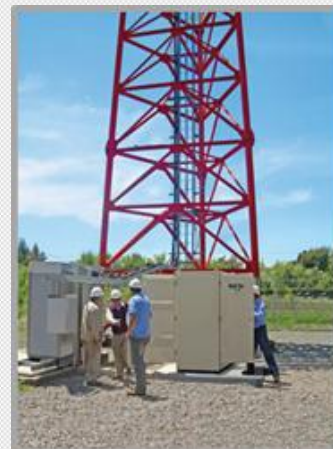




Fuel Cell &
Hydrogen Energy
Association

The Business Case for Fuel Cells 2015: Powering Corporate Sustainability



Authors and Acknowledgements

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

About This Report

The report provides an overview of recent private sector fuel cell installations at U.S. businesses, as well as highlighting international deployments until October 1, 2015. This list is by no means exhaustive. FCHEA estimates, over the past few decades, hundreds of thousands of fuel cells have been installed around the world, for primary or backup power, as well as in various other applications including portable and emergency backup power, heat and electricity for homes and apartments, material handling, passenger vehicles, buses and consumer electronics.

This report is the sixth in a series. The 2014, 2013, 2012, 2011, and 2010 *Business Case for Fuel Cells* reports can be accessed [here](#). The companies profiled in those reports are collectively saving millions of dollars in electricity costs while reducing carbon dioxide emissions by hundreds of thousands of metric tons per year.¹

The information contained in this report was gathered from public sources and through personal contact with fuel cell manufacturers and the customers and organizations profiled. Please contact us at jgangi@fchea.org or 202-261-1339 with any corrections, updates or questions.

About FCHEA

The [Fuel Cell and Hydrogen Energy Association](#) (FCHEA) is the trade association for the fuel cell and hydrogen energy industry. FCHEA members represent the full global supply chain, including fuel cell materials, components and systems manufacturers, hydrogen producers and fuel distributors, government laboratories and agencies, trade associations, utilities, and other end users.

Images

Cover images (clockwise from top left): Doosan fuel cell system at News Corp., New York City; Bloom Energy Servers at a retail Walmart store; Plug Power ReliOn stationary fuel cell system on rooftop in Bayview, California; fuel cell installation at a telecom tower; world's first fuel cell cargo trucks deployed by FedEx at Memphis International Airport using Plug Power fuel cells; Plug Power fuel cell-powered forklift refueling at a Walmart warehouse using a Plug Power GenFuel fueling system; forklift equipped with a Plug Power fuel cell operating at a Coca-Cola warehouse. Images included in the report are hyperlinked to source and credited in Appendix 3.

¹ As estimated by FCHEA based on company statements.

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Corporate Adoption Spearheads Fuel Cell Growth



Not long ago, few outside the industry could explain what a fuel cell was or how it operated. Now business customers regard fuel cells as a clean and efficient option to generate power, and sometimes heat, cooling, and hot water, for their facilities, warehouses and data centers; a generator of reliable, high quality backup power; a source of clean off-grid power; and a cost-efficient option to replace batteries to power forklifts and material handling equipment (MHE).

As more companies look for reliable, resilient technologies to provide constant power as well as reduce its carbon footprint, distributed generation (DG) and renewable energy are becoming more than buzzwords – they are becoming a mainstay in corporate culture. Fuel cells are a unique technology that can fit into a range of categories – primary, backup, or off-grid power generation scaled to fit any need (ranging from kilowatts to megawatts), as well as power for motive operations such as MHE – and provide a wide range of benefits.

Fuel cell customers are saving money on fuel and labor costs, lowering emissions, and yielding substantial energy savings through increased efficiency and reliability. Many have now become repeat customers, purchasing additional, and in many cases, larger, fuel cell systems for their facilities, or are expanding into other fuel cell uses such as material handling or backup power. With this corporate and municipal adoption, the emerging fuel cell market now reports sales above \$2 billion annually.¹

The 5th annual Deloitte Resources Study of more than 600 U.S. companies found that 55% of businesses generate at least some portion of their electricity supply on-site.² Nine percent of these companies generate electricity using fuel cells.³

Our own assessment of the Fortune 500 list shows the same percentage (9%) using fuel cell power generation. Of the top 100 companies on the Fortune list, the number increases significantly, with 23% using fuel cells for primary or backup power generation, or for MHE. American companies are adopting DG because it makes sound business sense. The Deloitte report sums up the rationale for DG this way:

- Businesses have an assured, reliable electricity supply.
- They have better energy management control.
- Clean, renewable energy boosts the company's image.
- DG reduces energy costs.

Fuel cells check all the boxes. The technology is available today and competitive with other power generation technologies.

Throughout this report you will read the customers' own words, latest corporate materials, and published data that showcase the range of benefits that fuel cells provide. This includes emission reductions, lower maintenance costs, high reliability, silent operation, fast and flexible fueling, and constant, high-quality uninterrupted power.

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

Stationary fuel cell benefits include:

- Primary or backup power generation
- Grid-tied or independent from the grid
- High quality, reliable power
- High electrical and electrical/thermal efficiency
- Exceptionally low emissions
- Lightweight, rugged, quiet
- Modular, scalable
- Fuel flexible (conventional or renewable fuels)

Fuel cell-powered MHE benefits include:

- Zero emissions
- Battery replacement
- Delivers consistent power throughout shift
- Reliable performance in cold environment
- Fast and easy fueling
- Eliminates battery charging room
- Above benefits increase worker productivity and lower operational costs

| Companies in Top 50 of the Fortune 500 Operating or Developing Fuel Cells | | |
|---------------------------------------------------------------------------|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ranking | Company | Details |
| 1 | Walmart | <ul style="list-style-type: none"> 44 retail Walmart and Sam's Club (CA, CT) using fuel cell power > 2,500 fuel cell forklifts operating at U.S. and Canadian distribution centers |
| 5 | Apple | 10 megawatt (MW) fuel cell installation provides power to iCloud data center (NC) |
| 6 | General Motors | Fuel cell electric vehicle (FCEV) development |
| 8 | General Electric | Solid oxide fuel cell (SOFC) development |
| 9 | Ford | FCEV development |
| 10 | CVS Health | 65 fuel cell forklifts operating at distribution facility (NY) |
| 12 | AT&T | <ul style="list-style-type: none"> 34 sites (CA, NY) using large-scale fuel cell power generation Hundreds of fuel cells installed at cell towers around the U.S. |
| 15 | Verizon | 10.4 MW of fuel cells operating at 13 sites (CA, NY, NJ) |
| 20 | Kroger | > 1,000 fuel cell forklifts operating at 6 sites (includes CA, CO, KY) |
| 21 | JPMorgan Chase | Fuel cell system powers data center (DE) |
| 23 | Bank of America | Fuel cell providing power at a call center (southern CA) |
| 24 | IBM | 1 MW fuel cell power plant powering data center (CT) |
| 27 | Boeing | Developing fuel cells for aircraft |
| 31 | Microsoft | <ul style="list-style-type: none"> Renewable, biogas-powered fuel cell powers data center (WY) Works with startup fuel cell company to develop small-scale SOFCs |
| 32 | Procter & Gamble | > 400 fuel cell forklifts operating at four sites (CA, LA, NC, PA) |
| 33 | Home Depot | 172 fuel cell forklifts operating at warehouse (OH) |
| 36 | Target | Two retail stores using fuel cell power generation (CA) |
| 37 | Johnson & Johnson | Two facilities powered by fuel cells (CA) |
| 40 | Google | Fuel cell system delivers power to headquarters (CA) |
| 43 | Comcast | Fuel cell system operating at the Western New England Regional Headquarters (CT) |
| 45 | United Technologies | <ul style="list-style-type: none"> Pioneer in fuel cell development Currently working on fuel cells for submarines |
| 47 | UPS | Participating in DOE-funded fuel cell delivery van demonstration |
| 50 | Lowe's | 161 fuel cell forklifts operating at distribution center (GA) |

Chart created by FCHEA based on info from <http://fortune.com/fortune500/>

Businesses Bank on Range of Fuel Cell Benefits

A fuel cell generates electricity using an electrochemical reaction, not combustion, and depending on the fuel source, produces zero or near-zero polluting emissions.

Besides electricity, the only byproducts a fuel cell generates are water and useful heat. When fuel cells are sited near the point of energy use, heat can be captured for heating (called combined heat and power [CHP] or cogeneration), or even cooling and refrigeration, resulting in system efficiencies of 90% or greater. CHP allows users to reduce or eliminate the need for boilers or water heaters and their associated costs and emissions.

Array of Savings

Fuel cells allow for savings on multiple levels – cost savings on electricity or fuel purchases; emissions savings from being a more efficient, non-combustion technology; time savings from less maintenance, fewer fuelings and longer run time; and water savings at a time where droughts are hitting some states so hard that restrictions are being imposed on water use.

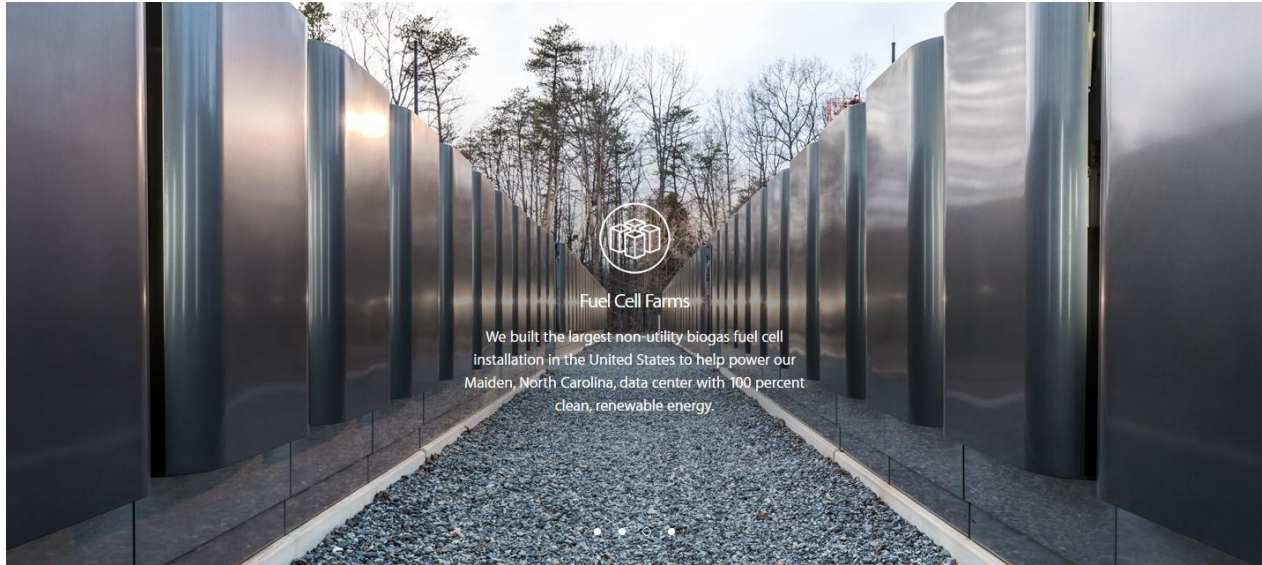
Fuel cells also save customers from worry – the worry that if the grid goes down during a bad storm or heat wave, business will grind to a halt. As companies around the country set corporate sustainability goals to reduce emissions and environmental impact, maintaining standards of high quality, reliable power is still usually highest on the list when choosing energy generation technologies. Fuel cells fit the bill. Fuel cells deliver high-quality power; are rugged, resilient and reliable; and able to connect to the grid, stand alone, or partner with other power sources and fuels, both conventional (batteries, natural gas, methanol, diesel) or renewable (solar, wind, biogas).

Combining technologies enables some companies to move completely off the grid while providing constant, assured power with substantial reductions in carbon emissions. Technology company Apple, for example, moved its data center

| Maiden, North Carolina 100% renewable since opening June 2010 | | | |
|------------------------------------------------------------------------------------------------------------------------------------|-----|--------------------------------------|-----------------------------|
| Duke Energy Carolinas Default Grid Mix | | Apple Actual Renewable Energy Use | |
| Nuclear | 51% | PV1 | 19% |
| Coal | 38% | PV2 | 20% |
| Other | 11% | Fuel Cells | 37% |
| Renewable | <1% | NC GreenPower | 24% |
| 2014 Emissions (metric tons CO ₂ e/year) | | | |
| Default Grid Emissions | | 92,306 | Apple's Effective Emissions |
| | | | 0 |
| <small>Duke Energy Carolinas: 2014 Statistical Supplement generation data Apple Energy: Actual fiscal 2014 energy data</small> | | | |

Renewable energy use at Apple's Maiden, NC data center

in Maiden, North Carolina, completely off the grid by combining a 10-MW fuel cell system with solar generation. Apple reports that in 2014 its facility effectively had zero emissions compared to the local North Carolina grid, eliminating 92,306 metric tons of CO₂ pollution that year.



Apple's website highlights their 10-MW NC fuel cell farm

Energy and Cost Savings

The National Fuel Cell Research Center, in a 2011 report, [Build-Up of Distributed Fuel Cell Value In California: 2011 Update Background and Methodology](#), found that fuel cells, operating on either natural gas or renewable biogas, provide economic value of five to 27 cents per kWh. This is based on quantifying the range of benefits fuel cells provide and also some of the costs they help to avoid.

One example of savings comes from the Wonderful Company (formerly Roll Global) which first turned to fuel cells in 2012. The company now has 3.05 MW of Bloom Energy fuel cells operating at several of its food and beverage company sites in California. This includes 250 kW at its corporate headquarters in Los Angeles; 2 MW at two facilities in Delano, including a Paramount Citrus

Combined Energy Savings of all 7 Fuel Cell Locations

Estimated Energy Savings

| | |
|------------------------------------------|---------------------|
| Original Cost: | \$41,412,164 |
| Incentives Received: | \$25,297,980 |
| Net Investment: | \$16,114,184 |
| Savings after 5 Years: | \$10,118,275 |
| Projected Savings after 20 Years: | \$63,256,916 |
| Payback: | 6.5 Years |

Wonderful Company – Fuel Cell Return on Investment

Halos packinghouse facility; 400 kW at Paramount Farms in Lost Hills; and 400 kW at its POM Wonderful facility in Del Rey.

