



# The Business Case for Fuel Cells **2013** Reliability, Resiliency & Savings



## ***Authors and Acknowledgements***

This report was written and compiled by Sandra Curtin and Jennifer Gangi of Fuel Cells 2000, an activity of the Breakthrough Technologies Institute in Washington, D.C. Special thanks to Peter Callowhill of [NetGain Energy Advisors](#) for contributing the PPA section and to Matthew Crescimanno and Eirik Mørk for assisting in research. Support was provided by the U.S. Department of Energy's Fuel Cell Technologies Office.

## ***About This Report***

This report profiles a select group of nationally recognizable companies and corporations that have purchased or deployed fuel cells since our last report (November 2012) through December 2013. These businesses are taking advantage of a fuel cell's unique benefits, especially for material handling and providing clean, reliable power to their data centers, stores, administrative offices and headquarters.

This list is by no means exhaustive. Over the past two decades, tens of thousands of fuel cells have been installed around the world, for primary or backup power, and many other companies in the United States and worldwide are using fuel cells. Outside of the business world, fuel cells are operating at wastewater treatment plants, government buildings, universities, military bases, homes, hospitals, and other sites. Fuel cells are used in many applications, including portable and emergency backup power, passenger vehicles, buses and consumer electronics, which are also being researched, demonstrated and deployed by numerous companies and organizations around the world.

The information contained in this report was gathered from public sources and via personal contact with fuel cell manufacturers and the companies profiled. Any quote not cited came directly from the company. Please contact Fuel Cells 2000 at [info@fuelcells.org](mailto:info@fuelcells.org) or 202-785-4222, ext. 17 with any corrections, updates or questions.

## ***About Fuel Cells 2000***

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

Fuel Cells 2000 is an activity of the [Breakthrough Technologies Institute](#) (BTI), a non-profit [501(c)(3)] independent, educational organization that identifies and promotes environmental and energy technologies that can improve the human condition. BTI was established in 1993 to ensure that emerging technologies have a voice in environmental and energy policy debates. Our current focus is on air quality, climate change, energy efficiency, and energy independence. Our programs have won international recognition and numerous awards.

***Cover Photo Credits:*** Top: Verizon ClearEdge PureCell 400 fuel cell system; Bottom: Bloom fuel cell installation at Macy's in Cheshire, MA.

## Acronyms Used in this Report

CHP	Combined heat and power
CO <sub>2</sub>	Carbon dioxide
DOE	U.S. Department of Energy
EERE	DOE's Energy Efficiency and Renewable Energy program
GHG	Greenhouse gases
GW	Gigawatt
GWh	Gigawatt-hour
ITC	Investment Tax Credit (federal)
kW	Kilowatt
kWh	Kilowatt-hour
LREC	Low-emissions Renewable Energy Credit program (Connecticut)
MW	Megawatt
NYSERDA	New York State Energy Research and Development Authority
O&M	Operation and maintenance
PPA	Power purchase agreement
R&D	Research and development
RPS	Renewable Portfolio Standard
SGIP	Self-Generation Incentive Program (California)
sq. ft.	Square feet
TRU	Transport refrigeration unit
UPS	Uninterruptible power supply

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## **Businesses Find Fuel Cells Cost-Effective: *Low Emissions + Increased Efficiency + Improved Reliability***

Corporate customers have discovered that investing in fuel cells pays off – saving money on fuel and labor costs, reducing emissions, and yielding substantial savings through increased efficiency and reliability. Many companies have become repeat customers, purchasing additional, and in many cases, larger, fuel cell systems for their facilities.

The fuel cell industry is growing, attracting customers from a wide range of market sectors. Fuel cells are now operating in stationary and motive power applications to provide:

- primary power to material handling equipment, resulting in improved efficiency and cost savings at warehouses and distribution centers;
- reliable, resilient primary power for high-volume data centers;
- high-efficiency, low-emission power for corporate headquarters;
- backup power to crucial computer and communications networks;
- clean, reliable power that keeps retail stores open even when grid power goes down; and
- megawatt-scale power feeding directly into the power grid.

New industries are coming into the fold. Major corporate data centers (Apple, eBay, Microsoft) have started to bypass grid power, using fuel cells with renewables to generate their own power onsite. Some energy providers (Delmarva Power, Dominion, NRG Energy) are building up grid resiliency by adding megawatt-scale fuel cell power generation to deliver reliable power to their grid networks.

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

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

### **Fuel Cell Benefits**

No other technology offers the combination of benefits fuel cells allow:

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

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

To learn more about fuel cells, please visit [www.fuelcells.org](http://www.fuelcells.org).

This report is the fourth in a series. In our [2012](#), [2011](#), and [2010](#) Business Case reports, Fuel Cells 2000 profiled more than 70 companies incorporating fuel cells with other technologies in order to better achieve their sustainability goals and improve resiliency. **The companies profiled are collectively saving millions of dollars in electricity costs while reducing carbon dioxide emissions by hundreds of thousands of metric tons per year.** This report discusses the different market sectors finding benefits using fuel cell technologies and outlines recent sales and installations to corporate customers.

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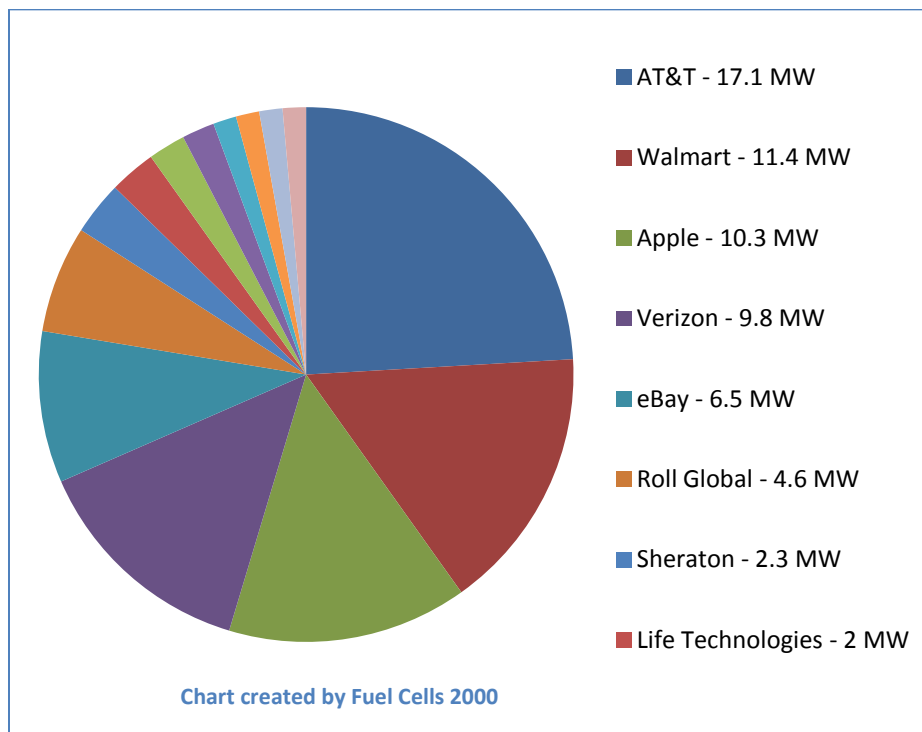
**Since our last report:**

- **More than 88 megawatts (MW) of stationary fuel cells** have been installed or ordered by U.S. businesses and utilities.
- **700+ fuel cell-powered material handling vehicles** have been ordered or deployed in warehouses and distribution centers around the country.

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These impressive numbers are just a snapshot of the overall fuel cell picture. Fuel Cells 2000 estimates that there is **at least 170 MW of fuel cells now installed in the U.S.**, providing primary or backup power to facilities, as well as **almost 5,000 fuel cell-powered material handling vehicles** currently or soon-to-be operating in North America.

**Companies with  $\geq 1$  MW of Fuel Cells (Installed or Planned)**



# Fuel Cells: Delivering Real Benefits

Fuel cells are finding success in a number of early market applications. Today, fuel cells provide power to data centers, material handling equipment, and telecom towers, as well as generating power sent directly to the power grid. Companies and electric utilities are choosing fuel cells since they provide increased power reliability, improve efficiency, lower emissions and/or provide higher cost savings than other technologies. The number of fuel cell applications continues to grow, with promising demonstrations underway involving zero-emission trucks at ports, stationary and motive applications at airports, and power for refrigerated trailers used to transport food to grocery stores and restaurants.

## Data Centers

Data centers use a *lot* of energy. In September 2012, the New York Times reported that data centers worldwide consumed about 30 billion watts of electricity annually.<sup>1</sup> In the U.S. alone, data center usage comprised 2 percent of all electric consumption – totaling 76 billion kilowatt-hours.<sup>2</sup> With the explosive growth of digital data and online purchasing, data center power requirements are, not surprisingly, expanding, growing 63 percent globally between 2011 and 2012 from 24 gigawatts (GW) to 38 GW.<sup>3</sup>

Keeping these systems up and running 24 hours a day, 7 days a week is critical in today's non-stop business environment. A study by the Aberdeen Group estimated that companies lose an average of \$138,000 for every hour their data center is offline, and outages can cause companies with more than 1,000 employees to lose an average of \$1.1 million per year.<sup>4</sup>

A November 2013 report from Microsoft engineers, published by ACM, [\*No More Electrical Infrastructure: Towards Fuel Cell Powered Data Centers\*](#),<sup>1</sup> finds that aside from the reliability and emissions reductions fuel cells offer, if placed close to power consumption units, fuel cells also eliminate the need for data center wide electrical infrastructure or a power distribution system, which is a big portion of the total capital cost for a state-of-the-art data center. The study finds that by using localized power production, fuel cells can bring more than a **20 percent reduction** in costs using conservative projections.

