generates 67 percent of the electricity required to power the building. After researching options, Intuit discovered that using Bloom Energy technology would save \$.04 per kWh. The gas used to power the fuel cells is cheaper than electricity from the Los Angeles Department of Water and Power. At least 75 percent of the fuel that Intuit will use for the first five years of the Bloom Energy fuel cell will be biogas.
Juniper Networks	Sunnyvale	1 MW	No further information is available.
Nokia	Sunnyvale	400 kW	Nokia's U.S. headquarters.
Paramount Citrus	Delano	1.6 MW	Installed at 640,000 sq. ft. CUTIES citrus packinghouse - the world's largest citrus packinghouse. The natural gas-powered fuel cell system supplies 35% of the energy required by the plant. A 2.7-MW solar system is also installed at the site.
Target	San Francisco, Pasadena	400 kW	Installed at two stores.
Taylor Farms	Salinas	1 MW	Provides 70% of needed power to the 85,000 sq. ft. salad processing plant and cuts CO ₂ emissions by 30%.
The TaylorMade-adidas Golf Company	Carlsbad	N/A	Manufacturing facility. Financing is coming from new leasing program with Bank of America Merrill Lynch.
University of California, Santa Barbara	Santa Barbara	200 kW	Directly connected to Southern California Edison's electric distribution system.
Verizon	Los Angeles, San Francisco, San Jose	1 MW total	Verizon is installing 1 MW of Bloom Energy fuel cell systems at three California locations - two call-switching centers in Los Angeles and San Francisco and a data center in San Jose.
Williams-Sonoma	Rocklin	600 kW	Installed at a data center.
Xilinx	San Jose	1 MW	Saved \$810,000 in first 10 months, projects \$580,000/year after.

There were numerous installations and orders to sites in California from other fuel cell manufacturers as well:

Customer, Location	Fuel Cell Manufacturer	Size	Notes
Blue Lake Rancheria Tribe, Humboldt County	Ballard Power Systems	175 kW	The fuel cell will be integrated with a biomass gasifier and syngas purification unit, making the system the first of its kind, converting locally-grown timber by-product feedstock into hydrogen-rich syngas, using pyrolysis gasification technology. The plant will provide base load power for the Tribe’s commercial enterprises and by-product heat will be used to warm the swimming pool in an adjacent hotel.
Inland Empire Utilities Agency (IEUA), Ontario	FuelCell Energy	2.8 MW	Municipal water treatment facility.
Naval Air Warfare Center Weapons Division (NAWCWD) Renewable Energy Office, China Lake	N/a	N/a	Trailer-mounted regenerative fuel cell system consisting of a fuel cell and an array of solar panels. During the day, the command center would be powered by solar energy and excess energy would be used to generate hydrogen. At night, the stored hydrogen that was produced during the day would be sent through the fuel cell to create electricity.
South Coast Air Quality Management District (AQMD), Diamond Bar	ClearEdge Power	400 kW	
Toyota Motor Sales U.S.A., Inc., Torrance	Ballard Power Systems	1.1 MW	Proton exchange membrane (PEM) fuel cell system.
Verizon, multiple sites	ClearEdge Power	8 MW	Verizon is investing \$100 million in a solar and fuel cell energy project that will help power sites across the country, including corporate offices, call centers, data centers, and central offices. As part of this investment, Verizon will install 20 ClearEdge Power PureCell® Model 400 fuel cell systems at Verizon sites in California, New Jersey and New York (8 MW).

Connecticut

Danbury-based FuelCell Energy, Inc. (FCE) acquired SOFC manufacturer Versa Power Systems (facilities in Colorado and Canada) and created a joint venture company focused on Germany, FuelCell Energy Solutions, GmbH. That company also sold a 300-kW fuel cell power plant for installation at the 20 Fenchurch office development in London, England. Also outside the U.S., FCE was awarded a contract to demonstrate a tri-generation stationary fuel cell power plant near Vancouver, British Columbia, Canada, utilizing landfill gas as the fuel source. The heat in the form of hot water will be supplied to Village Farms, a hydroponic greenhouse operator in North America. Renewable hydrogen will also be exported for vehicle fueling or industrial applications.

FCE has also expanded in the Korean market. Since 2012, the company received a \$181 million, multi-year order from its South Korean partner, POSCO Energy for 121.8 MW of fuel cell kits and services to be manufactured at the FuelCell Energy production facility in Torrington, Connecticut. This order is in addition to a 70-MW order from POSCO from June 2011 that was recently completed.

The Bridgeport/Dominion project is a "great example of public-private partnerships working together to create jobs, expand economic development and make our environment cleaner by producing virtually pollution-free electricity with a low carbon footprint." - Bridgeport Mayor Bill Finch

- Here at home, FCE has just begun constructing the world's second largest fuel cell power park (the largest being a FCE one in Korea) - 14.9 MW in Bridgeport. FCE is providing five of its 2.8 MW DFC3000® fuel cells for the facility, to be owned by Dominion Resources, a Virginia-based energy company, with Connecticut Light and Power Company (CL&P) on board to buy the electricity under a 15-year fixed-price energy purchase agreement (\$89 per MW/h). The groundbreaking was in May 2013, the first systems have been delivered and construction is expected to be completed by the end of the year.

The project is sited on a remediated brownfield site, FCE is receiving \$5.8 million in loans (that will be repaid) from Connecticut's Clean Energy Finance and Investment Authority (CEFIA) as well as a \$1.5 million grant. The fuel cell project fits into Bridgeport's BGreen 2020 Sustainability Initiative, the result of a public-private partnership between the City of Bridgeport and the Bridgeport Regional Business Council, a consortium of local business groups, in order to revitalize the city in a sustainable way.