The Wonderful Company was able to take advantage of the federal Investment Tax Credit (ITC), which provides either \$3,000/kW or up to 30% of the installed costs. Since the facilities were located in California, the fuel cell systems were also eligible for the state's Self Generation Incentive Program (SGIP) rebate. There were other incentives that helped bring the initial cost down by more than two-thirds.

Kern Energy Watch, a joint partnership of Pacific Gas and Electric Company, Southern California Edison, Southern California Gas Company, the County of Kern, and participating municipalities, profiled Wonderful Company in a case study. They report that the projected energy savings Wonderful will receive through their use of fuel cells could reach more than \$10 million after 5 years and \$63 million after 20 years. The estimated payback of Wonderful's fuel cell investment is 6.5 years.⁴

Water Savings

One benefit of fuel cells that has been extremely attractive of late is that they operate in water balance. According to the Union of Concerned Scientists' EW3 Energy-Water Database, the average coal plant in the U.S. uses 58.2 million gallons of water per 200 kW annually and combined cycle natural gas plants use 420,000 gallons per 200 kW annually.⁵

In comparison, Doosan Fuel Cell America's 400-kW fuel cell does not require any external water, as all the water needed is generated and utilized within the fuel cell. Each system can save up to 2 million gallons of water per year compared to the electric grid.⁶ Doosan's current U.S. fuel cell fleet totals more than 30 MW of capacity, which is estimated to save 100 million gallons of water per year, enough to fill 180 Olympic-sized swimming pools.⁷

Bloom Energy's fuel cell, after a 240-gallon water injection at start-up, also doesn't use water during operation. A 1-MW Bloom Energy system would save up to 86 million gallons a year compared to the U.S. grid.⁸

"At the end of the day, it takes water to grow food, and California's Central Valley provides the nation with half of the country's fruits, vegetables and nuts. We use water responsibly, down to the drop, and we are very wise in our water usage. When you walk through most orchards and farms, you don't see pools of water anywhere,"

Steven Clark, vice president for corporate communication, the Wonderful Company



Water Usage Compared

| Generation Type | Gallons per MWh | Annual Gallons (per MW of Bloom equivalent generation) |
|----------------------------------------------|-----------------|--------------------------------------------------------|
| Bloom Energy Server | 0 | .001 million |
| Combined Cycle Nat Gas Plant (cooling tower) | 250 | 2.1 million |
| Coal Power Plant (open loop cooling) | 35,000 | 291 million |
| U.S. Grid | 10,300 | 86 million |

Bloom Energy Server Water Usage Comparison

One company, food distributor Golden State Foods (GSF), has made water savings part of its corporate culture. GSF’s Chicago site makes use of ionized water, a by-product of the site’s fuel cells, which power forklifts, to clean warehouse floors.⁹

Reliability

In addition to providing quality, assured power to data centers and other facilities requiring constant communication, customers are finding that fuel cells can step up to provide seamless power for crucial services during storms and outages.

In the white paper, [*Enhancing the Role of Fuel Cells for Northeast Grid Resiliency*](#), the Fuel Cell and Hydrogen Energy Association included several case studies where fuel cells helped businesses and other critical services maintain power through hurricanes and other weather-related outages.¹⁰ This includes telecommunications towers, grocery stores, utility substations and hospitals.

When the power does go down in a community, the electricity from a fuel cell can also enable sites to serve as emergency shelters. In the past, schools with fuel cells installed have stepped up in this capacity, but it is now trending in the corporate world. One example is Beacon Capital Partners in New York, which installed a 400-kW Doosan Fuel Cell America fuel cell at its flagship Manhattan property at 1211 Avenue of the Americas, home to Fox News and its parent company News Corp. In addition to providing 20% of the building’s electricity, 50% of its hot water for heating, showers and bathroom sinks, the fuel cell is also configured to be able to provide backup power to a section of the first floor of the building. This enables the building to become a shelter in the case of an emergency, as well as to the outdoor Fox News ticker to provide important news updates and public service announcements.

Emission Reductions

Fuel cells utilize the chemical energy of fuel to generate electricity without combustion in a process that is inherently efficient and much cleaner than combustion technologies. When using pure hydrogen, the only emissions from the fuel cell itself are water and waste heat. Some larger fuel cells for stationary applications use natural gas as the hydrogen feedstock within the fuel cell system, but even that produces far fewer emissions than conventional power plants. These systems can also be configured to capture the waste heat byproduct, which can then be put to use in heating or cooling capacities, increasing its efficiency to upwards of 90%.

Verizon is one of the fuel cell industry's biggest customers, having invested \$137 million in both fuel cell and solar panel installations to help power its facilities, including office buildings and data centers across the U.S.¹¹ Verizon is working with two fuel cell manufacturers, Doosan Fuel Cell America and Bloom Energy, and currently operates 10.4 MW of fuel cells at 13 sites in California, New Jersey and New York. This is 1.4 MW more than was detailed in our last report. Recent installation updates include an 800-kW Doosan Fuel Cell America system located at Verizon's Data Center in Elmsford, New York. The company also recently replaced its long-running fuel cell system at its Garden City, New York, headquarters, with 800-kW of Doosan's next-generation fuel cells. Verizon's fuel cell fleet saves more than 5,376 metric tons of CO₂ per year.

Another customer, Kellogg's, installed a 1-MW Bloom Energy fuel cell at its Eggo® bakery in San Jose, California in 2013, generating enough renewable energy to provide power for half of the facility's annual energy consumption.¹² The company estimates the fuel cell reduces the facility's total system CO₂ emissions by more than 1,000 tons annually.¹³

This is a natural evolution of our sustainability efforts and of our use of alternative energy to power a variety of our facilities. These projects will reduce our carbon footprint, relieve demand on the electrical grid, and enhance the resiliency of our proven service continuity – even during outages.”

James Gowen, Verizon's Chief Sustainability Officer

“The fuel cell technology generates one megawatt of electricity onsite, which offsets almost half of the electricity Kellogg purchases from the utility provider. Our new fuel cell technology represents a sizable investment in our San Jose plant and our environmental commitments, as it will help us to deliver against our goals to reduce energy use and greenhouse gas emissions.”

Diane Holdorf, chief sustainability officer, The Kellogg Company

| Verizon PureCell® Installations (g) | Emissions Reduction * | Equivalent “Green” Benefit |
|-------------------------------------|-----------------------|----------------------------------------------|
| CO ₂ Emissions | 5,376 MT † | Planting 1,240 acres of trees |
| NO _x Emissions | 18 MT | Taking 1,062 cars off the road |
| Water Saved * | 27 MG † | Saving enough water to fill 41 Olympic pools |

* Compared to central power generation. † MT = metric tons; MG = million gal

Emissions savings through Verizon’s use of Doosan Fuel Cell America fuel cell systems

Flexible Footprint

Fuel cells are scalable and quiet, which allows for flexible siting – indoors in a parking garage or basement or outside, on a rooftop or in a parking lot. The technology has a much smaller footprint than solar arrays or wind turbines. In urban areas, access to sun or wind can be intermittent and finding enough space to site a power project can be a limiting factor, steering many companies towards fuel cells, or a combination of fuel cells and solar, or wind, to satisfy round-the-clock power needs.

For example, in Connecticut, two utilities are taking advantage of fuel cells’ reduced footprint.

- Dominion’s 14.9-MW FuelCell Energy fuel cell power plant in Bridgeport only utilizes 1½ acres of land to provide enough electricity to power 15,000 homes.
- Also in Bridgeport, United Illuminating plans to install 2.8-MW of FuelCell Energy fuel cells alongside a 2.2-MW solar array. The fuel cells will use ¼ acre of land compared to more than 8 acres for the solar installation.

The Wonderful Company (formerly Roll Global) also reports its 1,000 square foot pad of fuel cells can produce as much energy as six acres of solar panels.¹⁴

Several companies, including Nokia and Adobe Systems have installed large-scale stationary fuel cell systems within the confines of their building’s rooftops in California.

Many telecommunications companies are expanding networks across the globe, into both remote and rural



Ballard fuel cell system installed on rooftop

locations and in crowded metropolitan cities. Since fuel cells require little maintenance, last longer, and are lighter than batteries, rooftop installations are becoming more commonplace. Fuel cell manufacturer, Ballard Power Systems, has installed more than 100 of its methanol-fueled fuel cell systems on rooftops in major cities around the world to provide backup power to critical telecom sites.¹⁵

As we report on page 19, Sprint is participating in a U.S. Department of Energy (DOE)-supported project to install fuel cells on rooftops.

In Their Own Words

Many fuel cell customers are speaking out about their experiences with fuel cells and the technology's benefits. Businesses are excited that being environmental can also be economical. We've compiled some recent YouTube videos² that feature corporate customers highlighting their company's sustainability and efficiency efforts and how fuel cells are playing a key role to achieve them.

Stationary Fuel Cell Customers

[Adobe Systems](#)



The 1.2-MW fuel cell system generates 30% of energy onsite. Adobe sources natural gas from a local landfill to reduce CO₂ emissions by 12 million pounds a year. Justina Hyland, site manager, says the company plans to increase the installation from 1.2 MW to 3 MW.

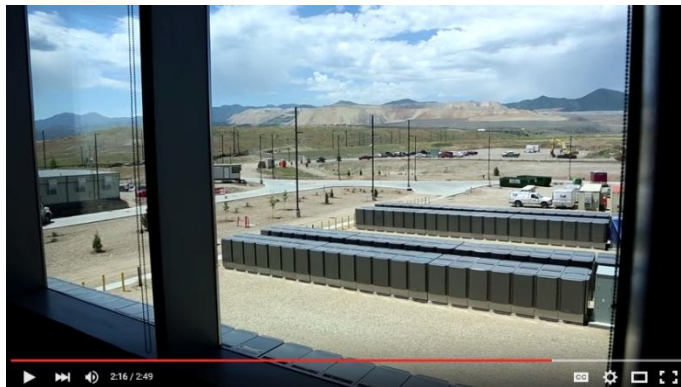
² Videos are hyperlinked through company name and listed in Additional Resources.

Taylor Farms



The 1-MW Bloom Energy fuel cell system reduces the facility's carbon footprint by up to 30% and water used by 99.99%. In 2013, the fuel cells provided 37% of the plant's total energy needs, ran 22% cleaner than the electric grid, and achieved a 12% reduction in CO₂.

eBay



Dean Nelson, eBay's VP of Global Foundation Services, said the company's 6-MW Bloom Energy fuel cell system at its mission critical data center helps create "cleaner commerce." The company is "adding value to the business – more than just cutting costs and increasing performance, we're addressing the environmental side, so we've got both the economic and ecological benefits."



Kaiser Permanente



Kaiser's goal is a GHG reduction of 30% by 2020, and energy reduction of 20%. The 300-kW fuel cell at its San Marcos medical building helps with critical peak pricing which helps keep medical costs down for patients. Kaiser Permanente also has installed 4 MW of fuel cells at other California facilities, including Baldwin Park, Downey, Fontana, Irvine and Ontario.

Walmart



David Ozment, Senior Director of Energy says "It's a clean technology...it's probably the most attractive technology of all the technology we've installed today."

Life Technologies (acquired by Thermo Fisher Scientific)



The 1-MW Bloom Energy fuel cell system has exceeded the company's expectations with performance and efficiency. It only takes up the equivalent of 6 parking spaces. The fuel cells are on 24/7, generating electricity to power refrigerators and freezers that house millions of dollars of inventory.

Macy's



Peter Longo, President of Logistics and Operations, says, "Macy's is very focused on what we would call important brand values... is to give back and be a sustainable organization and we have been, I think, very much a leader in our industry at this. The partnership and teamwork...it's a win-win situation for state of Connecticut, it's a win situation for Bloom, and a win situation for Macy's, so how can you get much better than that?"

Microsoft



Microsoft operates the world's first biogas-fueled data plant through a successful partnership between state, local groups, and industry.

Interlink Connectivity, Inc.



Alvin Starr, Interlink's CEO, reports that the advantage of fuel cells over batteries for backup power is that, so long as fuel is delivered to the system, you can keep it running, even for weeks on end. The fuel cell takes up roughly 8 sq.ft. of floor space – a benefit since floor space is at a premium: "The less floor space that is used for the power solution the better off we are."

Various Customers



This Bloom Energy video features a few of its customers, including eBay, Walmart and Google, on a panel discussing their decision to install fuel cells and experience with the technology.

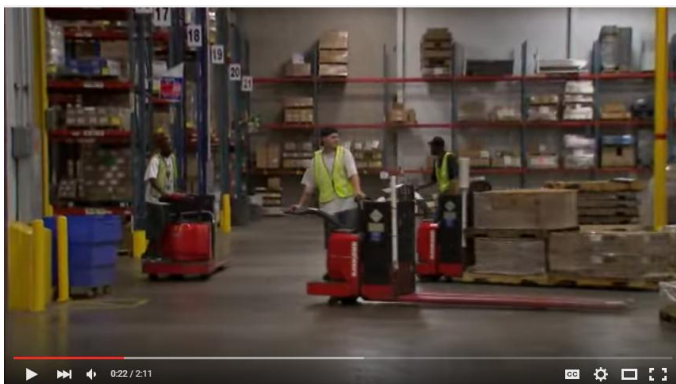
Material Handling Equipment Customers

BMW



Since 2010, BMW has operated about 100 fuel cell forklifts at its Greer, South Carolina, manufacturing plant and later added 130 more, making BMW one of the world's largest users of fuel cells at a single site. The fuel cells last twice as long as batteries and avoid the use of more than 1.8 million kWh per year of electricity consumption for battery charging. Additionally, CO₂ emissions are lowered by 1,200 tons of annually.