Quality assured power is a necessity at a data center. Many companies set a goal of 99.9 percent availability for their websites (unplanned downtime of about 8 hours and 45 minutes annually) while data centers and telephone companies aim for 99.999 percent (no more than 5 minutes and 15 seconds of unplanned downtime annually). Backup power and uninterruptible power supply (UPS) systems are crucial to attaining this goal, but diesel gensets used today are inefficient and costly to operate.

<sup>1</sup> [http://www.nytimes.com/2012/09/23/technology/data-centers-waste-vast-amounts-of-energy-belying-industry-image.html?pagewanted=all&\\_r=0](http://www.nytimes.com/2012/09/23/technology/data-centers-waste-vast-amounts-of-energy-belying-industry-image.html?pagewanted=all&_r=0)

<sup>2</sup> Ibid.

<sup>3</sup> <http://www.computerweekly.com/news/2240164589/Datacentre-power-demand-grew-63-in-2012-Global-datacentre-census>

<sup>4</sup> <http://www.thinkgig.com/do-you-know-the-cost-of-data-center-downtime-infographic>



Fuel cells are an ideal power source for data centers because they generate high quality, computer-grade power, have few moving parts and are extremely reliable. The First National Bank of Omaha (FNBO) in Nebraska boasts one of the longest running fuel cell systems, in operation for more than 14 years. Before the fuel cells were installed, grid power outages were impacting its processing of several million credit card, banking, and ATM transactions daily. During one outage, the backup generators failed, costing the bank several million dollars in credit card transactions (the bank estimates the cost of one hour of downtime at \$6 million). So, in 1999, four 200-kilowatt (kW) fuel cells from UTC Power (now ClearEdge Power) were installed to provide backup to the bank's data center. The fuel cells provide an unmatched 99.9999 percent availability, which gave FNBO enough confidence to forgo spending \$75 million on a second backup data center. In November 2013, FNBO upgraded to the newer 400-kW system from ClearEdge Power, underscoring the value it finds in the technology.

In 2007, **Fujitsu** was the first Silicon Valley company to install a fuel cell, using the system to generate 50 percent of the power needed to cool servers located in data centers and computer labs at the company's Sunnyvale, California, campus. The ClearEdge Power fuel cell system used at Fujitsu meets the most stringent air emissions standards set by the California Air Resources Board, and produces 35 percent less carbon dioxide (CO<sub>2</sub>) per megawatt-hour than the average fossil fuel-based power plant.

In the past few years, several other major corporations have purchased or deployed fuel cells for power generation at newly-developed data centers. These companies include **Microsoft, Apple, eBay, Google, Verizon, JPMorgan Chase, Williams-Sonoma**, and several others.

**Microsoft's** new Cheyenne, Wyoming, data center will be the world's first zero-carbon data center. This research and development (R&D) pilot project will test a small-scale data center powered by a 300-kW FuelCell Energy fuel cell system. It will utilize methane from Cheyenne's wastewater treatment plant – a potent greenhouse gas (GHG) precursor generated during the treatment process – as the source of hydrogen for the fuel cell system. Microsoft will use information gained from the demonstration to model how a biogas-powered fuel cell could be applied to a larger Microsoft facility.



In **eBay's** case, instead of one large generator, 6 MW of smaller fuel cells will give its South Jordan, Utah, data center the flexibility to roll with unexpected power challenges. If one fuel cell goes down, the facility loses only a small amount of capacity instead of losing power altogether. The grid will function as a backup to the fuel cells. Computers will consume energy 100 feet from where it's generated. According to a study by researchers at the University of Illinois at Urbana-Champaign,<sup>5</sup> such a fuel cell setup is 10

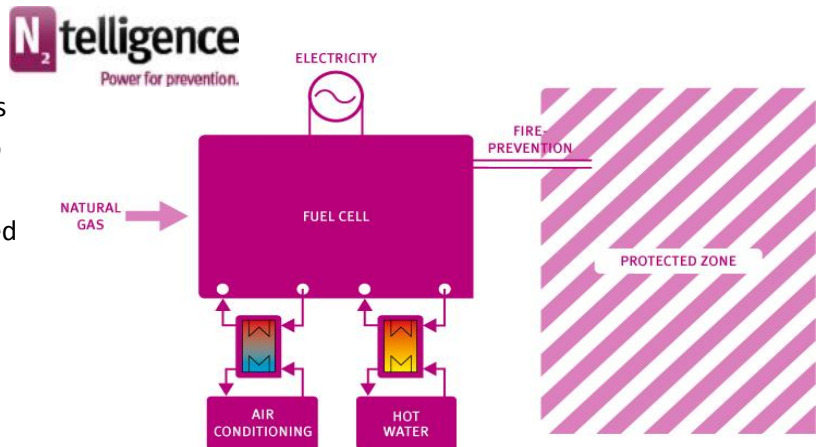
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<sup>5</sup> [http://tech.ebay.com/sites/default/files/Analysis\\_of\\_Design\\_Alternatives.pdf](http://tech.ebay.com/sites/default/files/Analysis_of_Design_Alternatives.pdf)

times less likely to fail than grid-powered alternatives. Over the course of a year, the study found, the system might go down for only six minutes, compared to as much as 10 hours with a traditional topology.

These fuel cell benefits for energy-intensive data centers have international appeal. In Frankfurt, Germany, **Equinix** installed a 100-kW Fuji Electric fuel cell system to generate energy for its FR4 data center. The fuel cell, supplied by N<sub>2</sub>telligence, will not only supply clean, reliable power for the data center, but will also be used as a fire suppression system, which is the company's area of expertise.

Utilizing the nitrogen-rich output from the fuel cell to manage the oxygen level helps ensure that there is enough to breathe, but not enough to support a fire. Most data centers currently use either water or gas-based fire suppression systems; the fuel cell installation at Equinix is the first of its kind in the world to be used in this capacity.



## Telecom

Major telecommunications companies in the U.S. – **AT&T, Sprint, MetroPCS** and **T-Mobile** (which recently acquired MetroPCS) – collectively have hundreds of fuel cells installed at telecommunications towers and sites around the country. Internationally, this market is growing rapidly in Latin America, the Caribbean, Indonesia, India, and South Africa, and as well as expanding into China and Japan.

Why are these companies incorporating fuel cells into their networks? Fuel cells can provide either short duration runtime or extended duration runtime for telecom switch nodes, cell towers, and other electronic systems that require a reliable, on-site, direct DC power supply. Fuel cells also last a lot longer than their battery counterparts – 10 years versus 3-5 years. They also require less maintenance, saving money and time.

Customers in areas without a source of hydrogen fuel can opt for systems using methanol. Other installations integrate solar and/or wind-power as a source for hydrogen via water electrolysis.

Fuel cells are virtually silent compared to the loud and smoky diesel gensets frequently used at these sites, and are scalable, so they can be constructed to meet any power requirement. Fuel cells also weigh less than batteries, so they offer much more flexible installation – inside, outside, even on rooftops.

The interest in reliable and seamless backup power has recently led the Telecommunications Industry Association (TIA) to create a focus group that will **develop a comprehensive understanding of existing fuel cell codes for stationary and mobile fuel cells - for specific use with telecom, wireless, datacom, emergency 911, police radio, security and surveillance, and catastrophic infrastructure.**

Fuel cell products are rugged and durable, so they can provide power to remote sites that may be subject to inclement weather. Ballard Power Systems has reported that during Superstorm Sandy, 17 of their 5-kW ElectraGen™-ME methanol fuel cell systems were put to the test. Each performed flawlessly to provide electricity to the Bahamas mobile telephone network during the three days that the storm passed over the Bahamas, maintaining consistent power.

Australian telecom operator, **Telestra**, has tested Ballard Power Systems' fuel cells to supply back-up power at some of the company's rural or remote locations prone to power outages and has been very satisfied with the results. Telestra's John Romano recently wrote:

*"We've been quite excited about the results that we've been getting and are seeing some strong benefits of using fuel cells as a power solution for our network. These were nicely illustrated during a recent incident at one of our mobile base stations in Queenstown, Tasmania. A lightning strike to the mobile base station's AC rectifier meant the AC power couldn't be converted to DC power to run our equipment.... So the back-up power supply had automatically kicked in to keep the base station running.*



*Normally, a base station in a residential location would use batteries rather than a diesel generator to supply back-up power. This is because a generator would be far too noisy for the people who live nearby. On average batteries will keep a base station running for about eight hours. Fortunately, a fuel cell had been installed in this particular site as part of our alternative energy trial. **This meant that we were able to keep the base station running for over two days – more than six times longer than a battery-based back-up system.***

*As a result of these trials, fuel cells have now been included as a standard solution as backup power in our mobile base stations and smaller exchanges (where the power consumption is less than 5 kilowatts per hour).... **We see fuel cell technology as offering a number of advantages over the more traditional battery and diesel generators solutions. These include increased reliability across a wider range of operating conditions (both in extreme heat and cold), reduced maintenance costs, longer operating life as well as reduced size, weight, installation footprint (the amount of space they physically occupy), noise and environmental impact<sup>6</sup>.***

## **Grid Power**

U.S. electric utility companies have begun to deploy megawatt-scale fuel cells at electric power stations to generate and deliver electricity to the power grid. Adding fuel cell power generation helps energy companies meet clean energy requirements imposed by Renewable Portfolio Standards (RPS) – a

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<sup>6</sup> <http://exchange.telstra.com.au/2013/10/31/more-power-to-our-network/>

regulation in place in many states (and countries) requiring energy companies to acquire a certain percentage of their electricity from renewable sources.

**NRG Energy** announced in September 2013 that it will convert a unit at its 500-MW Montville, Connecticut, power station to a wood-burning biomass generator, and will add a 5.6-MW FuelCell Energy natural-gas powered fuel cell system and a 2.3-MW solar power system, creating a “renewable energy park.” NRG Energy will also market FuelCell Energy’s fuel cell power plants to its customers. Customers will have two financing options – either purchasing the fuel cell power plant, or entering into a power purchase agreement (PPA) under which NRG Energy will purchase and own the power plant and sell electricity and heat to the end-user under a long-term contract. Potential end-users, according to NRG Energy, are universities, hospitals, and other large power users that could take advantage of the fuel cells’ reliable electricity, hot water, and steam or absorption chilling. NRG Energy’s agreement with FuelCell Energy also includes an option to purchase and own fuel cell power plants for its own portfolio to sell the power to the electric grid.