- FuelCell Energy is also part of a "renewable energy park" project at NRG Energy Inc.'s Montville power station. NRG is investing at least \$100 million to add 5.6 MW of fuel cells and 2.3 MW of solar and convert an old coal steam unit that currently burns oil and gas into a 42-MW biomass unit, which will run on locally harvested wood from tree trimmings, foresters and sawmills. The park will create 300 construction jobs and 200 long-term jobs.
- Bloom Energy has also seen activity in the state of Connecticut with a 600 kW installation at a Macy's distribution center in Chesire. CEFIA is providing a \$913,121 grant to help fund the project, and the CT Public Utilities Regulatory Authority has classified it as a Class I renewable energy source. In addition to powering the distribution center, Bloom intends to use the fuel cell to generate renewable energy credits and sell them to electricity suppliers to help meet their state-required renewable energy goals.
- Connecticut Light & Power and United Illuminating are funding 13 fuel cell projects, totaling more than 6.3 MW of power, under the Connecticut's Low Emission Renewable Energy Credit (LREC) Program. Installation sites will include Hartford Hospital (FuelCell Energy), six Walmart and five AT&T locations (Bloom Energy), and a Staples distribution center (manufacturer not announced).

Delaware

Bloom Energy has begun manufacturing at its new facility in Newark, which is still under construction. Bloom delivered the first units to a Delmarva Power site near New Castle. The city of Newark issued "certificates of completion" for portions of the building to allow assembly of the fuel cells. The factory now has 50 employees, with more to be added as construction is completed.

Illinois

Lewis and Clark Community College is working with Ameren Corporation of St. Louis, Missouri, to install a 5 kW ClearEdge Power PureCell System on its Godfrey Campus. The fuel cell is expected to be installed in November 2013 in the Trimpe Building which will be known as the Alternative Energy Production Center (AEPC). Ameren is paying for the installation costs in exchange for access to data for analysis and the use of the site for tours and partner visits.

Michigan

Brighton-based VP Energy, LLC will install its ElectroSelf™ fuel cell system at the Lansing Board of Water and Light's (LBWL) new REO Town Headquarters and Cogeneration Plant. VP Energy, LLC has exclusive rights to manufacture and distribute in North America the ElectroSelf™ product line, from Italian fuel cell company Electro Power Systems SpA (EPS). The REO Town installation is the second by VP Energy in the City of Lansing. In 2011 VP Energy installed an ElectroSelf™ product that is providing backup power to the E911 emergency communications system serving the City of Lansing and Ingham County.

New Jersey

Verizon is investing \$100 million in a solar and fuel cell energy project that will help power sites across the country, including corporate offices, call centers, data centers, and central offices. Verizon will install 20 ClearEdge Power PureCell® Model 400 fuel cell systems (8 MW total) at Verizon sites in California, New Jersey and New York.

New York

See above.

North Carolina

Apple added an additional 5 MW from Bloom Energy to increase the size of its fuel cell installation at its Maiden data center to 10 MW, making it the largest non-utility generation plant. The fuel cell system is coupled with 20 MW of solar arrays to provide the data center with 100% renewable energy. Apple is purchasing biogas credits from another company, so even though the fuel cells run off natural gas, the company can claim that the data center is run from renewable sources.

Pennsylvania

URBN (formerly Urban Outfitters) received a \$1.2 million alternative energy grant from the Commonwealth of Pennsylvania and a \$400,000 custom incentive grant from PECO to install a 600-kW Bloom Energy fuel cell at its main office in Philadelphia's historic Navy Yard. It's the first all-electric fuel cell installation in Pennsylvania, and will lead to projected annual cost savings of \$407,949, according to State Senator Larry Farnese. The system covers 60% of the building's energy requirements and will offset 4.8 million lbs of carbon dioxide (CO₂) each year.

Washington

Alpha Energy is integrating a 5 kW ReliOn E-2500™ fuel cell system into its Hybrid Power System (HPS) Test Facility in Bellingham. The HPS Test Facility simulates demanding off-grid environments and provides test engineers real-time representation of how certain products will perform in the field. If the fuel cell system meets Alpha's rigorous performance standards, it will then be evaluated for implementation into future Alpha Energy projects.

Wyoming

Microsoft is investing \$5.5 million in a pilot project in Cheyenne using renewable biogas to fuel a 300-kW FuelCell Energy DFC® fuel cell power plant at its Data Plant project. The fuel cell will be installed at the Dry Creek Water Reclamation Facility and will be configured to be grid independent to provide continuous power to the data center in the event of a grid outage. Any excess power will be provided to the water reclamation facility to offset their electric costs. The project also received \$1.5 million from the Wyoming State Loan and Investment Board. Other organizations involved include Cheyenne Light, Fuel & Power, Cheyenne LEADS, Wyoming Business Council, the Western Research Institute, and the University of Wyoming. At the end of the R&D pilot project, Microsoft intends to donate the Data Plant (including the fuel cell, clean-up equipment, servers and modular data center) to the City of Cheyenne and the University of Wyoming for further research. The clean CO₂ produced from the Data Plant will be used by local Wyoming's oil and gas industries as there is a CO₂ pipeline that intersects the state.





MATERIAL HANDLING

There are currently more than 4500 fuel cell-powered material handling vehicles on order or deployed at warehouses, distribution centers and other facilities around the U.S., with customers such as Sysco, Lowe's, Procter & Gamble, BMW, Walmart and FedEx.

Alabama

Mercedes-Benz U.S. International, Inc. (MBUSI) has ordered 123 additional Plug Power GenDrive® fuel cell units for its material handling fleet at a new \$70 million, 900,000 square-foot state-of-the-art logistics hub under construction in Tuscaloosa. In July 2012, Mercedes purchased 72 fuel cells to operate its Hyster electric truck fleet at its Tuscaloosa vehicle assembly plant. The hydrogen for the fuel cell vehicles is provided by Air Products.

California

Oorja Protonics of Fremont has become an Approved Service Provider of its fuel cell systems for UniPro FoodService, a Cooperative for food and produce distributors in the U.S.

Georgia

Children's clothing manufacturer Carter's will add Plug Power fuel cell forklifts to a new site in Georgia.

Louisiana

Associated Wholesale Grocers (AWG) has deployed more than 200 Plug Power fuel cell forklifts at its Pearl River facility.