UNFI (1)



The entire material fleet at UNFI's Sarasota, Florida, distribution center is powered by fuel cells. Michael Gartska, the site's operation manager, reports the amount of time formerly dedicated to battery changes has now become productive time and that all operators are trained on how to fuel the trucks with hydrogen.

UNFI (2)



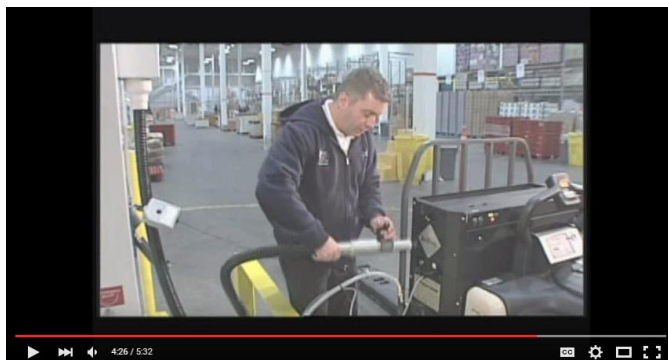
UNFI reports 10-12 hours of continuous use per hydrogen fueling, which is “absolutely outstanding” and an improvement over their previous battery vehicles, which operated 5-7 hours per charge.

Volkswagen



In Chattanooga, Tennessee, Volkswagen is seeing up to almost \$500,000 a year in savings due to the use of Plug Power's drop-in fuel cell products. In 2015, 45 lift trucks were in use at the facility and, by 2016, the entire fleet will use fuel cell power.

Wegman's



Wegman's reports the benefits of fuel cell material handling equipment over the previously used battery equipment: increased productivity; forklifts are lighter, smoother and easier to handle; no power loss during the shift; operates well in the refrigerated environment; and cost savings. “It's our intention to convert the remaining pallet jacks & forklifts to hydrogen power as they need to be replaced.”

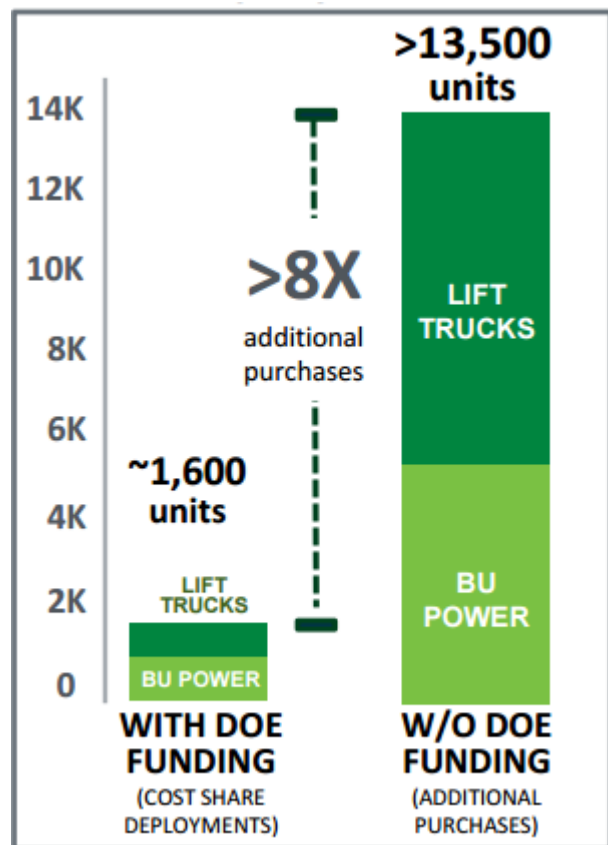
Government and Business Working Together

The U.S. Department of Energy (DOE), through its Fuel Cell Technologies Office, has sponsored market transformation demonstration projects that provide insight, data, and real world experience of fuel cells in potential new markets and applications. These projects bring together multiple partners for cost-share and expertise, including many in the private sector community, to test and demonstrate the value proposition of fuel cells and hydrogen.

In 2009, the American Recovery and Reinvestment Act (ARRA) provided a spark to the fuel cell industry, funding \$41.9 million for deployments of nearly 1,300 fuel cells for material handling vehicles (504 units at 8 facilities) and telecommunications backup power (607 at 203 sites). This funding was matched by approximately \$51 million in industry cost share. Private sector partners included H-E-B Grocery, Federal Express, AT&T, Sprint, Sysco (Houston) and through supply chain management company GENCO, Wegman's, Whole Foods, Sysco (Philadelphia), Coca-Cola, and Kimberly-Clark.

Several of those companies went on to purchase additional fuel cells, without government funding, including AT&T, Federal Express, Sprint and Sysco. Others, such as Whole Foods and Coca-Cola, moved into other applications, installing large-scale stationary fuel cells at stores and processing plants.

Since the ARRA, other DOE-led market transformation projects have brought government and industry together to demonstrate the feasibility of fuel cells in various real-world settings and gather crucial data needed to move markets forward. Approximately 1,600 fuel cell deployments, funded through ARRA and other DOE programs, have led to the additional purchase of more than 13,500 fuel cell systems.



Impact of Department of Energy cost-share funding on commercial purchases

The following are some of DOE's most recent projects partnering with industry.

Federal Express

In April 2015, a two-year demonstration of fuel cell-powered cargo tractor was launched at the Federal Express facility at Memphis International Airport in Tennessee, with partners electric airport ramp vehicle manufacturer Charlatte America and fuel cell manufacturer Plug Power. DOE provided \$2.5 million, with \$2.5 million in cost share. Fifteen cargo tractors will be tested at the airport and are expected to save more than 175,000 gallons of diesel fuel over two years, as well as reduce the airport's carbon dioxide emissions by more than 1,700 metric tons.¹⁶ The vehicles will operate at the airport for 87,600 hours over the course of the demonstration.

There are more than 60,000 ground support equipment trucks in North America, representing an important market and opportunity to offer further energy and environmental benefits at airports.

Sprint

Sprint has installed several hundred backup power fuel cell systems at cellular towers and sites around the U.S. with ARRA funding, as well as on its own.

At the end of 2013, the company partnered again with DOE and a range of fuel cell manufacturers, hydrogen providers and others to deploy fuel cell-powered backup systems for rooftop telecommunications equipment.¹⁷ The purpose of the project is to demonstrate modular and lightweight fuel cell systems that can be easily installed without heavy cranes and can be refueled from the ground – overcoming the need for transporting fuel to rooftops.

United Parcel Service (UPS)

UPS, the Center for Transportation and the Environment (CTE), fuel cell manufacturer Hydrogenics and partners are developing a fuel cell hybrid electric walk-in delivery van with a 150-mile range per fueling. The team will then retrofit 17 UPS delivery vans to test at distribution facilities across California. DOE is contributing \$3 million for this four-year project.¹⁸

“While these hydrogen fuel cell powered cargo tractors may not look big, they are capable of pulling 40,000 lbs. of cargo on airport dollies in even the harshest weather conditions; and they embody our strong commitments to innovation and to reducing our environmental footprint.”

John Dunavant, vice president of the FedEx Express World Hub in Memphis, Tennessee



Sysco and H-E-B Grocery

Sysco and H-E-B Grocery have had fuel cell-powered forklifts operating at their facilities for several years, with Sysco's fleet after the initial two sites supported by ARRA growing to seven sites and more than 700 vehicles.

Both companies are currently involved in DOE-funded demonstration projects focused on fuel cell-powered refrigeration transport units (TRUs).¹⁹ Two fuel cell manufacturers, Nuvera Fuel Cells and Plug Power, were each awarded \$650,000 to integrate their fuel cells into TRUs, working with trucking partners Thermo King and Carrier Transicold. Plug Power is integrating four of its fuel cell refrigeration units onto Carrier Transicold trailers delivering products for a Sysco Corp. distribution center on Long Island.²⁰ Nuvera Fuel Cells is doing the same with its fuel cell working with Thermo King, making deliveries for H-E-B's food distribution center in San Antonio, Texas.²¹

BMW

BMW operates one of the largest fleets of fuel cell-powered material handling vehicles at its Spartanburg, South Carolina, manufacturing facility. The automaker recently completed a Landfill Gas-to-Hydrogen project at that plant with its partner, SCRA, and support from DOE.²²

The project explored the economic and technical feasibility of converting landfill gas into hydrogen of sufficient purity to power FCEVs. SCRA and the DOE conceived the project based on the department's broad interest in examining biogas sources that could be used to generate renewable hydrogen and BMW's interest in exploring whether landfill gas-sourced hydrogen could provide the company an on-site hydrogen production capability. BMW currently procures its hydrogen from a large industrial gas supplier.

The first phase of the Landfill Gas-to-Hydrogen Project showed that a viable business case can be made for large-scale operation. The second phase of the project confirmed that commercially-available technologies are available to recover fuel cell-quality hydrogen from a landfill gas source.²³ As the final step in the project, several of BMW's fuel cell-powered material handling units were fueled with hydrogen from the project equipment with

"BMW was happy to facilitate the trial conversion of landfill gas into renewable hydrogen. This was a valuable project to support alternative energy testing and underscores BMW's commitment to environmental sustainability. Proving that reformed hydrogen can be successfully obtained from landfill gas is transformational for the hydrogen industry."

Manfred Erlacher, President and CEO, BMW Manufacturing Co.

no detectable difference in performance compared to that achieved when fueled by the existing delivered hydrogen at BMW.²⁴

Young Brothers Ltd. / Foss Maritime

A Maritime Hydrogen Fuel Cell Project is underway in conjunction with Young Brothers, Ltd., a subsidiary of Foss Maritime and primary interisland shipper of goods within Hawaii.²⁵

The project began field trials in August 2015 in a six-month deployment at Young Brothers' facility in the Honolulu Harbor, replacing a diesel generator used to provide power for refrigerated containers on land and on transport barges. DOE's Fuel Cell Technologies Office and the U.S. Department of Transportation's Maritime Administration are co-funding the pilot project.

Hydrogenics Corp. designed and manufactured a containerized 100-kW hydrogen fuel cell unit, which includes the fuel cell engine, a hydrogen storage system, and power-conversion equipment. The system is built into a standard shipping container.

After using the hydrogen fuel cell unit on land, Young Brothers Ltd. will, for six months, deploy the unit to power refrigerated containers onboard barges traveling between the Honolulu and Kahului harbors. Sandia National Laboratory will analyze the operational, safety, and cost performance data from the project to develop a business case for using hydrogen fuel cells at other commercial ports.

“The hydrogen fuel cell is exciting new technology. It underscores once again our company’s willingness to innovate and find solutions to decrease emissions from our operations. The entire maritime industry stands to benefit from the work we’ll be doing with Sandia’s hydrogen researchers.”

***Paul Stevens, CEO and President
of Foss Maritime***



New Corporate Customers

Since our last report, new corporations have joined the ranks and turned to fuel cells for on-site generation of clean, reliable, and high quality power generation at their corporate facilities, or to power forklifts in their warehouses and distribution centers.

In addition, companies already operating fuel cells – such as AT&T, Becker and Becker, Equinix, FedEx, IKEA, Pepperidge Farm, Stop & Shop, and Walmart – have experienced the technology’s benefits firsthand and purchased additional units.

Some, like AT&T and Walmart, use fuel cells in different applications, highlighting the range of fuel cell uses. These two corporations alone use fuel cells to power retail stores, data centers, administrative offices, network equipment facilities, material handling equipment, and cell phone towers.

Stationary Power Generation

Disney Pixar Animation Studios

1-MW fuel cell system

Disney’s strategy for meeting their long-term goal of zero net greenhouse gas emissions follows a hierarchy: 1) avoiding emissions, 2) reducing emissions through efficiencies, 3) replacing high-carbon fuels with low-carbon alternatives, and 4) using certified offsets for our remaining emissions. The company’s goal is, by 2020, to reduce net emissions by 50% from 2012 total levels.

The company reports that key efficiency projects during 2014 included the installation of a 1-MW fuel cell on its Pixar campus in Emeryville, California, to supplement electricity use.



Pepperidge Farm

1.4-MW FuelCell Energy Direct FuelCell® (DFC®)

Pepperidge Farm, a Campbell Soup Company, has been a fuel cell customer since 2006, when it installed a 250-kW FuelCell Energy fuel cell at its Bloomfield, Connecticut, plant. It became a repeat customer in 2008, when it installed another system, a 1.2-MW FuelCell Energy fuel cell, which, when combined with previous unit, provides 70% of the facility's required energy.

In March 2015, Pepperidge Farm announced will install another 1.4-MW FuelCell Energy fuel cell system in Bloomfield. Fuel cell start-up is planned for January 2016. The new 1.4-MW fuel power plant will be installed adjacent to the existing fuel cell plant, and together, will meet approximately the entire energy needs of the facility with an on-site solar array supporting peak power needs. Utilizing CHP will allow the recovery of heat that will be used to generate steam for the baking process, as well as to preheat supply air entering the thermal oxidizer used for odor destruction. The heat will also be an integral part of an ammonia-based chilling system to be installed.

Maxim Integrated

1-MW Bloom Energy Server

Maxim Integrated designs, manufactures, and sells analog and mixed-signal integrated circuits for a variety of industries.

In August 2014, the company installed a 1-MW Bloom Energy Server at its San Jose, California, headquarters. The fuel cell system is anticipated to reduce the carbon footprint of the campus by approximately 20%.

Pepperidge Farm

"The addition of this low-emission fuel cell power plant to complement our existing fuel cell installation further enhances our sustainability profile, reflecting our strong commitment to the environmental welfare of the communities in which Pepperidge Farm and our parent, Campbell Soup, operate."