In May 2013, energy company **Dominion**, broke ground on a 14.9-MW fuel cell power – generating facility in Bridgeport, Connecticut – enough electricity to power approximately 15,000 homes. FuelCell Energy will build, operate, and maintain the facility, which will include five Direct FuelCell® stationary fuel cell systems and an organic rankine turbine that will

use waste heat from the fuel cells, generating a total of almost 15 MW of electricity. Dominion will sell the output of the fuel cell power station to **Connecticut Light & Power (CL&P)** under a 15-year fixed power purchase agreement.

In November 2013, **United Illuminating (UI)** and the city of Bridgeport proposed a 5-MW Fuel Cell Energy renewable energy park at the city’s former landfill site that would include a 2.8 MW fuel cell and a 2.2 MW of solar array.

**Delmarva Power** operates 30 MW of natural gas-powered Bloom Energy Servers at two substations, enough to power about 22,000 homes, for its Delaware customers. This is the largest utility-scale deployment of fuel cell technology in the U.S. The Bloom Energy fuel cell units performed without trouble during Superstorm Sandy, delivering continuous and reliable

In 2013, European energy provider, **E.ON**, announced that it had invested \$100 million in U.S. fuel cell manufacturer Bloom Energy. E.ON has been involved in European fuel cell demonstrations for many years, including ongoing residential fuel cell field tests in Germany and large-scale wind-to-hydrogen energy storage projects around Europe.

power to the grid. Recently, the CEO of Delmarva Power’s parent company, **Pepco Holdings**, spoke about the possibility of placing more Bloom fuel cells in the regional grid to “shore up reliability” during natural disasters.<sup>7</sup>

Overseas, Korean energy company **POSCO Power** placed a 120-MW multi-year order commitment with FuelCell Energy to begin upon completion of an existing 70-MW order. POSCO has seen increasing demand for fuel cell power plants from electric utilities and independent power producers under the South Korean RPS. Fuel cells operating on natural gas and renewable biogas have earned a prominent position within the RPS pricing mechanism due to their efficient and reliable generation of clean power.

## ***Material Handling***

The material handling sector has provided the fuel cell industry with an early and growing market in the U.S., with deployments and orders for forklifts and lift trucks inching closer to 5,000. This includes many big name companies with multiple repeat orders, such as **BMW, Coca-Cola, Procter & Gamble, Kroger** and **Lowe’s**.

Companies are finding benefits to converting an existing fleet to operate on fuel cells, or purchasing new fuel cell material handling vehicles, above and beyond the great reduction in polluting emissions. These include economic benefits, saving a company time with increased productivity as well as money from fuel and labor costs. Fuel cells last longer than batteries, and take only a few minutes to refuel, allowing workers to spend more time on the warehouse floor moving product than they do swapping out batteries or chugging along as battery power decreases. Many facilities are also recouping space that was previously allotted to house and change batteries and are now storing more goods.



According to fuel cell manufacturer Ballard Power Systems, a typical high throughput warehouse can expect up to 24 percent savings in total lifetime ownership costs, resulting in a payback of less than one year, with over 50,000 hours of productivity recovered per year.<sup>8</sup>

Fuel cells can also operate in freezing temperatures, which led **Walmart**, a company that had already tested and deployed several hundred fuel cell forklifts at facilities in Ohio and Ontario, Canada, to choose fuel cell lift trucks for its sustainable refrigerated distribution center in Alberta, Canada. The fuel cell-powered vehicles operate in conditions as low as -20° F (-29° C).

The U.S. is by far the world leader in this fuel cell application, but Europe and others are taking notice.

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<sup>7</sup> <http://www.delawareonline.com/article/20131017/BUSINESS09/310170051/>

<sup>8</sup> [http://www.ballard.com/files/PDF/Material\\_Handling/Material\\_Handling\\_Value\\_Proposition\\_4192011.pdf](http://www.ballard.com/files/PDF/Material_Handling/Material_Handling_Value_Proposition_4192011.pdf)

**BMW** boasts one of the largest single fuel cell material handling fleets in the world, with more than 275 operating at its Spartanburg, South Carolina, manufacturing facility. The automaker, with partners Linde Material Handling and Munich Technical University, is taking the success and lessons learned in the U.S. to Germany, where the Federal Ministry of Transport, Building and Urban Development recently awarded the group €2.9 million (US\$3.9 million) for a three-year research project, H2IntraDrive, to develop and test nine fuel cell-powered forklifts from Linde at BMW's vehicle manufacturing plant in Leipzig. The project also boasts Germany's first ever indoor hydrogen refueling station, provided by Linde Gas and dispensing hydrogen produced from renewable sources.



Last year, British retailer **Marks and Spencer** conducted the U.K.'s first fuel cell material handling trial with on-site hydrogen production via ITM Power's HFuel electrolyzer system. The six-week trial was deemed successful with Marks and Spencer staff coming away impressed by the reliability and long operating time offered by the fuel cell forklifts. Swedish furniture company **IKEA** now operates 20 fuel cell-powered forklift trucks at its Saint-Quentin-Fallavier, France, shipping logistics center.

There are several other demonstration programs under way in Europe, including the HyLIFT program which is deploying small fleets of fuel cell material handling vehicles and hydrogen fueling infrastructure at three end-user sites.

Success with fuel cell-powered forklifts and other material handling vehicles in distribution centers and warehouses is transitioning to other related industry areas, including ground service equipment at airports and refrigerated transport, with the U.S. Department of Energy (DOE) Office of Efficiency and Renewable Energy (EERE) funding demonstrations for both. New York fuel cell manufacturer Plug Power, the industry leader in the fuel cell material handling sector with around 85 percent of the market, received \$2.5 million from DOE to retrofit 15 electric tow tractors with fuel cells. The tractors are deployed at a **FedEx** domestic airport in Memphis, Tennessee. If successful, this could be a ripe market as airports are coming under increased pressure to reduce emissions as well as fuel costs.



Transport refrigeration units (TRUs) are temperature-controlled storage units used to transport frozen or cold items from warehouses to retail stores, and keep goods at the proper temperature while a truck is idling during delivery. Most TRUs in operation today are powered by loud, polluting diesel generators – a typical TRU will consume about 10 gallons of diesel per day, which is costly, and emit roughly 101 kilograms of CO<sub>2</sub> as well as other harmful emissions. Companies are examining reliable and zero-

emission fuel cells as an alternative power source. Extremely quiet, fuel cells allow for around the clock deliveries without being disruptive to neighbors.

**Sysco**, already a leading fuel cell forklift customer with more than 700 vehicles operating at seven facilities around the country, is assisting two separate DOE-funded and one New York State Energy Research and Development Authority (NYSERDA) TRU demonstrations at its warehouse sites in New York and California that already have hydrogen infrastructure in place. Texas grocery store chain **H-E-B** is also participating in the trial, as the company has fuel cell forklifts operating in San Antonio, Texas. **Carrier Transicold** will integrate Plug Power's fuel cells in TRUs for its trailers and **Thermo King** will use fuel cells from Nuvera. Plug Power claims that increased hydrogen usage drives down the cost, so this model of multiple vehicles (forklifts, TRUs) fueling at a facility's hydrogen station helps make the business case even better.

## More Fuel Cell Benefits

### *Resiliency and Reliability*

Recent powerful storms underscore the ability of weather-related disasters to knock out power lines and cripple communities. Resiliency has jumped to the top of the wish list for companies when it comes to technology purchases. Fuel cells can be configured to be grid independent, which comes in very handy when the power goes out in a city or town.

The **Sheraton New York Hotel and Tower** has a 250-kW fuel cell from FuelCell Energy that has provided electricity and heat since 2005. Power from the system can be diverted to emergency lights on 20 floors of the hotel in the event of a blackout.

During the 2003 Northeast blackout, the Central Park Police Station was not aware there was a widespread power outage in New York City. The building was the only place with power, thanks to the station's 200-kW ClearEdge Power fuel cell that operates independent from the grid.

There are many stories like this from fuel cell customers. Recent catastrophic weather events such as Hurricane Katrina, Hurricane Irene, Superstorm Sandy and Winter Storm Alfred have justified the choice of fuel cells. In Hurricane Irene, ReliOn fuel cells owned by **Sprint** provided continuous backup power, keeping communications lines open. **Whole Foods** was able to prevent major food spoilage thanks to the ClearEdge Power fuel cell that kept its coolers operating during that storm.

During Superstorm Sandy, James Gowen, **Verizon's** chief sustainability officer said that the ClearEdge Power fuel cells at its Garden City site on Long Island enabled it to keep network operations running when various segments

**Walmart** states, "we've led in the development of hydrogen fuel cells. We have 35 stores, clubs and distribution centers currently being served by Bloom Energy fuel cells. There is real potential for these [solar and fuel cell] technologies to someday keep our stores up and running even in the worst storms and power outages."

*[Leslie Dach](#), Walmart's Executive Vice President, Corporate Affairs*

of the traditional power grid were being repaired. **Becker+Becker's** ClearEdge Power fuel cell installation at the Octagon, an apartment building in New York City, was also able to maintain operation of hot water throughout the building during the storm. The company is currently engineering the system to pick up additional critical loads in the event of an extended utility grid outage.

CommScope installed an 8-kW fuel cell system at the **Society of Cable Telecommunications Engineers (SCTE)** headquarters in Exton, Pennsylvania, to provide backup power to its data center. The fuel cell is part of a 19.7-kW hybrid power system and integrated with a 2.8-kW grid interactive solar array and 20-hour runtime storage batteries. The hybrid system was used in both Hurricane Irene and Superstorm Sandy and provided sufficient backup power until normal power was restored.

