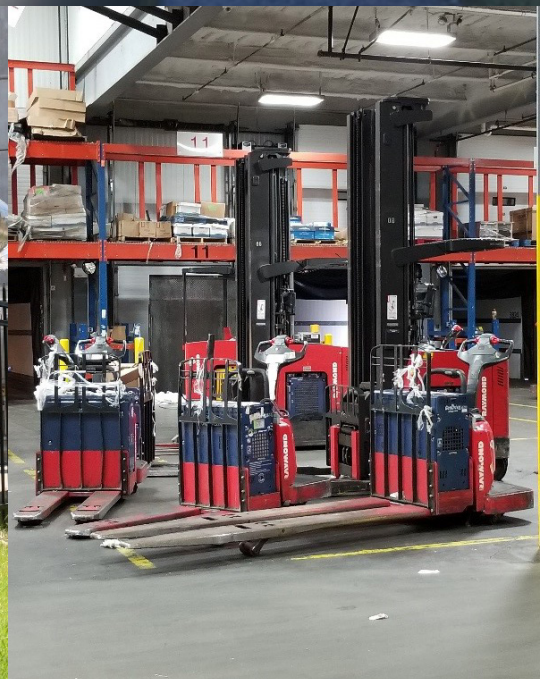


State of the States: Fuel Cells in America 2017

8th edition | January 2018



About this Report

The information contained in this report was collected from public records, websites and via direct contact with state and industry representatives as of July 31, 2017. This report is a follow-up to State of the States: Fuel Cells in America 2016, 2015, 2014, 2013, 2012, 2011 and 2010 editions, available online at the U.S. Department of Energy's Fuel Cell Technologies Office (FCTO) - Market Analysis Reports webpage. If we have missed something in your state, please let us know at jgangi@fcchea.org.

Authors and Acknowledgements

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

About FCHEA

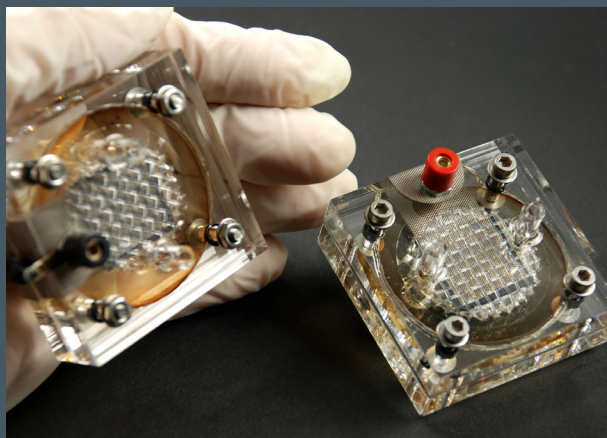
The Fuel Cell and Hydrogen Energy Association (FCHEA) represents the leading companies and organizations that are advancing innovative, clean, safe, and reliable energy technologies.

FCHEA drives support and provides a consistent industry voice to regulators and policymakers. FCHEA educational efforts promote the environmental and economic benefits of fuel cell and hydrogen energy technologies.

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About Fuel Cells

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

Hydrogen can be sourced from fossil fuels, such as natural gas or propane, or renewable fuels including anaerobic digester gas and landfill gas. Hydrogen can also be produced by water electrolysis, which can be powered by electricity including from renewables such as solar or wind power or from nuclear energy and the grid.

Fuel cells are part of a portfolio of technologies that can enable energy security, resiliency and economic growth through a number of applications across sectors. As research and development (R&D) continues to help drive down cost and improve performance, States and the private sector have been deploying fuel cells in stationary, transportation, and portable power applications, helping to achieve economies of scale in this emerging industry. Despite the primary challenge of cost, fuel cells offer a number of benefits.

Fuel Cell Benefits

- High quality, reliable power, enables resiliency
- Fuel flexible – can use diverse domestic fuels (conventional, renewables or waste products such as waste water or landfill gas) and enables energy security
- Scalable to fit any power need and diverse applications across stationary, transportation and portable power sectors
- Offers combined heat and power options and can co-produce fuel
- Efficient – 50%+ electric efficiency, 90%+ electric and thermal efficiency (combined heat and power)
- Quiet
- Durable and rugged
- Exceptionally low/zero emissions
- Can produce drinkable water

Motive

- Fuel Cell Vehicles (FCVs) – replicates today's driving experience: range of 300+ miles per hydrogen fueling, refuel at a pump in 3-5 minutes
- Material Handling Equipment (MHE) – fuel cell provides constant power, and can refuel in minutes

Stationary

- Flexible siting – indoors or outdoors
- Lightweight – enables rooftop siting
- Modular/scalable to meet any need, ranging from a few watts to multi-megawatt (MW) systems
- Able to provide primary, supplemental, or backup power
- Can be grid-tied, or can operate independently from the grid
- Compatible with solar, wind, batteries and other renewable/conventional technologies
- Can be connected to existing natural gas infrastructure, or use hydrogen fuel generated by renewables
- Operates in water balance/uses very little water in operation

Portable

- Refuel on the go by swapping a cartridge
- Low-thermal, low-sound profile



Examples Of Fuel Cell Applications

At the state and local level, fuel cells are helping to meet environmental goals, boost reliability and resiliency to ensure constant power, and save taxpayer dollars and industry investment. Deployed by both businesses and local governments, fuel cells are now operating in a variety of stationary and motive applications.



Primary and backup power

- Retail stores, corporate headquarters, data centers, hotels, apartment buildings
- Government offices, jails, fire and police stations, wastewater treatment plants
- Communications and emergency networks, cell phone towers, railroad signals
- Schools and universities
- Utility substations, providing multi-megawatts of power to local users, microgrids
- Off-grid equipment for security, energy exploration, recreation, lighting



Motive power

- MHE operating in distribution centers, warehouses, and cold storage facilities, ports
- Buses running on public routes
- Light-duty automobiles for consumers and fleets, delivery vans
- Heavy-duty trucks, trash trucks, utility vehicles
- Baggage tow tractors (airports)

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More than Power: BENEFITS TO STATES

The fuel cell and hydrogen industry is taking root around the world in a variety of market sectors, leading to opportunities for the United States (U.S.) to grow jobs, manufacturing capability and energy production here at home, while expanding international exports. Many of the world's largest fuel cell companies are based in the U.S., and they continue to design and manufacture their products in the U.S. Their products are utilized not only in the U.S., but also overseas, with several manufacturers exporting nearly 70% of their products to Asia and Europe.

States see the potential of the industry and some are supporting business development for new and expanding innovative fuel cell and hydrogen companies. As the industry expands, so does employment, adding to economic growth in the state through job creation, tax revenues and investment.

Fuel cells also deliver benefits to states that are encouraging their adoption.

- emissions reductions in the transport and power generation sectors;
- reliable power generation in the face of extreme weather; and
- highly efficient power generation, which can include capturing waste heat for energy production to provide heating, cooling, and hot water.

As customers (both corporate and municipal) take advantage of these policies and incentives, energy generation is diversified – using home-grown energy – and we all experience the multitude of benefits that fuel cells offer.



High Tech Industry: Fuel Cells and Hydrogen

Increasing sales and industry growth may bring rewards to states that invest in fuel cell and hydrogen technologies. Today, nearly every U.S. state is home to some facet of the fuel cell and hydrogen industry, be it developers, supply chain and component companies, fuel providers, integrators, engineering, construction, and more.

Fuel cell system and fuel cell vehicle (FCV) manufacturers, and industrial gas and hydrogen fueling station suppliers, make up an important portion of the industry. Supply chain companies also play a critical role, with an increasing number of component companies finding a market niche for their products in the fuel cell and hydrogen industry. Companies that manufacture compressed natural gas tanks are moving into the hydrogen tank market, while components manufacturers, for products such as nozzles, coatings and powders, or valves, see potential opportunities in supplying parts to automotive companies for FCVs, and to fuel cell and hydrogen manufacturers.

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State and Local Goals: Reliable Power, Lower Emissions

Fuel cells are a low-to-zero emissions technology, depending upon the fuel source. Most large-scale fuel cells for power generation run on natural gas, and can be directly connected to the existing network of resilient underground pipelines. They can also utilize biogas, so cities and towns with landfills, wastewater treatment plants, farms, or food processing facilities can turn waste into a clean fuel supply.

run on hydrogen, which can be generated from natural gas, biogas, or electrolysis, using standard electricity or renewably via solar or wind.

Fuel cells generate power as long as fuel is supplied and can operate independent of the electric grid. Both municipal and private sector customers are installing fuel cells at critical facilities where power outages are not only costly, but potentially dangerous, including data centers, hospitals, microgrids that power emergency services, and even jails.

Fuel cells are also being used to extend communications networks into rural areas and allow for siting in rough terrain and remote locations.

For material handling operations in warehouses or on the docks, fuel cells deliver constant power with no voltage sags and do not run down, even in cold environments. The fast fueling and longer runtime is resulting in increased productivity and major savings.

State programs and incentives encourage businesses and local governments to invest in fuel cell and hydrogen technologies. The growing list of fuel cell customers includes not only businesses, but also municipalities that use fuel cells to power facilities such as wastewater treatment plants or government buildings, or use FCVs in their motor pools.



Federal Support: Aid to Universities and Local Business

The federal impact on the fuel cell and hydrogen businesses has been significant. Federal funds help start-ups, university spin-offs, and universities fund R&D projects, or partner with U.S. Department of Energy (DOE) national laboratories for research and development (R&D) efforts. DOE, the Federal Transit Administration (FTA), the US Department of Defense (DoD), National Aeronautics and Space Administration (NASA) and National Science Foundation (NSF) have provided grant funding for R&D projects for a number of years, with funding awards made to companies and universities in dozens of states.

DOE reports that 650 U.S. hydrogen and fuel cell patents have been enabled by Fuel Cell Technologies Office (FCTO) funds within DOE's Office of Energy Efficiency and Renewable Energy (EERE). In addition, more than 30 technologies have been commercialized by private industry, and over 75 have potential to be commercialized in the next 3-5 years, all being traced back to R&D supported by FCTO.¹

Historically, DOE has worked with industry and local governments to validate in working with industry and local governments to implement demonstration projects that validate technologies and feed back to early stage R&D, such as fuel cell-powered ground support operated by FedEx at Memphis International Airport in Tennessee, fuel cells for maritime applications, and fuel cell delivery truck prototypes by both UPS and FedEx; and a demonstration of fuel cell-powered Class 8 drayage trucks at the Ports of Los Angeles, Long Beach and San Pedro, California. FTA has been instrumental in funding fuel cell buses operated by transit agencies in multiple states and the partnership with DOE for data

collection helps to further guide R&D to continue to improve the technology.

Companies in several states have also taken advantage of the U.S. Small Business Administration's State Trade Expansion Program (STEP) that provides support for small businesses related to export development, to

650
U.S. hydrogen and fuel cell
PATENTS
have been enabled by FCTO funds



Fuel Cells and Hydrogen in the United States

attend international fuel cell and hydrogen conferences and exhibitions. This has led to expanding sales and distribution agreements with international partners.

To showcase the wide reach and strong footprint of fuel cell and hydrogen activity in the U.S., and to give credit to examples that have incentivized hundreds of fuel cells projects, we have created easy-to-read summary charts for each of the 50 states.

The state charts highlight recent or ongoing fuel cell operations – large and small stationary fuel cells, and fuel cells powering light- and heavy-duty vehicles and material handling equipment – as well as the state-level footprint of policies, coalitions, university R&D, federal funding awards and industry presence.

The following key lays out the categories featured and the symbols used to represent them:










Checkmarks by these symbols denote whether a state has a fuel cell or hydrogen installation, deployment, or policy.

We have also summarized recent activities that have been announced or achieved since the last State of the States report as well as notable deployments or installations.

In some states, we have also included a short case study to highlight either how state programs have been utilized to move the industry forward, or how fuel cell and hydrogen companies are contributing to the state economically, through job creation, manufacturing expansion, or by attracting federal or state investment.








The good news is that the fuel cell industry now has a presence in nearly every state, with many boasting manufacturers, component suppliers, R&D at universities or industry, and fuel cell installations and deployments.