Massachusetts

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

Missouri

Associated Wholesale Grocers (AWG) has deployed 297 Plug Power fuel cell forklifts at its Kansas City facility.

New York

- Plug Power, headquartered in Latham, has received \$2.5 million from DOE to retrofit 15 electric tow tractors with fuel cells. The tractors will be deployed at a FedEx domestic airport in Memphis, Tennessee. Massachusetts company Nuvera will provide the hydrogen fueling equipment.
- DOE also awarded \$650,000 to Plug Power to demonstrate the use of hydrogen-based fuel cells to power TRUs. Plug Power's TRU fuel cells will cool Carrier Transicold refrigeration units on trailers delivering products for a Sysco Corp. distribution center on Long Island. Each TRU will run for a minimum of 400 hours over the two-year contract period. Hydrogen will be supplied by Air Products.

Pennsylvania

Procter & Gamble Co. (P&G) has purchased 140 Plug Power's GenDrive® fuel cells for its electric lift truck fleet at its manufacturing facility located in Mehoopany. This expands P&G's fuel cell footprint to four facilities and 340 vehicles.

South Carolina

BMW Manufacturing expanded its fleet of fuel cell material handling equipment at its 4 million-square-foot Spartanburg production facility from 100 to 275 units (from Plug Power), which service assembly halls and the site's paint and body shops. Hydrogen for the forklifts is supplied by Linde and stored in a large on-site cylinder, but soon the company plans on using renewable hydrogen from a nearby landfill.

Texas

Ace Hardware purchased 65 GenDrive® fuel cell units from Plug Power for its newest Retail Support Center under construction in Wilmer, Texas. The facility is set to open in early 2014. The lift trucks are manufactured by Crown Equipment Corporation (New Bremen, Ohio).



FUEL CELL TRANSPORTATION

Fuel cells are powering cars, buses, ships, planes, trains, and other vehicles. Automakers have targeted the 2015-2017 timeframe for small-scale commercialization of FCEVs and fuel cell buses are starting demonstrations and even revenue service in states around the country.

California

- CALSTART, based in Pasadena, has received \$7.7 million from the Federal Transit Administration's (FTA) National Fuel Cell Bus Program for four fuel cell bus projects, including \$4 million to develop and demonstrate a battery-dominant fuel cell bus based on a commercial hybrid platform. Project partners and suppliers include SunLine Transit Agency from Thousand Palms, EIDorado National from Riverside, and BAE System from Endicott, New York. The other funding awards focus on states outside of California, including Ohio and Pennsylvania.
- Golden Gate Transit (GGT) will operate a third-generation hydrogen fuel cell bus as part of Zero Emission Bay Area (ZEBA), a group of five transit agencies jointly operating zero-emission, fuel cell buses in real-world service throughout the Bay Area in California. ZEBA includes 12 next-generation fuel cell hybrid buses and joins GGT with AC Transit (lead transit agency), Santa Clara Valley Transportation Authority (VTA), San Mateo County Transit District (SamTrans), and San Francisco Municipal Railway (Muni).
- Global Fresh Foods' (GFF) of San Francisco is using its patented *SAF-D*[®] system that maintains a high CO₂ and a low oxygen controlled atmosphere, with a fuel cell to convert residual oxygen to water vapor, to ship fish and other fresh proteins for long periods of time without freezing them. GFF has completed 30 day tests on salmon and concluded that the produce can be shipped by sea without being frozen using the *SAF-D*[®] fuel cell technology.

Colorado

The National Renewable Energy Laboratory (NREL) in Golden received four Toyota FCEVs through a two-year Cooperative Research and Development Agreement. NREL will showcase the fuel cell electric vehicles at various events to educate the public about advanced vehicle technologies and to solicit feedback for assessing consumer acceptance and interest. The vehicles will be fueled with renewable hydrogen generated from wind.

Connecticut

The Center for Transportation and the Environment (CTE) has finalized a deal with Connecticut Transit (CTTransit) to deliver a fuel cell-powered, 40-foot, heavy-duty transit bus in partnership with EIDorado National, BAE Systems, and Ballard Power Systems. CTE reports that this will be the first commercially procured fuel cell bus under a standard Request for Proposal (RFP) process. The bus will use a Ballard FCvelocity-HD6 fuel cell and BAE Systems' HybriDrive propulsion system. CTE plans to deliver the bus in fall 2014.

Delaware

The University of Delaware is adding two new fuel cell buses to its existing fleet (two) as well as installing a fueling station at the school's Science Technology and Research campus. The buses use a Ballard Power Systems fuel cell and Air Liquide will provide the fueling technology.

Georgia

The Center for Transportation and the Environment (CTE), based in Atlanta, has received \$5.6 million from the FTA's National Fuel Cell Bus Program to manage several fuel cell bus projects around the country. The projects include a new fuel cell bus demonstration in New York and managing the extension of existing projects in Alabama and California. In addition, CTE received funding to oversee various educational and outreach efforts including an international workshop and creating instructional guides for transit agencies.

Massachusetts

Nuvera Fuel Cells has inaugurated a program with Toyota Motor Sales, USA, Inc. (TMS) in which Nuvera will operate and maintain two Toyota FCHV-adv at its headquarters in Billerica. The two-year program is the first of its kind in Massachusetts and will help build awareness of fuel cell technology, the benefits of hydrogen as a clean fuel, and the development of hydrogen infrastructure in the Northeast.

New York

- The Center for Transportation and the Environment (CTE) has received \$3 million from the FTA's National Fuel Cell Bus Program to oversee a project building and demonstrating a next-generation American Fuel Cell Bus in a cold, northeast, climate. Project partners include Tompkins Consolidated Transit Authority in Ithaca, BAE Systems from Endicott, and EIDorado National from Riverside, California.
- Parker Hannifin Corporation has installed its combined heat and power SOFC system on a 36-foot sailboat. Parker co-developed the system with Watt Fuel Cell Corporation of Port Washington.