Overseas, a Spanish television channel, **Vision 6**, has installed a 5-kW Ajusa fuel cell UPS unit at its offices to prevent loss of power in the event of a blackout.

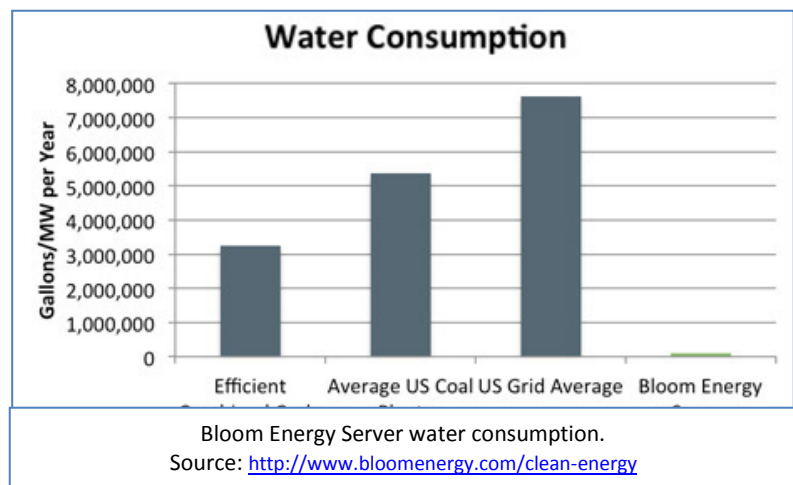
### ***Water Balance and Useful Heat***

Fuel cells not only save fuel by their inherent efficiency, but they also can save water – a benefit which will become important as pressures mount in water-stressed areas of the U.S. and the world. Sandia National Laboratories reports that the electricity industry is second only to agriculture as the largest user of water in the United States:<sup>9</sup>

- Electricity production from fossil fuels and nuclear energy requires 190,000 million gallons of water per day, which is 39 percent of all U.S. freshwater withdrawals. Almost three-quarters of this water is for fossil-fuel electricity generation.
- Each kilowatt-hour (kWh) generated from coal requires withdrawal of 25 gallons of water.<sup>10</sup>

The world's growing population will only increase the demand for both electricity and limited freshwater supplies. Already, the U.S. southwest faces a looming water crisis as demand begins to outstrip supply.

Fuel cell companies rightfully tout their technologies' water-saving features. ClearEdge Power claims its PureCell® Model 400 fuel cell saves about 1.6 million gallons of water per year compared to the U.S. electric grid. Bloom Energy states that its fuel cell technology uses no water beyond a 240-gallon injection at start up.



<sup>9</sup> [http://www.sandia.gov/energy-water/nexus\\_overview.htm](http://www.sandia.gov/energy-water/nexus_overview.htm)

<sup>10</sup> Ibid.



Fuel cell customers also report water savings:

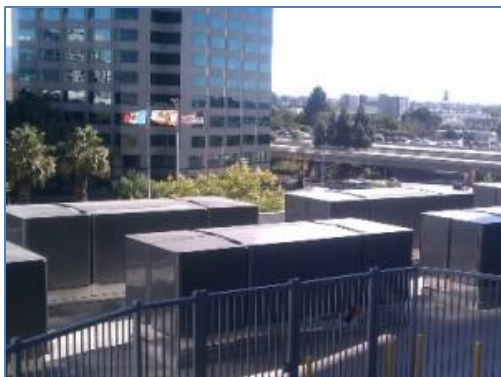
- **Fujitsu**, which has operated a 200-kW fuel cell at their Sunnyvale, California, campus for more than five years now, claims to save 800,000 gallons of water per year.<sup>11</sup>
- **Honda** installed a 1-MW fuel cell system at its U.S. headquarters in Torrance, California, and estimates that the fuel cell will save more than 3.25 million gallons of equivalent water used per year, compared to the average water demands of California power plants.
- A **Price Chopper** supermarket in Albany, New York, saves 4 million gallons of water each year with a 400-kW fuel cell that was installed in 2010.
- A **Verizon** call center in Garden City, New York, installed a 1.4-MW fuel cell system in 2005 that saves 5.5 million gallons of water annually.

In addition to saving water via normal operation, fuel cells also produce high quality heat. This is often captured and used for cogeneration (also called combined heat and power, or CHP), where the heat is used for facility heating (hot water, space heating, pools, laundry, etc.), reducing or even eliminating the need for boilers or water heaters on the property. For retail customers such as grocery stores, where the customer list includes **Whole Foods, Safeway, Albertsons, Stop & Shop, Star Market** and **Price Chopper**, that heat can be converted to cooling and used for refrigeration. By capturing useful waste heat, a fuel cell system's energy efficiency can approach 90 percent.

## ***Smaller Footprint***

Fuel cells offer high-density power in a small footprint. Bloom Energy's fuel cell server, for example, takes up little more than a parking space.

Four FuelCell Energy DFC3000 power plants that total 11.2 MW occupy only about one acre of land, which is a distinct advantage for providing environmentally friendly power in urban locations. By comparison, a concentrating solar power plant of similar capacity would occupy about 55 acres, according to DOE. Solar power also requires

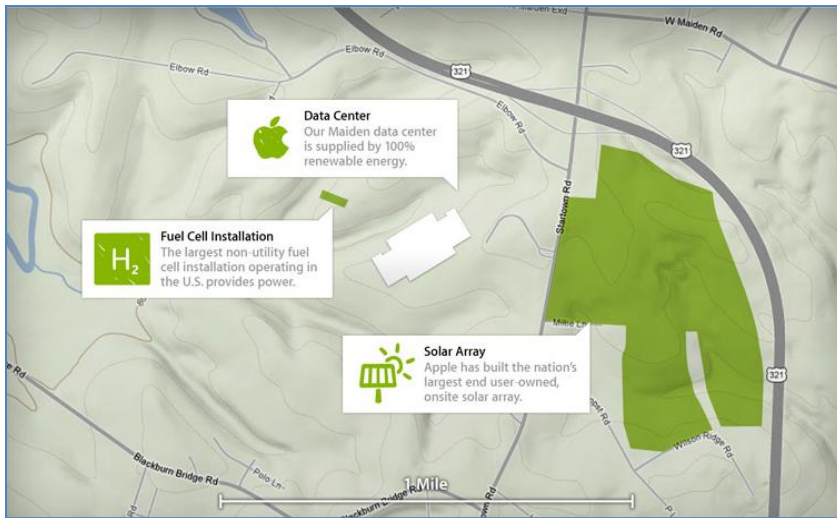


batteries for energy storage, and housing the batteries requires additional space.

Quiet, low-emission fuel cells are also flexible in their siting requirements, and are able to be located either inside of buildings, or out of doors – even on rooftops as companies like **Adobe Systems** and **Nokia** opted to do. Fuel cells are hardy, able to perform at ambient temperatures ranging

<sup>11</sup> [http://www.fujitsu.com/downloads/US/GND/ga\\_green.pdf](http://www.fujitsu.com/downloads/US/GND/ga_green.pdf)

from below zero to above 120 degrees F. Sound levels are typically just 65-75 decibels, equivalent to voices in conversation.



Apple's Maiden, North Carolina data center includes 10 MW of fuel cells and 20 MW of solar power. Note the relative size differential between the fuel cell installation and solar array.

## Fuel Flexibility

Fuel cells use hydrogen to make water, electricity and heat. Some systems, such as smaller units for telecommunications backup or to propel vehicles, use hydrogen directly. Others, such as larger-scale systems to power buildings, typically use other fuels as a hydrogen feedstock, the most popular being natural gas. Natural gas is often used today due to its widespread availability. Since there is no combustion, a fuel cell is more energy efficient and cleaner than burning natural gas in a combustion turbine. Some of these natural gas-fueled fuel cells have been running for more than a decade.

There are a wide variety of other sources for hydrogen, including other fossil fuels such as diesel, propane or JP-8, or more renewable pathways, such as biogas or methane, or using water via electrolysis, which could be conducted with solar or wind energy.

Facilities that generate organic waste as a byproduct of daily operations, such as wastewater treatment plants (WWTP), wineries, breweries, or food and beverage processing facilities can turn that waste into fuel via anaerobic digestion. This biogas can be fed into a fuel cell, providing not only a reliable and efficient electricity and heat source, but also tremendous savings from eliminating the need for costly waste removal.

One example of a business taking advantage of a fuel cell's ability to turn waste gas into power is **Gills Onions** of Oxnard, California. Since 2009, Gills Onions' award-winning Advanced Energy Recovery System (AERS) has used onion juice to produce biogas to power two 300-kW FuelCell Energy fuel

"After four years in operation, the system continues to solve the onion waste problem and provides clean energy. I would invest in this technology again."

*Steve Gill, Partner/Co-Founder, Gills Onions LLC*

cells, which provide 100 percent of the base-load electricity for the processing plant. Despite some initial technical issues that resulted in lower than expected performance during the first three years of operation, the AERS has generated 17 gigawatt-hours (GWh) of electricity since its commission. After stack replacements, the fuel cell system performance has markedly increased and the company anticipates that the fuel cells will supply close to 50 percent of the overall electricity needs and further reduce operational costs. We initially profiled Gills in our [2010 report](#), and since then, the company reports saving \$800,000 in 2012 in electricity and labor costs associated with the disposal of onion remains.

**Microsoft** is also examining the use of biogas to power data centers. The company is constructing a new, small-scale data center next to a wastewater treatment plant in Cheyenne, Wyoming that will use biogas, generated during the wastewater treatment process, to power its fuel cell system.

**BMW** has used methane gas to power part of the plant's total energy requirements, using methane gas collected from a local landfill, which is cleaned, compressed and delivered to the plant via a 9.5-mile pipeline. BMW and its partners (DOE, South Carolina Research Authority, Gas Technology Institute, Ameresco Inc., South Carolina Hydrogen and Fuel Cell Alliance) are working together to develop a method to convert some of this methane gas onsite into hydrogen for use the company's fuel cell forklifts.