Key/Definitions		Commercial Deployments	Government Deployments	Initiatives/Incentives/ Funding
	Fuel Cell Vehicles	<ul style="list-style-type: none"> Commercially-produced FCVs on state roadways. Effective state initiatives (e.g. incentives, programs, funding, etc) that have helped to bring commercial FCVs to state roadways. 		
	Hydrogen Stations	<ul style="list-style-type: none"> Commercial (retail) or government (private) hydrogen stations. Effective state initiatives (e.g. incentives, programs, funding, etc) that have helped to bring hydrogen stations to the state. 		
	Fuel Cell Buses	<ul style="list-style-type: none"> Fuel cell buses deployed by a transit operator Effective state initiatives (e.g. incentives, programs, funding, etc) that have helped to bring fuel cell buses to the state. 		
	Material Handling Equipment	<ul style="list-style-type: none"> Fuel cell material handling equipment (MHE) operating in warehouses/ distribution centers, etc. Effective state initiatives (e.g. incentives, programs, funding, etc) that have helped to bring fuel cell MHE to the state. 		
	Other Fuel Cell Vehicles	<ul style="list-style-type: none"> Other fuel cell-powered vehicles - such as a truck, van, or street sweeper – being tested in everyday operations. Effective state initiatives (e.g. incentives, programs, funding, etc) that have helped bring new applications for fuel cell vehicles to the state. 		
	Large Stationary Fuel Cells	<ul style="list-style-type: none"> Large stationary fuel cells providing onsite power generation, or CHP generation. Effective state initiatives (e.g. incentives, programs, funding, etc) that have led to deployments of large stationary fuel cells. 		
	Small Stationary Fuel Cells	<ul style="list-style-type: none"> Small stationary fuel cells providing onsite power generation for communications networks, remotes sites, equipment, etc. Effective state initiatives (e.g. incentives, programs, funding, etc) that have led to deployments of small stationary fuel cells. 		
Fuel Cell Manufacturers		<ul style="list-style-type: none"> Original Equipment Manufacturers (OEMs) of fuel cells for stationary or motive applications. 		
Hydrogen Suppliers & Services		<ul style="list-style-type: none"> Suppliers of hydrogen stations and/or hydrogen fuel for vehicles or stationary applications. 		
Components/Services Suppliers		<ul style="list-style-type: none"> Suppliers of components or services to fuel cell manufacturers, hydrogen stations or FCVs (e.g. membrane electrode assemblies, hydrogen tanks, etc.). 		
University H2/FC R&D		<ul style="list-style-type: none"> Faculty-led R&D on fuel cells and/or hydrogen. 		
Federal R&D Funding		<ul style="list-style-type: none"> Recent federal funding (e.g. DOE, FTA, or other agencies) for university or business R&D on fuel cells or hydrogen (since our last report). 		




State Coalitions

- Coalitions promoting fuel cell and hydrogen in the state (e.g. the California Fuel Cell Partnership, Connecticut Hydrogen-Fuel Cell Council, or Ohio Fuel Cell Collaborative)









State Activities Categorized Alphabetically

Alabama	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment	✓		
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells	✓		
	Small Stationary Fuel Cells	✓		


Details:

	In late 2016, FuelCell Energy and ExxonMobil announced they will test novel fuel cell carbon capture technology at the James M. Barry Electric Generating Station, a 2.7 gigawatt mixed-use coal and gas-fired power plant located in Bucks and operated by Southern Company subsidiary Alabama Power. Molten carbonate fuel cells will concentrate and capture carbon dioxide from the power plant in Bucks.
	Fuel cells supply reliable backup power to equipment used at government, utility, railroad, and telecommunications sites.
	195 hydrogen-powered Plug Power fuel cell forklifts operate at the Mercedes-Benz plant (Vance).








Fuel Cell Manufacturers	✓	Hydrogen Suppliers		Components/ Services Suppliers	✓
University H2/FC R&D	✓	Federal RD&D Funding	✓	State Coalitions	

Alaska	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment			
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells			
	Small Stationary Fuel Cells			



Details:

	<p>Small stationary fuel cells power several remote radio towers located at government sites.</p> <p>A fuel cell powers Exit Glacier Nature Center at Kenai Fjords National Park. The center first installed a fuel cell in 2003 and replaced it with a newer version that runs on propane from Altrex Corporation (formerly Acumentrics) in 2012.</p>
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Fuel Cell Manufacturers		Hydrogen Suppliers		Components/ Services Suppliers	
University H2/FC R&D		Federal RD&D Funding		State Coalitions	

Arizona	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment	✓		
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells			
	Small Stationary Fuel Cells	✓	✓	


Details:

	Wine and spirits distributor Young's Market is using Plug Power fuel cells and hydrogen fueling equipment to power industrial vehicles at its newly constructed distribution center in Phoenix.
	Fuel cells supply backup power at 18 AT&T sites.
	Fuel cells provide backup power at government and railroad sites.

Fuel Cell Manufacturers		Hydrogen Suppliers		Components/ Services Suppliers	✓
University H2/FC R&D	✓	Federal RD&D Funding	✓	State Coalitions	

Arkansas	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment			
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells			
	Small Stationary Fuel Cells			

Details:

	Fuel cells power pipeline Cathodic Protection stations at natural gas wellhead sites in the state.
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DOE Funding University Project





























Dr. Tansel Karabacak, professor of physics and astronomy at University of Arkansas at Little Rock, was awarded \$500,000 for a three-year project to develop fuel cells for transportation applications.² Most of the funding (\$400,000) came from a larger award the U.S. Department of Energy granted to United Technologies Research Center of Connecticut. The University will add \$100,000 in matching funds.

Karabacak and his team will focus on decreasing the amount of platinum in the fuel cell, which will help reduce cost, as well as increasing the performance and durability in vehicles.




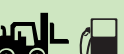



The funding will also be used to add a postdoctoral researcher and a graduate assistant to help Karabacak.

Fuel Cell Manufacturers		Hydrogen Suppliers		Components/ Services Suppliers	
University H2/FC R&D		Federal RD&D Funding		State Coalitions	

RECOGNIZED AS A HIGH ACTIVITY FUEL CELL STATE FOR THE 8TH YEAR

California	Commercial	Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment			
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells			
	Small Stationary Fuel Cells			

Details

	Almost 1,500 FCVs were sold or leased in California ³ between Jan 2016-July 2017.
	As of July 2017, 29 retail hydrogen stations have been opened in California. ⁴ The state is providing up to \$20 million in annual funding until 100 retail hydrogen stations are opened.
	Nineteen fuel cell-powered buses are operating in daily transit service in the East Bay area, Coachella Valley, in Orange County and at the University of California-Irvine with more planned.
	Fuel cell forklifts are deployed in at least five locations, including distribution centers operated by Coca-Cola (San Leandro), Kroger (Compton), Proctor & Gamble (Oxnard), Sysco (Riverside) and WinCo Foods (Modesto).
	The Ports of Los Angeles and Long Beach will test fuel cell-powered drayage trucks from Hydrogenics/ Daimler and Toyota, and fuel cell range-extended electric trucks from BAE/Kenworth, US Hybrid and TransPower. The project has been awarded funding from SCAQMD and DOE. UPS, in partnership with DOE, will deploy an electric-powered delivery vehicle with a fuel cell range extender. The vehicle will be tested in daily operations in the Sacramento area.
	The Energy Commission's SGIP program supports deployment of distributed energy systems. SGIP has funded almost 175 MW of stationary fuel cells, with more than 400 systems installed or planned as of August 2, 2017. ⁵ Recent installations include fuel cells at IKEA stores, California State University-San Marcos, Riverside Regional Water Quality Control Plant, Santa Rita Jail and Tulare Wastewater Treatment Facility.
	Small stationary fuel cells supply backup power at telecom, government, railroad, and utility sites.

California's State Agencies: Coordinated Action Enables FCV Growth








Nationally and globally, California is on the "cutting edge" in the adoption of FCVs and hydrogen fueling infrastructure as a means of improving air quality and reducing greenhouse gas emissions. The state reports that, "California is proof positive that investing in transportation infrastructure and the deployment of zero emission vehicles leads to statewide economic growth."⁶

California’s state agencies play a critical role in enabling FCVs and hydrogen fueling. The agencies’ coordinated activities, in conjunction with cost-shared funding that encourages private investment, plus customer incentives for FCV purchase or lease, provides an example of successful implementation of ZEV policies in order to reach state goals:





- The California Energy Commission (CEC) is investing in a growing network of conveniently-located refueling stations to support FCVs now operating on state roadways and to encourage more consumers to consider ZEVs. Funding for hydrogen station development is made available through CEC’s competitive Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP) with up to \$20 million awarded annually until 100 retail hydrogen stations are open in the state.
- The California Environmental Protection Agency’s Air Resources Board (ARB) provides customer rebates through the Clean Vehicle Rebate Project, funded by proceeds from the state’s cap-and-trade program to help Californians lease FCVs.
- ARB also supports development of fueling infrastructure by matching projected market demand and advancing station technology. ARB annually reports on FCV and hydrogen fueling stations in the state and provides recommendations for CEC’s use in developing grant programs for hydrogen stations – assessing daily fueling capacities and technical capabilities of stations, and identifying areas with the greatest need for fueling infrastructure development using the California Hydrogen Infrastructure Tool (CHIT).⁷
- GO-Biz – the California Governor’s Office of Business and Economic Development – helps station providers, local government and developers with planning and permitting of new hydrogen stations, supporting the goal of 1.5 million ZEVs on California’s roads by 2025.

In April 2017, leaders from ARB, CEC, GO-Biz, and other members of the California Fuel Cell Partnership (CaFCP) caravanned from Sacramento to the Bay Area and back to demonstrate how easy it is to drive and fuel hydrogen fuel cell electric vehicles in California, and to celebrate the state’s global leadership in efforts to get more ZEVs on the road.

Fuel Cell Manufacturers		Hydrogen Suppliers		Components/ Services Suppliers	
University H2/FC R&D		Federal RD&D Funding		State Coalitions	

Colorado	Category	Commercial Deployments	Government Deployments	Initiatives/Incentives/Funding
	Fuel Cell Vehicles		✓	
	Hydrogen Stations		✓	✓
	Fuel Cell Buses			
	Material Handling Equipment	✓		
	Other Fuel Cell Vehicles		✓	
	Large Stationary Fuel Cells			
	Small Stationary Fuel Cells	✓	✓	








Details:

	<p>Several FCVs are driven by staff at the National Renewable Energy Laboratory (NREL) in Golden.</p> <p>NREL opened its first hydrogen fueling research station in 2009 at its National Wind Technology Center south of Boulder as part of the Wind-to-Hydrogen project studying renewable hydrogen production through electrolysis.</p> <p>In 2015, NREL opened a 700-bar hydrogen fueling station to test FCV and infrastructure components and systems, and improve renewable hydrogen production methods.</p>
	Retail food chain Kroger operates 120 Plug Power fuel cell-powered forklifts at its Stapleton distribution center.
	The fuel cell-powered Chevy Colorado ZH2 prototype, developed by GM and the Army's Tank Automotive Research, Development and Engineering Center (TARDEC), is being tested at Fort Carson.
	Small stationary fuel cells power radio power transmitter/receivers at an FAA location, provide primary power to equipment at oil and gas drilling sites, and backup power to a head-end and cable modem termination system.




Colorado Announces Readiness for FCVs and Hydrogen Fueling

The Colorado Department of Labor and Employment's Division of Oil and Public Safety hosted an event at the Colorado State Capitol to commemorate Hydrogen and Fuel Cell Day, celebrated on October 8 in honor of the atomic weight of hydrogen – 1.008. The governor issued a proclamation in celebration of the day, adding that Colorado is ready and open for the construction of hydrogen fueling stations and the introduction of fuel cell vehicles.⁸ Colorado has adopted retail hydrogen fueling regulations, which became effective on January 1, 2017.⁹

Fuel Cell Manufacturers	✓	Hydrogen Suppliers		Components/Services Suppliers	✓
University H2/FC R&D	✓	Federal RD&D Funding	✓	State Coalitions	✓

Connecticut	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			✓
	Hydrogen Stations	✓		
	Fuel Cell Buses			
	Material Handling Equipment			
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells	✓		✓
	Small Stationary Fuel Cells	✓		

Details:

	Air Liquide has entered into long-term lease agreement for a Hartford hydrogen fueling station in Hartford that will be part of the northeast states hydrogen fueling network being developed by Toyota and Air Liquide in the northeast.
	More than 64 MW of large stationary fuel cells are currently operating or planned in Connecticut. Recent installations and announcements include fuel cells at Amity Regional High School, Central Connecticut State University, Hartford/Parkville Microgrid, IKEA, Middletown High School, Naugatuck Wastewater Treatment, New Britain High School, Naval Submarine Base New London, Pfizer, Shelton High School and Trinity College. These include systems from Connecticut –based FuelCell Energy and Doosan Fuel Cell America, as well as Bloom Energy.
	Small stationary fuel cells provide backup power for telecommunications equipment in the state.

Connecticut Expands Support for Fuel Cell Technologies

After California, Connecticut is home to the nation's second largest installed fuel cell capacity. State government support has been critical in enabling these installations.

Fuel cells are classified as a Class I renewable energy source, with several state programs providing fuel cell project funding. In 2017, two new fuel cell systems were started up in Woodbridge and in Hartford's Parkville neighborhood, with funding from the state's Microgrid Program. Fuel cells are also eligible for 15-year contracts to sell Low Emission Renewable Energy Credits (LRECs) from the two investor-owned electric utilities, United Illuminating (UI) and Connecticut Light & Power (CL&P).

A new public act may encourage further installations. In June, H.B. 7036 was signed into law, enabling Connecticut's electric utilities to purchase up to 30 MW of fuel cells through a competitive process, for the purpose of providing distribution system benefits, including avoiding or deferring distribution capacity upgrades and enhancing distribution system reliability.