Ohio

A fuel cell bus at the Greater Cleveland Regional Transit Authority (RTA) began service in January 2013. The 40-foot bus has a capacity of 57 passengers and will be in service between six and eight hours daily on various RTA routes. Air Products provided the hydrogen. Building on the success of the American Fuel Cell Bus Project that the RTA fuel cell bus came out of, CALSTART, a California organization focused on advanced transportation, was recently awarded \$2.7 million to oversee the building of a next-generation fuel cell bus to be demonstrated with the RTA for two years.

Pennsylvania

CALSTART, a California organization focused on advanced transportation, was awarded \$554,316 from the FTA's National Fuel Cell Bus Program for comprehensive testing of a fuel cell bus at the National Bus Testing Facility in Altoona.

Texas

DOE awarded the Houston Galveston Area Council (HGAC) \$3.4 million towards 20 new Vision Motors TYRANO™ hydrogen fuel cell-electric trucks being developed for use at the Port of Houston. The trucks are made by California-based Vision Industries and will fuel up at a new hydrogen station, the first public one in the state of Texas (and only one of a handful in U.S.) that will be installed at the port.

Washington

Seattle-based aerospace company Boeing is partnering with American Airlines and the Federal Aviation Administration on the ecoDemonstrator program, a 737-800 airplane that will be a flying testbed for environmentally progressive technologies. One of the technologies slated for testing on the ecoDemonstrator is a regenerative fuel cell developed in partnership with Japan's IHI for auxiliary power.





HYDROGEN FUELING

The hydrogen infrastructure to support fuel cell electric vehicles is slowly starting to emerge. Since hydrogen can be generated from many sources – fossil fuels, water, biomass, and others – there are many ways to produce and deliver hydrogen. Fuel Cells 2000 has a [Google Map](#) of all North American hydrogen stations and fueling dispensers.

California

In July 2013, CEC awarded more than \$18 million for hydrogen station projects, with all but one including match-funding requirements.² The funding awards went to:

- **South Coast Air Quality Management District:** \$6.7 million to evaluate, test and upgrade publicly accessible hydrogen fueling stations.
- **Linde, LLC:** \$4.5 million to install three hydrogen fueling stations (\$1.5 million each) in the cities of Mountain View, Cupertino, and Foster City. \$3 million cost-share.
- **Hydrogen Frontier, Inc.:** \$3 million to build a new 100 percent renewable hydrogen fueling station at Hyundai America Technical Center Inc.'s 8-year old hydrogen fueling station in Chino. The \$1.7 million in cost-share by Hydrogen Frontier Inc., Powertech and ITM Power will go toward modernizing the facility to meet the latest industry standards for hydrogen generation, storage and dispensing.
- **Air Products and Chemicals, Inc.:** \$3 million to install two hydrogen fueling stations in Woodland Hills and Mission Viejo, as well as to automate two trailer loading operations for transporting hydrogen for fueling from a production facility in Southern California. \$1.6 million cost-share.
- **Air Liquide Industrial US LP:** \$1.5 million to build a hydrogen fueling station in Anaheim that is slated to open to the public in the fourth quarter of 2014. Once opened, it will be Air Liquide's first owned and operated hydrogen fueling station for consumer vehicles in the U.S. \$900,000 in cost-share.

IGX Group's Hydrogen Fueling Services performed the first on-site hydrogen fueling of a Multiquip fuel cell mobile lighting unit at the San Francisco International Airport (SFO) using its mobile refueler.

Colorado

The four Toyota FCEVs recently delivered to NREL in Golden will be fueled with renewable hydrogen made from wind and solar energy from NREL's wind-to-hydrogen project, Wind2H2, located in Boulder. The Wind2H2 project uses two wind turbine technologies: a Northern Power Systems 100-kW wind turbine and a Bergey 10-kW wind turbine. The energy from the 10-kW wind turbine is converted from its wild AC form to

² http://www.energy.ca.gov/releases/2013_releases/2013-06-12_award_expand_CA_hydrogen_fueling_stations_nr.html

direct current (DC) and then used by two HOGEN 40RE polymer electrolyte membrane electrolyzers from Proton OnSite (Connecticut) and one Teledyne HMXT-100 alkaline electrolyzer to produce hydrogen and oxygen from water. After compressing the hydrogen, it is stored for later use where it is used to generate electricity and fed into the utility grid during peak demand hours.

Massachusetts

- The two Toyota FCEVs recently delivered to Nuvera's Billerica headquarters for a two-year trial will be fueled using Nuvera's PowerTap hydrogen generation and fueling equipment.
- Nuvera is also working with Plug Power to provide its PowerTap hydrogen generation systems to various sites around the country, including a FedEx domestic airport in Memphis, Tennessee, in conjunction with a DOE ground service equipment project and Ace Hardware in Wilmer, Texas, for fuel cell-powered material handling vehicles.

South Carolina

For its fuel cell material handling fleet expansion at its Spartanburg manufacturing facility, BMW added two higher capacity compressors, new storage tubes and distribution piping, and eight new hydrogen dispensers from Linde that will deliver 400 kg of hydrogen per day. BMW also entered the second phase of its Landfill Gas-to-Hydrogen Pilot Project with SCRA to use locally sourced methane fuel for the forklift fleet. The final phase of this project is scheduled to begin later this year when BMW will conduct side-by-side trials of material handling equipment fueled by landfill gas derived hydrogen versus commercially sourced hydrogen.

Texas

Vision Industries Corporation, Environmental Defense Fund (EDF), Air Products and project partners were recently awarded \$500,000 from the Texas Emission Reduction Program (TERP) to partially fund the building of the first public hydrogen fueling station in the state. The station, which is proposed to be fed from an existing hydrogen pipeline, will fuel 20 new TYRANO™ hydrogen fuel cell-electric trucks being developed by Vision for use at the Port of Houston and be publicly available for personal vehicles.





UNIVERSITY ACTIVITY

There are many colleges and universities around the U.S. offering fuel cell courses, research opportunities and even degrees. Fuel Cells 2000 keeps [track](#) of all of them.

Many are performing crucial cutting-edge research, generating patents and even launching spin-off companies (this was included in the GC copy).