Harry Pettit, Manager of Systems and Infrastructure Engineering, Pepperidge Farm

Maxim Integrated



CenturyLink

500-kW Bloom Energy server

After announcing in 2013 it would be installing a fuel cell at its Irvine, California, data center, CenturyLink, Inc. flipped the switch on its 500-kW Bloom Energy system in March 2015.

This facility houses the company's cloud, managed hosting, and colocation services. The fuel cells are expected to produce nearly 4.4 million kWh of electricity per year.

Fed Ex

500-kW Bloom Energy Server

In August 2014, FedEx Ground deployed a 400-kW Bloom Energy fuel cell at its facility in Rialto, California. The system provides about one-third of the facility's electricity and will reduce CO₂ emissions by at least 230 metric tons a year. Rialto has become one of the most energy-efficient hubs at FedEx Ground, home to one of the company's largest rooftop solar installations.²⁶

FedEx Express has operated a 500-kW Bloom Energy fuel cell system at its Oakland, California, hub since 2010, which, when combined with the solar energy system at that location, provided 44% of that facility's electricity demand in FY14.

FedEx also deployed 40 forklifts powered by Plug Power fuel cells at its Springfield, Missouri, Service Center in 2010 and is currently demonstrating fuel cell ground support equipment at the FedEx World Hub in Memphis, Tennessee.

CenturyLink

"Synchronizing the fully commissioned Bloom Energy fuel cells to our electrical infrastructure supports the escalating power demands for network and IT infrastructure in an environmentally sustainable way."

David Meredith, senior vice president at CenturyLink



FedEx



Bloom Energy fuel cell systems at FedEx's Oakland, California location

AT&T

Multiple Bloom Energy Servers

In the 2014 version of this report, AT&T had reported 16.7-MW of fuel cells installed in several states. Since then, that number has grown to 21 MW of fuel cells installed at 34 sites in California, Connecticut, New Jersey and New York.²⁷

More locations have been made public since the last report, including a 1-MW fuel cell system located in Fairfield, California, and a 400-kW fuel cell system in Gardena, California, both using Bloom Energy fuel cell systems.

Equinix

1-MW Bloom Energy Server

Equinix, a global interconnection and data center company, installed a 1-MW Bloom Energy biogas fuel cell at its SV5 International Business Exchange data center in San Jose, California. The fuel cells will provide 8.3 million kWh of electricity per year and a 15% carbon dioxide reduction over the local PG&E grid. The project also includes uninterruptible power modules configured to protect a portion of the data center's energy load from electrical outages.

In 2013, Equinix installed a 100-kW Fuji Electric fuel cell at its FR4 data center in Frankfurt, Germany. In addition to providing reliable power, the fuel cell system is configured to provide fire suppression by managing the oxygen level in the room, leaving enough oxygen for staff to breathe comfortably but not enough oxygen to support a fire.²⁸ The company now generates approximately 30% of its global energy from clean, renewable sources, with a long-term sustainability goal of 100% clean and renewable energy across its global platform of more than 100 data centers.²⁹

AT&T

"AT&T is using Bloom Energy fuel cell technology at 34 AT&T facilities, decreasing CO₂ emissions by 50%."

Randall Stephenson, CEO of AT&T



Equinix

"This project demonstrates Equinix's commitment to find cost-effective ways to reduce our carbon footprint and move toward 100% renewable energy. By working with Bloom Energy to purchase 100% biogas and fuel cells, we're able to support the energy needs of our customers in an environmentally responsible way."

Sam Kapoor, chief global operations officer, Equinix

SouthernLINC Wireless

Multiple Relion Fuel Cell Systems

Plug Power has signed a multi-year contract with SouthernLINC Wireless, a subsidiary of Southern Company, to provide ReliOn integrated backup power fuel cell solutions for use in its wireless network, which supports Southern Company's communication needs and provides a wireless communications network for customers. SouthernLINC Wireless anticipates deploying as many as 500 new LTE sites utilizing the Plug Power ReliOn integrated solution, which includes fuel cell systems and bulk refillable hydrogen storage, DC plant rectifiers and distribution, battery technology and space for radio equipment, in an environmentally-hardened outdoor cabinet.

Southern Company is an Atlanta-based energy company serving 4.4 million customers in the Southeastern United States.

Walmart

Fuel cells installed at multiple retail locations

Walmart, a major fuel cell customer, continues to deploy the technology to power retail sites and power material handling equipment operating across the U.S. and in Canada.

In April 2015, Walmart reported that 44 retail stores (42 in California, 2 in Connecticut) use fuel cell power generation from Bloom Energy.³⁰ While most are financed through power purchase agreements (PPAs), Walmart owns the recently -installed Connecticut fuel cell systems. The retail Walmart stores located in New Haven and Waterford, Connecticut, use the fuel cells to provide 40-60% of the store's electricity requirements. These fuel cells are also configured to power a portion of the store's load for an extended period of time when grid power is lost.

Walmart is a part of the RE100 initiative, committing to source 100% of their electricity from renewable energy to reduce CO₂ emissions.

Southern Company

In 2014, Southern Company held the SO Prize competition to recognize the most inventive solutions to challenges faced by the electric utility industry. One of six winners was a team that envisioned a plan to use existing power plants to make hydrogen, which could be transported by liquid carriers to fueling stations using existing oil pipeline infrastructure. The gas could be used to power FCEVs on roadways or in industrial settings.

Southern Company's [SO Prize](#)

Walmart

"Our approach is consistent with our business strategy and mission, and will drive the biggest, fastest and most sustainable acceleration of new renewable energy projects globally....we believe it's the right thing to do and the best way to leverage our size and scale to drive positive change.

As a result, our approach is to directly drive new renewable energy projects through on-site generation such as solar, wind and **fuel cells**; large project off-take agreements such as wind farms; wholesale energy purchases in deregulated markets coupled with renewable energy supplies; utility green power purchases; and so forth."

[Walmart's Approach to Renewable Energy](#)

IKEA

300-kW Bloom Energy Server

Home furnishing company IKEA installed a 300-kW Bloom Energy fuel cell system behind its Emeryville, California, retail store. When combined with the solar energy system installed on the store's roof in 2011, the biogas-fueled fuel cells will help to generate more than a majority of the store's energy on-site. The fuel cell system was installed in July 2015 and will produce almost 2.5 million kWh of electricity annually for the store, the equivalent of reducing 1,304 tons of CO₂. IKEA purchases renewable biogas from Arizona to offset the use of natural gas in the fuel cell system.

This investment in fuel cell technology reflects the company's goal to be energy independent by 2020 and complements other IKEA renewable programs in the U.S., including solar presence at nearly 90% of its locations, a geothermal heating and cooling system at two stores, and two wind farms totaling 104 turbines. IKEA is also a part of the RE100 initiative, committing to source 100% of their electricity from renewable energy to reduce CO₂ emissions.

IBM

1-MW fuel cell

IBM aims to reduce its operational CO₂ emissions by 35% by 2020 against a 2005 baseline. To help meet this goal, in December 2014, IBM installed a 1-MW fuel cell to provide electricity to its Southbury, Connecticut, data center.

The system is expected to deliver more than 8,500,000 kWh and reduce IBM's expenses for the electricity it purchases while lowering the associated CO₂ emissions by over 600 metric tons per year.³¹ The fuel cell system will meet 20% of IBM's electrical needs.

IKEA

"We are excited about furthering our sustainability commitment with fuel cells at IKEA Emeryville. Similar to our rooftop solar array, this fuel cell system will reduce greatly our carbon footprint and the store's reliance on the power grid as well as contribute to our vision of creating a better everyday life for the many."

[Pat Choa](#), IKEA's Emeryville, California store manager



"In FY14, we have started to test fuel cell technologies in the USA; they use a chemical reaction to convert biogas and natural gas into electricity and water. We expect that a 300-kW fuel cell installation can generate enough energy to cover 40% of the annual energy consumption of an average store."

[IKEA Group Sustainability Report FY 2014](#)

Medtronic

400-kW Bloom Energy Server

Medtronic, specializing in medical technology, has established a carbon reduction goal of 15% by 2020 for its global operations. Medtronic's facilities in Santa Rosa, California, support its Coronary and Structural Heart and Aortic and Peripheral Vascular divisions and within that, its Fountaingrove site utilizes more than 4,300 MWh of electricity annually. The company implemented a 320-kW solar array at the facility in 2011 and in late 2014, installed a 400-kW Bloom Energy fuel cell. The fuel cell system generates a constant flow of electricity 24 hours a day, 7 days a week and provides 96% of the electrical requirement for the Fountaingrove B building. This increases Medtronic's Fountaingrove campus' on-site electrical generation from 13% to 85%. The fuel cell will also provide an estimated \$2.3 million in energy savings over 15 years. The site anticipates reducing its carbon emissions by 19% and will save 3 million gallons of water annually.³²

Panasonic Avionics

750-kW Bloom Energy Server

Panasonic Avionics Corporation, a member of the Panasonic Corporation family of companies, installed a 750-kW Bloom Energy Server at the company's global headquarters in Lake Forest, California, in September 2014.

The fuel cells provide 85% of the facility's energy load and will and reduce the facility's carbon footprint by 19%, an estimated 12 million lbs. of CO₂ over 10 years.

Medtronic

"This installation symbolizes Medtronic's long standing commitment to energy conservation and doing right by the environment. We're pleased to be the first within Medtronic to adopt this exciting technology and bring its value to our triple bottom line."

Erik Kunz, Medtronic's Director of EHS & Facilities



Panasonic Avionics

"Panasonic Avionics is focused on high quality products that lower the eco-footprint of airplanes and we have made this a fundamental part of our operations as well. We are constantly looking for ways to enhance our world-class manufacturing facilities, and this project supports our goal of powering our facilities with sustainable critical power."

Phil Wee, Director, Global Real Estate and Facilities, Panasonic Avionics

Becker + Becker / 777 Main Street

400-kW Doosan Fuel Cell America PureCell system

Architectural planning and development firm Becker + Becker has opened its third mixed-use property powered by fuel cells.

Becker + Becker rehabilitated an historic property, the Hartford National Bank & Trust Company building (777 Main Street) in Hartford, Connecticut, and installed a Doosan Fuel Cell America 400-kW fuel cell to provide heat and electricity. Started up in May 2015, the fuel cell system provides power and heat to the 285-unit apartment building, 30,000 square feet of commercial space, and a parking garage. The fuel cell also supplies power to 11 Chargepoint battery-electric vehicle (BEV) chargers located at the building. Energy utility Connecticut Light & Power has a 15-year contract to buy renewable energy credits from the fuel cell.³³

Becker + Becker's first 400-kW Doosan fuel cell was installed 360 State Street in New Haven, Connecticut. This fuel cell follows the electrical load of the building's commercial and common areas. This site will soon be producing power at the fuel cell's full capacity as electric sub-metering is now approved in Connecticut for apartment communities. With full capacity operation, Becker + Becker expect to attain even greater efficiency out of the unit in 2014, the fuel cell's combined electric and thermal efficiency was 55%. Since 2011, the fuel cell has operated at 95% uptime.³⁴

The Octagon, a 500-unit apartment building located on Roosevelt Island in New York City, also uses a 400-kW Doosan fuel cell system to power the site. It has operated at 96% uptime with an average combined electric and thermal efficiency of 93%.³⁵

Becker + Becker

"This is the third apartment building where we've utilized a PureCell® Model 400 fuel cell solution to create electricity and heat, which is a much cleaner, more energy-efficient alternative to conventional use of fossil fuels – eliminating over 99% of particulate pollution and significantly reducing the project's carbon footprint. We take a holistic approach in our design to leverage all facets of energy savings, which is the reason Doosan, whose fuel cell solutions have supplied more than 11 million hours of secure, continuous power, is the logical choice for this project."

[Bruce Becker](#), founder of Becker + Becker



Comcast

400-kW Bloom Energy Server

Comcast installed 400-kW of Bloom Energy fuel cells at its Western New England Regional Headquarters in Berlin, Connecticut, that provides service to customers in more than 300 communities throughout Connecticut, Western Massachusetts, Vermont, Western New Hampshire and New York.³⁶

The fuel cells provide up to 80% of the facility's total energy load and are installed with uninterruptable power modules to enable the Comcast facility to maintain operations through grid outages.

Additionally, the project will help Comcast reduce the facility's carbon emissions by an estimated 1.93 million lbs. of CO₂ emissions each year, as compared to electricity purchased from the grid in Connecticut.

Morgan Stanley

250-kW Bloom Energy Server, 790-kW fuel cell system

In late 2014, Morgan Stanley installed a 250-kW Bloom Energy fuel cell at its headquarters facility in Purchase, New York. The fuel cell system will supply constant base load power to the facility, as well as grid-independent electricity to power portions of the building's critical load during grid outages. Combined with a solar field that was installed in 2014, the technologies are expected to produce approximately 3 million kWh of energy annually. During periods of peak energy consumption, they can supply approximately 1 MW, or up to 30% of the building's demand.³⁷ The New York State Energy Research and Development Authority (NYSERDA) provided a \$1 million subsidy to help offset the cost of the fuel cells.³⁸

In September 2015, Morgan Stanley was among the winners of NYSERDA's Renewable Portfolio Standard (RPS) Main Tier solicitation to install a 790-kW fuel cell at its Manhattan offices.

Comcast

"Technology and innovation are at the core of everything Comcast does and this project is another example of how we are deploying innovative technology to build a stronger, more reliable and secure broadband network for our customers. By generating clean energy onsite, we can enhance the resiliency of our operations while also supporting our sustainability goals and reducing our carbon footprint."

**Mary McLaughlin, Comcast
Senior Vice President for the
Western New England Region**



Morgan Stanley

"We think that the Bloom Energy installation gives us additional electricity security to a point, which is important because we need redundant sources of power. The solar panels help, but of course, they only operate when it's sunny outside. The Bloom Energy installation can operate all the time."

