The Business Case for Fuel Cells 2014: Powering the Bottom Line for Businesses and Communities

Breakthrough Technologies Institute

Authors and Acknowledgements

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About This Report

This report provides an overview of fuel cell installations at businesses and municipal buildings or facilities run by non-profit organizations or institutions. These include wastewater treatment plants, government buildings, universities, military bases, hospitals, and other sites.

This list is by no means exhaustive. According to BTI estimates, over the past few decades, more than a 100,000 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.

The information contained in this report was gathered from public sources and via personal contact with fuel cell manufacturers and the customers and organizations profiled. Please contact us at info@fuelcells.org or 202-785-4222 with any corrections, updates or questions.

About BTI

The Breakthrough Technologies Institute is a non-profit [501(c)(3)] independent, educational organization established in 1993 to ensure that emerging technologies have a voice in environmental and energy policy debates.

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- Nuvera Fuel Cell's Power Tap hydrogen dispenser at a Sysco facility. Source: Nuvera Fuel Cells, Inc.
- ReliOn, a Plug Power company, fuel cell sited on a Seattle rooftop. Source: ReliOn
- Bloom Energy installation at the Yahoo! campus in Sunnyvale, California. Source: Bloom Energy

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Fuel Cells: Powering the Bottom Line

The list of fuel cell customers is growing; fuel cells are attracting interest from a wide range of market sectors. Fuel cell users 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 expanding into other uses such as material handling equipment (MHE) or backup power.

This report is the fifth in a series. In our 2013, 2012, 2011, and 2010 Business Case reports, our focus was on private sector companies incorporating fuel cells with other technologies to better achieve their sustainability goals and improve resiliency. 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]

Dozens of Fortune 500 companies utilize fuel cells to power corporate buildings and data centers, to provide backup power to telecom towers, and to run MHE used in warehouse operations. These companies include:

Recent fuel cell trends:

- **The fuel cell industry has become a $1.3 billion industry worldwide.**
- **Fuel cell forklift deployments have tripled, with more than 2,000 units deployed or on order since our last report (up from the 700+ units reported in our *2013 Business Case*).**
- **U.S. electric utilities are adding fuel cells to their energy portfolios, brokering multi-MW deals.**
- **Reliable and efficient fuel cells are adding up to savings for customers and opening up a wide range of municipal market sectors.**

Adobe, Apple, AT&T, Baker Hughes, Bank of America, CenturyLink, Coca-Cola, CVS Caremark, eBay, FedEx, Google, JP Morgan Chase, Juniper Networks, Kellogg's, Kimberly-Clark, Kroger, Lowe's, Macy's, Microsoft, Owens Corning, Procter & Gamble, Safeway, Staples, Sysco, Target, Urban Outfitters, United Natural Foods, Verizon, Walmart, Whole Foods, Williams-Sonoma, Xilinx, and Yahoo!.

Since our last report, Walmart, AT&T and Verizon all have furthered their commitment to fuel cell technology, with more than 30 MW of stationary fuel cells collectively installed or on order at sites in California, Connecticut, New Jersey and New York. Walmart also ordered more than 2,000 fuel cells for MHE and hydrogen fueling for seven sites, boosting its fuel cell fleet to more than 2,500 fuel cell-powered forklifts at ten sites in North America. New customers include Yahoo!, Dreamworks Animation SKG, and SoftBank.

Fuel cells are not only finding success with Fortune 500 companies. This clean technology is also providing power to publicly-funded sites such as government buildings, wastewater treatment plants and other municipal sites, helping governments save taxpayer dollars while improving air quality and

[1] As estimated by BTI based on company statements.

ensuring reliable service to citizens. Local governments use fuel cells to power city halls, jails, public buildings, and transit buses, and have begun to demonstrate fuel cells in stationary and motive power applications to reduce emissions at airports and ports. Local governments that use, or will soon deploy, fuel cells for stationary or motive power include:

- *California:* Cities of Dublin, Los Angeles, Moreno Valley, Perris Valley, San Diego, and San Jose; region that includes the nine cities of the Coachella Valley and Riverside County; region serving 13 cities and adjacent unincorporated areas in Alameda and Contra Costa counties; Santa Clara County, and Sonoma County
- *Connecticut:* Cities of Hartford, Middletown and New Haven; town of Hamden
- *Hawaii:* Honolulu
- *New York:* New York City, Suffolk County
- *Ohio:* Stark County

Thus, this 2014 edition of the report highlights not only businesses that have deployed fuel cells at their facilities, but also the many fuel cells installed by local and state governments to generate clean and reliable power to buildings, even when the grid goes down.