Most companies can't locate a fuel cell near a biogas source, but there is another option to take advantage of this renewable fuel: "directed biogas." With this option, an equivalent amount of "scrubbed" (contaminants removed) and pressurized biogas is injected monthly into a natural gas pipeline. While this biogas does not flow directly to the fuel cell – it is instead consumed by other natural gas users - the injection "offsets" the natural gas used by the fuel cell. California's Self-Generation Incentive Program (SGIP), which provides funding to encourage stationary fuel cell installations, permits the use of both onsite and directed biogas. Companies taking advantage of this option include **Adobe, Coca-Cola/Odwalla, Cox Enterprises, eBay, Fireman's Fund, and NTT America.**

## ***Auto Manufacturers Go Green***

Major automakers will begin to sell fuel cell vehicles in the next few years. But automakers aren't only interested in fuel cells to power their vehicles. Like other mainstream adopters, these automakers are taking advantage of fuel cells' emissions savings and cost-efficient energy production by installing them at their facilities.

**Daimler** purchased a 100-kW Fuji Electric fuel cell from N2telligence and installed it at its Mercedes-Benz dealership in Hamburg, Germany, making it the world's first (and only) car dealership powered by a fuel cell. That location houses several of Daimler's B-Class FCEVs. At an event in August 2013, the company celebrated a year of fuel cell power and claimed the energy cost savings will lead to a payback that will be well achieved before the original calculation.



**Honda** installed five Bloom Energy fuel cell systems (totaling 1 MW) to provide 25 percent of the electricity needs for its 1.13 million square feet (sq. ft.) of office space, research, design and development operations, and parts distribution center in Torrance, California. The fuel cells, which run on natural gas, will reduce Honda's carbon dioxide emissions by approximately 16 million pounds over 10 years.

**Toyota Motor Sales, U.S.A., Inc. (TMS)** installed a 1.1-MW fuel cell from Ballard Power Systems to supply approximately half of the electricity for 6 headquarters buildings (also located in Torrance, California) during peak demand. The fuel cell is powered by hydrogen gas fed directly from a pre-existing industrial hydrogen pipeline that also supplies a filling station adjacent to the TMS campus used to fuel Toyota's and other manufacturers' fuel cell hybrid vehicle fleets. The fuel cell system is expected to reduce carbon dioxide (CO<sub>2</sub>) emissions by 3.3 million pounds during summer peak period operating hours and save \$130,000 a year in energy costs.



## Fuel Cell Financing

One of the most asked questions is, “How much does a fuel cell cost?”<sup>12</sup> The answer isn’t that simple, as many installations aren’t direct off-the-shelf purchases, instead using innovative financing mechanisms and state and federal tax incentives to fund them.

Power Purchase Agreements (PPA) are a mainstay of the energy industry for securing financing for alternative and renewable energy projects. They have the following major benefits to a “buyer” (aka, purchaser):

- Pre-defined price of electricity (\$/kWh) is specified for up to 20-year periods (providing budget certainty);
- On-site use of the system’s waste heat (when applicable);
- Systems are installed without any upfront capital (no capital expense for the buyer);
- System design, engineering, permitting, installation and utility interconnection are included;
- Operation and maintenance (O&M) costs are included for the duration of the contract; and
- Performance guarantees are provided.

Utilities, as buyers, have led the way in the utilization of PPAs to buy energy from independent producers who own large-scale generation projects (i.e., fuel cell, wind, solar PV, microturbines, etc.). The availability of this form of energy procurement, under long-term contracts, has evolved over a period of decades to now include commercial, non-profit and residential buyers.

An agreement (the PPA), unique to the specific project, is established between the “producer” (aka, seller) and the buyer. *The producer is the entity that owns the system asset and generates the electricity that is sold to the buyer.*

The producer is frequently organized as a special-purpose entity (e.g., a limited liability company). This entity is often comprised of the project developer and an outside investor(s) or the system manufacturer and an outside investor(s). *The producer secures and provides all of the capital necessary to initiate the project and own and operate the generation asset for the full term of the agreement.*

Sellers enjoy the following benefits:

- Stable and predictable cash flow
- Federal (and state, if applicable) tax credits, i.e., 30 percent Investment Tax Credit
- Accelerated depreciation, i.e., the federal Modified Accelerated Cost Recovery System (MACRS)
- Green attributes, e.g., market incentives, including Rebates, Renewable Energy Credits (RECs), and/or GHG reductions. The ownership of the green attributes is negotiable, if the buyer wishes to retain such, although it increases the overall fixed rate (i.e., cost/kWh) paid for the electricity.

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<sup>12</sup> DOE has an online Fuel Cell Power Analysis financial tool for analyzing high-temperature, fuel cell-based tri-generation systems, which produce onsite power and heat, as well as hydrogen that can be used for fueling vehicles or stored and later converted to electricity. The model uses a discounted cash flow rate of return methodology to determine the cost of delivered energy, and it quantifies energy inputs/outputs and greenhouse gas emissions. The model can be accessed at: [http://www.hydrogen.energy.gov/fc\\_power\\_analysis.html](http://www.hydrogen.energy.gov/fc_power_analysis.html).

Many manufacturers of distributed generation equipment (e.g., fuel cell and solar PV manufacturers) have forged key relationships with major banks and other financial sources. The capital commitments they have received are for the sole purpose of allowing them to directly offer their own clients PPAs (versus through a 3<sup>rd</sup> party project developer). Several of Bloom Energy clients have appreciated the availability of Bloom Electron's, the company's in-house PPA program. Bloom Energy forged agreements with global financial services companies to secure a dedicated pool of funds for this client financing option. In recent news, FuelCell Energy has teamed with NRG Energy, under a reportedly similar arrangement, to make PPAs available to their new clients. In the world of solar PV the number of PPAs in place is enormous and the sources of the capital range from banks to investment houses to international funds.

PPAs are inclusive of all costs, to include the on-going O&M costs for the full term of the agreement. It has thus become standard practice for the producer to contract directly with the manufacturer or the project developer to provide the O&M services for the term of the PPA. As a great result, all parties involved in a project have a vested interest in the quality of the product, its timely installation and the on-going support. The producer (who is often the owner and operator) is financially incented to ensure the system delivers the maximum possible kWhs each year of the term. In tandem, the buyer who has contracted for up to 100 percent of their annual electricity requirements at a known price during the full term of the PPA, has a financial incentive to select the best possible solution and PPA provider.

The net is that PPAs are often a great Win-Win for the buyer and producer and frequently ensure that viable generation projects get built. They are often seen as the key document in the development of independent generating assets. This has the added benefit of producing affordability and stability to projects of all sizes and types.

Bloom Energy recently joined with **Bank of America Merrill Lynch** to offer a new leasing program similar to a PPA where the customer is not responsible for upfront capital while locking in fixed rates for electricity. The program already boasts two customers, the **TaylorMade-adidas Golf Co.**, installing a 300-kW fuel cell system at its manufacturing facility in Carlsbad, California, and the **Honda Center** (home to the National Hockey League's Anaheim Ducks), which will install a 750-kW system in Anaheim, California.

Fuel cells are eligible for the Federal Investment Tax Credit (ITC) which provides a 30 percent tax credit or \$3,000/kW on a fuel cell system installed before 2017. A credit of 10 percent is also available for CHP systems. There is also an option to accept a grant in lieu of tax credit for fuel cell purchasers with insufficient tax liability (entities that pay taxes are eligible for the credit). The ITC also applies to fuel cells for forklifts and the hydrogen fueling infrastructure.

At the state level, the most active and generous policy helping stimulate fuel cell purchases and installations is California's SGIP, which provides \$2,225/kW for a fuel cell running on natural gas and \$4,500/kW for fuel cell systems utilizing renewable fuel, under which biogas and anaerobic digester gas (ADG) qualify. Other states have tax credits or favorable policies in place, while others have active industry associations or public agencies helping secure funding or loans for installations.

## Cost Savings

Fuel cells can generate power at a cost that can be competitive with grid electricity rates in some states. Bloom Energy's fuel cell systems can generate electricity at 8-10 cents/kWh.<sup>13</sup> ClearEdge Power's fuel cell, used in a 20-year light commercial application, can generate power at 9.1 cents/kWh, which includes the cost of the unit plus natural gas, maintenance, replacement parts, taxes and installation.<sup>14</sup> The levelized cost of energy for FuelCell Energy's systems is 14-15 cents/kWh without subsidies (depending on the cost of natural gas), and with incentives (such as federal and California incentives) their fuel cell systems can generate power at 9-11 cents/kWh.<sup>15</sup>

At these prices, large stationary fuel cell power can be cost competitive in states with high electricity prices for commercial or industrial applications, such as Alaska, California, Connecticut, Hawaii, Massachusetts, New Hampshire, New Jersey, and Vermont, among other states.<sup>16</sup>

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## Recent Purchases, Deployments and Installations

The following is a list of fuel cell purchases, deployments and installations by corporate customers since our last report (November 2012). There have been many others in the public sector, installed by universities, state and local governments, and municipalities. Fuel Cells 2000 tracks and compiles all of these in our [State Fuel Cell and Hydrogen Database](#).

### Stationary Fuel Cells

#### *Altera Corporation*

Altera, a manufacturer of Programmable Logic Devices, installed a 1-MW Bloom Energy system (two 500-kW fuel cells) at its headquarters in San Jose, California. The company estimates the annual CO<sub>2</sub> reduction will be 1.9 million pounds, or 2 percent less than 2011 levels.



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<sup>13</sup> [http://www.nytimes.com/2010/02/24/business/energy-environment/24bloom.html?\\_r=0](http://www.nytimes.com/2010/02/24/business/energy-environment/24bloom.html?_r=0)

<sup>14</sup> <http://www.greentechmedia.com/articles/read/ClearEdge-Buys-UTC-Powers-Fuel-Cell-Business>

<sup>15</sup> <http://www.greentechmedia.com/articles/read/fuelcell-energy-eyes-grid-support-market>

<sup>16</sup> [http://www.eia.gov/electricity/monthly/epm\\_table\\_grapher.cfm?t=epmt\\_5\\_6\\_a](http://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_5_6_a)

## **AT&T**

In late 2012, AT&T ordered an additional 9.6 MW of Bloom Energy fuel cell systems, making AT&T Bloom Energy's largest non-utility customer. The company originally purchased 7.5 MW from Bloom in July 2011 for 11 sites in California. This additional order expanded that to 17.1 MW of fuel cells helping to power 28 sites in California and Connecticut.