**Jim Rosenthal, Morgan Stanley's
chief operating officer**

Johnson & Johnson Advanced Sterilization Products 500 kW Bloom Energy Server

Johnson & Johnson's Advanced Sterilization Products (ASP) designs and manufactures medical device processing products and solutions for hospitals and healthcare facilities around the world. As ASP evaluated the various energy options for its Irvine, California, site, carbon reduction was an important factor, as well as improving the resiliency of the facility.

The 500-kW Bloom Energy system installed at ASP's Irvine, California, site in 2015 includes uninterruptible power modules (UPMs) and will provide 25% of the daily energy consumption. This is estimated to save \$10 million over the 20-year life of the project and achieve a 22% reduction in CO₂ emissions, compared to the California electric grid.³⁹

Johnson & Johnson has operated a 375-kW Bloom fuel cell system at its Irwindale, California, location, since January 2015.

Macerich / Danbury Fair Mall 750-kW Bloom Energy Server

In October 2014, Macerich, the developer/owner of the Danbury Fair Mall in Danbury, Connecticut, installed a 750-kW Bloom Energy fuel cell system to power the 1.3 million square foot building. The fuel cell is expected to produce more than 6.2 million kWh annually, reducing carbon emissions by nearly 3 million pounds each year.⁴⁰

The fuel cells provide power for 36% of the facility's overall usage and Macerich plans on installing solar panels to boost that number to 46%.

Johnson & Johnson ASP

"Today's customers are very focused on sustainability and require us to pursue environmentally and socially conscious options over our product lifecycles. This partnership with Bloom Energy will help us meet the demands of our customers and the industry, and significantly improve upon the sustainability of our business."

**Dennis James, ASP Facilities
Manager**



Macerich

Macerich has a comprehensive sustainability plan which focuses on efficient and environmentally friendly operating practices throughout our Company. Our success to date has shown that environmental and financial goals are not mutually exclusive and this project will enhance the reliability of our operations, improve cost predictability, and contribute to a healthy environment for our employees, retailers, guests and communities."

**Jeff Bedell, Vice President of
Sustainability at Macerich**

Blue Lake Rancheria Tribe

175-kW Ballard Power Systems ClearGen™ Fuel Cell

The Blue Lake Rancheria Tribe of northern California is a regional leader in greenhouse gas reductions and community resiliency measures, reducing energy consumption by 35% from 2008 levels through energy efficiency upgrades, developing on-site renewable energy, and switching to green fuels.

In 2013, the Tribe partnered with Humboldt State University and the Redwood Coast Energy Authority to install a first of its kind biomass-to-fuel fuel cell energy system, integrating a 175-kW Ballard Power Systems ClearGen fuel cell system with a biomass gasifier and syngas purification unit. Locally-grown timber byproduct will serve as the biomass feedstock. The fuel cell will supply one-third of the power need for the Tribe's casino, as well as heat to warm the swimming pool in an adjacent hotel. The project is supported by funding from the California Energy Commission (CEC).⁴¹

In 2015, the Tribe announced plans to build a low-carbon community microgrid, which will include the biomass-fueled fuel cell system. The decision to go off-grid was impacted by several events. During heat spikes and other events, Pacific Gas & Electric (PG&E) asked the Tribe to go off-line almost 50 times.⁴² The Tribe's facilities have also served as an evacuation site, accommodating residents of low-lying coastal areas following a 2011 tsunami warning.⁴³

The new microgrid will integrate the Tribe's new fuel cell system with a 0.5-MW solar photovoltaic installation, a 950-kWh battery storage system, and diesel generators. This self-generated energy will power government offices, economic enterprises, and Red Cross safety shelter-in-place facilities across 100 acres. The new microgrid is anticipated to reduce carbon emissions by 150 tons annually. CEC will provide a \$5 million grant through the Electric Program Investment Charge (EPIC) program. The microgrid will be operational by fall 2016.⁴⁴

Blue Lake Rancheria

"The Blue Lake Rancheria Tribe is committed to renewable power to reduce greenhouse gas emissions and increase the energy efficiency of our facilities. Biomass-to-fuel cell power is an excellent match for our community and our region, and we see tremendous potential for deployments beyond our own facilities."

Arla Ramsey, Blue Lake Rancheria vice chairperson



"The big takeaway is that these systems and entities that can cost effectively implement their own renewable energy power systems on site. This will relieve pressure from the greater grid, and provide energy security for not only communities like the Rancheria, where these systems are located, but help provide energy security throughout California."

Jana Ganion, Energy Director at Blue Lake Rancheria

Stop & Shop

250-kW Bloom Energy Server

The Stop & Shop Supermarket Company LLC, a division of Ahold USA, installed a 250-kW Bloom Energy fuel cell at a Mt. Vernon, New York, store in 2014. The fuel cell will generate more than 2 million kWh each year, resulting in carbon reductions of more than 700,000 lbs. of CO₂ annually. Support was provided by NYSERDA.

As part of its Better Neighbor Promise to care for the environment, Stop & Shop has a goal to reduce its carbon footprint by 20% by 2015 using 2008 as a baseline. This project supports the company's carbon reduction goals and continues to deliver electricity even through grid outages, like those experienced in the aftermath of Superstorm Sandy. Stop & Shop is also committed to building energy efficient and sustainable stores.

Stop & Shop installed a 400-kW Doosan Fuel Cell America fuel cell at its Torrington, Connecticut, store in 2010. The fuel cells supply 95% of the store's electricity and during Superstorm Sandy, the fuel cells provided the grocery store with power, heat, and cooling while grid power was intermittent.

A 200-kW Bloom Energy fuel cell also operates at Stop & Shop's Peekskill, New York, site.

Widmer Brothers Brewery

Waste2Watergy Fuel Cell

Widmer Brothers Brewery, based in Portland, Oregon, is working with Waste2Watergy, a startup company that has developed a microbial fuel cell that generates electricity while cleaning the brewery's wastewater. The companies are working together to demonstrate the technology with funding support from the National Science Foundation and OregonBEST.

Stop & Shop

"Stop & Shop has invested heavily in energy conservation, green building and alternative energy projects. This project in the New York metro area will contribute to reducing our greenhouse gas emissions and the environmental impact of our operations on our communities. It will also increase the resiliency of our stores and enable us to serve our customers during grid interruptions."

[Don Sussman](#), president of Stop & Shop New York Metro division

Widmer Brothers Brewery

"Here at Widmer Brothers, we're pleased to be the first host site and be playing a key role in the development of this innovative technology. It's been impressive to see our wastewater being cleaned and electricity generated and it's exciting to see the technology grow from the first prototype to the larger scale version."

[Julia Person](#), sustainability manager at Widmer Brothers

Hyatt Regency Greenwich

500-kW Bloom Energy Server

The fuel cell will provide up to 75% of the hotel's energy load, generating significant cost savings and reducing its carbon emissions by 40% compared to electricity purchased from the grid.

Amgraph Packaging

800-kW Doosan Fuel Cell Power Plant

In July, packaging solutions company Amgraph Packaging ordered two PureCell® Model 400 power plants from Doosan Fuel Cell America.

The fuel cells, which will be started up by the end of 2015, will provide CHP to Amgraph's Baltic, Connecticut, facility that produces flexible packaging for the food, pharmaceutical, health and beauty industries.

The project was awarded a grant under the Connecticut Low and Zero Emissions Renewable Energy Credit (LREC) program, which distributes renewable energy credit payments for each MWh of power that is generated.

Hyatt Regency

"Climate change is a critical issue we collectively face, and Hyatt has been focused on reducing our impact, primarily through energy efficiency measures. Through this new relationship with Bloom Energy, we have the ability to explore technology that has not yet been widely incorporated across hotels as a way to reduce our carbon emissions and energy costs."

[Brigitta Witt](#), Global head of corporate responsibility for Hyatt

Amgraph Packaging

"Amgraph has been dedicated to environmentally-friendly manufacturing operations and sustainable practices for over 30 years. We had conversations with a variety of fuel cell manufacturers and selected Doosan's PureCell technology because it most closely aligns with our environmental goals. It's quiet, clean, reliable and produces the ideal combination of power and heat."

[Kenneth A. Fontaine](#), Amgraph President and CEO

Material Handling Equipment

Over the past half-decade, fuel cells have proven themselves in warehouses and distribution centers as a drop-in replacement for batteries. More than 7,500 fuel cell forklifts are now in operation in dozens of facilities across the country.

Fuel cell attributes have made them a go-to technology with proven value. Customers are seeing a host of benefits:

Improved efficiency. By using fuel cell-powered forklifts – which fuel with hydrogen in just two minutes compared to 13 minutes to change a forklift’s depleted battery – BMW has regained over 156 hours of lost productivity over its three-shift operation, which has an economic value of more than \$65 million annually.⁴⁵

Constant, reliable power. Fuel cells provide continuous power for material handling equipment throughout the entire shift, with no sag in power generation as is experienced by battery units losing their charge. Fuel cells also operate reliably in cold storage facilities and in sub-zero freezer environments.

Cost savings. In large, multi-shift operations, fuel cell forklifts cost 59% less to operate and maintain than battery forklifts.⁴⁶ By eliminating the electricity costs for charging hundreds of batteries, businesses can save \$75,000 to \$225,000 per year.⁴⁷

Space savings. Hydrogen infrastructure takes significantly less space than a battery room, recouping around 5,000 square feet in valuable storage space.⁴⁸

Since our last report, more than 1,300 fuel cell forklifts have been ordered or added to corporate warehouse fleets, with both new customers and returning customers.

Hydrogen Delivery and Production Lifting MHE Sales

When fuel cell-powered forklifts are deployed in warehouses, hydrogen generation and/or dispensing systems also need to be installed. Rather than leave the customer to find a fuel source on their own, fuel cell companies are offering packages and systems to help.

In January 2014, Plug Power Inc. launched GenKey, its turnkey hydrogen solution for material handling sites, which includes the fuel cells, hydrogen fueling and maintenance service. GenKey customers now include Dietz & Watson, Fed Ex, FreezPak, Honda, Kroger (2 sites), Newark Farmers Market, Uline, Volkswagen, Walmart and Walmart Canada (2 sites).

Generating hydrogen on-site is an alternative to having fuel delivered. Nuvera Fuel Cells’ PowerTap® Hydrogen Generator converts natural gas and city water into 99.995% pure hydrogen using steam methane reforming technology. These systems are currently providing hydrogen for fuel cell forklift fleets around the country, including Ace Hardware’s Retail Support Center in Wilmer, Texas, a Stihl facility in Norfolk, Virginia, and a Golden State Foods (GSF) distribution facility in Chicago.

Kroger

After a successful pilot demonstration in Ohio in 2010, in 2012, Kroger ordered 174 Plug Power GenDrive units to replace the lead-acid batteries in class-1, -2, and -3 lift and reach trucks and three hydrogen fueling stations for its Compton, California, distribution center. This facility supplies groceries for Ralphs markets. Kroger reports that the Compton site has experienced decreasing maintenance costs and a return on investment (ROI) of approximately 20% to date. The fuel cells are running longer (1.5x, 2x for class-3 vehicles) than lead-acid batteries and operate at consistent speed and power with quick refueling.⁴⁹

In 2014, Kroger expanded its fleet and deployed additional fuel cells at other distribution centers, including Stapleton, Colorado (120) and Louisville, Kentucky (185). According to the company's 2015 Sustainability Report, Kroger now has more than 1,000 fuel cells powering forklifts and pallet jacks at six locations throughout the U.S.⁵⁰ Two sites utilize Plug's GenKey service.

Home Depot

In May 2015, Plug Power announced that a big box retailer (since revealed as Home Depot) purchased a GenKey package for the retailer's material handling fleet in its new distribution warehouse constructed in Troy Township near Toledo, Ohio. This includes 177 GenDrive units to power a mix of 172 class-2 and class-3 lift and reach trucks, a GenFuel hydrogen fuel supply and storage infrastructure. This site is also the first to deploy Plug Power's outdoor skid.

Home Depot has more than 100 distribution centers in North America and Plug Power is currently in discussions regarding future deployments.⁵¹



Statistics for Home Depot's Troy Township location – includes fuel cell data (bottom box)

FreezPak Logistics

FreezPak Logistics selected Plug Power's GenKey solution for its new cold storage distribution center freezer warehouse under construction in Carteret, New Jersey. The deployment includes 25 GenDrive fuel cells, a GenFuel outdoor hydrogen storage infrastructure with two indoor GenFuel dispensers. In addition, the contract includes a 10-year hydrogen supply agreement.⁵²

Newark Farmers Market

In November 2014, Newark Farmers Market expanded its fuel cell material handling fleet by purchasing an additional 110 GenDrive units from Plug Power for a new refrigerated food distribution building at its Newark, New Jersey, site.⁵³ This new order is comprised of 25 class-2 standup reach truck units and 85 class-3 pallet jack units that will operate in temperatures kept at a constant 28 degrees F.

Plug Power will construct a complete GenFuel hydrogen infrastructure, including indoor dispensers and outdoor fuel storage. The outdoor infrastructure includes a 15,000 gallon hydrogen tank with dual redundant pumps and gas compressor.

Newark Farmers Market has used fuel cell forklifts since 2011, with its original fleet of more than 100 vehicles accumulating more than 625,000 hours of run time.

Uline

In May 2015, Uline, a distributor of shipping, industrial and packaging materials to businesses throughout North America, purchased more than 130 Plug Power GenDrive fuel cells to power its forklift fleets at two facilities in Pleasant Prairie, Wisconsin.⁵⁴

The initial deployment is for a distribution center and the second fleet will operate in a newly constructed facility. Plug Power is also installing a full liquid hydrogen fueling system with eight dispensers. The new system will require a fraction of the floor space of a traditional battery handling system.

Newark Farmers Market

"We've been very happy with the fuel cell units that have been running our lift truck fleet since 2011. We made the decision to go with Plug Power's full GenKey solution in combination with the construction of our new state-of-the-art food distribution center, because it aligns with our energy-efficiency initiatives and our desire to reduce the environmental impact of warehouse operations on local communities."