Why Fuel Cells?

The market for fuel cells is growing, exceeding $1.3 billion in worldwide sales during 2013. Both businesses and municipalities have taken notice and are deploying fuel cells in a range of applications.

Fuel cells offer a unique combination of benefits that makes it a vital technology ideally suited for a number of applications. From high efficiency to scalability, fuel cells provide a distinct advantage over incumbent energy generation technologies, which is why top companies, governments, and the military are adopting fuel cells for everyday use.

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

Fuel Cell Benefits

- **High quality, reliable power**
- **Exceptionally low/zero emissions**
- **Increased efficiency and productivity**
- **Modularity/scalability/flexible installation**
- **Can operate independent of the grid**
- **Extremely quiet**
- **Lightweight and rugged**
- **Can be used with or instead of batteries and diesel generators**
- **Able to partner with solar, wind, and other renewable technologies**
- **Fuel flexible - operation on conventional or renewable fuels, including natural gas, propane, methanol, hydrogen, methane and biogas**

No other technology offers the combination of benefits that fuel cells allow. Fuel cells are complementary, not competitors, to other electricity generation technologies, including renewable ones.

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

Corporations and municipalities increasingly recognize fuel cells as a technology that can:

- stand alone to deliver power (as well as heat, hot water and cooling) to buildings, data centers, and other facilities;
- provide reliable and uninterruptible energy to cell towers, communications networks and other off-grid or remote sites; and
- generate continuous power for demanding motive applications such as forklifts and other MHE.

Fuel cells are also used by customers to generate power in conjunction with other conventional and renewable energy sources or fuels, such as batteries, turbines, wind, solar, and existing natural gas lines.

Resiliency and Reliability

With increasing reliance on personal electronics and technology for banking, communication, teleworking and other daily transactions, staying connected is more important to people these days. Data centers, banks, hospitals, grocery stores, telecom companies and government agencies all rely on constant and high quality power to maintain crucial operations. In many areas, the aging electrical grid does not meet this requirement and high power demand is causing a strain, especially at peak times. Extreme weather such as hurricanes, snow storms and even excessive heat has also been a major factor in widespread power outages around the country.

These blackouts can be very costly, so reliability and resiliency has become a top priority for businesses and municipalities.

A recent White House report, *Economic Benefits of Increasing Electric Grid Reliance to Weather Outages,*[1] states that weather-related power outages between 2003 and 2012 are estimated to have cost the U.S. economy an inflation-adjusted average of $18-$33 billion annually. A 2012 Congressional Research Service study puts the number higher, estimating the annual inflation-adjusted cost of weather-related outages at $25-$70 billion. Variance in cost estimates reflect different input data and assumptions, which may include a range of costs such as, "lost output and wages, spoiled inventory, delayed production, inconvenience and damage to the electric grid."

Fuel cells can help by generating power independent of the grid, providing crucial backup power to a grid-connected building that can eliminate the fear of losing power. Fuel cells can also be configured to be a building's primary source of power. Fuel cells have proved themselves through several recent

storms, providing reliable primary power and emergency backup power to customers ensuring seamless communications and services when the electric grid was vulnerable or out of commission.

"We run the nation's most reliable networks, and that requires constant investments in what is best for network integrity. No matter what superstorm or disaster comes, our priority is to keep uninterrupted service to our customers. This investment is not going to take us 100% off the grid in any specific location, but it will help reduce the load on our nation's power grid while enhancing our service continuity – even during outages."

– Verizon (8/28/2014) and Verizon (8/25/2014)

"With fuel cells on each campus, it allows for a reliable power source on-site. In addition, the high efficiency of the power plants is a way to save energy while promoting a healthy environment."