Colorado

The Colorado School of Mines has received a geothermic fuel cell, a modified SOFC, to test for extraction of oil from oil shale. The fuel cell was built by Delphi, a Rochester, New York company, for IEP Technology, of Parker.

Connecticut

- A partnership was launched between the University of Connecticut (UConn), Fraunhofer USA and the Connecticut Department of Energy and Environmental Protection - the Fraunhofer Center for Energy Innovation - which will be temporarily located at UConn's Depot Campus. The research center will relocate to the new UConn Technology Park when it opens. The center will focus on developing advanced technologies related to energy storage, fuel cells, power management, and distribution and is just one of seven Fraunhofer research centers in the country. Fraunhofer USA is a subsidiary of the European company Fraunhofer-Gesellschaft, Europe's largest applied R&D organization.
- Engineers at Yale University in New Haven have developed a new breed of micro fuel cell for portable electronic devices using bulk metallic glasses (BMGs). BMGs are extremely pliable metal alloys that can be finely shaped and molded with a relatively efficient and inexpensive fabrication process akin to processes used for shaping plastics. The BMG components of the Yale team's micro fuel cell (the entirety of which measures three cubic centimeters) are based on zirconium and platinum compounds. The team demonstrated that its fuel cell generates power and is now working to increase output.

Maryland

University of Maryland (UMD) researchers are partnering with Redox Power Systems LLC, a company based in Fulton that took advantage of the Maryland Technology Enterprise Institute's (Mtech) VentureAccelerator Program that helps UMD staff transition research into the marketplace. Redox is focusing on solid oxide fuel cells based upon patented technology from UMD Professor Eric Wachsman, director of UMD's Energy Research Center (UMERC) in the A. James Clark School of Engineering. The company has developed the PowerSERG 2-80, also called "The Cube," a solid oxide fuel cell that connects to a natural gas line to convert methane to electricity, and plans to release a 25-kW version of the product in 2014.

Michigan

Jason D. Nicholas, an assistant professor in the Michigan State University Department of Chemical Engineering and Materials Science, received a five-year \$400,000 National Science Foundation Faculty Early Career Development award for research to reduce operating temperatures and costs while improving performance and extend the operational lifetime of solid oxide fuel cells.

New Hampshire

Xiaowei Teng, assistant professor of chemical engineering at the University of New Hampshire, received two National Science Foundation (NSF) grants totaling nearly \$1 million to improve the efficiency of ethanol oxidation fuel cell reactions. The grants, each lasting for three years, include a \$375,000 grant through by the NSF's Chemical Catalysis Program and \$572,802 from NSF's Catalysis and Biocatalysis Program.

North Carolina

Durham-based Duke University engineers have developed a novel method for producing clean hydrogen using a new catalytic approach, and have shown in the laboratory that they can reduce carbon monoxide levels to nearly zero in the presence of hydrogen. They also demonstrated that they could produce hydrogen by reforming fuel at much lower temperatures than conventional methods, which makes it a more practical option.

Ohio

Researchers from Ulsan National Institute of Science and Technology (South Korea), Case Western Reserve University and University of North Texas report breakthroughs with graphene nanoparticles as a fuel cell catalyst, performing better than platinum in oxygen-reduction reactions. This research is partially supported by UNIST-World Class University (WCU), the US-Korea Nanotechnology, Biotechnology, and Information Technology (NBIT) program, and the U.S. Department of Defense's (DOD) U.S. Air Force Office of Scientific Research (AFOSR) Multidisciplinary Research Program of the University Research Initiative (MURI).

Oregon

Professor Hong Liu and researcher Yanzhen Fan from Oregon State University's Department of Biological and Ecological Engineering have launched a startup company, Waste2Watergy that developed a fuel cell that will be used by Widmer Brothers Brewing for a new pilot project. Widmer will use the fuel cell to treat its wastewater and generate electricity.

Texas

See Ohio above.

Utah

University of Utah chemist Michael Bartl and physicist Jordan Gerton each were granted \$125,000 from the Research Corporation for Science Advancement to conduct research aimed at producing hydrogen fuel from solar energy. The two Utah researchers have teamed with P. James Schuck, a staff scientist at the Molecular Foundry at Lawrence-Berkeley National Laboratory, to experiment with gallium nitride "nanowires" for harvesting solar energy as an alternative means to generate hydrogen fuel.

Virginia

Researchers at Virginia Tech have discovered a new way to extract large amounts of hydrogen from plants, a breakthrough that could revolutionize hydrogen production and make the fuel cost-competitive sooner than anticipated. A team led by Y.H. Percival Zhang used a specially designed enzyme to liberate large amounts of pure hydrogen from xylose, a simple sugar found in every plant. The reaction occurs at low temperatures and normal atmospheric pressure, produces no greenhouse gases, and achieves a perceived energy efficiency of over 100%.

Washington

A Washington State University (WSU) team of mechanical and electrical engineering students has been working the first student-built hydrogen-powered unmanned aerial vehicle. The prototype, named Genii is made of fiberglass-laminated plastic foam with a carbon-fiber wing spar, and has a wing span of 19 feet. Test flights of the battery-powered version have been successful, and in the next few months, the students will move to using a hydrogen fuel cell.





U.S. DEPARTMENT OF ENERGY-SPONSORED R&D

DOE's Fuel Cell Technologies Office supports more than 300 research, development and demonstration (RD&D) projects with fuel cell companies, universities and other stakeholders around the country. This support has led to more than 440 patents, 40 commercial technologies and 65 emerging technologies, as well as significant progress in reducing cost and increasing durability and efficiency.

California

- DOE selected Nextgen Aeronautics, Inc., of Torrance as one of the FY 2012 Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) Phase I Release 3 awards. The company will incorporate low-cost nanoreinforcement into high-pressure all-composite tank designs for hydrogen storage.
- DOE's SBIR/STTR program awarded \$149,997 in Phase I funding to Acree Technologies Incorporated of Concord (California) for "Energetic Deposition of Fully Dense, High-Quality Doped-Ceria Coatings for Solid Oxide Fuel Cells," which may lead to a significant reduction in the cost of fabricating state-of-the-art, highly efficient SOFCs.