When fully operational, all of AT&T's fuel cells are expected to produce more than 149 million kWh of electricity annually. In 2012, 6.5 MW was installed in California and in 2013, 5.5 MW was installed in both California and Connecticut.

Bloom Energy also received \$23 million from Connecticut's Low-emissions Renewable Energy Credit (LREC) program for five AT&T sites (2.6 MW total) in the state. The locations include Bridgeport, Cheshire, Meriden, New London, and Waterbury.

## **Baker Hughes**

Baker Hughes, an oilfield services company, installed a 300-kW Bloom Energy fuel cell system to supply 60 percent of the power to the main office, laboratories, and vehicle maintenance workshop at its new 70-acre integrated campus in Shafter, California.

## **CableLabs**

Cable Television Laboratories, Inc. (CableLabs®), a non-profit research and development consortium, has installed an 8-kW fuel cell backup system from CommScope to support the head-end and cable modem termination system at its headquarters in Louisville, Colorado.



## **CenturyLink**

CenturyLink, a leading provider of Internet and TV services, has ordered 500 kW of Bloom Energy fuel cells to help power cloud, managed hosting and co-location services at its Irvine, California, data center. The fuel cells will help CenturyLink avoid approximately one million pounds of CO<sub>2</sub> emissions annually. The installation is expected to be complete by mid-2014.

## **First National Bank of Omaha**

The First National Bank of Omaha (FNBO) in Nebraska boasts one of the longest-running fuel cell systems in the world. The bank's 800 kW of ClearEdge Power fuel cells (four 200 kW units) has been powering its data center since 1999. In November 2013, FNBO announced an upgrade to a next



generation 400-kW fuel cell from ClearEdge Power to power its First National Technology Center in Omaha. The fuel cell is installed in the main floor of the building.

“We have had a great experience with the reliability afforded our data centre operations since installing our first fuel cells in 1999. They’ve repeatedly proven their value to our business, so we are confident in relying on this latest generation of fuel cell technology.”

-- [Brenda Dooley](#), *President, First National Buildings*

## ***Honda Center***

Home to the National Hockey League's Anaheim Ducks, the Honda Center in Anaheim, California, is installing 750 kW of Bloom Energy fuel cells with financing from a new leasing program with Bank of America Merrill Lynch. The fuel cells will provide 80 percent of the venue's base load power and 25 percent during a Ducks game or concert and allow the venue to offset about 2 million pounds of CO<sub>2</sub> annually.

## ***Intuit***

Intuit, a business and financial management solutions company, installed 500 kW of Bloom Energy fuel cells at its Woodland Hills, California, facility to generate 67 percent of the electricity required to power the building. After researching options, Intuit discovered that using Bloom Energy technology would save \$0.04 per kWh. The gas used to power the fuel cells is cheaper than electricity from the Los Angeles Department of Water and Power. At least 75 percent of the fuel that Intuit will use for the first five years of the Bloom Energy fuel cell will be biogas.<sup>17</sup>

## ***JPMorgan Chase***

JPMorgan Chase recently announced that it will install 500 kW of Bloom Energy fuel cells at its Morgan Christiana site in Delaware that will provide support power to its data centers. The head of JPMorgan Chase's property operation has stated that the company eventually wants to add additional fuel cells, for a total of 12 MW distributed between the company's three Delaware sites (Bear, Christiana, and Wilmington).

“The fact that Bloom is opening this additional manufacturing plant in Delaware gives us easy access to maintenance and monitoring engineers at our Morgan Christiana site. We hope to expand the pilot as we move forward. We are able to not only improve our facility right here in Delaware, but also fulfill our companywide commitment to investing in new technologies designed to reduce our impact on the planet.”

[Bill McHenry](#), *global head of Property Operation, JPMorgan Chase*

<sup>17</sup> [http://http-download.intuit.com/http.intuit/CMO/intuit/philanthropy/intuit\\_2011\\_sustainability\\_report.pdf](http://http-download.intuit.com/http.intuit/CMO/intuit/philanthropy/intuit_2011_sustainability_report.pdf)

## ***Juniper Networks***

Juniper Networks, a networking equipment manufacturer, has installed 1 MW of Bloom Energy fuel cells at its new Sunnyvale, California, headquarters. The new LEED-certified buildings also include a 300-kW photovoltaic system and a 97-kW solar water installation. Building A received Gold certification, while Building B was awarded Platinum status, the U.S. Green Building Council's greenest level.



“Juniper Networks is always looking at ways to reduce the environmental impact of our offices. One of the ways is the use of clean energy from alternative renewable resources. In our newest headquarters buildings, we installed 1 MW of Bloom Energy solid oxide fuel cells next to the parking garage to handle the large 24x7 electrical loads in our labs. This installation will result in a 24 percent reduction in electricity costs, and it emits no smog, resulting in the removal of approximately 14 tons of CO<sub>2</sub>.”

*John Lucas, Vice President, Worldwide Real Estate & Workplace Services*

## ***Kellogg's***

The Kellogg Company has installed a 1-MW Bloom Energy fuel cell system at its San Jose, California, Eggo® waffle bakery. The system generates about half of the facility's electricity and uses less water to generate this power than if it had been supplied by the utility grid.

## ***Life Technologies***



In 2012, Life Technologies installed a 1-MW Bloom Energy fuel cell system at its Carlsbad, California, campus. The fuel cells were installed in an uninterruptible power configuration to protect Life Technologies' labs, freezers, and critical experiments and provide 60 percent of the electricity needs for the facility while reducing carbon emissions by 30 percent. The company previously installed a 1-MW fuel cell system at its Pleasanton, California facility.

## **Macy's**

Bloom Energy has installed a 600-kW fuel cell to replace most of the grid-produced power at a Macy's distribution center in Cheshire, Connecticut. The state's Clean Energy Finance & Investment Authority (CEFIA) provided a \$913,121 grant to help fund the project, and the CT Public Utilities Regulatory Authority has classified the fuel cell as a Class I renewable energy source. In addition to powering the distribution center, Bloom intends to use the fuel cell to generate renewable energy credits and sell them to electricity suppliers to help meet their state-required renewable energy goals.



The fuel cell system is equipped with an uninterruptible power module so that the distribution center can operate during grid outages. This is an important feature – Macy's and Bloom report that during 2011 Connecticut businesses experienced about 140 hours of outages (excluding major storms).

"Macy's has made significant progress over the past five years in making our company more efficient, less wasteful and greener, which is important to our customers, associates, shareholders and communities. The more we do, the more we learn about the opportunities for future progress. For the needs of our company's facility at Cheshire – and the realities of the marketplace – we believe a Bloom Energy Server is the cleanest, most efficient and reliable option available."

[Amy Hanson](#), Executive Vice President of Macy's

## **Microsoft**

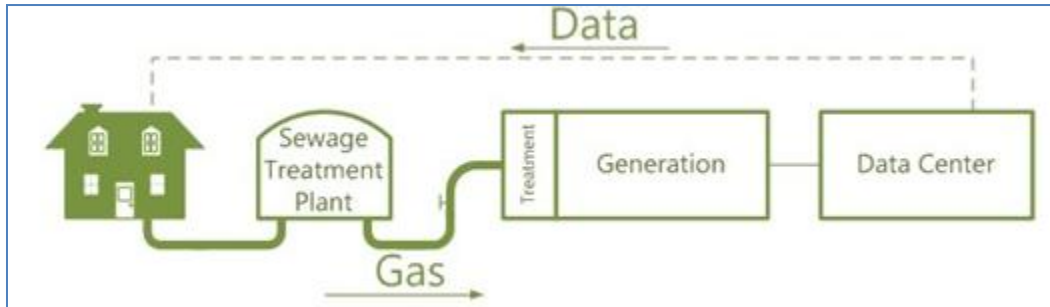
Microsoft is investing \$5.5 million on a Data Plant pilot project in Cheyenne, Wyoming, which will be comprised of a fuel cell-powered data center designed to run on biogas generated from landfills or water treatment plants. It will be the first zero-carbon data center in the world.

The project will use a 300-kW FuelCell Energy DFC® fuel cell power plant installed next to the Dry Creek Water Reclamation Facility that will operate in a grid-independent to provide continuous power to the data center in the event of a grid outage. Any excess power will be provided to the water reclamation facility to offset their electric costs.

The project has received \$1.5 million from the Wyoming State Loan and Investment Board. Other organizations involved include Cheyenne Light, Fuel & Power, Cheyenne LEADS, Wyoming Business Council, the Western Research Institute, and the University of Wyoming.

At the end of the R&D pilot project, Microsoft will donate the Data Plant (including the fuel cell, clean-up equipment, servers and modular data center) to the City of Cheyenne and the University of Wyoming for

further research. The clean CO<sub>2</sub> produced from the Data Plant will be used by local Wyoming's oil and gas industries as there is a CO<sub>2</sub> pipeline that intersects the state.



"Electricity is one of our largest operating costs, so we expend significant efforts on strategies to reduce the amount of electricity that we consume and on finding innovative ways to drive down those costs. Off-grid data centers like the Cheyenne Data Plant have the potential to reduce our costs if we can deploy this sort of concept at scale and if we can demonstrate that we can meet the service requirements to ensure reliable service for our customers. Our goal with the project is to show that the concept is possible and will support more pervasive use, enabling greater flexibility for siting and powering future data centers. Our hope is we will be able to replicate this model globally."