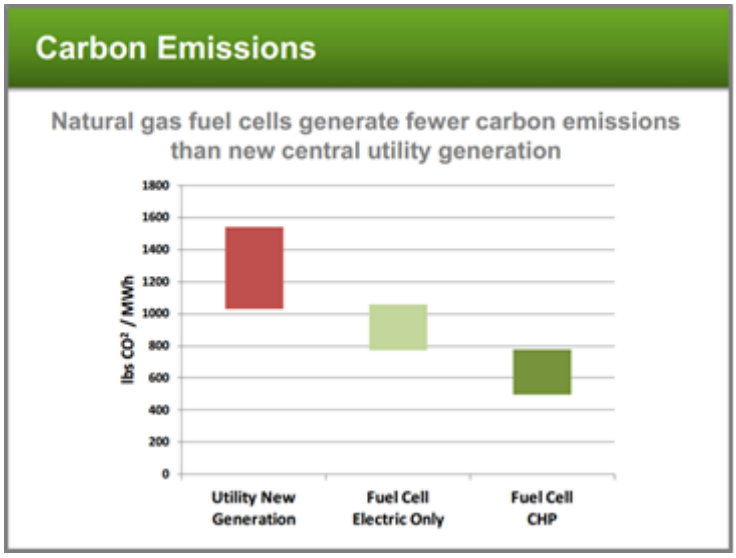
– Robert J. Falaguerra, Saint Francis Hospital's vice president of facilities, support services and construction

"I believe that this installation at our SoftBank Group headquarters greatly enhances our business continuity capabilities in the event of an emergency. We will continue to promote this innovative, reliable, and safe on-site electric generation method as a clean energy solution for future generations."

– Masayoshi Son, SoftBank Group Representative, and main tenant of the Tokyo Shiodome Building

Emissions Reduction

A fuel cell that operates using hydrogen fuel, mainly for applications such as backup power to cellular phone towers or MHE, generates power without any on-site greenhouse gas (GHG) or other polluting emissions. Many large stationary fuel cells operate using natural gas as a fuel, but even these systems produce far fewer emissions than conventional power plants. Emissions from natural gas-powered fuel cells are so low that some areas of the United States have exempted fuel cells from air quality permitting requirements, saving customers time and money.



Comparison of carbon emissions for fuel cells (electric-only and CHP) and utility new generation.

Companies or municipalities that use fuel cells to generate power can reduce, or eliminate, dependence upon an often unreliable, dirty and costly power grid while lowering GHG emissions by thousands of tons annually. Some examples include:

- Cox Enterprises has 3 MW of fuel cells installed at three different locations in California. The fuel cells, which run off a biogas mixture, are eliminating more than 15,800 tons of carbon emissions per year.[2]
- AC Transit, the transit agency serving the East Bay area of San Francisco, installed a 420-kW fuel cell system that will reduce GHG emissions by 1,500 metric tons per year and save the agency over $2 million in energy costs over 10 years.
- Kaiser Permanente has 4 MW of fuel cells installed at several facilities, avoiding approximately 5,700 metric tons of GHG emissions in 2013 while reducing the organization's reliance on the public electric grid and helping to diversify energy sources.[3]

"We weren't interested in a token project. We wanted to do something that was significant in terms of sustainability and efficiency. The PureCell® model 400 system at 1211 Avenue of the Americas in New York City accomplishes both, offering a strong example of how major urban office buildings can economically reduce carbon emissions through leading-edge technology. It was a win-win for us."

Al Scaramelli, Senior Vice President, Beacon Capital Partners, LLC

"This project actually avoids 1.8 million kilowatt-hours per year of electricity consumption (otherwise needed) to charge batteries…If you don't buy that electricity, you avoid about 1,200 tons per year of CO_2 emissions."

– **Briggs Hamilton, BMW Environmental Services Manager,** speaking about their fleet of more than 85 forklift trucks powered by Ballard GenDrive® fuel cells, located at BMW's automotive manufacturing plant in South Carolina

"WGL is committed to providing clean and efficient energy answers while remaining a responsible steward of our resources. We are proud to partner with Bloom Energy, and to service Santa Clara County, as we continue to invest in clean energy solutions as part of our expanding diversified energy portfolio."

– **Terry D. McCallister, WGL Chairman and CEO,** speaking of a 2.6 MW of Bloom Energy fuel cells powering four Santa Clara County, California facilities

Increased Efficiency and Productivity

Fuel cells are inherently more efficient than combustion systems. Fuel cell systems today can achieve around 50% fuel-to-electricity efficiency using hydrocarbon fuels such as natural gas. Compared to a natural gas-fired gas turbine, which is about 25% efficient, and combined cycle, internal combustion, and steam generators, which are about 33% efficient,[4] using natural gas in a fuel cell means more power for less money. If hydrogen is used as a fuel, efficiencies of nearly 60% have been demonstrated on the road.[5]

Fuel cells also produce heat as a by-product, so when they are sited near the point of energy use, heat can be captured for heating (called combined heat and power, or CHP), or even cooling, resulting in system efficiencies of 85% or greater and allowing users to reduce or eliminate the need for boilers or water heaters and their associated costs and emissions.