The bill was backed by the governor and lawmakers, and several state agencies and business associations testified in support of the bill. In its testimony, the New Haven Chamber of Commerce stressed that, "the bill will support home-grown high tech manufacturing, compliance with our state's Renewable Portfolio Standards goals, and provide sales tax revenue to the State and much needed revenue to municipalities through new local property tax payments. This bill will help solidify Connecticut's position as a world leader and supporter of fuel cell technologies."¹⁰

A recent study by the Connecticut Center for Economic Analysis (CCEA) (Dec. 2016) indicates that, “if the State retains its relative market share of fuel cell sales, the fuel cell industry will be a major contributor in restoring Connecticut’s economic vitality, particularly in retaining high tech research and advanced manufacturing jobs, generating increased investments, and delivering more tax revenue.” In addition, between 2015-2042, the aggregated impact on employment yields 170,000 to 244,000 jobs over the 27-year period, averaging 6,300-9,000 jobs of various durations per year relative to the status quo. Similarly the aggregated impact on real gross domestic product yields between \$38 and \$54 billion in terms of constant 2009 dollars.”¹¹



Connecticut has more than 64 MW of planned or installed stationary fuel cell systems and is currently home to 10 fuel cell and hydrogen manufacturers and 611 supply chain companies. The industry provides over \$726 million in revenue and investment; more than 3,406 direct, indirect and induced jobs; and \$340 million in labor income.

Connecticut is also a signatory to the eight-state ZEV MOU. The Connecticut Hydrogen and Electric Automobile Purchase Rebate (CHEAPR), administered by the CT Department of Energy and Environmental Protection (DEEP), offers FCV rebates. A hydrogen station, in development by Air Liquide and Toyota, will be located in Hartford and will be part of a northeast hydrogen fueling network.

Fuel Cell Manufacturers		Hydrogen Suppliers		Components/ Services Suppliers	
University H2/FC R&D		Federal RD&D Funding		State Coalitions	

Delaware	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses	✓		
	Material Handling Equipment			
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells	✓		
	Small Stationary Fuel Cells			

Details:

	Fuel cell-powered buses operate daily on the University of Delaware campus.
	Delmarva Power has deployed 30 MW of fuel cells, installed at two of its substations, which supply enough grid power for about 22,000 homes.

University Entrepreneurship








The University of Delaware (UD) is home to a Center for Fuel Cell Research as well as a Fuel Cell Bus Program, which is currently operating two 22-foot, 22-seat shuttle buses and one 40-foot, 42-seat bus on campus. The buses also serve as a research platform to study new fuel cell system components and control strategies. The Federal Transit Administration helped fund these buses.

In addition to overseeing the Center for Fuel Cell Research and UD's fuel cell bus fleet, Dr. Ajay Prasad, has also launched a new start-up company, Sonijector LLC, with assistance from UD's Office of Economic Innovation and Partnerships (OEIP).

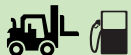

The OEIP runs the Delaware Small Business Development Center (DSBDC), the Technology Transfer Center (TTC), and the Procurement Technical Assistance Center which support entrepreneurial, technical and business communities to reach new levels of economic development.

Prasad and his UD collaborators' company, Sonijector, offers a patented variable-area ejector that recirculates the hydrogen used in fuel cell vehicles reliably and with minimal parasitic power consumption, replacing the conventional pump that is typically used.¹² The company has shipped prototypes to several automotive manufacturers and it has been tested and proven in the fuel cell buses at UD for the past few years. The product is available in various sizes for various applications, including forklifts, motorcycles, cars, buses, trucks, and stationary power systems.

Fuel Cell Manufacturers	✓	Hydrogen Suppliers	✓	Components/ Services Suppliers	✓
University H2/FC R&D	✓	Federal RD&D Funding	✓	State Coalitions	

Florida	Category	Commercial Deployments	Government Deployments	Initiatives/Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment	✓		
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells			
	Small Stationary Fuel Cells	✓	✓	

Details:

	United Natural Foods, Inc. operates 65 Plug Power fuel cell forklifts at its Sarasota distribution center.
	<p>Fuel cells are providing backup power to telecommunications sites across the state, including more than 130 T-Mobile/MetroPCS sites.</p> <p>The Sunrail commuter train network uses a solar-fuel cell-battery system to power safety signaling equipment at a Florida location that lacks grid power.</p> <p>Fuel cells are also supplying backup power to government sites in the state.</p>








Home-grown Hydrogen

In Pinellas Park, an interesting synergistic relationship is leading to a new hydrogen fueling station with potentially more to come.


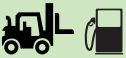

Polypack, Inc. is a manufacturing company that specializes in shrink wrap machines and packaging equipment. The company is well versed in sustainability and has had a solar rooftop system installed for several years now. Polycerf provides industrial mechanical engineering services to Polypack, as well as expertise in automotive historical research and restorations. Polycerf owns the Tampa Bay Automobile Museum which is located on same property in Pinellas Park. The company is currently working on building a fully sustainable hydrogen refueling station for fuel cell vehicles, with an accompanying hydrogen educational and outreach center, the Center for Hydrogen and Next Generation Energy (CHANGE).

Polycerf will utilize Polypack's facilities and equipment to reduce costs. The company plans to design two versions of a hydrogen station, one that would generate hydrogen on-site with an electrolyzer and the other with tanks that would receive delivered hydrogen. Polycerf plans to expand Florida's hydrogen infrastructure to other locations across the state with the hopes that automakers and other providers of zero-emission fuel cell vehicles deploy them there.








Fuel Cell Manufacturers		Hydrogen Suppliers		Components/Services Suppliers	✓
University H2/FC R&D	✓	Federal RD&D Funding	✓	State Coalitions	

Georgia	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment	✓		
	Other Fuel Cell Vehicles		✓	
	Large Stationary Fuel Cells	✓		
	Small Stationary Fuel Cells	✓	✓	




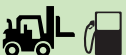


Details:

	A fuel cell-powered Chevy Colorado ZH2 prototype, developed by GM and the Army's Tank Automotive Research, Development and Engineering Center (TARDEC), will be tested at Fort Benning in 2017.
	Fuel cell-powered forklifts operate at two Georgia distribution centers: Lowe's (Rome), which utilizes 157 fuel cell forklifts, and Carter's (Braselton). The fuel cells were supplied by Plug Power. The Home Depot is planning on deploying fuel cell forklifts at its Savannah distribution center.
	SouthernLINC Wireless, headquartered in Atlanta, is deploying hydrogen-powered fuel cells at as many as 500 LTE sites in its wireless network that includes Georgia Power sites. The Federal Aviation Administration utilizes fuel cells to power two Remote Transmitter Receivers (RTRs). Fuel cells are supplying backup power to railroad equipment in the state.

Fuel Cell Manufacturers	✓	Hydrogen Suppliers		Components/ Services Suppliers	✓
University H2/FC R&D	✓	Federal RD&D Funding		State Coalitions	

Hawaii	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles	✓		
	Hydrogen Stations		✓	
	Fuel Cell Buses		✓	
	Material Handling Equipment	✓		
	Other Fuel Cell Vehicles		✓	
	Large Stationary Fuel Cells			
	Small Stationary Fuel Cells	✓		

Details:

	Six Toyota Mirai FCVs were delivered to Servco Toyota (Honolulu) in 2016.
	<p>A fast-fill hydrogen fueling station is located at Marine Corps Base Hawaii at Kaneohe, which supported GM FCVs leased by the Office of Naval Research for use by Marine Corps and Navy personnel on Oahu.</p> <p>HCATT has purchased a palletized 2kg/day hydrogen production /storage /dispensing station with 8 kg of storage at 5000 psi, which will be the first operational hydrogen dispenser on Oahu outside a military base.</p> <p>A private hydrogen station at Servco is planned to open in 2018.</p>
	Fuel-cell/battery buses are scheduled for delivery in 2017 at Hawaii Volcanoes National Park and an additional bus to be operated by the County of Hawaii Mass Transit Authority between the Kona International Airport and Kailua-Kona will be in service early 2018. A hydrogen station at the Natural Energy Laboratory of Hawaii fuels county vehicles and supports a tube trailer dispenser station for Volcano National Park buses.
	The Blue Planet Foundation's research facility (Big Island) operates a fuel cell-powered forklift. Hydrogen is produced onsite and is compressed, stored, and dispensed from the onsite hydrogen refueling station.
	Joint Base Pearl Harbor-Hickam has been a U.S. Air Force test bed for a variety of hydrogen-fueled vehicles. A 65kg/day electrolyzer and hydrogen station with 350 kg of storage are located at the base.
	<p>The research facility at the Blue Planet Foundation site on the Big Island operates small stationary fuel cells that supply power to its microgrid, which also includes photovoltaic panels, battery storage, and hydrogen production by electrolysis.</p> <p>The Air Force Research Lab's Advanced Power Technology Office and the HCATT have initiated the design of the Pacific Energy Assurance and Resiliency Laboratory (PEARL), a renewable energy microgrid laboratory that will allow researchers to evaluate renewable energy generation, storage, and control technologies, including fuel cells.</p>

Hawaii Plots Hydrogen Future

Hawaii is the most oil dependent state in the nation, spending about \$5 billion annually on foreign oil to meet its energy needs, and has a goal to the transition to renewable, indigenous resources for power generation to provide 100% renewable energy use by 2045.¹³ This would help to improve the state’s economy, energy security and the environment.

Hydrogen is a key fuel in the state’s clean energy strategy. In 2016, the legislature created the Hydrogen Implementation Coordinator position to facilitate establishment of infrastructure and policies across state agencies to promote the expansion of hydrogen-based energy in Hawaii.










Many demonstration projects have gotten off the ground through the work of the Hawaii Center for Advanced Transportation Technologies (HCATT).¹⁴ Managed by the state’s Hawaii Technology Development Corporation, a state agency established to facilitate the development and growth of Hawaii’s commercial high technology industry, HCATT has organized public/private partnerships between the federal government and private industry to develop electric drive advanced low emission and zero emission vehicles technologies.

HCATT has facilitated the deployment of a number of fuel cell-powered vehicles including a 30-foot shuttle bus, step van, MB-4 aircraft towing vehicle, Ford Ranger electric pick-up truck, light cart,R-12 refueling truck, and a 25-passenger crew bus, all of which have been tested at Joint Base Pearl Harbor-Hickam (JBPHH) (located near Honolulu). In 2006, HCATT introduced a modular/deployable hydrogen production and dispensing station and, in 2009, installed a 146 kW photovoltaic array to power the hydrogen station. Current hydrogen vehicles being demonstrated are an MJ-1E Weapons Loader, 25 passenger Surrey, a U-30 Heavy aircraft Tow Tractor, and a Maintenance Van with on board dispatch able power.


HCATT has also:

- Commissioned construction of a prototype electrolyzer capable of generating 3000 psi hydrogen without mechanical compression.
- Purchased a palletized hydrogen production/storage/dispensing station.
- Purchased two hydrogen light carts and two 5kW hydrogen fuel cell generators from Luxfer-GTM to introduce local customers to the advantages of hydrogen power generation.
- Converted a Low Speed Vehicle with high school students, adding a hydrogen fuel cell range extender that improves vehicle range by 400%.








Fuel Cell Manufacturers		Hydrogen Suppliers		Components/ Services Suppliers	
University H2/FC R&D		Federal RD&D Funding		State Coalitions	

Idaho	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment			
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells			
	Small Stationary Fuel Cells			


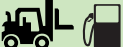
Details:

	Fuel cell backup power systems are installed at telecommunication sites in Clark Fork and Dover. Fuel cell systems are also installed at government and railroad sites to supply backup power.
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Fuel Cell Manufacturers		Hydrogen Suppliers		Components/ Services Suppliers	
University H2/FC R&D		Federal RD&D Funding		State Coalitions	

Illinois	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment	✓		
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells			
	Small Stationary Fuel Cells	✓	✓	


Details:

	Two AT&T locations use fuel cells to supply backup power. The Federal Aviation Administration utilizes fuel cells to supply power at a Remote Air/Ground Communications (RCAG) site in Marion. Fuel cells also supply backup power at a railroad site.
	Walmart operates 290 Plug Power fuel cell-powered forklifts at its Sterling distribution center. Golden State Foods has 40+ fuel cell forklifts in operation at its Lemont distribution center. Central Grocers uses 180+ Plug Power fuel cell forklifts at its Joliet distribution center. This fleet, ordered in 2014, replaced the original fleet of 234 fuel cell forklifts the company had in place since 2009. The entire fleet at this site has operated for more than two million hours.