David Forem, President of Forem Facility Management, which operates the Newark Farmers Market



Walmart

In 2014, Walmart expanded its fleet of fuel cell-powered forklifts with a purchase of more than 2,000 units from Plug Power for seven of its North American distribution centers. Since our last report, the locations of those centers have been made public and include:⁵⁵

- Johnstown, New York
- Pottsville, Pennsylvania
- Bedford, Pennsylvania
- Sterling, Illinois
- Wintersville, Ohio
- Mankato, Minnesota
- Gas City, Indiana.

Plug Power is also deploying 330 fuel cells to power Walmart's entire lift truck fleet in New Caney, Texas.⁵⁶

At Walmart Canada's new High Velocity Distribution Center in Balzac, Alberta, 124 additional fuel cells were ordered in 2015 to expand that facility's fleet to 230.⁵⁷ Plug Power's GenFuel system will support two buildings – the new High Velocity Distribution Center and the existing Perishable Distribution Center.



Walmart Green @WalmartGreen · 28 Jul 2014

We are to expanding our contract w/ @PlugPowerInc to install a hydrogen refueling station at our #Sterling, #IL, DC:
walmarturl.com/1rL0kCr



Walmart



"These [fuel cell-powered forklifts] will usually operate for a full shift. And while the battery ones start losing power toward the end, these keep full power the whole time."

John Nelson, a manager at Walmart's Mankato, Minnesota distribution center

Honda

Japanese automaker Honda operates 51 fuel cell-powered forklifts, and two hydrogen stations supporting them, at its largest manufacturing facility (4 million square feet), located in Marysville, Ohio. Sixteen of the vehicles were retrofitted, saving Honda money by replacing lead-acid batteries with fuel cells. Plug Power provides both the fuel cells and hydrogen fueling via its GenKey package.

Honda, in its March/April 2015 newsletter WING, reports that the 51 fuel cell forklifts have reduced the plant's total emissions by 3.8 kg per unit, equivalent to taking 440,000 cars off of the road. Honda is also finding time savings as battery-powered forklifts need to change batteries every six hours, with that swap taking around 25 minutes to complete, and performance draining as the battery does. The fuel cell forklift lasts for 12 hours of steady operation and takes under a minute to fuel.

In August 2015, the Marysville plant was one of three Honda facilities in the state to win the Ohio EPA's highest award for environmental stewardship – the Encouraging Environmental Excellence (E3) Gold-Level Award. The recognition included Honda's hydrogen-fueled fuel cell forklifts which help to reduce the site's electricity and natural gas usage.⁵⁸

Volkswagen

Since July 2015, the Volkswagen Group of America and Schellecke Logistics USA, its logistics company,⁵⁹ has operated 45 fuel cell-powered forklifts at its Chattanooga, Tennessee, manufacturing plant. The company is planning an expansion of the plant and, with that, Volkswagen will convert the entire forklift to fuel cells and use solar power to generate hydrogen.⁶⁰

According to Volkswagen,⁶¹ the 45 vehicles are saving \$65,000 a year due to the quick refueling and longer run time. The savings are expected to increase to \$420,000 a year when the entire fleet is converted to fuel cells.

Unidentified Large Footwear Manufacturer

After a successful demonstration at one of its distribution centers, a large footwear manufacturer entered into a master sales agreement (MSA) with Plug Power, defining the first three sites where Plug Power's GenKey hydrogen and fuel cell solution will be implemented and is analyzing wide adoption of the technology at its 30 sites globally.⁶²

Honda



Refueling with hydrogen at Honda's Marysville, Ohio site

Volkswagen



Forklift in operation at Volkswagen's Chattanooga, TN manufacturing plant

Dietz & Watson

Dietz & Watson, a family owned business for more than 75 years, is one of the largest manufacturers and distributors of premium deli meats, artisan cheeses, and related products in North America. For its newly constructed 200,000 square foot warehouse and distribution center located next to its headquarters in Philadelphia, Pennsylvania, Dietz & Watson will deploy Plug Power's GenDrive fuel cells in its entire fleet of class-2 and class-3 lift trucks for its new warehouse building under a GenKey agreement.⁶³

Golden State Foods

Golden State Foods (GSF) a global, California-based food manufacturer and distributor for the quick service restaurant industry, has purchased Plug Power GenDrive fuel cells to power 39 material handling vehicles – 11 class-2 stand-up reach lift trucks and 28 class-3 rider pallet trucks – at its new 158,300 square foot regional headquarters and logistics center in McCook, Illinois. This facility services more than 460 McDonald's in the Midwest region.⁶⁴ GSF utilizes a Nuvera Fuel Cells' PowerTap system to generate hydrogen on-site.⁶⁵

"After an extensive analysis of our options to operate our lift truck fleet in the most efficient manner, Plug Power offered a cost effective solution with significant potential labor savings. We are pleased to join other food industry distribution leaders such as Walmart and Wegmans Food Markets in implementing this solution."

John Tsigounis, Vice President of Logistics for Dietz & Watson



Golden State Foods forklift operator fueling a material handling vehicle with hydrogen, using a Nuvera PowerTap refueling system.

International Deployments

While most corporate fuel cell purchases are U.S.-based, there is growing international interest, particularly for fuel cells operating in telecommunication (developing countries) and material handling applications (Europe). Several stationary fuel cell sales have also been announced, some in the MW range, to supply power to business and production facilities.

Stationary Power

Stationary fuel cells can supply reliable baseload power, as well as provide backup power generation in the event of power outages. Fuel cells can meet a range of user needs, which can vary by locale. In Japan and South Africa, power generation reliability is priority in case of grid power disruptions, such as earthquakes in the former and an unreliable power grid in the latter, while clean and efficient power generation is a priority in Germany.

Japan

California's Bloom Energy, which partnered with SoftBank in 2013 to form the joint venture company Bloom Energy Japan, announced the deployment of two new corporate fuel cell systems:

- In June 2014, Bloom installed a 200-kW Energy Server at the Tokyo Shiodome Building in Tokyo, home to SoftBank's headquarters. The fuel cell meets 14% of the building's overall electricity needs and also provides power for electric vehicle charging stations installed in the building's underground parking garage. In case of an emergency, the fuel cell power can also be directed to streetlights and public power outlets.⁶⁶
- In March 2015, Bloom Energy Japan installed a 1.2-MW fuel cell system at the Osaka Prefectural Central Wholesale Market in Ibaraki City, Japan. The fuel cell supplies 50% of the buildings' overall electricity needs.⁶⁷ The prefecture supplied 350 square meters of land in the market free of charge and the installation was subsidized by Japan's Environment Ministry.



Tokyo Shiodome - Bloom Energy Server (left) supplies power to both the facility and the building's EV charging stations (right)

"It's good for the environment and ensures electricity even in the event of an earthquake."

[Prefectural government official](#) speaking about the fuel cell system at Osaka Prefectural Central Wholesale Market

Germany

In July 2015, FRIATEC AG, a company specializing in products made of non-corroding and wear-resistant materials, purchased a 1.4-MW fuel cell from FuelCell Energy Solutions, the German subsidiary of Connecticut's FuelCell Energy. The fuel cell system will be deployed at FRIATEC's headquarters and production facility in Mannheim, Germany, and will meet approximately 60% of the power needs of the manufacturing operations. Excess heat will be supplied to the existing on-site heating grid to be used at multiple production areas within the facility.⁶⁸

German fuel cell manufacturer Proton Power Systems announced that it has signed a major reseller deal with DB Bahnbau Gruppe GmbH, the service company of German Rail (DB). Bahnbau will sell and install Proton Power's containerized fuel cell systems as uninterruptible power supply (UPS) applications to DB and third party customers. DB is planning to replace the installed base of diesel generator UPS systems with zero-emission fuel cell applications over the coming years.⁶⁹

"Our production-processes require a large amount of power and heat, so we are very happy to have the opportunity to utilize fuel cells to generate these necessities as efficiently and as cleanly as possible to advance our environmentally-friendly production processes."

[Klaus Wolf](#), CEO of FRIATEC AG

South Africa

Impala Platinum Holdings Limited (Implats) announced plans in April 2015 to install a 1.8-MW fuel cell system from Japan's Fuji Electric at its platinum group metals refinery in Springs, South Africa, in early 2016.⁷⁰ The fuel cells will utilize the excess hydrogen piped in for the metal reduction process. Implats also announced a potential second phase that will include a 22-MW facility that would enable complete grid independence.

Telecommunications

For years now, telecommunications companies have installed fuel cells to provide reliable and long-lasting backup power at cellular towers and network switching sites around the U.S. These units have a proven record of powering through hurricanes and grid outages to ensure critical services and communications are up and running.

This success and range of benefits is leading many telecommunications and wireless network providers in international markets to follow suit. Fuel cells last a lot longer and are lighter than

batteries, and are less smoky, noisy, and more reliable than diesel generators. This allows for installation in remote, rural areas as well as on rooftops in more urban cities where space is a premium. Systems can run off hydrogen or methanol, or be integrated with solar or wind to generate hydrogen from water.

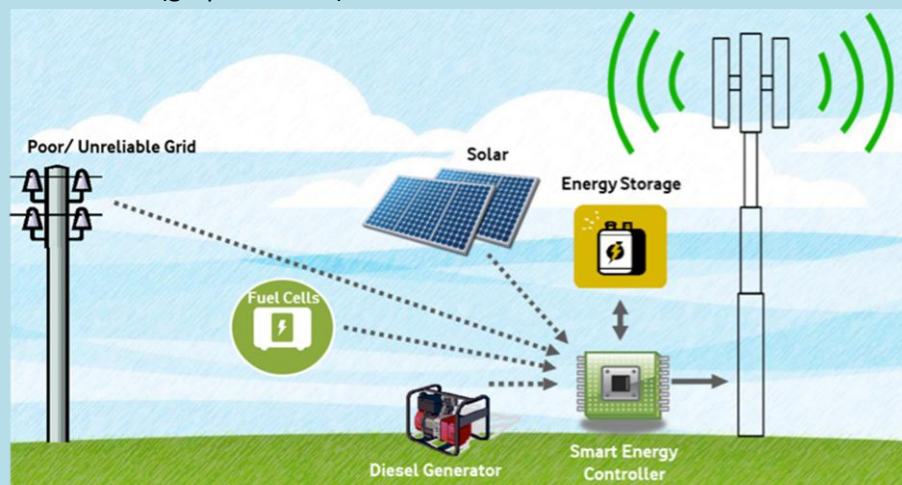
There are now thousands of fuel cells operating throughout Africa, the Caribbean, Europe, the Middle East, as well as Indonesia, India, China, and more.

The list of companies and countries continues to grow, with recent deployments by Jiangsu Communications Services Company, Ltd. (**China**), Ascend Telecom (**India**), Microqual Techno Limited (**India**), Reliance Jio Infocomm (**India**), Telkomsel (**Indonesia**), Digicel Group Limited (**Jamaica**), Vodafone (**Netherlands**), Warid Telecom (**Phillipines**), Globe Telecom (**Pakistan**), and Vodacom (**South Africa**). For more details on these deployments, see Appendix 1.

“Over the past six months, the fuel cell has been called upon six times to provide back-up power. These mains power outages have range from as short as 12 minutes to over seven hours. Each time the fuel cell has cut in to seamlessly keep our customers connected.”

Australian telecommunications company [Telestra](#), reporting in a January 2015 blog about its renewable solar/fuel cell system undergoing testing at a small telecom exchange near Melbourne

Mobile communications company Vodacom (South Africa) [reports](#) that it started using hydrogen fuel cell systems eight years ago and now has more than 200 fuel cells deployed. The company is exploring other fuel sources for fuel cells, trialing several at the company’s Site Solution Innovation Centre in Johannesburg. Vodacom would like to use renewable energy where possible to power mobile sites, but since energy demand is often too large and capital investment costs too high, the company has found that their optimum solution is to combine two energy sources supported by an intelligent on-site management controller (graphic below).



Material Handling

The success of fuel cell-powered forklifts and lift trucks in the U.S. – where more than 7,700 are now in operation – is generating interest from European corporations. A number of major European companies have begun testing fuel cell forklifts in their operations over the past few years.

Austria

Logistics company DB Schenker is testing 10 fuel cell-powered pallet trucks at its facility in Linz. An indoor hydrogen refueling station is sited at the facility, delivering hydrogen generated from biogas.

Fronius, a manufacturer of battery charging systems, welding technology and solar electronics, operates five fuel cell-powered forklifts at its facility in Sattledt. Hydrogen fuel is generated on-site by solar-powered electrolysis.⁷¹

Belgium

Colruyt, a Belgian supermarket chain, uses 13 fuel cell-powered trucks at its distribution center in Halle. Hydrogen is produced for the on-site hydrogen station by electrolysis using both wind and solar power.⁷²

The Colruyt Group is also the first company in Belgium to order a Hyundai ix35 FCEV. Employees will fuel the vehicle at the Halle distribution center's hydrogen service station.⁷³

Denmark

Starks construction market in Copenhagen, which sells timber, building materials and tools and to professionals and do-it-yourself builders, purchased four fuel cell powered forklifts in 2013 to operate at the facility.⁷⁴



Linde T20 pallet trucks with fuel cell hybrid drive operating at DB Schenker's Linz, Austria facility



Fuel cell forklift fueling at Colruyt's renewable hydrogen station



Fuel cell forklift at Starks construction market in Copenhagen

France

FM Logistic, a French third party logistics company operating in 12 countries, has deployed 10 fuel cell-powered forklifts at its Neuville aux Bois logistics site, through a collaboration with HyPulsion, Air Liquide, Toyota Material Handling, Crown and Diagma. This project could lead to the conversion of the site's entire forklift fleet of 84 vehicles.⁷⁵

Retailer IKEA operates 20 fuel forklift trucks at its distribution center in Saint-Quentin-Fallavier. This site is a key warehouse for the upstream logistics of IKEA's stores in southern Europe, organizing the receipt and storage of products. The facility's hydrogen fueling station was supplied by Air Liquide and fuel cells by Plug Power through HyPulsion.⁷⁶

Freight and cargo company Prelogis has deployed Plug Power fuel cell to power forklifts at its new construction, 20,000 square foot, retail food warehouse in Saint Cry en Val. Operated by Prelocentre, a subsidiary of Prelogis, the facility runs three shifts of operation.⁷⁷

Germany

Automaker BMW, with partners Linde Material Handling and Munich Technical University, began a three-year research project to develop and test fuel cell-powered forklifts at its plant in Leipzig. Eleven units are currently in operation.⁷⁸

Daimler has deployed two heavy-duty fuel cell forklifts and uses Air Products' SmartFuel® hydrogen refueling technology at its Sprinter van manufacturing site in Düsseldorf.⁷⁹

U.K.