When used for off-grid power, such as backup power to cell towers or primary power for remote monitoring equipment, fuel cells can operate on hydrogen or methanol for days to weeks at a time, reducing trips to deliver fuel to diesel or propane generators or to replace spent batteries.

In material handling applications, fuel cells can operate for an entire 6 to 8 hour shift on a single tank of hydrogen and deliver constant power to forklifts with no voltage sag, improving the efficiency of operations. Since fuel cells do not need to be swapped out and recharged every few hours as batteries do, warehouse operators can eliminate recharging and storage areas, recovering this space for other purposes. Forklifts can also be easily and quickly refueled directly by the vehicle's operator, so staff required for battery swaps and recharging activity can be redeployed to other duties in the warehouse. With fuel cells, there is also no more need for handling and disposing of toxic lead and acid from batteries.

"We anticipate the new [hydrogen fuel cell] technology will provide a payback of 2½ years. The fuel cells free up valuable space that would otherwise be dedicated to a room needed to store and charge batteries, which reduces the building's electrical consumption."

– Lowe's 2012 Sustainability Responsibility Report

"Hydrogen fuel cells run longer and maintain consistent power as they operate and are refueled more quickly than batteries. Our operators are pleased with the lift trucks powered by GenDrive, and management has been impressed by the high levels of productivity within our facility."

– Ken Nameth of Central Grocers

"Now that Ace Hardware's state-of-the-art retail support center is operating, we can see what a positive difference it makes to have Plug Power's hydrogen fuel cells in our lift trucks. Our material handling equipment drivers can refuel quickly, and maintain a clean space, while supporting our efforts to use clean energy."

– Rick Whitson, Vice President of Retail Support, Ace Hardware

Substantial Savings

Fuel cell-powered MHE operating at a 24/7 distribution center are reducing operational costs and increasing productivity through their longer run times and shorter refueling times.

For power generation, fuel cells can reduce dependence on the electric grid and offer stability, providing crucial and seamless backup power in the event of an outage. This assurance is priceless to many industries, including banking, healthcare, biotechnology and food retailers, where downtime can cost millions of dollars, or lead to spoiled research or inventory when a refrigeration system goes down.

Customers in states with high commercial or industrial electricity prices, such as Alaska, California, Connecticut, Hawaii, Massachusetts, New Hampshire, New Jersey, and Vermont,[6] are finding they can generate electricity onsite with a fuel cell that is cost competitive and in some cases cheaper than grid power. Fuel cell power can also cost less where utilities charge extra for electricity at times of peak demand. Bloom Energy's fuel cell systems can generate electricity at 8-10 cents/kilowatt-hour (kWh).[7] The levelized cost of energy for FuelCell Energy's systems is 14-15 cents/kWh without subsidies

(depending on the cost of natural gas), and with incentives (such as federal and California incentives) their fuel cell systems can generate power at 9-11 cents/kWh.[8]

Most of the recent purchases of fuel cells have been via power purchase agreements (PPAs), where a pre-defined price of electricity ($/MWh) is specified for up to 20-year periods, providing the customer with budget certainty and protection against fluctuating energy prices. There is also a federal tax credit that offers $3,000/kW until end of 2016 and, in states like California, additional financial incentives for installing fuel cells.

One installation that hasn't received much press is Sutter Home Winery in St. Helena, California. One of the largest family-run independent wineries and fifth largest winery overall in the U.S., Sutter Home has had two 200-kW Bloom Energy fuel cells operating since 2011. The fuel cells were sized to offset Sutter Home's baseload electricity usage on two utility meters. After analyzing its operation for three full years, the fuel cells have exceeded the company's expectations and the savings are higher than original projections.[9]

Bloom Energy installation at Sutter Home Winery.

Local governments are also investing in clean technologies to save taxpayer dollars while lowering GHG emissions. Alameda County's Santa Rita Jail (a 1 million square foot facility that operates 24/7 and has large energy demands) has operated a 1-MW fuel cell power plant since 2006 that generates 50% of the facility's power and pre-heats the jail's hot water systems. The county reports that the fuel cell, combined with the facility's rooftop solar power array and energy efficiency upgrades, is reducing power purchases by up to 80% during peak-demand summer months and avoids 3,200 tons of annual GHG emissions. The county anticipates gross savings of $21.6 million ($864,391/year) over 25 years, with net savings $6.6 million ($266,825/year) over 25 years, and annual net electricity savings of $266,825.[10]

"We estimate that by using the gas we save about US$445,000 a year, based on production at 450 kW and 740 hours. If they can keep the output above 90% they are well worth the cost…People don't realize that if you invest in some of these efficiency measures, you can save a lot of money in the long run, not only on utility power but on preparations."