Fuel Cell Manufacturers		Hydrogen Suppliers		Components/ Services Suppliers	✓
University H2/FC R&D	✓	Federal RD&D Funding	✓	State Coalitions	

Indiana	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment			
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells			
	Small Stationary Fuel Cells			


Details:

	AT&T utilizes fuel cells to supply reliable backup power to more than 19 cell phone towers. Fuel cells provide backup power at undisclosed government and railroad sites.
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Fuel Cell Manufacturers		Hydrogen Suppliers		Components/ Services Suppliers	
University H2/FC R&D		Federal RD&D Funding		State Coalitions	

Iowa	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment			
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells			
	Small Stationary Fuel Cells			


Details:

	Western Iowa Telecom has deployed fuel cells for backup power at undisclosed sites.
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Fuel Cell Manufacturers		Hydrogen Suppliers		Components/ Services Suppliers	
University H2/FC R&D		Federal RD&D Funding		State Coalitions	

Kansas	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment			
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells			
	Small Stationary Fuel Cells			

Details:

	<p>In 2016, a 12 kW hydrogen fuel cell was commissioned at Kansas City Power & Light's Hawthorn generation station. KCP&L utilizes the system as a backup power source for one electric vehicle and electric service cart charging at their facility.</p> <p>Fuel cells are supplying backup power at telecommunications sites.</p>
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Kansas Engineering Company Has National Hydrogen Reach

Headquartered in Overland Park, Black & Veatch (B&V) is an employee-owned, global engineering, consulting and construction company that is more than 100 years old, with more than 100 offices around the world. Listed among Forbes magazine's "500 Largest Private Companies in the United States," B&V, through its Smart Integrated Infrastructure (SII) team, is finding a groove in the site selection, development, engineering and construction of hydrogen fueling stations.

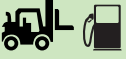

As fuel cell vehicles continue to enter the marketplace in California, the hydrogen infrastructure to support them is growing as well. Toyota, one of the automakers with a vehicle for sale, is working with both industrial gas company Air Liquide and California start-up FirstElement Fuel to develop a network of hydrogen stations in California and in the Northeast U.S. For both coasts, the companies contracted with B&V's SII team for engineering, procurement, and construction (EPC) services. Initially this included 19 hydrogen stations in California (FirstElement) and the upcoming 12 stations plus liquid hydrogen storage hubs in the Northeast (Air Liquide).

"Black & Veatch continues to achieve tremendous success in Overland Park and contribute to our state's strong economic growth. With an excellent business environment and outstanding workforce, Kansas is an ideal place for global companies to innovate, grow and create jobs." - Sam Brownback, Kansas Governor¹⁵

Fuel Cell Manufacturers		Hydrogen Suppliers		Components/ Services Suppliers	
University H2/FC R&D		Federal RD&D Funding		State Coalitions	

Kentucky	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment	✓		
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells			
	Small Stationary Fuel Cells	✓		








Details:

	Retail food chain Kroger operates more than 180 Plug Power fuel cell-powered forklifts at its Louisville distribution center.
	17 AT&T telecom sites use fuel cells to supply backup power. Fuel cells supply backup power to equipment at railroad sites.

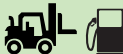

University Focused on Low-Cost Carbon Fiber Components

The University of Kentucky is receiving funding from the Department of Energy's (DOE) Fuel Cell Technologies Office on R&D to lower the cost of carbon fiber for use in high-pressure hydrogen storage tanks onboard fuel cell electric vehicles. The project focuses on developing innovative carbon fiber precursor and processing approaches. These include developing spinning processes for a low-cost and multifilament hollow TechPAN precursor fiber to meet specific tensile strength requirements and achieve a production cost of less than \$12.60/kg of carbon fiber. In addition to the potential to achieve cost and performance metrics, the approach could leverage existing capital equipment and facilities with some degree of retrofitting. In collaboration with Oak Ridge National Laboratory (ORNL) through the DOE LightMAT consortium, the University of Kentucky project is a valuable component of the FCTO portfolio and represents a well-recognized core capability to the program.








Fuel Cell Manufacturers		Hydrogen Suppliers		Components/ Services Suppliers	✓
University H2/FC R&D	✓	Federal RD&D Funding	✓	State Coalitions	

Louisiana	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment	✓		
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells			
	Small Stationary Fuel Cells	✓		

Details:

	Associated Wholesale Grocers utilizes 200+ Plug Power fuel cell-powered forklifts at its Pearl River location. Procter & Gamble operates 99 Plug Power fuel cell-powered forklifts at its Pineville site.
	Sprint uses fuel cells to supply reliable backup power at 12 telecommunication sites.








Fuel Cell Manufacturers		Hydrogen Suppliers		Components/ Services Suppliers	✓
University H2/FC R&D	✓	Federal RD&D Funding		State Coalitions	

Maine	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment			
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells			
	Small Stationary Fuel Cells			



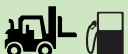
Maine's Industry Snapshot

According to the Northeast Electrochemical Energy Storage Cluster (NEESC), there are around 26 supply chain companies located in the state, involved in supplying components, fuel, materials, equipment and consulting/financial services¹⁶. Based on NEESC calculations, in 2016, those companies generated more than \$5 million in revenue and investment and contributed \$1.5 million in labor income and more than \$219,000 in state and local taxes.

Fuel Cell Manufacturers		Hydrogen Suppliers		Components/ Services Suppliers	
University H2/FC R&D		Federal RD&D Funding		State Coalitions	

Maryland	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment	✓	✓	
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells		✓	
	Small Stationary Fuel Cells		✓	

Details:

	A 1.6 MW Bloom Energy fuel cell supplies power to the National Security Agency (NSA) campus at Fort Meade.
	Fuel cells supply reliable backup power to equipment used at government sites.
	In 2017, the U.S. Postal Service placed 80+ fuel cell forklifts at a U.S. Postal Service National Distribution Center in Capitol Heights, utilizing Plug Power fuel cells. Hydrogen fueling was supplied by Nuvera. 60+ Plug Power fuel cell-powered forklifts are operating at a Whole Foods distribution center in Landover.















Algae for Fuel Cell Power

The Maryland's Port Administration's (MPA) Algal Flow-way Technology (AFT) pilot project at the Port of Baltimore is reducing nutrients in tributaries that feed the Chesapeake Bay.¹⁷







MPA, with the Maryland Environmental Service, U.S. DOT and other partners, are expanding this project to incorporate biogas generation as feedstock for a fuel cell. Instead of sending algal waste to a landfill, the project will direct harvested algae to a digester to generate biogas. The biogas will be used as a supplemental fuel to a fuel cell operating on natural gas. Electricity from the fuel cell will power the circulations pumps for the AFT.

If successful, this system will provide waterfront industries, such as ports, a sustainable method for producing electricity while improving water quality and reducing emissions.

Fuel Cell Manufacturers	✓	Hydrogen Suppliers		Components/ Services Suppliers	✓
University H2/FC R&D	✓	Federal RD&D Funding	✓	State Coalitions	

Massachusetts	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment			
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells			
	Small Stationary Fuel Cells			

Details:

	The MOR-EV Program provides a \$2,500 rebate for the purchase or lease of FCVs. Once hydrogen stations come online, the greater Boston and New York City areas will see the introduction of FCVs.
	Toyota and Air Liquide are developing four hydrogen stations in Massachusetts, including stations to be located in Braintree and Mansfield. The stations will be part of a northeast states hydrogen fueling corridor. Air Liquide will locate a hydrogen distribution hub in Massachusetts for delivery of hydrogen.
	Whole Foods Market (Dedham) uses a Doosan Fuel Cell America fuel cell system to supply power to the store. Waste energy from the fuel cell is captured and used for local cooling and heating.
	Fuel cells supply backup power at undisclosed telecommunication equipment sites.
	Foodservice distributor Sysco operates 198 Plug Power fuel cell forklifts at its Plympton distribution center. Wine and spirits distributor Martignetti operates fuel cell forklifts using Nuvera Fuel Cells' systems at its Taunton distribution facility.
	In February, a fuel cell bus joined the Massachusetts Bay Transit Authority (MBTA) fleet as part of a FTA-sponsored project. Billerica, Massachusetts, company Nuvera provided a hydrogen fueling station.











Hydrogen Fueling/EV Charging Project Using Solar Power

In February 2017, the state announced funding, awarded through the Massachusetts Clean Energy Center's (MassCEC) InnovateMass program, to support early-stage clean energy, water technology and energy storage innovations.¹⁸



One project award (\$150,000) supports a project by Ivys Energy Solutions (Waltham) to develop combined battery-electric and fuel cell vehicle fueling infrastructure integrated with a solar-based energy storage system.

Ivys was also part of the winning team, SimpleFuel, claiming DOE's \$1 million H-Prize for a small-scale hydrogen fueller with fellow Massachusetts company, McPhy. The other member was PDC Machines from Pennsylvania.

Fuel Cell Manufacturers		Hydrogen Suppliers		Components/ Services Suppliers	
University H2/FC R&D		Federal RD&D Funding		State Coalitions	

Michigan	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment			
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells			
	Small Stationary Fuel Cells			








Details:

	<p>A fuel cell system supplies power at the Lansing Board of Water and Light's REO Town Headquarters and Cogeneration Plant.</p> <p>A fuel cell system provides backup power to the Lansing/Ingham County E911 emergency communications system serving the City of Lansing and Ingham County.</p> <p>AT&T utilizes fuel cells to provide backup power at 59 sites.</p>
	<p>Flint Mass Transportation Authority leased a fuel cell bus in 2012 and installed a hydrogen fueling station at its alternative fuel facility in Grand Blanc township.</p>



New Manufacturing Grows Jobs

In June 2017, General Motors and Honda announced they are investing a combined \$85 million in investment to expand their fuel cell partnership into a new manufacturing venture, Fuel Cell Systems Manufacturing LLC, located in Brownstown Township.¹⁹ Manufacturing will start in 2020. The plant is expected to create 100 jobs.

Fuel Cell Manufacturers		Hydrogen Suppliers		Components/ Services Suppliers	
University H2/FC R&D		Federal RD&D Funding		State Coalitions	

Minnesota	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment	✓		
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells			
	Small Stationary Fuel Cells		✓	









Details:

	Walmart has operated Plug Power fuel cell-powered forklifts at its Mankato cold storage distribution center.
	The state has fuel cell systems installed at various government communications sites to provide backup power in the case of weather or other outages to the grid or communication lines.


Legislative-Citizens Commission Awards Hydrogen R&D Funding

In 2016, the Legislative-Citizens Commission on Minnesota Resources (LCCMR), through the Environment and Natural Resources Trust Fund, awarded \$250,000 to a University of Minnesota project proposal - “Clean Vehicles Fueled by Hydrogen from Renewable Ammonia.”²⁰ The LCCMR, which is made up of 17 members (5 Senators, 5 Representatives, 5 citizens appointed by the governor, 1 citizen appointed by the Senate, and 1 citizen appointed by the House), makes funding recommendations to the legislature for special environment and natural resource projects.








Fuel Cell Manufacturers		Hydrogen Suppliers		Components/ Services Suppliers	✓
University H2/FC R&D	✓	Federal RD&D Funding	✓	State Coalitions	

Mississippi	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment			
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells			
	Small Stationary Fuel Cells			


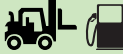
Details:

	Fuel cells provide backup power to telecommunications sites.
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Fuel Cell Manufacturers		Hydrogen Suppliers		Components/ Services Suppliers	
University H2/FC R&D		Federal RD&D Funding		State Coalitions	

Missouri	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment	✓	✓	
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells			
	Small Stationary Fuel Cells	✓	✓	









Details:

	<p>A fuel cell provides backup power to remote FAA transmitter/receiver (RTR) equipment.</p> <p>Fuel cells provide backup power to undisclosed telecommunications and railroad sites.</p>
	<p>Associated Wholesale Grocers operates 297 forklifts using fuel cells from Plug Power at its Kansas City site.</p> <p>FedEx Freight East in Springfield converted fleet of 35 class-1 electric lift trucks to fuel cell power in 2010. DOE awarded \$1.3 million in Recovery Act funds. The site's hydrogen fueling infrastructure includes two indoor fueling dispensers and an outdoor hydrogen dispenser to support the testing of a fuel cell powered Class 8 truck.</p>


University Research Secures DOE Funding, Local Collaboration

In 2016, the University of Missouri, St. Louis was awarded \$500,000 from the U.S. Department of Energy (DOE) for a three year project within DOE's Energy Materials Network Hydrogen Materials—Advanced Research Consortium (HyMARC).²¹ The University is partnering with both Washington University in St. Louis and Saint Louis University on “Fundamental Studies of Surface Functionalized Mesoporous Carbons for Thermodynamic Stabilization and Reversibility of Metal Hydrides.”








Fuel Cell Manufacturers		Hydrogen Suppliers		Components/ Services Suppliers	✓
University H2/FC R&D	✓	Federal RD&D Funding	✓	State Coalitions	

Montana	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment			
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells			
	Small Stationary Fuel Cells			



Details:

	Fuel cell systems supply backup power to government communications networks.
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Fuel Cell Manufacturers		Hydrogen Suppliers		Components/ Services Suppliers	
University H2/FC R&D		Federal RD&D Funding		State Coalitions	

Nebraska	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment			
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells	✓		
	Small Stationary Fuel Cells		✓	

Details:









	First National Bank of Omaha (FNBO) has operated one of the longest running fuel cell systems in the U.S. First installed in 1999, the bank upgraded to a next generation 400-kW Doosan Fuel Cell America fuel cell system in 2013. FNBO was the first data center in the world to generate power using fuel cells.
	A fuel cell powers a FAA Airport Traffic Control Tower in Grand Island.