[Brian Janous](#), utility architect, data center advanced development at Microsoft

## **Nokia**

The Finnish communications and information technology corporation, Nokia, installed a 400-kW Bloom Energy system at its U.S. headquarters in Sunnyvale, California. Currently 75-80 percent of the fuel used by the fuel cells is biogas, specifically landfill gas, and total carbon dioxide consumptions at the site have dropped by 87 percent. This is a monthly reduction of around 80 tons of CO<sub>2</sub>, which represents six percent of Nokia's gross emissions from all office and R&D sites in the Americas region.



## **Pratt and Whitney Rocketdyne**

Aerospace engine manufacturer, Pratt & Whitney Rocketdyne (PWR) installed a ClearEdge Power 400-kW fuel cell at its headquarters in Canoga Park, California. The fuel cell will generate more than 18 percent of the energy supply at the company's DeSoto Avenue campus. Excess heat will be used to heat a neighboring building, allowing PWR to turn off its boilers in that particular building, further reducing site emissions. PWR opted for fuel cell over other renewable technologies because it can provide clean energy 24/7. The fuel cell cost about \$3 million to install but qualifies for both state and federal tax credits via California's SGIP incentives and the federal Investment Tax Credit.

## **Ramar Foods International**



Asian food product manufacturer, Ramar Foods International, has installed a 200-kW Bloom Energy fuel cell at its Pittsburg, California, manufacturing and packaging plant. The fuel cell system will provide 65 percent of the site's electricity – which will save the company at least \$15,000 each month – and will reduce the plant's carbon footprint of by over 400,000 pounds annually.

"As part of our greater sustainability efforts, we've had our eye on a number of alternative energy solutions, and fuel cells make the most sense for our operations, which run 24/7, unlike the sun. Not only is the Bloom Energy server a great investment for our company and the environment, but the system is made here in California, which is very important to us."

[PJ Quesada](#), VP of Marketing for Ramar Foods International

## **Roll Global**

Roll Global, the parent company of Fiji Water, POM juice, Wonderful-brand pistachios and almonds, Paramount Citrus and other brands, has installed a total of 4.6 MW of Bloom Energy fuel cells at various sites around California. This includes a 1.6-MW system at Paramount Citrus, the largest fully integrated orange, lemon and clementine grower, packer, shipper, and marketer of fresh citrus in North America, at its 640,000 sq. ft. CUTIES citrus packinghouse in Delano, California – the world's largest citrus packinghouse. The natural gas-powered fuel cell system supplies 35 percent of the energy required by the plant. A 2.7-MW solar system is also installed at the site.

## **Sprint**

Sprint received \$250,000 from DOE to deploy fuel cell-powered backup power systems for rooftop telecommunications equipment. The project aims to demonstrate how modular and lightweight fuel cell systems can be easily installed without heavy cranes and refueled from the ground, eliminating the need for transporting fuel to rooftops. Sprint will be working with fuel cell manufacturers Alteryx Systems, CommScope Inc., First Element Energy LLC, and ReliOn Inc. as well as hydrogen providers IGX Group and Air Products and Burns & McDonnell Engineering Inc. Sprint currently has hundreds of fuel cells installed around the U.S. providing backup power to its telecommunication sites.

## **Target**

Target is now powering two stores in California, one in San Francisco and the other in Pasadena, with 200-kW Bloom Energy fuel cells at each site. The pilot is part of a larger effort to incorporate onsite energy-generating technology at Target locations that includes rooftop solar panels (currently on the roofs of 26 stores) that convert sunlight into electrical energy for the stores during the day. If these first fuel cell pilots are successful, the team will look to expand the installations to stores on the East Coast, particularly those prone to power outages.

"A typical Target store has energy needs during the day that can be significantly met by solar energy produced by solar panels on the roof. So consider this: If we were to combine daytime solar generation with fuel cell energy powering the store's additional energy needs, we'd approach a facility that runs on 100 percent self-generated power."

[Dave Hughes](#), group manager of Target's Energy & Carbon Management team in Minneapolis

## **Taylor Farms**

Taylor Farms, a producer of fresh-cut fruits, vegetables and salad has installed a 1-MW Bloom Energy system at its Salinas, California, salad processing plant. The fuel cell system provides 70 percent of needed power to the 85,000 sq. ft. facility and cuts CO<sub>2</sub> emissions by 30 percent.



"This innovative clean energy system allows us to continue exploring ways to reduce our impact on the environment and moves us much closer to our specific goal of taking this Salinas production facility off the electrical grid."

[Bruce Taylor](#), Taylor Farms chief executive officer

## **The TaylorMade-adidas Golf Company**

The TaylorMade-adidas Golf Company is taking advantage of a new leasing program created by Bank of America Merrill Lynch and Bloom Energy to install a 300-kW fuel cell system at its manufacturing facility in Carlsbad, California.

## **URBN**

URBN (formerly Urban Outfitters) received a \$1.2 million alternative energy grant from the Commonwealth of Pennsylvania and a \$400,000 custom incentive grant from PECO to install a 600-kW Bloom Energy fuel cell at its main office in Philadelphia's historic Navy Yard. It's the first all-electric fuel cell installation in Pennsylvania, and will lead to annual cost savings of \$407,949, according to State

Senator Larry Farnese. The system covers 60 percent of the building's energy requirements and will offset 4.8 million lbs of CO<sub>2</sub> each year.



## ***Verizon***

Verizon has made some major investments in fuel cells lately. The company is installing a total of 1 MW of Bloom Energy fuel cell systems at three California locations – two call-switching centers in Los Angeles and San Francisco, and a data center in San Jose. The fuel cells are expected to generate over 16 million kilowatt hours of clean electricity in the state each year.

Verizon is also investing \$100 million in a solar and fuel cell energy project that will include 22 ClearEdge Power PureCell® Model 400 (8.8 MW) of fuel cell systems at Verizon sites, including corporate offices, call centers, data centers, and central offices, in California, New Jersey and New York. The systems will generate more than 60 million kilowatt hours of electricity and result in a carbon reduction of approximately 6,000 metric tons per year.

Verizon has operated a 1.4 MW ClearEdge Power fuel cell system at its Garden City, New York central office since 2005.

## ***Walmart***

Walmart installed its first Bloom Energy Server at its Lancaster, California store in 2009 and today has 35 Bloom installations at stores and distribution centers in California, totaling 11.4 MW. Most recently, Bloom Energy received more than \$14.3 million from Connecticut's LREC program for six Walmart and Sam's Clubs sites (2.3 MW total) in the state. The locations include Hartford, Manchester, New Haven, Newington (2), and Waterford.

## ***Whitbread***

U.K. hospitality company, Whitbread, is conducting a two-year fuel cell trial at its Glastonbury Premier Inn, using a Baxi Innotech fuel cell to generate energy and to meet approximately 20 percent of the hotel's total hot water demand. The demonstration project is supported under the European Union's Ene.field program which is contributing 40 percent of the project costs.

## ***Williams-Sonoma***

Kitchenware retail giant Williams-Sonoma has installed a 600-kW Bloom Energy system at its Rocklin, California, data center.

## ***Xilinx***

Technology company Xilinx installed 1 MW of Bloom Energy fuel cells at its headquarters in San Jose, California, and saved \$810,000 in the first 10 months. The company projects \$580,000 a year in savings going forward.<sup>18</sup> The fuel cell generates electricity approximately \$0.03 less than the cost of utility electricity (\$0.11 vs. \$0.14) and the company took advantage of both federal and state tax



incentives - \$3.15 million from California's SGIP and \$2.7 million from the federal Investment Tax Credit.

## **Material Handling**

### ***Ace Hardware***

Ace Hardware purchased 65 Plug Power GenDrive<sup>®</sup> fuel cell units for material handling vehicles for its new Retail Support Center that is currently being built and set to open in early 2014 in Wilmer, Texas. Nuvera Fuel Cells is supplying the hydrogen with its PowerTap<sup>™</sup> on-site hydrogen generation, compression, and storage equipment that will be located on a small pad located adjacent to the new facility. Dispensers will be located indoors, making refueling convenient for operators. Ace Hardware chose fuel cells after comparing its costs and performance with standard and fast charge lead acid batteries. Nuvera estimates that as a result of the new equipment, Ace Hardware will be producing 70 tons less carbon dioxide and avoid 330,115 kWh of electrical consumption annually<sup>19</sup>.



### ***Associated Wholesale Grocers***

Associated Wholesale Grocers (AWG) acquired over 500 Plug Power GenDrive<sup>®</sup> fuel cell units to use at its facilities in Kansas City, Missouri, and Pearl River, Louisiana. AWG has allocated 297 of the fuel cells for the Missouri fleet.

### ***FedEx Express***

FedEx Express received \$3 million from DOE to develop a fuel cell-powered delivery truck with a range of up to 150 miles per fueling. The company will test 20 of these trucks at FedEx facilities in Tennessee and California. FedEx will work with fuel cell manufacturer Plug Power and Smith Electric Vehicles on

<sup>18</sup> <http://svlg.org/wp-content/uploads/2013/05/Copy-of-2-Xilinx.pdf>

<sup>19</sup> <http://www.nuvera.com/index.php/pressroom/press-releases/142-nuvera-fuel-cells-to-supply-hydrogen-at-ace-hardware-s-new-distribution-center>



the project. FedEx is already working with Plug Power on a ground service equipment demonstration, operating 15 fuel cell-powered baggage tow tractors at one of its domestic airports in Memphis, Tennessee, and has 35 fuel cell-powered forklifts deployed at a Springfield, Missouri service center.

### ***H-E-B Grocery Company***

Grocer H-E-B already has a small fleet of fuel cell forklifts operating at its San Antonio food distribution center and is now participating in a DOE demonstration of hydrogen fuel cells to power TRUs. Nuvera Fuel Cells will work with Thermo King to integrate fuel cells in a refrigerated trailer supporting H-E-B's San Antonio site, delivering goods from the distribution center to stores in the area.