Colorado

- DOE awarded a Phase 1 SBIR/STTR grant to Composite Technology Development, Inc. of Lafayette for "Optimizing the Cost and Performance of Composite Cylinders for H2 Storage using a Graded Construction." The project will seek to reduce the cost of these vessels by 25% by using cheaper fibers from Oak Ridge National Laboratory (ORNL) in a graded construction of the vessel wall.
- The Colorado School of Mines of Golden is receiving \$1.5 million from DOE to develop advanced hybrid membranes for cutting edge, next-generation fuel cells that are simpler and more affordable and able to operate at higher temperatures.
- DOE and the NREL opened the Energy Systems Integration Facility (ESIF), a 182,500 square foot facility in Golden to help both public and private sector researchers scale up promising clean energy technologies and test how they interact with each other and the grid at utility scale. ESIF will house more than 15 experimental laboratories and several outdoor test beds, including an interactive hardware-in-the-loop system that lets researchers and manufacturers test their products at full power and real grid load levels. ESIF includes a state-of-the-art Fuel Cell Development and Test Laboratory.

Connecticut

- FuelCell Energy, Inc. of Danbury received a \$6.0 million cost share award from DOE's Phase III of the Solid State Energy Conversion Alliance (SECA) program to improve the performance and endurance of a 60 kW SOFC power plant connected to the electric grid at FuelCell Energy's Danbury facility. The company will also enter Phase II of the carbon capture development project under the previously announced award from the DOE Office of Fossil Energy's Carbon Capture Program implemented by

the National Energy Technology Laboratory. FuelCell Energy will continue research that evaluates the use its DFC® systems to efficiently and cost effectively separate CO₂ from the emissions of coal fired power plants. Approximately \$0.8 million from the total DOE award of \$3 million was authorized to continue the development of the carbon capture system development based on DFC technology.

- DOE's SBIR/STTR program awarded \$1,000,000 in Phase 2 funding to Proton OnSite of Wallingford for "Low-Noble-Metal-Content Catalysts/Electrodes for Hydrogen Production by Water Electrolysis." This project aims to reduce the cost and energy required to manufacture these units through development of improved electrode application methods and reduction in platinum group metals.

Florida

DOE's SBIR/STTR program awarded \$149,468 in Phase I funding to Ultrasonic Technologies, Inc., in Wesley Chapel for "In-Line Quality and Process Control in Solar and Fuel Cell Manufacturing" which will develop a new quality and process control methodology and tool prototype for real-time inspection of crystalline silicon solar and ceramic solid oxide fuel cells.

Illinois

DOE's Advanced Research Projects Agency – Energy (ARPA-E) awarded \$772,897 to the Gas Technology Institute, Inc. of Des Plaines, for its "Methane to Methanol Fuel: A Low Temperature Process" project.

Massachusetts

- The Massachusetts Institute of Technology (MIT) of Cambridge was awarded \$547,289 by DOE's Advanced Research Projects Agency – Energy (ARPA-E) for a "Small and Efficient Reformer for Converting Natural Gas to Liquid Fuels." MIT will develop a compact reformer for natural gas. Reformers produce synthesis gas, the first step in the commercial process of converting natural gas to liquid fuels. Other systems are too large to be deployed remotely; MIT's reformer could be used for small, remote sources of gas.
- Ashwin Ramasubramaniam, assistant professor of mechanical and industrial engineering at the University of Massachusetts, has been awarded a five-year \$750,000 grant from DOE to study the nanoscale materials inside fuel cells.

Minnesota

DOE awarded 3M of St. Paul \$3 million to focus on developing innovative fuel cell membranes with improved durability and performance using processes which are easily scalable to commercial size.

New Jersey

- DOE selected Treadstone Technologies, Inc., of Princeton as one of the FY 2012 SBIR/STTR Phase I Release 3 award winners. The company will develop a novel, low cost structured metal bipolar plate technology for low temperature PEM fuel cells for transportation applications.
- DOE's ARPA-E awarded \$601,860 to Bio2Electric, LLC of Princeton, for its "Electrogenerative System for Co-Production of Green Liquid Fuels and Electricity from Methane" project. The company is partnering with FuelCell Energy, Inc. and North Carolina State University.

North Carolina

See New Jersey above.

Ohio

- DOE's SBIR/STTR program awarded \$1 million in Phase 2 funding to NexTech Materials in Lewis Center for "SOFC Protection Coatings Based on a Cost-Effective Aluminization Process" which will develop a low cost process to achieve a protective coating for SOFCs.
- Stark State College's LG Fuel Cell Systems Inc. (LGFCS) has been awarded a \$5.1 million grant from DOE to further develop the LGFCS laboratory and to improve the affordability and reliability of its solid oxide fuel cells.

Tennessee

DOE's Advanced Manufacturing Office opened a Manufacturing Demonstration Facility at Oak Ridge National Laboratory that focuses on Additive Manufacturing and Low-cost Carbon Fiber. Carbon fiber is a critical material for efficient lightweight vehicles, including FCEVs.

Texas

- DOE's SBIR/STTR program awarded \$149,467 in Phase I funding to Applied Nanotech, Inc. of Austin for Hydrogen Leak Detector for Hydrogen Dispenser to develop a low-cost, long lifetime, miniature hydrogen detectors capable of detecting hydrogen in low concentrations.
- DOE's ARPA-E awarded \$1.7 million to the Texas A&M University - Engineering Experiment Station of College Station for its "Generating Electricity from Waste Heat Using Metal Hydrides" project. The university is partnering with ERRA Inc. of San Antonio and the Texas A&M University at San Antonio to develop a system to generate electricity from low-temperature waste heat. The system would cycle between heating and cooling a metal hydride to produce a flow of high-pressure hydrogen. This hydrogen flow is then used to generate electricity via a turbine and generator.