125 MW of Hydrogen-Powered Energy

The state's largest electric utility, Nebraska Public Power District (NPPD), is converting one of two boilers at Sheldon Station, near Hallam, to burn hydrogen instead of coal.²² When burned, hydrogen fuel produces no GHG emissions, which will reduce air emissions from Unit 2 by about 1 million metric tons of CO₂ annually. The hydrogen-fueled boiler will continue to be capable of generating 125 MW of electricity for NPPD customers. Hydrogen for the boiler will be produced as a co-product from the production of carbon black using natural gas as a feedstock. Monolith Material has begun developing the Hallum carbon black plant and anticipates that the boiler's conversion to hydrogen will begin in 2020.

Nebraska is also home to one of the largest developers and manufacturers of carbon-fiber composite tanks, Hexagon Lincoln, a subsidiary of Hexagon Composites. The company has received DOE FCTO funding and is now manufacturing and exporting tank systems originally developed for hydrogen and now being used for natural gas.









Fuel Cell Manufacturers		Hydrogen Suppliers		Components/ Services Suppliers	✓
University H ₂ /FC R&D	✓	Federal RD&D Funding	✓	State Coalitions	

Nevada	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment			
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells			
	Small Stationary Fuel Cells			


Details:

	Fuel cells provide backup power to telecommunications sites.
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Fuel Cell Manufacturers		Hydrogen Suppliers		Components/ Services Suppliers	
University H2/FC R&D		Federal RD&D Funding		State Coalitions	

New Hampshire	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment			
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells			
	Small Stationary Fuel Cells			








Details:

	Remotely-sited fuel cell systems power LIDAR wind measurement instruments that collect data for wind energy farms.
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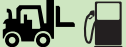
New Hampshire's Industry Snapshot

According to the Northeast Electrochemical Energy Storage Cluster (NEESC), there are around 26 supply chain companies located in the state, involved in supplying components, fuel, materials, equipment and consulting/financial services²³. Based on NEESC calculations, in 2016, those companies generated more than \$14.8 million in revenue and investment and contributed \$5.4 million in labor income and more than \$699,000 in state and local taxes.

Fuel Cell Manufacturers		Hydrogen Suppliers		Components/ Services Suppliers	
University H2/FC R&D		Federal RD&D Funding		State Coalitions	

New Jersey	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment	✓		
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells	✓		✓
	Small Stationary Fuel Cells	✓	✓	

Details:








	Toyota and Air Liquide are developing two hydrogen stations in northern New Jersey that will be part of a northeast states hydrogen fueling corridor.
	New Jersey boasts multiple fuel cell installations, including: AT&T – 2 MW in Middletown, 600 kW in Freehold, and 700 kW in Trenton Verizon – 2 MW at Basking Ridge headquarters Walmart – Mays Landing, Washington Township, Williamstown, Woodbury retail stores
	There are fuel cells installed at telecommunications sites across the state. A fuel cell powers an FAA Remote Transmitter Receiver (RTR) in Teterboro.
	Wakefern Food operates 181 Plug Power fuel cell-powered forklifts at the Newark Farmers Market. FreezPak Logistics operates 25 Plug Power fuel cell forklifts at its new cold storage distribution center freezer warehouse in Cateret.

New Jersey Funding for Microgrid Feasibility Studies

New Jersey communities have suffered significant damages from major storms and weather events. In early 2017, the New Jersey Board of Public Utilities (BPU) authorized the opening of an application period for Town Center distributed energy resources (DER) microgrid feasibility studies, part of an effort to improve New Jersey's energy resiliency and emergency preparedness and response of utility companies. Applicants were limited to local government entities or state agencies which own or manage critical facilities.

In July, the BPU approved Clean Energy Program funding for 13 town center microgrid feasibility studies.²⁴ Three of the studies (Galloway Township, Highland Park, Hudson County) include fuel cells in their evaluation of commercial technologies that could be used to power town halls and other government buildings, police and fire stations, schools, medical facilities, senior centers, and other critical facilities. The studies will be completed in 12 months.

Fuel Cell Manufacturers		Hydrogen Suppliers	✓	Components/ Services Suppliers	✓
University H2/FC R&D	✓	Federal RD&D Funding	✓	State Coalitions	✓

New Mexico	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment			
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells			
	Small Stationary Fuel Cells			








Albuquerque Start-Up Attracting Federal Investment and International Attention

In Albuquerque, venture-backed start-up company Pajarito Powder is amassing a sizeable collection of funding and partnerships. Since being founded in 2012, the company now has 17 employees and growing. The company is selling its products to automobile manufacturers, fuel cell stack companies, and MEA suppliers worldwide.




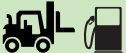
Specializing in precious metal-free catalysts and Engineered Catalyst Supports for both fuel cells and more recently, electrolyzers, the company has nearly 50 U.S. and international patents, both issued and pending, many developed in conjunction with leading U.S. universities and national laboratories, and with the support of the U.S. Department of Energy. Pajarito has been awarded more than \$3 million from the U.S. Department of Energy via several programs, including the Advanced Research Projects Agency-Energy (ARPA-E), Small Business Vouchers Pilot, and Small Business and Innovation Research (SBIR) Grants to further develop and expand its technology.

Additionally, Pajarito Powder has licensed or optioned intellectual property from Los Alamos National Laboratory, the University of New Mexico, and Institut National de la Recherche Scientifique (INRS) in Québec City, Canada.

Fuel Cell Manufacturers		Hydrogen Suppliers		Components/ Services Suppliers	
University H2/FC R&D		Federal RD&D Funding		State Coalitions	

New York	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			✓
	Hydrogen Stations	✓		
	Fuel Cell Buses			
	Material Handling Equipment	✓		
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells	✓	✓	✓
	Small Stationary Fuel Cells	✓	✓	

Details:

	Toyota and Air Liquide are developing four hydrogen stations in New York, and have announced the location of three stations –Brooklyn, the Bronx and Hempstead.
	More than 15 MW of large stationary fuel cells located at retail businesses (including 10 Home Depot stores), corporate buildings, production facilities, residential buildings, the World Trade Center and New York City Hall.
	The FAA uses fuel cell to power Remote Air/Ground Communications (RCAG) equipment in Rockdale. Fuel cells are deployed to provide backup power to telecommunications and railroad sites in the state.
	Fuel cell-powered forklifts are in operation at several distribution centers: Baldor Foods (Bronx), CVS (Chemung), Walmart (263 units - Johnstown) and Sysco (Long Island).

Brooklyn's Marcus Garvey Microgrid

In June 2017, New York State Homes and Community Renewal and the New York State Energy Research and Development Authority (NYSERDA) announced the completion of a \$190 million renovation at the Marcus Garvey Apartments in Brownsville, Brooklyn.²⁵ The 32-building apartment complex was constructed in 1974 and spans 10 city blocks.








The renovation includes construction of a microgrid that will reduce power consumption by managing the generation and storage of renewable energy. The microgrid includes a 400 kW solar array, located on 21 rooftops; a 400 kW fuel cell; and a 300 kW lithium battery, which stores excess energy generated by the solar panels and fuel cell for later use. Savings realized from the microgrid will be for more social services and programs for residents.

State University Enables University/Industry Partnerships





The New York State Center of Excellence in Materials Informatics (CMI), at the University at Buffalo, is spurring economic development by connecting private industry with material scientists making research breakthroughs. CMI focuses on several key areas to advance material science and Western New York's economy, including advanced manufacturing (such as nanomaterials, graphene and ceramics) and clean energy (such as rare earth elements and fuel cell technologies).

In January 2017, CMI announced several funding awards to university researcher/industry partnerships, with one award (\$27,000) going to Dr. Gang Wu, assistant professor in the Department of Chemical and Biological Engineering at the University at Buffalo, who is working with industry collaborator Bettergy Corporation of Peekskill, New York, to develop novel materials for fuel cell applications with greatly enhanced corrosion resistance.²⁶









Fuel Cell Manufacturers	✓	Hydrogen Suppliers		Components/Services Suppliers	✓
University H2/FC R&D	✓	Federal RD&D Funding	✓	State Coalitions	

North Carolina	Category	Commercial Deployments	Government Deployments	Initiatives/Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment	✓		
	Other Fuel Cell Vehicles		✓	
	Large Stationary Fuel Cells	✓		
	Small Stationary Fuel Cells	✓	✓	


Details:

	In 2013, Apple installed a 10 MW fuel cell system to power its Maiden data center. This is one of the largest fuel cell site deployments in the U.S.
	Fuel cells are providing back up power to a number of FAA sites in the state, including remote transmitter/receivers (RTR) in Asheville and Remote Communications Air/Ground (RCAG) in Hickory.
	Fuel cells are also providing backup power at undisclosed railroad and telecommunications sites. Coca-Cola has 40 Plug Power fuel cell-powered forklifts operating at its Charlotte bottling facility.
	Procter & Gamble operates 148 Plug Power fuel cell-powered forklifts at its Greensboro facility. The fuel cell-powered Chevy Colorado ZH2 prototype, developed by GM and the Army's Tank Automotive Research, Development and Engineering Center (TARDEC), will be tested at Fort Bragg in 2017.








Fuel Cell Manufacturers	✓	Hydrogen Suppliers		Components/Services Suppliers	✓
University H2/FC R&D	✓	Federal RD&D Funding		State Coalitions	

North Dakota	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment			
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells			
	Small Stationary Fuel Cells			


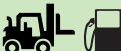

Details:

	A fuel cell currently provides backup power to remote FAA communications air/ground (RCAG) equipment.
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Fuel Cell Manufacturers		Hydrogen Suppliers		Components/ Services Suppliers	
University H2/FC R&D		Federal RD&D Funding		State Coalitions	

Ohio	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses		✓	✓
	Material Handling Equipment	✓		
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells			
	Small Stationary Fuel Cells	✓	✓	

Details:

	Fuel cells provide backup power to undisclosed government, railroad and telecommunications sites across the state.
	There are several fuel cell forklift deployments in Ohio. Honda operates 51 at its Marysville manufacturing facility; The Home Depot has 177 at its Troy Township distribution center; and Ace Hardware has 35 fuel cell reach trucks, 36 fuel cell pallet jacks, and a fuel cell-powered floor scrubber at its West Jefferson retail support center. All are using Plug Power fuel cells.
	By 2018, the Stark Area Regional Transit Authority (SARTA) in Canton will have the second largest fuel cell bus fleet in the nation. Ten buses will join the fleet in 2017 and 2018. The first bus debuted in March 2017 and will operate at Ohio State University.








SARTA's Fuel Cell Bus Fleet Attracts Federal and State Funding

To support deployment of its fuel cell bus fleet, SARTA received several grants from both the Federal Transit Administration's National Fuel Cell Bus and LoNo Programs. In addition, the state, through the Ohio Diesel Emission Reduction Grant Program, awarded SARTA \$1 million towards its fuel cell bus fleet and the Ohio Department of Transportation is providing a \$500,000 grant for a hydrogen fueling station that will use delivered hydrogen.

Ohio Key to Industry Supply Chain

Ohio is home to a large cluster of fuel cell and hydrogen supply chain companies. The Ohio Fuel Cell Coalition (OFCC) includes a broad group of stakeholders representing solid oxide and other fuel cell technologies. The OFCC was competitively selected by FCTO to be a regional center to enable a domestic supply chain and hold supplier-integrator events every year.

Fuel Cell Manufacturers	✓	Hydrogen Suppliers		Components/ Services Suppliers	✓
University H2/FC R&D	✓	Federal RD&D Funding	✓	State Coalitions	✓

Oklahoma	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment			
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells			
	Small Stationary Fuel Cells			









Oklahoma's Nascent Fuel Cell and Hydrogen Industry Growing

Luxfer-GTM Technologies (LGTM), based in San Francisco, California, also has a 20,000 sq. ft. facility in Port of Catoosa, Oklahoma, that is home to 30 employees. A growing part of LGTM's business is focused on hydrogen and fuel cell applications. The company develops hydrogen storage and transport equipment, including mobile hydrogen fuelers, as well as the Zero-Set line of portable, zero-emission, zero-noise power generators and light towers.


LGTM is planning on installing a liquid hydrogen storage system at its Port of Catoosa facility to not only fill its own equipment, but to support new fuel cell customers in the state.

Also in Oklahoma, scientists and engineers at the Phillips 66 Research Center in Bartlesville are working on developing a new generation of solid oxide fuel cells (SOFC) that run on natural gas.