### ***Mercedes-Benz***

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

### ***Sysco***

Sysco is participating in two separate demonstration projects from DOE's EERE Fuel Cell Technologies Office to demonstrate the use of hydrogen fuel cells to power TRUs. Two fuel cell manufacturers were each awarded \$650,000 to demonstrate their TRU. Plug Power will be working with Carrier Transicold to put TRUs on Carrier trailers delivering products for a Sysco Corporation distribution center in Long Island, New York. Nuvera Fuel Cells will work with Thermo King to integrate fuel cells in a refrigerated trailer supporting a Sysco food distribution facility in Riverside, California. Both Sysco sites already have hydrogen infrastructure in place, fueling fleets of fuel cell-powered material handling vehicles. The Long Island site has 50 vehicles and the Riverside facility has 105.

In November 2013, Plug Power received an additional \$500,000 from the NYSERDA to demonstrate its TRU fuel cell on a Carrier Transicold refrigeration unit servicing Sysco's distribution center in Long Island, New York, for a period of 12 months.

### ***UPS***

DOE recently awarded \$3 million to the Center for Transportation and the Environment (CTE) in Atlanta, Georgia, to develop a fuel cell hybrid electric walk-in delivery van with a 150-mile range per fueling. CTE will retrofit 15 UPS delivery vans with fuel cell hybrid power trains from fuel cell manufacturer Hydrogenics and test these vehicles at distribution facilities across California. The University of Texas's Center for Electromechanics, Electric Vehicles International and Valence Technology will also participate in this project.

## **Appendix 1: Companies/Corporations with Fuel Cells Operating or Planned in the U.S. (Mobile and Stationary Applications)**

Ace Hardware	Gills Onions	Roll Global
Adobe	Golden State Foods	Safeway
Albertsons Supermarket	Google	San Diego Gas & Electric
Alpha Energy	Hartford Steam	Shark's Sports & Entertainment
Alltera	H-E-B	Sheraton
Americold	Hilton Hotels	Sierra Nevada
Apple	Honda Center	Sprint
Associated Wholesale Grocers	HP Pavilion	Staples
AT&T	Intuit	Star Market
Baker Hughes	JMB Realty	Stihl, Inc.
Baldor Specialty Foods	JPMorgan Chase	Stone Edge Farm
Bank of America	Juniper Networks	Stop & Shop
Becker + Becker	Kaiser Permanente	Super Store Industries (SSI)
Becton Dickinson (BD)	Kellogg's	Sutter Home Family Vineyards
BMW	Kimberly-Clark	Sysco
Bridgestone-Firestone	Kroger	Target
Cabela's Sporting Goods	Lafayette Hotel	Taylor Farms
CableLabs	Life Technologies Corp.	Testa Produce
Cache Creek Casino Resort	Lowe's	The Palace apartments
Carla's Pasta	Macy's	The Ratkovich Co.
Cache Creek Casino Resort	Martin-Brower	The TaylorMade adidas Co.
Carter's	Mercedes-Benz	Time-Warner Cable
CBS Studios	MetroPCS	T-Mobile
Central Grocers	Microsoft	TST, Inc.
CenturyLink	Napa Wine Company	Toyota Motor Sales U.S.A.
Coca-Cola	NBCUniversal	United Natural Foods Inc. (UNFI)
Constellation Place	Nestlé Waters	UPS
Cox Communications	News Corp.	URBN (formerly Urban Outfitters)
CVS	Nissan North America	US Foodservice
Cyprus Semiconductor	Nokia	Verizon
Delmarva Power	NRG Energy	Wakefern Food Corp.
Diversey	NTT America	Walmart
Dominion	Odwalla	Washington Gas
EARP Distribution	Owens Corning	Wegmans
East Penn Manufacturing Co.	Pepperidge Farm	Westin Hotels
eBay	Pratt & Whitney	Whole Foods Market
FedEx	Pratt Rocketdyne	Williams Sonoma
Fireman's Fund	Price Chopper	WinCo
FirstEnergy Generation Corp.	Procter & Gamble	Xilinx
First National Bank of Omaha	Ramar Foods International	
Fujitsu	Roger's Gardens	

*This list is not a comprehensive list of U.S. fuel cell installations. To learn more about these fuel cells and others, please visit Fuel Cells 2000's free, searchable State Fuel Cell and Hydrogen Database (<http://www.fuelcells.org/fuel-cell-databases>).*

## **Appendix 2: Companies Included in This Report and Additional Resources**

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

### **Fuel Cell Manufacturers and Hydrogen Suppliers**

Air Products and Chemicals, Inc. – [www.airproducts.com](http://www.airproducts.com)

Altery Systems – [www.altery.com](http://www.altery.com)

Ballard Power Systems – [www.ballard.com](http://www.ballard.com)

Baxi Innotech – [www.baxi-innotech.de](http://www.baxi-innotech.de)

Bloom Energy – [www.bloomenergy.com](http://www.bloomenergy.com)

ClearEdge Power – [www.clearedgepower.com](http://www.clearedgepower.com)

CommScope – [www.commscope.com](http://www.commscope.com)

First Element Energy – [www.firstelementenergy.com](http://www.firstelementenergy.com)

FuelCell Energy – [www.fuelcellenergy.com](http://www.fuelcellenergy.com)

Fuji Electric – [www.fujielectric.com](http://www.fujielectric.com)

Hydrogenics – [www.hydrogenics.com](http://www.hydrogenics.com)

IGX Group – [www.igxgroup.com](http://www.igxgroup.com)

ITM Power – [www.itm-power.com](http://www.itm-power.com)

Linde Gas – [www.lindeus.com](http://www.lindeus.com)

Linde Material Handling – [www.linde-mh.com](http://www.linde-mh.com)

Nuvera Fuel Cells – [www.nuvera.com](http://www.nuvera.com)

Plug Power – [www.plugpower.com](http://www.plugpower.com)

ReliOn – [www.relion-inc.com](http://www.relion-inc.com)

### **Fuel Cells 2000**

Fuel Cells 2000 is a non-profit education and outreach program of the [Breakthrough Technologies Institute](http://www.fuelcells.org) and offers numerous resources on its website, <http://www.fuelcells.org> for any audience.

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

- All reports, including previous Business Case reports and the State of the States: Fuel Cells in America series;
- State Fuel Cell and Hydrogen Database, which includes all U.S. fuel cell installations, vehicle demonstrations, hydrogen fueling stations and state legislation and policies;
- Comprehensive charts, including Fuel Cell Vehicles, Fuel Cell Forklifts, Specialty Vehicles, Fuel Cell Buses, Worldwide Hydrogen Fueling Stations and Fuel Cell Equity and Investment;
- Other resources including conference presentations, articles, regional, state and international organizations and alliances and fuel cell financing information.

### **DOE Energy Efficiency and Renewable Energy Fuel Cell Technologies Program**

The DOE Fuel Cell Technologies Program conducts comprehensive efforts to overcome the technological, economic, and institutional obstacles to the widespread commercialization of fuel cells and related technologies. <http://www1.eere.energy.gov/hydrogenandfuelcells>

## **Photo Credits**

**Page 4:** Bloom Energy fuel cells at eBay data center, South Jordan, Utah

**Page 5:** Schematic of N<sub>2</sub>telligence's fuel cell installation (photo courtesy of Fuji Electric)

**Page 6:** Ballard Power fuel cell at Telestra site <http://exchange.telstra.com.au/2013/10/31/more-power-to-our-network/>

**Page 7:** FuelCell Energy installation in Bridgeport, Connecticut

<https://www.dom.com/about/stations/fossil/dominion-bridgeport-fuel-cell.jsp>

**Page 8:** Fuel cell-powered forklift using Plug Power fuel cells (photo courtesy of Plug Power); Fuel cell powered forklift from Linde Material Handling at BMW's Leipzig, Germany, manufacturing plant (photo courtesy of Linde Material Handling)

**Page 9:** FedEx vehicle fueling at airport

[http://www.hydrogen.energy.gov/pdfs/review13/mt011\\_petrecky\\_2013\\_o.pdf](http://www.hydrogen.energy.gov/pdfs/review13/mt011_petrecky_2013_o.pdf)

**Page 12:** FuelCell Energy installation at Sheraton in San Diego, California; Bloom Energy installation at Adobe Systems in San Jose, California

**Page 13:** Schematic of Apple data center <http://www.apple.com/environment/renewable-energy/>

**Page 15:** Top – Fuji Electric fuel cell at Daimler dealership; Middle – Bloom Energy installation at Honda in Torrance, California; Bottom – Ballard Power Systems fuel cell installation at Toyota in Torrance, California

**Page 18:** Bloom Energy installations at Altera Corporation in San Jose, California

**Page 19:** Bloom Energy fuel cell at AT&T California site; CommScope fuel cell at CableLabs

**Page 21:** Bloom Energy Installations at Juniper Networks in Sunnyvale, California (courtesy of Juniper Networks)

**Page 22:** Bloom Energy fuel cells at Life Technologies in Carlsbad, California, and Macy's in Cheshire, Connecticut

**Page 23:** Microsoft biogas diagram

<http://www.globalfoundationservices.com/posts/2012/november/19/microsoft-recycles-waste-to-provide-clean-power-for-data-center-r-and-d>; Bloom Energy installations at Nokia headquarters in Sunnyvale, California.

**Page 24:** Bloom Energy installation at Ramar Foods International plant in Pittsburg, California (Ramar photo courtesy of Jose Carlos Fajardo/Bay Area News Group via Contra Costa Times)

**Page 25:** Bloom Energy installation at Taylor Farms processing plant in Salinas, California

**Page 26:** Bloom Energy installation at URBN, Philadelphia, Pennsylvania

**Page 27:** Bloom Energy installation at Xilinx headquarters in San Jose, California

<http://svlg.org/wp-content/uploads/2013/05/Copy-of-2-Xilinx.pdf>

**Page 27:** Nuvera PowerTap™ hydrogen generation system (courtesy of Nuvera Fuel Cells)

Bloom Energy images from [www.bloomenergy.com](http://www.bloomenergy.com) unless otherwise noted.