Utah

DOE's ARPA-E awarded \$2.1 million to Ceramatec, Inc., of Salt Lake City for "Intermediate Temperature Proton Conducting Fuel Cells for Transportation Applications." The company is partnering with Nissan Technical Center North America.

Virginia

- DOE has selected Strategic Analysis of Arlington to lead a \$1 million project to analyze and evaluate potential cost-competitive pathways for producing and transporting hydrogen fuel.
- DOE's SBIR/STTR program awarded \$150,000 in Phase I funding to NanoSonic, Inc. of Pembroke for Cryogenically Flexible, Low Permeability Thoraesus Rubber H2 Dispenser Hose.

West Virginia

West Virginia University associate professor Xingbo Liu received a DOE grant to study the development of low-cost, SOFC technology and advance cathode performance in SOFCs.

Wisconsin

Supported by DOE's Basic Energy Sciences program, researchers at the University of Wisconsin-Madison have achieved high performance with a new catalyst made of molybdenum disulfide, eliminating platinum altogether. So far, the group has produced milligram quantities of the catalyst and plans to experiment with scaling and improving performance as well as exploring related compounds.



MILITARY

All branches of the U.S. military have invested in fuel cell R, D &D. Main areas of interest include portable soldier power, unmanned aerial, ground and undersea vehicles, backup power for facilities and transportation.

California

- SAFCCell, Inc. (Pasadena) has received a \$1 million Army Phase II SBIR grant to demonstrate a 50-W wearable power unit for the dismounted warrior. SAFCCell will integrate its proprietary solid acid fuel cell (SAFC) stacks into UltraCell Inc.'s (Livermore) micro fuel cell systems for alpha testing in late 2014.
- The Naval Air Warfare Center Weapons Division (NAWCWD) Renewable Energy Office in China Lake received a trailer-mounted regenerative fuel cell system consisting of a fuel cell and an array of solar panels. Since it is trailer-mounted, it is a mobile source of electricity. During the day, the command center would be powered by solar energy and excess energy would be used to generate hydrogen. At night, the stored hydrogen produced during the day would be sent through the fuel cell to create electricity. The team will test and evaluate the system in a lab at China Lake before sending it out with troops for field testing.

Connecticut

FuelCell Energy was awarded a \$3.8 million contract award from the U.S. Navy to develop and test a Hybrid SOFC-Battery power system for large displacement undersea vehicle propulsion. The objective of the project is to develop a refuelable power system, with high energy density, suitable for long duration underwater missions of unmanned submersibles. Team partners include the Energy Systems Division of NASA's Lyndon B. Johnson Space Center, Yardney Technical Products, Inc., Naval Underwater Warfare Center (NUWC), and Pacific Northwest National Laboratory (PNNL).

Florida

L2 Aerospace (Rockledge) is partnering with Cella Energy (Kennedy Space Center) to develop plug and play hydrogen power solutions that use lightweight flexible polymer packaging that can be carried by dismounted soldiers or packaged into unmanned aerial vehicles.

Hawaii

The High Technology Development Corporation (HTDC), Hawaii Center for Advanced Transportation Technology (HCATT) and the U.S. Air Force Advanced Power Technology Office (APTO) selected Canadian

fuel cell manufacturer Hydrogencis to develop, fabricate and deliver a 100-kW HyPM-OH outdoor containerized hydrogen power system for the Joint Military Base at Pearl Harbor-Hickam.

Michigan

Ultra Electronics, AMI (Ann Arbor) delivered 45 of its ROAMIO D245XR fuel cells for use in unmanned aerial systems. The delivery is valued at more than \$2 million.

Ohio

Lockheed Martin's Akron division secured a \$3 million contract with the Office of Naval Research for the design and development of solid oxide fuel cell generator sets integrated with solar panels to power battlefield equipment. At the end of the 32-month development program, Lockheed Martin will demonstrate and deliver a multi-kilowatt JP-8 compatible Fuel Cell Efficient Power Node for evaluation by the U.S. Marines. Lockheed is working with Cleveland-based Technology Management Inc. (TMI) on the contract.

Washington

Neah Power Systems, Inc. (Bothell) received a purchase order for one of its 25-Watt Powerchip® fuel cells from a Fortune 110, U.S.-based defense supplier. The defense supplier is exploring the use of fuel cells for a range of applications including soldier power, remote power stations, and unmanned underwater and aerial vehicles.



PHOTO CREDITS

Page 5 – Chart from the Clean Energy Patent Growth Index courtesy of the Cleantech Group at the law firm of Heslin Rothenberg Farley & Mesiti P.C.

Page 6 – Shell Hydrogen station in Newport Beach, CA.

Page 7 – FuelCell Energy installation at Central Connecticut State University; ClearEdge Power unit at Price Chopper in Colonie, NY.

Page 8 – Ohio Fuel Cell Corridor Map; Plug Power fuel cell forklift at Kimberly-Clark warehouse facility in Graniteville, SC.

Page 10 – 1.4 MW FuelCell Energy fuel cell system at South Bay Wastewater Treatment Facility, San Diego, California; ClearEdge Power 400 kW PureCell fuel cell system at City Hall, New Haven, Connecticut.

Page 11 – ClearEdge Power 400 kW PureCell fuel cell system being delivered to Freedom Tower, New York City, New York.

Page 12 – Fuel cell bus now operating in Cleveland, Ohio; Fuel cell-powered forklifts at BMW manufacturing facility in Spartanburg, South Carolina.

Page 13 – Fuel cell-powered forklifts at Sysco Houston (Houston, Texas) distribution center.

Page 25 – 600 kW Bloom Energy installation at URBN's main office in Philadelphia, Pennsylvania; 2.8 MW FuelCell Energy Installation at Inland Empire Utilities Agency (IEUA), Ontario, California; Ballard Power Systems' 1 MW installation at Toyota Motor Sales U.S.A., Inc., Torrance, California.

Page 27 – Fuel cell-powered forklifts at BMW manufacturing facility in Spartanburg, South Carolina; Oorja Protonics' DMFC system on forklift; Crown Equipment Corporation fuel cell forklift.