Fuel Cell Manufacturers		Hydrogen Suppliers		Components/ Services Suppliers	
University H2/FC R&D		Federal RD&D Funding		State Coalitions	

Oregon	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment			
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells			
	Small Stationary Fuel Cells			



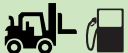
Details:

	There are fuel cells installed for backup power at various Federal Aviation Administration sites in the state.
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Fuel Cell Manufacturers		Hydrogen Suppliers		Components/ Services Suppliers	
University H2/FC R&D		Federal RD&D Funding		State Coalitions	

Pennsylvania	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			✓
	Hydrogen Stations			✓
	Fuel Cell Buses			
	Material Handling Equipment	✓		
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells	✓		✓
	Small Stationary Fuel Cells	✓	✓	

Details:

	<p>URBN (formerly Urban Outfitters) installed a 600-kW Bloom Energy server in 2012 to supply 60% of the electricity needed at its main campus in Philadelphia. The fuel cell reduces CO₂ emissions by an estimated 5,100,000 lbs. per year.</p> <p>A TJX Distribution Center in Philadelphia was awarded \$2 million by the state's Alternative and Clean Energy Program for a 750-kW fuel cell system.</p>
	<p>Fuel cells are installed at sites across the state to provide reliable back up power. These include the Society of Cable Telecommunications Engineers (SCTE) in Exton, a Communication Infrastructure Corp. (CIC) remote microwave relay site, oil and gas exploration equipment at Marcellus pipeline Cathodic Protection stations, and undisclosed government and railroad equipment sites.</p>
	<p>Fuel cell-powered material handling vehicles are in operation across the state. This includes Procter & Gamble (140, Mehoopany), Deitz & Watson (Philadelphia), Sysco (120, Philadelphia), and Wegman's (136, Pottsville) sites. All are using Plug Power fuel cells.</p>

Warminster Company Wins \$1 Million DOE Prize

PDC Machines, based in Warminster, is part of the \$1 million winning team in the U.S. Department of Energy's H2 Refuel H-Prize Competition.²⁷ PDC joined with Ivys Energy Solutions and McPhy Energy, both Massachusetts companies, to form SimpleFuel.








The team developed an on-site hydrogen generation system that could be used to fuel hydrogen vehicles.

Family-owned and operated, PDC Machines has been in business since 1977. The company has more than 60 employees in two facilities that encompass more than 60,000 square feet of manufacturing space.


"I am pleased that PDC Machines of Warminster – as part of the collaborative group, SimpleFuel - has been named as a winner of the Department of Energy's H2 Refuel H-Prize Competition. Investment in energy innovation is critical to powering our country and reducing our reliance on fuels of the past. I am proud that Bucks County-based businesses are set to play a leading role in this important field."

- Congressman Brian Fitzpatrick (PA-08)²⁸

Fuel Cell Manufacturers		Hydrogen Suppliers	✓	Components/ Services Suppliers	✓
University H2/FC R&D	✓	Federal RD&D Funding	✓	State Coalitions	

Rhode Island	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations	✓		
	Fuel Cell Buses			
	Material Handling Equipment			
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells			
	Small Stationary Fuel Cells			








Details:

	Toyota and Air Liquide are developing a hydrogen stations in Rhode Island, which will be part of a northeast states hydrogen fueling corridor.
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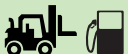
Rhode Island's Industry Snapshot

According to the Northeast Electrochemical Energy Storage Cluster (NEESC), there are around 26 supply chain companies located in the state, involved in supplying components, fuel, materials, equipment and consulting/financial services²⁹. Based on NEESC calculations, in 2016, those companies generated more than \$13 million in revenue and investment and contributed \$3.5 million in labor income and more than \$509,000 in state and local taxes.








Fuel Cell Manufacturers		Hydrogen Suppliers		Components/ Services Suppliers	✓
University H2/FC R&D	✓	Federal RD&D Funding		State Coalitions	

South Carolina	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment	✓		
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells			
	Small Stationary Fuel Cells	✓		








Details:

	Fuel cells are installed at ten Sprint telecommunications tower sites across the state as well as at railroad equipment sites.
	At the Sage Mill Industrial Park in Aiken, a private hydrogen fueling station is used by tenant Bridgestone-Firestone to fuel its fuel cell-powered forklifts, and by the nearby Center for Hydrogen Research's to fuel its hydrogen-powered vehicles.
	Fuel cell-powered material handling vehicles are in operation in Graniteville at Bridgestone-Firestone (43 forklifts) and Spartanburg at a BMW manufacturing plant (275 forklifts, tuggers and stackers). Both companies are using Plug Power fuel cells.




Fuel Cell Manufacturers		Hydrogen Suppliers		Components/ Services Suppliers	✓
University H2/FC R&D	✓	Federal RD&D Funding	✓	State Coalitions	

South Dakota	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment			
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells			
	Small Stationary Fuel Cells			

Fuel Cell Manufacturers		Hydrogen Suppliers		Components/ Services Suppliers	
University H2/FC R&D		Federal RD&D Funding		State Coalitions	

Tennessee	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment	✓		
	Other Fuel Cell Vehicles	✓		
	Large Stationary Fuel Cells			
	Small Stationary Fuel Cells	✓		

Details:








	Fuel cells are providing backup power to telecommunications and railroad sites in the state.
	<p>Forklifts using Plug Power forklifts are currently in operation at:</p> <ul style="list-style-type: none"> • Volkswagen – 46 at its Chattanooga manufacturing facility • Bridgestone-Firestone – 69 at its Morrison site <p>Lowe's will deploy fuel cell forklifts at its new direct fulfillment center in Coopertown.</p>
	<p>FedEx Express operates 10 fuel cell-powered baggage tow tractors at Memphis Airport as part of a two-year DOE trial.</p> <p>FedEx Express is also developing 20 fuel cell-powered delivery trucks and will demonstrate them in Memphis and in California.</p>

Fuel Cell Vehicles Help Spotlight Memphis Airport




In June 2017, the Tennessee Department of Environment and Conservation, Tennessee Department of Transportation, and Tennessee Clean Fuels celebrated Clean Air month showcasing sustainable transportation, including the fuel cell-powered ground support equipment (GSE) that FedEx is operating at the Memphis International Airport.

DOE launched a two-year demonstration of 15 fuel cell-powered cargo tractors at the Federal Express facility at Memphis International Airport with partners Plug Power (New York) and Charlotte America (Virginia).³⁰ The vehicles are more than twice as efficient as diesel tow tractors (45% compared to 20%), which saves more than 85,000 gallons of fuel per year, and also help reduce the airport's carbon dioxide emissions by more than 1,700 metric tons.

Fuel Cell Manufacturers		Hydrogen Suppliers	✓	Components/ Services Suppliers	✓
University H2/FC R&D	✓	Federal RD&D Funding	✓	State Coalitions	

Texas	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/ Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment	✓		
	Other Fuel Cell Vehicles		✓	
	Large Stationary Fuel Cells			
	Small Stationary Fuel Cells	✓	✓	

Details:

	<p>Fuel cells are installed at telecommunications sites around the state to provide backup power to industry and first responder networks. This includes Chappell Hill, Brenham, Burton, Irving, and Ledbetter.</p> <p>The Federal Aviation Administration has a fuel cell powering a Remote Transmitter/ Receiver (RTR) in Big Spring.</p> <p>Fuel cells are powering wellhead sites in Barnett and multiple locations in North Texas and also powering multi-well pads at a Cathodic Protection bed in East Texas.</p>
	<p>Fuel cell-powered forklifts are in operation at several facilities around the state, including:</p> <ul style="list-style-type: none"> • Nestlé Waters – 32 in Dallas bottling facility • Sysco – 102 at Houston distribution center and 110 in San Antonio distribution center • H-E-B Grocers – 14 at a Perishables Distribution Center in San Antonio. • Ace Hardware – 65 at its Wilmer Retail Support Center
	H-E-B Grocers is participating in a U.S. Department of Energy project to demonstrate a fuel cell refrigerated transport unit for tractor trailers.

Hydrogen Headquarters












Air Liquide has its U.S. corporate headquarters in Houston and recently commissioned the largest hydrogen storage facility in the world, an underground cavern in Beaumont.

Shell has its U.S. corporate headquarters in Houston.




Both companies are involved in developing the hydrogen fueling network in California and around the world. Air Liquide is working with Toyota on expanding that network to the Northeast U.S.

Toyota recently moved its U.S. corporate headquarters to Plano and also has a manufacturing plant in San Antonio.

Fuel Cell Manufacturers		Hydrogen Suppliers	✓	Components/ Services Suppliers	✓
University H2/FC R&D	✓	Federal RD&D Funding	✓	State Coalitions	✓

Utah	Category	Commercial Deployments	Government Deployments	Initiatives/Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment			
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells			
	Small Stationary Fuel Cells			









Details:

	eBay now has 9.75 MW of Bloom Energy fuel cells installed at its South Jordan data center, adding 3.75 MW in 2015 to its existing 6 MW installation. The fuel cell system is grid-tied, with the electric grid serving as backup power.
	AT&T has nine fuel cells installed at telecommunications sites in the state to provide backup power. There are also fuel cells at undisclosed government and railroad equipment sites.
	Nikola Motor Company, based in Salt Lake City, is developing prototype fuel cell-powered Class-8 trucks, with plans to road test the vehicles in 2018-2021 and to build the first 5,000 trucks in 2020-2021. Nikola also plans to develop a network of hydrogen fueling stations in the U.S. and Canada to fuel the trucks and will generate hydrogen by solar electrolysis.


Hydrogen Bill

In March 2017, Utah's governor signed a bill providing potential incentives for the production of hydrogen fuel. The bill expands the uses for money in the Community Impact Fund to include a plant for the production of hydrogen fuel for zero emission motor vehicles or a plant for the manufacture of zero emission hydrogen fueled trucks; and provides for an oil and gas severance tax credit for a taxpayer that produces natural gas for use in the production of hydrogen fuel for zero emission motor vehicles.

Fuel Cell Manufacturers		Hydrogen Suppliers		Components/Services Suppliers	
University H2/FC R&D		Federal RD&D Funding		State Coalitions	

Vermont	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment			
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells			
	Small Stationary Fuel Cells			








Details:

	There are fuel cell systems providing backup power to government communications networks in the state.
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Vermont's Industry Snapshot

According to the Northeast Electrochemical Energy Storage Cluster (NEESC), there are around 26 supply chain companies located in the state, involved in supplying components, fuel, materials, equipment and consulting/financial services³¹. Based on NEESC calculations, in 2016, those companies generated more than \$4.9 million in revenue and investment and contributed \$1.6 million in labor income and more than \$275,000 in state and local taxes.










Fuel Cell Manufacturers		Hydrogen Suppliers		Components/ Services Suppliers	
University H2/FC R&D		Federal RD&D Funding		State Coalitions	

Virginia	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment	✓		
	Other Fuel Cell Vehicles	✓		
	Large Stationary Fuel Cells	✓		
	Small Stationary Fuel Cells	✓	✓	


Details:

	Washington Gas installed a 200-kW Bloom Energy fuel cell system in 2011 to provide approximately 35% of its Springfield facility's baseload power.
	Fuel cells are providing back up power to an FAA Air Traffic Control Tower in Manassas as well as equipment at an undisclosed railroad site.
	Sysco operates 112 Plug Power fuel cell forklifts at its Front Royal Northeast Co-op redistribution facility.
	Stihl, Inc. has 75 fuel cell-powered forklifts in operation at its Norfolk warehouse.
	The fuel cell-powered Chevy Colorado ZH2 prototype, developed by GM and the Army's Tank Automotive Research, Development and Engineering Center (TARDEC), will be tested at Quantico in 2017.

Fuel Cell Manufacturers		Hydrogen Suppliers		Components/ Services Suppliers	✓
University H2/FC R&D	✓	Federal RD&D Funding	✓	State Coalitions	

Washington	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment			
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells			
	Small Stationary Fuel Cells			









Details:

	Fuel cells are providing backup power to government, telecommunications, and railroad sites in the state, including 15 of the Washington State Patrol's network radio towers.
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Microsoft Developing Fuel Cell Lab

In September 2016, Microsoft was awarded funding by the Washington State Department of Commerce's Clean Energy Fund to develop a fuel cell data center lab at the McKinstry Seattle Innovation Center.³² The lab will test and demonstrate highly efficient distributed fuel cell systems to power data centers and accelerate development of distributed fuel cell technology.

Fuel Cell Manufacturers		Hydrogen Suppliers		Components/ Services Suppliers	
University H2/FC R&D		Federal RD&D Funding		State Coalitions	

West Virginia	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment			
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells			
	Small Stationary Fuel Cells			








Details:

	Fuel cells are deployed to power equipment at Marcellus wellhead sites as well as railroad network equipment in the state.
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West Virginia University Research Garner Federal Support

West Virginia University has been the recipient of several recent early stage hydrogen and fuel cell R&D awards from the U.S. Department of Energy, through both the Office of Fossil Energy's Solid Oxide Fuel Cell (SOFC) Program and the Advanced Research Projects Agency-Energy (ARPA-E). WVU has received almost \$1 million for SOFC work, and \$1.25 million through ARPA-E's Renewable Energy to Fuels through Utilization of Energy-Dense Liquids (REFUEL) program to develop cutting-edge technology to synthesize ammonia from hydrogen and nitrogen using microwave plasma catalysis.









Fuel Cell Manufacturers		Hydrogen Suppliers		Components/ Services Suppliers	
University H2/FC R&D		Federal RD&D Funding		State Coalitions	

Wisconsin	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment	✓		
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells			
	Small Stationary Fuel Cells	✓	✓	


Details:

	Fuel cells are providing backup power to a variety of sites in the state, including an FAA site in Milwaukee, a Cellcom off-grid site, and telecommunications and government network locations.
	Uline, in Pleasant Prairie, uses Plug Power fuel cells to power its entire fleet, which consists of 130+ forklifts operating at two separate warehouses on the site. Each building houses four hydrogen fueling dispensers, for a total of eight hydrogen fueling pumps.