The Honda plant in Swindon operates fuel cell-powered forklifts as part of the Innovate UK supported demonstration project. The modified Yale trucks are configured to use a small lithium-ion battery which partners with the fuel cell to ensure that the battery remains charged. Hydrogen for the forklifts is generated by solar electrolysis. The hydrogen station also



Forklift operator fueling at FM Logistic's Neuville aux Bois location



Forklifts equipped with Plug Power fuel cells at Prelogis' warehouse in France

supplies hydrogen for fueling converted vans and also supplies a fuel cell used to power the refueling station.⁸⁰

Finding Fuel Cell Financing

Many fuel cell installations today are being financed via power purchase agreements (PPAs) and also in many cases, take advantage of federal and state tax credits or incentives to offset initial cost.

Our [2013](#) report has an extensive overview of how PPAs work.⁸¹ To help make financing easier, several fuel cell companies are getting into the game themselves.

Bloom Energy offers a few different options for customers: purchase the fuel cells outright, lease them through Bloom's leasing program with Bank of America Merrill Lynch or its other partners, or use Bloom Electrons® which allows customers to lock in electricity costs for 15 years, similar to a PPA.

In September 2015, Constellation, a subsidiary of Exelon Corporation, entered into an agreement with Bloom Energy to develop 40 MW of fuel cell projects for commercial and public sector customers in California, Connecticut, New Jersey and New York.⁸² Under the agreement, Constellation will provide equity financing and own a majority equity interest in Bloom Energy Servers at more than 170 sites for customers, including AT&T and Walmart, among others, under 15-year power purchase agreements. This agreement builds upon the 2014 investment Exelon made in Bloom to finance 21 MW of projects.⁸³

Doosan Fuel Cell America and FuelCell Energy also work with customers and third party financial providers or energy companies to structure PPAs and leases.

In September 2015, Plug Power Inc. formed Plug Power Capital Inc., a subsidiary to focus on financing through GenFund, giving customers easy access to third-party leases and a standardized financing process.⁸⁴ Plug Power Capital will work with its customers and commercial banks, facilitating project funding for the purchase of Plug Power Inc. hydrogen and fuel cell solutions.

As the newest element to this equation, GenFund will expedite deal closure and will be offered to both material handling and stationary customers through GenKey, and will also be available on an individual-case basis to assist other non-GenKey customers.

On the tax credit side, fuel cells are eligible for the Federal Investment Tax Credit (ITC) which provides a 30% tax credit up to \$3,000/kW on a fuel cell system installed before the end of 2016. A credit of 10% is also available for combined heat and power systems. The ITC also applies to fuel cells for forklifts. This tax credit is set to expire on December 31, 2016.

At the state level, a variety of programs that may include fuel cells can help with funding, including Renewable Portfolio Standards, energy credits and tax rebates.⁸⁵ Several states, including California, Connecticut, New York and New Jersey, have substantial incentives to help offset the cost of fuel cell purchases and installation.

Appendix 1: International Telecom Companies Purchasing Fuel Cells 2014-2015

| International Telecommunications Companies Purchasing Fuel Cells 2014-2015 | | | | |
|----------------------------------------------------------------------------|--------------|----------------------------------|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Company | Country | Fuel Cell Provider | # of Units | Notes |
| Jiangsu Communications Services Company, Ltd. | China | First Element Energy | 2 | Feasibility study and pilot project, consisting of the installation of fuel cell units at two sites – one fueled by compressed hydrogen gas and the other using a mixture of liquid methanol and water. |
| Ascend Telecom | India | Intelligent Energy | 1 | Over a six-month period, fuel cell improved site power availability significantly while reducing fuel usage by 18%. |
| Microqual Techno Limited | India | Intelligent Energy | N/a | Exclusive 15-year agreement to provide fuel cell power solutions to Microqual-installed mobile telecom base station equipment on existing electricity transmission towers |
| Reliance Jio Infocomm | India | Ballard Power Systems | 100 | The order is the first of a series of planned deployments in Jio's India network. |
| Telkomsel | Indonesia | Ballard Power Systems | N/a | Fuel cells will supply critical back-up power to sites on the island of Sumatra. |
| Digicel Group Limited | Jamaica | Ballard Power Systems | 13 | This purchase brings Digicel's total number of fuel cells to 25. |
| Vodafone | Netherlands | Ericsson (Ballard Power Systems) | 1 | This pilot project in Rotterdam is expected to reduce emissions by 33 tons a year. |
| Warid Telecom | Pakistan | Ballard Power Systems | N/a | Field trial - fuel theft was reduced and reliability improved with the fuel cell system, both of which positively impacted operating cost of the network site. |
| Globe Telecom | Philippines | Ballard Power Systems | 20 | Methanol-powered units are installed on rooftop locations in Manila. |
| Vodacom (Vodafone) | South Africa | N/a | N/a | Vodacom began using hydrogen fuel cell systems eight years ago and now has more than 200 fuel cells deployed. The company is now testing methanol-fueled fuel cells. |

Appendix 2: Additional Resources

U.S. Department of Energy’s Fuel Cell Technologies Office

<http://energy.gov/eere/fuelcells/fuel-cell-technologies-office>

Fuel Cell and Hydrogen Energy Association (FCHEA)

<http://www.fchea.org>

- FCHEA Reports <http://www.fchea.org/reports/>
- FCHEA Fact Sheets <http://www.fchea.org/factsheets/>

| YouTube Videos of Fuel Cell Customers | |
|--------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Bloom Energy | https://www.youtube.com/watch?v=l83ZB4WJ8Pw |
| Adobe Systems | https://www.youtube.com/watch?v=AfB7WewLV4g&list=PLNJrR6KSxqLyQvPxtzDXE5BDz5V_3WOF&index=13 |
| Taylor Farms | https://www.youtube.com/watch?v=hmUtscY5yPg |
| Microsoft | https://www.youtube.com/watch?v=IUHAqFRN9I |
| Walmart | https://www.youtube.com/watch?v=IFVJ7n67Hts and https://www.youtube.com/watch?v=HLwiya0kqDI |
| eBay | https://www.youtube.com/watch?v=xfneQywfPDo and https://www.youtube.com/watch?v=TcRyUmxeYt8 |
| Verizon | https://www.youtube.com/watch?v=PJ1U3U3S-hA |
| Kaiser Permanente | https://www.youtube.com/watch?v=4FTd4N_YlnY |
| StoneEdge Farm | https://www.youtube.com/watch?v=XiD3nOOgGzc |
| Macy’s | https://www.youtube.com/watch?v=7mJVovRcK2E |
| Life Technologies (now ThermoFisher Scientific) | https://www.youtube.com/watch?v=Gx-Y6PLac |
| Wegman’s | https://www.youtube.com/watch?v=vvJk8RciZX0 |
| BMW | https://www.youtube.com/watch?v=EEpegKc7tvc and https://www.youtube.com/watch?v=FN6-JkrJ7vE |
| Volkswagen | https://www.youtube.com/watch?v=M_jKc_5F30k |
| UNFI | https://www.youtube.com/watch?v=KzBTIXjrzi0 |

Appendix 3: Photo and Graphic Credits

| Page | Image | URL |
|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Cover | Top row (L-R) | |
| | News Corp. | http://www.doosanfuelcell.com/attach_files/link/White%20Paper%20-%20Critical%20and%20Clean%20Power.pdf |
| | Walmart | http://www.bloomenergy.com/customer-fuel-cell/walmart-renewable-energy/#!prettyPhoto |
| | Middle row (L-R) | |
| | Coca-Cola | Courtesy of Plug Power |
| | Rooftop | Courtesy of ReliOn |
| | Bottom row (L-R) | |
| | Walmart | http://www.plugpower.com/2015/08/genkey-success-with-walmart |
| | FedEx | http://energy.gov/eere/success-stories/articles/worlds-first-fuel-cell-cargo-trucks-deployed-memphis-international |
| Telecom tower | Courtesy of Black & Veatch Corporation | |
| 3 | Top row (L-R) | |
| | Becker and Becker / Octagon Building | http://www.doosanfuelcell.com/en/resources/photo.do#Next |
| | JMB Realty | http://www.bloomenergy.com/customer-fuel-cell/jmb-realty-renewable-energy/ |
| | Unspecified food processor | http://www.fuelcellenergy.com/news-resources/photo-library/ |
| | Bottom row (L-R) | |
| | Unspecified telecom customer | http://www.hydrogenics.com/hydrogen-products-solutions/fuel-cell-power-systems/stationary-stand-by-power |
| | CSX | http://www.plugpower.com/# |
| Unspecified forklift customer | http://www.nuvera.com/blog/index.php/category/material-handling/ | |
| 6 | Apple renewable energy chart | http://images.apple.com/environment/pdf/Apple_Environmental_Responsibility_Report_2015.pdf |
| 7 | Apple | http://www.apple.com/environment/renewable-resources/ |
| | Wonderful Company estimated energy savings chart | http://www.kernenergywatch.com/wp-content/uploads/2014/06/The-City-of-Delano-Small-Fuel-Cells-Provide-a-Megawatt-Answer1.pdf |
| 8 | Wonderful Company | http://www.kernenergywatch.com/wp-content/uploads/2014/06/The-City-of-Delano-Small-Fuel-Cells-Provide-a-Megawatt-Answer1.pdf |
| 9 | Bloom Energy Server water usage comparison chart | http://www.bloomenergy.com/clean-energy/ |
| 11 | Doosan Fuel Cell America emission reduction chart | http://www.doosanfuelcell.com/attach_files/link/White%20Paper%20-%20The%20Green%20Edge%20of%20Fuel%20Cells.pdf |
| | Ballard | http://www.ballard.com/files/PDF/Backup_Power/BUP_Case_Study_Rooftop.pdf |
| 12 | Adobe Systems video | https://www.youtube.com/watch?v=AfB7WewLV4g&list=PLNjR6KSxqLQvPxtzDXE5BDz5V_3WOF&index=13 |

| Page | Image | URL |
|------|-------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 13 | Taylor Farms video | https://www.youtube.com/watch?v=hmUtscY5yPg |
| | eBay video | https://www.youtube.com/watch?v=TcRyUmxeYt8 |
| 14 | Kaiser Permanente video | https://www.youtube.com/watch?v=4FTd4N_YlnY |
| | Walmart video | https://www.youtube.com/watch?v=IFVJ7n67Hts |
| | Life Technologies video | https://www.youtube.com/watch?v=Gx_X-Y6PLac |
| 15 | Macy's video | https://www.youtube.com/watch?v=7mJVovWRcK2E |
| | Microsoft video | https://www.youtube.com/watch?v=IUHAqFRN9I |
| | Interlink Connectivity, Inc. video | https://www.youtube.com/watch?v=jwllcDSckzY&feature=player_embedded |
| 16 | Video of various customers (includes eBay, Walmart, Google) | https://www.youtube.com/watch?v=l83ZB4WJ8Pw |
| | BMW video | https://www.youtube.com/watch?v=EEpegKc7tvc |
| | UNFI video (1) | https://www.youtube.com/watch?v=KzBTiXjrzi0 |
| 17 | UNFI video (2) | https://www.youtube.com/watch?v=l4HoX5gwNWY |
| | Volkswagen video | https://www.youtube.com/watch?v=M_jKc_5F30k |
| | Wegman's video | https://www.youtube.com/watch?v=wwJk8RciZX0 |
| 18 | Department of Energy cost-share/additional purchases chart | http://energy.gov/sites/prod/files/2015/06/f23/01_satyapal_plenary_2015_amr_0.pdf |
| 19 | FedEx | http://about.van.fedex.com/newsroom/global-english/fedex-works-with-us-doe-plugpower-inc-charlatteamerica-to-rollout-worlds-first-zero-emissions-hydrogen-fuel-cell-ground-support-equipment/ |
| 21 | Foss Maritime | http://energy.sandia.gov/hydrogen-fuel-cell-project-seeks-to-reduce-port-emissions/ |
| 22 | Disney's Pixar Animation Studios | https://cdn.thewaltdisneycompany.com/sites/default/files/reports/FY14-Performance-Summary.pdf |
| 23 | Maxim Integrated | http://www.bloomenergy.com/customer-fuel-cell/maxim-integrated-installs-fuel-cells/ |
| 24 | FedEx | http://csr.fedex.com/wp-content/uploads/2015/03/fedex_fullreport.pdf |
| | CenturyLink | Courtesy of CenturyLink |
| 25 | AT&T | http://www.bloomenergy.com/customer-fuel-cell/att-alternative-energy/ |
| 27 | IKEA | http://www.businesswire.com/news/home/20150701005344/en/IKEA-Plugs-in-Onsite-Power-Emeryville-CA-Store#.VenUryVVhBe |
| 28 | Medtronic | http://www.bloomenergy.com/customer-fuel-cell/medtronic-powers-campus/ |
| 29 | Becker + Becker | Courtesy of Becker + Becker |
| 30 | Comcast | https://www.linkedin.com/pulse/comcast-dedicates-turns-fuel-cell-berlin-ct-campus-chris-edge |
| 31 | Johnson & Johnson ASP | http://www.bloomenergy.com/customer-fuel-cell/asp-installs-fuel-cells/ |
| 32 | Blue Lake Rancheria Tribe | http://www.schatzlab.org/news/2015/04/repower-humboldt-biomass-fired-fuel-cell-power-system/ |
| 36 | Home Depot chart | http://builtfromscratch.homedepot.com/ohio-direct-fulfillment-center-opens/ |

| Page | Image | URL |
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| 37 | Newark Farmers Market | http://www.newjerseycommunitycapital.org/about-us/media/senator-menendez-tours-newark-farmers-market |
| 38 | Walmart | Courtesy of Tim Krohn, Mankato Free Press |
| 39 | Honda | Courtesy of Honda |
| | Volkswagen | http://www.schnellecke.com/press/news/emissions-free-forklifts.381.htm |
| 40 | Golden State Foods | Courtesy of Nuvera Fuel Cells |
| 41 | SoftBank / Tokyo Shiodome | http://www.softbank.jp/en/corp/news/press/sb/2014/20140617_01/ |
| 43 | Vodacom | http://www.vodafone.com/content/index/about/what/technology-blog.html/ |
| 44 | DB Schenker | http://www.linde-mh.com/en/main_page/news/pressreleases/pressreleases_1_3392.jsp |
| | Colruyt | http://www.h2euro.org/2014/lifting-fuel-cell-powered-material-handling-to-new-h2heights-in-europe |
| | Starks | http://ing.dk/artikel/hurtig-pafyldning-gor-brintdrevne-trucks-til-et-hit-135925 |
| 45 | FM Logistic | http://www.toyota-forklifts.eu/en/News/news/Pages/fm-logistics-pilots-fuel-cell-trucks-with-tmh.aspx |
| | Preloadis | https://pbs.twimg.com/media/COit11-UEAAYahd.jpg |