Page 29 – Fuel cell bus at University of Delaware, Newark, Delaware; Tyrano™ Class 8 fuel cell-powered truck from Vision Motors Corporation; Toyota FCHV-adv fuel cell electric vehicles at Nuvera Fuel Cells headquarters in Billerica, Massachusetts.

Page 31 – Air Products hydrogen station in Fountain Valley, California; Nuvera Fuel Cells' PowerTap™ hydrogen generation and fueling system; Fueling station at National Renewable Energy Laboratory's Wind-to-Hydrogen project in Golden, Colorado.

Page 35 - Gov. Dannel P. Malloy at inauguration of the Fraunhofer Center for Energy Innovation at UConn, image from Peter Morenus/UConn Photo; Redox Power Systems' PowerSERG 2-80 "Cube"; Washington State University's liquid hydrogen unmanned aerial vehicle, Genii.

Page 39 – Trailer-mounted regenerative fuel cell system at Naval Air Warfare Center Weapons Division (NAWCWD) Renewable Energy Office in China Lake; Ultra Electronics, AMI ROAMIO D245XR fuel cell system; Lockheed Martin's SOFC.

APPENDIX 1 – ADDITIONAL RESOURCES

Fuel Cells 2000

Fuel Cells 2000 is a non-profit education and outreach program of the Breakthrough Technologies Institute and offers numerous resources on its website, www.fuelcells.org for any audience.

In addition to the basics such as how a fuel cell works, markets, benefits, Fuel Cell Library and a free monthly industry newsletter, the website includes:

- [State Fuel Cell and Hydrogen Database](#), which includes all U.S. fuel cell installations, vehicle demonstrations, hydrogen fueling stations and state legislation and policies.
- [Comprehensive charts](#), including Fuel Cell Vehicles, Fuel Cell Forklifts, Specialty Vehicles, Fuel Cell Buses, Worldwide Hydrogen Fueling Stations and Fuel Cell Equity and Investment
- A searchable “[Fuel Cell Top 200](#)” directory of the most active companies in the fuel cell industry.
- Links to other resources mentioned in this report, such as regional, [state and international organizations and alliances and financing information](#).

Database of State Incentives for Renewables & Efficiency

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

State and Regional Fuel Cell and Hydrogen Associations/Coalitions

California Fuel Cell Partnership – www.cafcp.org

California Hydrogen Business Council – www.californiahydrogen.org

California Stationary Fuel Cell Collaborative – www.casfcc.org

CT Hydrogen-Fuel Cell Coalition – www.chfcc.org

Fuel Cell and Hydrogen Energy Association – www.fchea.org

Massachusetts Hydrogen Coalition – <http://massh2.org>

Ohio Fuel Cell Coalition – www.fuelcellcorridor.com

South Carolina Hydrogen and Fuel Cell Alliance – www.schydrogen.org

DOE Efficiency and Renewable Energy Fuel Cell Technologies Program

The DOE Fuel Cell Technologies Program conducts comprehensive efforts to overcome the technological, economic, and institutional obstacles to the widespread commercialization of fuel cells and related technologies.

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

For more information about any of the information included in this report, please contact Fuel Cells 2000 at info@fuelcells.org.

APPENDIX 2 – COMPANIES INCLUDED IN THE REPORT

The following is a list of all the companies mentioned in this report with their websites. For a searchable directory of these and other companies involved in the fuel cell industry, please visit <http://www.fuelcells.org/top-200/>.

Fuel Cell Manufacturers

Ballard Power Systems – www.ballard.com
Bing Energy – <http://bingenergyinc.com>
Bloom Energy - www.bloomenergy.com
ClearEdge Power - www.clearedgepower.com
FuelCell Energy - www.fuelcellenergy.com
Genport srl - www.genport.it/our-mission
Global Energy Innovations - <http://geifuelcells.com>
Hydrogenics – www.hydrogenics.com
Lilliputian Systems - www.nectarpower.com
Neah Power Systems - www.neahpower.com
Nuvera Fuel Cells – www.nuvera.com
Oorja Protonics - www.oorjaprotonics.com
Parker Hannifin – www.parker.com
Plug Power - www.plugpower.com
Redox Power Systems, LLC - www.redoxpowersystems.com
ReliOn - www.relion-inc.com
SAFCeLL - <http://safcell.com>
Solid Cell - <http://solidcell.com>
Technology Management Inc. - <http://tmi-anywherenergy.com>
Ultra Electronics, AMI - www.ultra-ami.com
Vision Motors – www.visionmotorcorp.com
VP Energy, LLC - <http://vpenergy.com>
Watt Fuel Cell Corporation - <http://wattfuelcell.com>

Hydrogen Generation/Fueling

Air Liquide - www.us.airliquide.com

Air Products and Chemicals, Inc. - www.airproducts.com

AlumiFuel Power Technologies - www.alumifuelpowertech.com

Hydrogen Frontier, Inc. - <http://hydrogenfrontier.com>

IGX Group - www.igxgroup.com

Linde North America LLC - www.linde.com

Nuvera Fuel Cells – www.nuvera.com

Proton OnSite – www.protononsite.com

Fuel Cell Supply Chain

3M – www.3m.com

Acree Technologies Incorporated - <http://acreetech.com>

Advent Technologies - www.advent-energy.com

Applied Nanotech, Inc. - <http://appliednanotech.net>

Bio2Electric - <http://bio2electric.com>

Borit - www.borit.us

Cella Energy – www.cellaenergy.com

Ceramatec, Inc. - <http://ceramatec.com>

Composite Technology Development - www.ctd-materials.com

Gas Technology Institute - www.gastechnology.org

Global Tungsten & Powders Corporation - www.globaltungsten.com

NanoSonic - www.nanosonic.com

Nextgen Aeronautics - www.nextgenaero.com

NexTech Materials – www.nexttechmaterials.com/energy/

Treadstone Technologies, Inc. - www.treadstone-technologies.com

Ultrasonic Technologies - www.ultrasonictech.com



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