Fuel Cell Manufacturers		Hydrogen Suppliers		Components/ Services Suppliers	✓
University H2/FC R&D	✓	Federal RD&D Funding		State Coalitions	

Wyoming	Category	Commercial Deployments	Government Deployments	Initiatives/ Incentives/Funding
	Fuel Cell Vehicles			
	Hydrogen Stations			
	Fuel Cell Buses			
	Material Handling Equipment			
	Other Fuel Cell Vehicles			
	Large Stationary Fuel Cells			
	Small Stationary Fuel Cells			

Details:

	Fuel cells are providing backup power to FAA sites in Casper (remote communications air/ground (RCAG) equipment) and Cheyenne (Radio Communications Link Repeater (RCLR) equipment).
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Data Center Project Proved Biogas Feasibility

A project at the Dry Creek Water Reclamation Facility used the renewable biogas generated there to power a FuelCell Energy fuel cell that in turned provided carbon-neutral electricity to power a Microsoft datacenter in Cheyenne.³³ Microsoft was able to demonstrate the effectiveness of using fuel cells to efficiently use on-site biogas to power future sustainable data centers. Organizations involved in project included the Cheyenne Board of Public Utilities, Cheyenne Light, Fuel and Power Company, Western Research Institute, the University of Wyoming, the Wyoming Business Council, Siemens, and Cheyenne LEADS, the economic development organization for Cheyenne and Laramie County, Wyoming.

Fuel Cell Manufacturers		Hydrogen Suppliers		Components/ Services Suppliers	
University H2/FC R&D		Federal RD&D Funding		State Coalitions	

Beyond the States: U.S. Territories and the District of Columbia

Fuel cell activity goes beyond states, with the District of Columbia and U.S. territories adding fuel cells to their policies (such as Renewable Portfolio Standard, net metering rules, and/or interconnection standards). Puerto Rico also offers funding support to attract industry and installations.

Fuel Cell & Hydrogen Policies/Funding/Installations in U.S. Territories and the District of Columbia			
District or Territory	Policies	Funding Incentives	Installations
District of Columbia	X		Private hydrogen station on National Park Service property
Guam	X		
N. Mariana Islands	X		
Puerto Rico	X	Industry recruitment & support Renewable energy development	
Information on policies/incentives gathered from DSIRE (Database of State Incentives for Renewables & Efficiency) website - accessed on 8/7/ 2017.			

Appendix: Federal Funding Awards

The following chart outlines funding programs from the U.S. Department of Energy and other agencies that have been awarded since the 2016 State of the States report.

DOE includes fuel cell and hydrogen funding in its Office of Energy Efficiency and Renewable Energy (EERE) Fuel Cell Technologies Office (FCTO), its Office of Fossil Energy (FE), Office of Basic Energy Science (BES) and the Advanced Research Projects Agency-Energy (ARPA-E).

DOE also provides funding through the Small Business Innovation Research (SBIR)/ Small Business Technology Transfer (STTR) program, which other agencies, such as the National Science Foundation (NSF), National Aeronautics and Space Administration (NASA) and branches of the military, also use to fund fuel cell and hydrogen research projects.

FEDERAL FUNDING AWARDS | August 2016 – July 2017

Alabama

City	Company	Amount	Program	Project
Auburn	Auburn University	\$0.171 million	U.S. DOE/FE SOFC Program - SOFC Core Technology Funding Award	Chromium Vapor Sensor for Monitoring SOFC Systems

Arizona

City	Company	Amount	Program	Project
Tempe	Arizona State University	\$0.16 million	DOE/EERE HydroGEN – Durable, HighPerformance Materials and Interfaces for Advanced Water Splitting – Solar Thermochemical H ₂ Production	Mixed Ionic Electronic Conducting Quaternary Perovskites: Materials by Design for Solar Thermochemical Hydrogen

California

City	Company	Amount	Program	Project
Berkeley	Opus 12	\$0.2 million	U.S. DOE/EERE Small Business Vouchers Pilot, Round 2	Computational Model of the Co-Electrolysis of Carbon Dioxide and Water to Make Syngas - Lawrence Berkeley National Laboratory
		\$1.9 million	ARPA-E REFUEL Program Award	Renewable Electricity-Powered Carbon Dioxide Conversion to Ethanol for Storage and Transportation
Berkeley	University of California, Berkeley	\$0.25 million	DOE/EERE HyMARC - Hydrogen Storage Materials Discovery	Super Metallated Frameworks as Hydrogen Sponges
Folsom	Alteryx Systems, Inc.	\$0.1 million	U.S. DOE/EERE Small Business Vouchers Pilot, Round 2	Evaluation and Cost Modeling of Membrane Electrode Assembly Manufacturing Processes - National Renewable Energy Laboratory
Fremont	Oorja Fuel Cells	\$0.1 million	U.S. DOE/EERE Small Business Vouchers Pilot, Round 2	Testing New Nanowire Catalysts with Methanol-Based Fuel Cells - National Renewable Energy Laboratory
Pasadena	SAFCel	\$3 million	ARPA-E REFUEL Program Award	Distributed Electrochemical Production and Conversion of Carbon-Neutral Ammonia
San Diego	General Engineering & Research, L.L.C	\$1 million	U.S. DOE/EERE FY2017 STTR Phase II, Release 2	Low Cost Alloys for Magnetocaloric Refrigeration
San Jose	PolarOnyx, Inc.	\$0.99 million	U.S. DOE/BES FY2017 SBIR Phase II, Release 1	Direct 3D femtosecond laser manufacturing of SOFC
Stanford	Stanford University	\$0.22 million	DOE/EERE HydroGEN - Durable, HighPerformance Materials and Interfaces for Advanced Water Splitting - Photoelectrochemical	Protective Catalyst Systems on III-V and Si-based Semiconductors for Efficient, Durable Photoelectrochemical Water Splitting Devices
Torrance	Physical Optics Corporation	\$0.15 million	U.S. DOE/EERE FY 2017 SBIR Phase I, Release 2	Hydrogen by Osmotic Disparity

Colorado

City	Company	Amount	Program	Project
Boulder	University of Colorado, Boulder	\$0.25 million	DOE/EERE HydroGEN – Durable, HighPerformance Materials and Interfaces for Advanced Water Splitting – Solar Thermochemical H2 Production	Computationally Accelerated Discovery and Experimental Demonstration of High-Performance Materials for Advanced Solar Thermochemical Hydrogen Production
Broomfield	Pneumaticoat Technologies LLC	\$0.15 million	U.S. DOE/BES FY2017 SBIR Phase I, Release 1	Highly Robust Low-PGM MEAs Based upon Composite Supports
Golden	Colorado School of Mines	\$0.25 million	DOE/EERE HydroGEN – Durable, HighPerformance Materials and Interfaces for Advanced Water Splitting – Solar Thermochemical H2 Production	High Temperature Reactor Catalyst Material Development for Low Cost and Efficient Solar Driven Sulfurbased Processes
	National Renewable Energy Laboratory	\$0.15 million	DOE/EERE HyMARC - Hydrogen Storage Materials Discovery	ALD (Atomic Layer Deposition) Synthesis of Novel Nanostructured Metal Borohydrides
		\$0.15 million		Fluorinated Covalent Organic Frameworks: A Novel Pathway to Enhance Hydrogen Sorption and Control Isothermic Heats of Adsorption
Wheat Ridge	TDA Research, Inc.	\$0.08 million	U.S. Navy FY 2017 SBIR Phase I	Advanced PEM Electrocatalysts for Submarine Oxygen Generators

Connecticut

City	Company	Amount	Program	Project
Danbury	FuelCell Energy	\$3 million	U.S. DOE/FE SOFC Program - SOFC Innovative Concepts Funding Award	Transformational SOFC Technology
		\$3.1 million	ARPA-E REFUEL Program Award	Protonic Ceramics for Energy Storage and Electricity Generation with Ammonia
East Hartford	United Technologies Research Center	\$0.25 million	DOE/EERE HydroGEN – Durable, HighPerformance Materials and Interfaces for Advanced Water Splitting – High Temperature Electrolysis	Thin-Film, Metal-Supported HighPerformance and Durable ProtonSolid Oxide Electrolyzer Cell

North Haven	Precision Combustion, Inc.	\$0.08 million	U.S. Navy FY 2016 SBIR Phase I	Power-dense, Scalable, JP-5/JP-8/DF2 Fueled, SOFC Power Generator
Storrs	University of Connecticut	\$0.25 million	DOE/EERE HydroGEN – Durable, HighPerformance Materials and Interfaces for Advanced Water Splitting – High Temperature Electrolysis	Proton-Conducting Solid Oxide Electrolysis Cells for Large-scale Hydrogen Production at Intermediate Temperatures
		\$0.5 million	U.S. DOE/FE SOFC Program - SOFC Core Technology and Innovative Concepts Funding Awards	Development of Chromium and Sulfur Getter for SOFC Systems
Wallingford	Proton OnSite	\$2 million	DOE/EERE HydroGEN - Development of Best Practices in Materials Characterization and Benchmarking for Advanced Water Splitting Technologies	Benchmarking Advanced Water Splitting Technologies: Best Practices in Materials Characterization
		\$0.25 million	DOE/EERE HydroGEN – Durable, HighPerformance Materials and Interfaces for Advanced Water Splitting – Low Temperature Electrolysis	High Efficiency PEM Water Electrolysis Enabled by Advanced Catalysts, Membranes and Processes
		\$0.2 million	U.S. DOE/EERE Small Business Vouchers Pilot, Round 2	Renewable Electrolysis System Development – National Renewable Energy Laboratory
		\$0.08 million	U.S. Navy FY 2017 SBIR Phase I	Increased Utilization of Non-Strategic Metals for PEM Electrolyzers

Delaware

City	Company	Amount	Program	Project
New Castle	Ion Power, Inc.	\$0.26 million	U.S. DOE/EERE Small Business Vouchers Pilot, Round 2	Advanced Characterizations for Fuel Cells Using New Coating Technology – Los Alamos National Laboratory
Newark	University of Delaware	\$1.8 million	ARPA-E IONICS Program Award	Highly Conductive, Stable and Robust Hydroxide Exchange Membranes Based on Poly (Aryl Piperidinium)
		\$2.5 million	ARPA-E REFUEL Program Award	Direct Ammonia Fuel Cells for Transport Applications

Florida

City	Company	Amount	Program	Project
Orlando	Garmor	\$0.1 million	U.S. DOE/EERE Small Business Vouchers Pilot, Round 2	Fuel Cell Cost Reduction Using Graphene Oxide Composites – National Renewable Energy Laboratory
Wesley Chapel	Ultrasonic Technologies, Inc.	\$1 million	U.S. DOE/EERE FY2017 SBIR Phase IIB, Release 2	In-Line Quality and Process Control in Solar and Fuel Cell Manufacturing

Hawaii

City	Company	Amount	Program	Project
Honolulu	Hawaii Hydrogen Carriers	\$0.3 million	U.S. DOE/EERE Small Business Vouchers Pilot, Round 3	To analyze performance and design of low-pressure hydrogen storage systems to power mobile applications of polymer electrolyte membrane hydrogen fuel cells – Savannah River National Laboratory
	University of Hawaii at Manoa	\$0.24 million	DOE/EERE HydroGEN – Durable, HighPerformance Materials and Interfaces for Advanced Water Splitting – Photoelectrochemical	Novel Chalcopyrites For Advanced Photoelectrochemical Water Splitting

Illinois

City	Company	Amount	Program	Project
Argonne	Argonne National Laboratory	\$0.25 million	DOE/EERE HydroGEN – Durable, HighPerformance Materials and Interfaces for Advanced Water Splitting – Low Temperature Electrolysis	PGM-free OER Catalysts for PEM Electrolyzer
Evanston	Northwestern University	\$0.25 million	DOE/EERE HydroGEN – Durable, HighPerformance Materials and Interfaces for Advanced Water Splitting – High Temperature Electrolysis	Degradation Characterization and Modeling of a New Solid Oxide Electrolysis Cell Utilizing Accelerated Life Testing
		\$0.25 million	DOE/EERE HydroGEN – Durable, HighPerformance Materials and Interfaces for Advanced Water Splitting – Solar Thermochemical H ₂ Production	Transformative Materials for HighEfficiency Thermochemical Production of Solar Fuels

Indiana

City	Company	Amount	Program	Project
Indianapolis	Green Fortress Engineering, Inc.	\$0.225 million	NSF FY2017 STTR Phase I	Hydrogen Storage in Catalytically-modified Porous Silicon

Kentucky

City	Company	Amount	Program	Project
Lexington	University of Kentucky	\$0.98 million	Precursor development for low-cost, high-strength carbon fiber for use in composite overwrapped pressure vessel applications	Precursor Processing Development for Low Cost, High Strength Carbon Fiber for Composite Overwrapped Pressure Vessel Applications