Endnotes

- ¹ http://energy.gov/sites/prod/files/2015/10/f27/fcto_2014_market_report.pdf
- ² <http://www2.deloitte.com/content/dam/Deloitte/us/Documents/energy-resources/us-er-deloitte-resources-study-series.pdf>
- ³ <http://energyefficiencymarkets.com/55-of-businesses-say-they-now-generate-onsite/>
- ⁴ <http://www.kernenergywatch.com/wp-content/uploads/2014/06/The-City-of-Delano-Small-Fuel-Cells-Provide-a-Megawatt-Answer1.pdf>
- ⁵ http://www.ucsus.org/clean_energy/our-energy-choices/energy-and-water-use/ucs-power-plant-database.html#.VJC_UyvF-RZ
- ⁶ <http://www.doosanfuelcell.com/en/solutions/benefits/clean.do>
- ⁷ According to Doosan Fuel Cell America
- ⁸ <http://www.bloomenergy.com/clean-energy/>
- ⁹ <http://www.triplepundit.com/2015/07/water-corporate-culture-golden-state-foods/>
- ¹⁰ <http://static1.squarespace.com/static/53ab1fee4b0bef0179a1563/t/54e5e838e4b0072e73714e4b/1424353336299/Northeast-Resiliency-White-Paper-February-2015.pdf>
- ¹¹ <http://www.verizon.com/about/responsibility/sustainability>
- ¹² <http://www.triplepundit.com/2014/08/kellogg-sets-bold-sustainability-goals-2020/>
- ¹³ https://www.kelloggcompany.com/content/dam/kelloggcompanyus/corporate_responsibility/pdf/2015/Kelloggs_CRR_2014_FINAL.pdf
- ¹⁴ <http://www.kernenergywatch.com/wp-content/uploads/2014/06/The-City-of-Delano-Small-Fuel-Cells-Provide-a-Megawatt-Answer1.pdf>
- ¹⁵ http://www.ballard.com/files/PDF/Backup_Power/Rooftop_Application_Paper_FINAL_121814.pdf
- ¹⁶ http://www.hydrogen.energy.gov/pdfs/review15/mt011_petrecky_2015_o.pdf
- ¹⁷ <http://energy.gov/articles/energy-department-invests-over-7-million-commercialize-cost-effective-hydrogen-and-fuel>
- ¹⁸ http://www.hydrogen.energy.gov/pdfs/review15/mt016_hanlin_2015_o.pdf
- ¹⁹ http://www.hydrogen.energy.gov/pdfs/review14/mt014_brooks_2014_o.pdf
- ²⁰ <http://www.ir.plugpower.com/profiles/investor/ResLibraryView.asp?ResLibraryID=64715&GoTopage=11&Category=44&BzID=604&G=795>
- ²¹ <http://www.nuvera.com/pressroom/press-releases/179-nuvera-and-doe-demonstrate-fuel-cell-powered-refrigerated-trucks>
- ²² http://www.hydrogen.energy.gov/pdfs/review14/mt007_baxterclemmons_2014_o.pdf
- ²³ <http://energy.gov/eere/success-stories/articles/one-mans-trash-another-mans-fuel-bmw-plant-converts-landfill-gas>
- ²⁴ <http://blog.scra.org/2015/08/03/scra-completes-energy-project-at-bmws-spartanburg-facility/>
- ²⁵ <http://energy.sandia.gov/transportation-energy/hydrogen/market-transformation/maritime-fuel-cells/maritime-hydrogen-fuel-cell-project/>
- ²⁶ http://csr.fedex.com/wp-content/uploads/2015/03/fedex_fullreport.pdf
- ²⁷ Source: Bloom Energy
- ²⁸ <http://www.datacenterknowledge.com/archives/2013/07/22/equinix-using-fuel-cell-to-power-frankfurt-data-center/>
- ²⁹ <http://www.equinix.com/company/news-and-events/press-releases/equinix-to-install-bloom-energy-fuel-cells/>
- ³⁰ <http://info.aee.net/a2r-webinar-post?submissionGuid=c29aff77-44bd-4005-9274-a2736ff52951>
- ³¹ http://www.ibm.com/ibm/environment/news/first_fuel_cell_2015.shtml
- ³² <http://www.bloomenergy.com/customer-fuel-cell/medtronic-powers-campus/>
- ³³ <http://www.hartfordbusiness.com/article/20150113/NEWS01/150119981>

³⁴ Contact with Becker + Becker
³⁵ Ibid.
³⁶ <http://www.bloomenergy.com/newsroom/press-release-04-21-15/>
³⁷ <http://www.morganstanley.com/about/press/articles/d339e54b-370a-4834-a5cf-bfa6a80411db.html>
³⁸ <http://www.lohud.com/story/money/business/2014/11/19/moving-grid/19307239/>
³⁹ <http://www.bloomenergy.com/customer-fuel-cell/asp-installs-fuel-cells/>
⁴⁰ <http://www.bloomenergy.com/newsroom/press-release-10-23-14/>
⁴¹ <http://www.times-standard.com/general-news/20150108/blue-lake-rancherias-innovative-power-program-in-spotlight> and <http://www.energy.gov/indianenergy/articles/blue-lake-rancheria-s-bold-action-climate-front-pays-dividends>
⁴² <http://www.sacbee.com/entertainment/casino/article40385613.html#storylink=cpy>
⁴³ <http://www.sacbee.com/entertainment/casino/article40385613.html#storylink=cpy>
⁴⁴ <http://www.businesswire.com/news/home/20150824005598/en/Siemens-Blue-Lake-Rancheria-Humboldt-State-University#.VeRd2SVVhBc>
⁴⁵ <http://www.plugpower.com/2015/08/genkey-enabling-the-auto-industry-to-drive-on-powerahead/>
⁴⁶ <http://www.plugpower.com/wp-content/uploads/2014/12/Whitepaper-Fuel-Cells-A-Smart-Decision.pdf>
⁴⁷ <http://www.plugpower.com/wp-content/uploads/2014/12/Whitepaper-Fuel-Cells-A-Smart-Decision.pdf>
⁴⁸ <http://www.plugpower.com/wp-content/uploads/2014/12/Whitepaper-Fuel-Cells-A-Smart-Decision.pdf>
⁴⁹ <http://www.plugpower.com/2015/03/blog-kroger-sustainability-program-finds-hydrogen-fuel-cell-technology-is-robust-reliable-safe/>
⁵⁰ <http://sustainability.kroger.com/dl/Kroger-2015CSR.pdf>
⁵¹
<http://www.ir.plugpower.com/profiles/investor/ResLibraryView.asp?ResLibraryID=77195&GoTopage=2&Category=44&BzID=604&G=795>
⁵² http://www.plugpower.com/news/pressreleases/15-03-19/FREEZPAK_LOGISTICS_SELECTS_GENKEY_SOLUTION_FROM_PLUG_POWER_FOR_NEW-CONSTRUCTION_FREEZER_WAREHOUSE_IN_NEW_JERSEY.aspx
⁵³
<http://www.ir.plugpower.com/profiles/investor/ResLibraryView.asp?ResLibraryID=73574&GoTopage=5&Category=44&BzID=604&G=795>
⁵⁴
<http://www.ir.plugpower.com/profiles/investor/ResLibraryView.asp?ResLibraryID=77240&GoTopage=2&Category=44&BzID=604&G=795>
⁵⁵ <http://www.plugpower.com/2015/08/genkey-success-with-walmart/>
⁵⁶ <http://www.plugpower.com/2015/08/genkey-success-with-walmart/>
⁵⁷
<http://www.ir.plugpower.com/profiles/investor/ResLibraryView.asp?ResLibraryID=77381&GoTopage=1&Category=44&BzID=604&G=795>
⁵⁸ <http://ohio.honda.com/article/honda-plants-in-marysville-east-liberty-and-anna-receive-top-environmental>
⁵⁹ <http://www.schnellecke.com/press/news/schnellecke-logistics-usa-receives-contract-extension.358.htm>
⁶⁰ https://www.volkswagen-media-services.com/en/detailpage/-/detail/Volkswagen-Group-of-America-Chattanooga-Operations-LLC/view/2085794/bcba9e865831a723794dcfab60f57f4?p_p_auth=RuGrMJz1
⁶¹ https://www.youtube.com/watch?v=M_jKc_5F30k
⁶²
<http://www.ir.plugpower.com/profiles/investor/ResLibraryView.asp?ResLibraryID=77304&GoTopage=2&Category=44&BzID=604&G=795>
⁶³
<http://www.ir.plugpower.com/profiles/investor/ResLibraryView.asp?ResLibraryID=77337&GoTopage=1&Category=44&BzID=604&G=795>

⁶⁴ http://www.plugpower.com/news/pressreleases/14-10-29/PLUG_POWER_COMMISSIONS_SITE_AT_GOLDEN_STATE_FOODS_DEPLOYS_GENDRIVE_HYDROGEN_FUEL_CELLS_AT_NEW_REGIONAL_DISTRIBUTION_CENTER.aspx

⁶⁵ <http://www.nuvera.com/pressroom/press-releases/186-powertap-makes-hydrogen-cost-effective-for-golden-state-foods>

⁶⁶ <http://www.bloomenergy.com/newsroom/press-release-06-17-14/>

⁶⁷ <http://www.bloomenergy.com/newsroom/press-release-03-09-15/>

⁶⁸ <http://fcel.client.shareholder.com/releasedetail.cfm?ReleaseID=924730>

⁶⁹ <http://www.protonpowersystems.com/cooperation-agreement-with-german-rail-subsiidiary-bahnbau/>

⁷⁰ [http://www.implats.co.za/implats/downloads/2015/press/1 April 2015 Impala fuel cell.pdf](http://www.implats.co.za/implats/downloads/2015/press/1%20April%202015%20Impala%20fuel%20cell.pdf)

⁷¹ http://www.fronius.com/cps/rde/xchg/SID-2BA8F620-E7494690/fronius_china/hs.xml/83_18125_ENG_HTML.htm

⁷² <http://www.colruytgroup.com/en/news/colruyt-group-buys-first-series-produced-hydrogen-car-belgium>

⁷³ <http://www.colruytgroup.com/en/news/colruyt-group-buys-first-series-produced-hydrogen-car-belgium>

⁷⁴ <http://ing.dk/artikel/hurtig-pafyldning-gor-brintdrevne-trucks-til-et-hit-135925>

⁷⁵ <http://www.toyota-forklifts.eu/en/News/news/Pages/fm-logistics-pilots-fuel-cell-trucks-with-tmh.aspx>

⁷⁶ <http://www.airliquide.gr/en/first-hydrogen-filling-station-for-forklift-trucks-in-france-for-ikea.html>

⁷⁷ <http://www.ir.plugpower.com/profiles/investor/ResLibraryView.asp?BzID=604&ResLibraryID=78880&Category=44&G=795>

⁷⁸ <http://www.fml.mw.tum.de/H2Intradrive/download/WorldOfEnergySolution.pdf>

⁷⁹ <http://www.sciencedirect.com/science/article/pii/S1464285915301929>

⁸⁰ <https://connect.innovateuk.org/web/energy-efficiency/article-view/-/blogs/19500530>

⁸¹ http://energy.gov/sites/prod/files/2014/03/f12/business_case_fuel_cells_2013.pdf (see pages 16-17)

⁸² <http://www.businesswire.com/news/home/20150812005259/en/Constellation-Bloom-Energy-Develop-40-Megawatts-Fuel#.VfhTk9JVhBe>

⁸³ http://www.exeloncorp.com/Newsroom/pages/pr_20140729_EXC_Bloom.aspx

⁸⁴ <http://www.ir.plugpower.com/profiles/investor/ResLibraryView.asp?ResLibraryID=78911&GoTopage=1&Category=44&BzID=604&G=795>

⁸⁵ <http://static1.squarespace.com/static/53ab1feee4b0bef0179a1563/t/54b97097e4b0c2c1fae62b95/1421439127286/2014-States-H2FC-Policy-WrapUp.pdf>