Maryland

City	Company	Amount	Program	Project
College Park	Redox Power Systems, the University of Maryland Research Center, and the Center for Advanced Life Cycle Engineering.	\$3 million	U.S. DOE/FE SOFC Program - SOFC Innovative Concepts Funding Award	Robust SOFC Stacks for Affordable and Reliable Distributed Generation Power Systems

Massachusetts

City	Company	Amount	Program	Project
Boston	Boston University	\$0.6 million	U.S. DOE/FE SOFC Program - SOFC Innovative Concepts Funding Award – Phase 2	Processing of SOFC Anodes for Enhanced Intermediate Temperature Catalytic Activity at High Fuel Utilization
	Northeastern University	\$0.25 million	DOE/EERE HydroGEN – Durable, HighPerformance Materials and Interfaces for Advanced Water Splitting – Low Temperature Electrolysis	Developing Novel Platinum Group Metal-Free Catalysts for Alkaline Hydrogen and Oxygen Evolution Reactions
Cambridge	GVD Corp.	\$0.99 million	U.S. DOE/BES FY2017 SBIR Phase II, Release 1	Flexible Barrier Coatings for Harsh Environments
Newton	Giner, Inc.	\$2 million	DOE/EERE ElectroCat (Electrocatalysis Consortium) – PGM-free Catalyst and Electrode R&D	Durable Mn-based PGM-Free Catalysts for Polymer Electrolyte Membrane Fuel Cells
		\$0.08 million	U.S. Navy FY 2017 SBIR Phase I	Virginia Class PEM Electrolyzer Cost Reduction by Reduced PGM Loadings

Walpole	Altrex and the University of South Carolina	\$2.45 million	U.S. DOE/FE SOFC Program - SOFC Innovative Concepts Funding Award	Performance and Reliability Advancements in a Durable Low Temperature Tubular SOFC
	Altrex	\$0.6 million	U.S. DOE/FE SOFC Program - SOFC Innovative Concepts Funding Award – Phase 2	Degradation and Reliability Advancements in Tubular SOFC
Waltham	SimpleFuel – collaboration of Ivy's Energy Solutions, McPhy Energy (MA), and Pdc Machines (PA)	\$1 million	H2 Refuel H-Prize	On-site hydrogen generation system, using electricity or natural gas, to fuel hydrogen vehicles, that can be used in homes, community centers, small businesses, or similar locations.
Westford	Reactive Innovations, LLC	\$0.15 million	U.S. DOE/EERE FY 2017 Phase I, Release 2	Emergency Hydrogen Refueler for Individual Consumer Fuel Cell Vehicles

Michigan

City	Company	Amount	Program	Project
Ann Arbor	University of Michigan	\$0.25 million	DOE/EERE HydroGEN – Durable, HighPerformance Materials and Interfaces for Advanced Water Splitting – Photoelectrochemical	Monolithically Integrated ThinFilm/Silicon Tandem Photoelectrodes for High Efficiency and Stable Photoelectrochemical Water Splitting
		\$0.25 million	DOE/EERE HyMARC - Hydrogen Storage Materials Discovery	Optimized Hydrogen Adsorbents via Machine Learning and Crystal Engineering

Minnesota

City	Company	Amount	Program	Project
Minneapolis	Cummins Power Generation	\$3.9 million	U.S. DOE/FE SOFC Program - SOFC Innovative Concepts Funding Award	Metal-Supported Ceria Electrolyte-Based SOFC Stack for Scalable, Low Cost, High Efficiency and Robust Stationary Power Systems
St. Paul	3M Company	\$2.3 million	ARPA-E IONICS Program Award	Low Cost, Durable, Commercially Viable Polymeric Anion Exchange Membranes

Montana

City	Company	Amount	Program	Project
Belgrade	Glacigen Materials, Inc.	\$0.15 million	U.S. DOE/FE FY 2017 STTR Phase I, Release 2	Hybridization of Freeze Casting with Additive Manufacturing for Simplified Production of High Performance SOFCs

New Jersey

City	Company	Amount	Program	Project
New Brunswick	Rutgers - State Un. of NJ: New Brunswick/ Piscataway	\$0.25 million	DOE/EERE HydroGEN – Durable, HighPerformance Materials and Interfaces for Advanced Water Splitting – Photoelectrochemical	Best-in-class Platinum Group Metalfree (PGM-free) Catalyst Integrated Tandem Junction Photoelectrochemical (PEC) Water Splitting Devices

New Mexico

City	Company	Amount	Program	Project
Albuquerque	Pajarito Powder, LLC	\$2.79 million	ARPA-E OPEN 2015 Awards	To develop a reversible hydrogen electrode that would enable cost-effective hydrogen production and reversible fuel cells.
		\$0.2 million	U.S. DOE/EERE Small Business Vouchers Pilot, Round 2	Increasing Utilization for a Non-Platinum-Group-Metal - Los Alamos National Laboratory
	Verge NewTech I, LLC DBA Pajarito Powder	\$0.14 million	U.S. DOE/BES FY2017 SBIR Phase I, Release 1	Durable Active Supports for Low Platinum Group Metal Catalysts
Los Alamos	Los Alamos National Laboratory	\$0.25 million	DOE/EERE HydroGEN – Durable, HighPerformance Materials and Interfaces for Advanced Water Splitting – Low Temperature Electrolysis	High-Performance Ultralow-Cost Non-Precious Metal Catalyst System for AEM Electrolyzer
		\$0.25 million		Scalable Elastomeric Membranes for Alkaline Water Electrolysis
		\$0.25 million	DOE/EERE HydroGEN – Durable, HighPerformance Materials and Interfaces for Advanced Water Splitting – Photoelectrochemical	Efficient Solar Water Splitting with 5,000 Hours Stability Using Earthabundant Catalysts and Durable Layered 2D Perovskites

New York

City	Company	Amount	Program	Project
Albany	Mohawk Innovative Technology, in collaboration with FuelCell Energy (CT)	\$0.6 million	U.S. DOE/FE SOFC Program - SOFC Core Technology Funding Award	High Temperature Anode Recycle Blower for SOFC
Niskayuna	General Electric, in partnership with SUNY Polytechnic Institute and GE-Fuel Cells LLC.	\$0.54 million	U.S. DOE/FE SOFC Program - SOFC Core Technology Funding Award	Highly Selective and Stable Multivariable Gas Sensors for Enhanced Robustness and Reliability of SOFC Operation
Peekskill	Bettergy Corporation	\$1.5 million	ARPA-E REFUEL Program Award	Low Temperature Ammonia Cracking Membrane Reactor for Hydrogen Generation
Rochester	American Fuel Cell	\$0.2 million	U.S. DOE/EERE Small Business Vouchers Pilot, Round 2	Optimization of Roll-to-roll Coating of Gas Diffusion Media – Oak Ridge National Laboratory
		\$0.15 million	U.S. DOE/EERE FY 2017 Phase I, Release 2	Over-Molded Plates for Reduced Cost and Mass PEM Fuel Cells
Troy	Rensselaer Polytechnic Institute	\$2.25 million	ARPA-E IONICS Program Award	Channel Engineering of Hydroxide Ion Exchange Polymers and Reinforced Membranes

Ohio

City	Company	Amount	Program	Project
Columbus	Ph Matter	\$0.15 million	U.S. DOE/BES FY2017 SBIR Phase I, Release 1	Multi-Functional Catalyst Support
Lewis Center	Nexceris, Inc.	\$0.08 million	U.S. Navy FY 2016 SBIR Phase I	Lightweight Solid Oxide Fuel Cell System

Oregon

City	Company	Amount	Program	Project
Covalis	Waste2Watergy	\$0.75 million	NSF FY2017 SBIR Phase II	Next-Generation Microbial Fuel Cell for Highly Efficient Wastewater Treatment

Pennsylvania

City	Company	Amount	Program	Project
Pittsburgh	Carnegie Mellon University	\$2 million	DOE/EERE ElectroCat (Electrocatalysis Consortium) – PGM-free Catalyst and Electrode R&D	Advanced PGM-free Cathode Engineering for High Power Density and Durability
State College	HAMR Industries LLC	\$0.15 million	U.S. DOE/FE FY 2017 SBIR Phase I, Release 2	Three Step Additive Manufacturing of Complete Solid Oxide Fuel Cells
	The Pennsylvania State University	\$0.8 million	Precursor development for lowcost, high-strength carbon fiber for use in composite overwrapped pressure vessel applications	Developing A New Polyolefin Precursor for Low-Cost, HighStrength Carbon Fiber

South Carolina

City	Company	Amount	Program	Project
Aiken	GreenWay Energy LLC	\$0.15 million	U.S. DOE/BES FY2017 SBIR Phase I, Release 1	Metal Hydride Material Development for High Efficiency and Low Cost Hydrogen Compressors
		\$2 million	DOE/EERE ElectroCat (Electrocatalysis Consortium) – PGM-free Catalyst and Electrode R&D	PGM-free Engineered Framework Nano-Structure Catalysts
		\$0.25 million	High Temperature Reactor Catalyst Material Development for Low Cost and Efficient Solar Driven Sulfurbased Processes	HydroGEN – Durable, HighPerformance Materials and Interfaces for Advanced Water Splitting – Solar Thermochemical H2 Production
Columbia	University of South Carolina	\$0.6 million	U.S. DOE/FE SOFC Program - SOFC Innovative Concepts Funding Award – Phase 2	Employing Accelerated Test Protocols to Full-Size Cells and Tuning Microstructures to Improve Robustness, Reliability, and Endurance of SOFC
		\$1.6 million	ARPA-E REFUEL Program Award	A Novel Hollow Fiber Membrane Reactor for High Purity Hydrogen Generation from Thermal Catalytic Ammonia Decomposition
Pendleton	Tetramar Technologies	\$1 million	U.S. DOE/BES FY2017 SBIR Phase II, Release 1	New Approaches to Improved PEM Electrolyzer Ion Exchange Membranes

Tennessee

City	Company	Amount	Program	Project
Oak Ridge	Oak Ridge National Laboratory	\$0.27 million	Precursor development for lowcost, high-strength carbon fiber for use in composite overwrapped pressure vessel applications	Novel Plasticized Melt Spinning Process of PAN Fibers Based on Task-Specific Ionic Liquids

Texas

City	Company	Amount	Program	Project
Austin	Nzyme2HC, LLC	\$0.1 million	U.S. DOE/EERE Small Business Vouchers Pilot, Round 2	Renewable and Cost Effective In-vitro Bio Hydrogen Production – National Renewable Energy Laboratory

Utah

City	Company	Amount	Program	Project
Salt Lake City	Materials and Systems Research, Inc.	\$1.1 million	ARPA-E REFUEL Program Award	Cost-Effective, Intermediate-Temperature Fuel Cell for Carbon-Free Power Generation

Virginia

City	Company	Amount	Program	Project
Pembroke	NanoSonic, Inc.	N/A	U.S. DOE/EERE Small Business Vouchers Pilot, Round 2	Working with Los Alamos National Laboratory
		\$1 million	U.S. DOE/BES FY 2017 SBIR Phase II, Release 1	Novel Hydrocarbon Ionomers for Durable Proton Exchange Membranes
		\$1 million	U.S. DOE/EERE FY 2017 SBIR Phase IIB, Release 2	Cryogenically Flexible, Low Permeability Thoraeus Rubber H2 Dispenser Hose
Sterling	Ceraintech, Inc.	\$0.13 million	U.S. DOE/BES FY2017 SBIR Phase I, Release 1	Mesoporous Non-carbon Catalyst Supports for PEMFC

Washington

City	Company	Amount	Program	Project
Redmond	Emerald Energy NW, LLC	\$0.16 million	U.S. DOE/EERE Small Business Vouchers Pilot, Round 3	To fabricate and test a versatile rotary magnetic wheel seal test apparatus with low friction and low loss – Pacific Northwest National Laboratory
Richland	Pacific Northwest National Laboratory	\$0.64 million	DOE/EERE ElectroCat (Electrocatalysis Consortium) – PGM-free Catalyst and Electrode R&D	Highly Active and Durable PGM-free ORR Electrocatalysts through the Synergy of Active Sites

West Virginia

City	Company	Amount	Program	Project
Morgantown	West Virginia University, in partnership with Oak Ridge National Laboratory (TN), Carpenter Technology Corporation (PA), and FuelCell Energy (CT)	\$0.369 million	U.S. DOE/FE SOFC Program - SOFC Core Technology Funding Award	Minimizing CR-Evaporation From Balance of Plant Components by Utilizing Cost-Effective Alumina-Forming Austenitic Steels
	West Virginia University	\$0.6 million	U.S. DOE/FE SOFC Program - SOFC Core Technology Funding Award – Phase 2	Scalable Nano-Scaffold Architecture on the Internal Surface of SOFC Anode for Direct Hydrocarbon Utilization

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Cover left: Toyota fuel cell-powered Mirai. Photo courtesy of Fuel Cell and Hydrogen Energy Association.

Cover middle: FuelCell Energy 1.4 MW combined heat and power fuel cell at Hartford Hospital in Hartford, Connecticut. Photo courtesy of FuelCell Energy.

Cover right: Plug Power fuel cell-powered forklifts at Newark Farmer's Market in Newark, New Jersey. Photo courtesy of Fuel Cell and Hydrogen Energy Association.

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Endnotes

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