– Nael Younes, NTT America director of facilities engineering - West

"Verizon isn't going green just to go green. We have analyzed the on-site green energy business case and anticipate a positive ROI [return on investment] over the next several years. Our chief financial officer realizes the value of this investment, and that this is the right thing to do for our stakeholders."

– Verizon news center (8/28/2014), referring to the company's investment in solar and fuel cell power

"CCSU's power costs will be reduced annually by more than $100,000 – a savings for both the university and Connecticut taxpayers."

– Jack Miller, President, Central Connecticut State University (CCSU), speaking about the university's 1.4 MW FuelCell Energy DFC® power plant

"An analysis of actual savings from 2012, completed one year after Sutter Homes' fuel cells were interconnected, showed that savings were higher than we had projected in our 2010 feasibility analysis."

– Gopal Shanker, President, Récolte Energy

Quote from author's contact with Récolte Energy, consultant to Sutter Home Winery

"I have a CFO and a CEO who are telling me quite often, 'We are not going green for green's sake.' So we absolutely have a positive return on investment based on a 10-year net present value."

– James Gowen, chief sustainability officer for Verizon Communications Inc.

"We're going to be replacing a large amount of grid energy we purchase with energy we purchase on site. We're cutting the wire." The reported net electricity savings is about $15,000/month, *"and that's a conservative estimate."*

– P.J. Quesada, vice president of marketing for Ramar Foods

Small Footprint, Quiet Footsteps

Fuel cells can take up much less space than other technologies offering similar power output. This is a huge benefit in areas where land is expensive and hard to come by. The fuel cell's smaller footprint and weight also mean that fuel cells can be situated not only outside, but also inside buildings or on roofs, offering maximum flexibility.

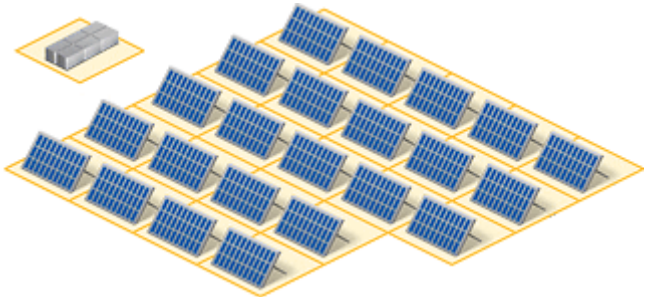
Redox Power Systems fuel cell sited on a roof.

Fuel cells can be a good alternative or supplement to intermittent renewable energy technologies. An end user may wish to generate electricity from solar or wind power, but an assessment may reveal that the site does not have sufficient space. Recent fuel cell installations in Connecticut reinforce that a lot of power doesn't have to take up a massive amount of land.

- A 14.9-MW fuel cell system, the largest single installation in the country, at a Dominion facility in downtown Bridgeport takes up about 1½ acres of land.[11]
- The footprint for Hartford Hospital's 1.4-MW fuel cell is 2,250 square feet, about 200 times smaller than a 1.4-MW solar array.[12]
- United Illuminating (UI) is installing 2.8 MWs on just ¼ acre; the 2.2-MW solar array it is collocated with to generate renewable electricity requires more than 8 acres.[13]

A fuel cell can also become part of a hybrid system in order to reduce the space requirement or, for limited or costly real estate, can be the sole source of zero-emission power.

In addition, since fuel cells have few moving parts, they are very quiet – about 60 decibels, the volume of a typical conversation. Noise pollution is all but eliminated, so fuel cells can be sited indoors or outdoors, near schools, parks, residential areas and other public sites without being obtrusive. Fuel cells' silent operation also discourages fuel or equipment theft.



Size comparison: A 100-kW fuel cell system takes up about 546 square feet, while a 100-kW solar system requires about 12,440 square feet.

Quiet operation is helping fuel cells find success in niche markets. They have recently been used to power media cameras at the Daytona 500, remote wildlife surveillance operations, awards shows and a radio broadcast from a tree-house studio.

Fuel cells may also be able to help meet noise ordinances in the future. Local governments and other facilities (hotels, hospitals, nursing homes and underground parking lots) are implementing restrictions on loud diesel-engine trucks that require drivers to turn off their engines when idling, especially during early morning and night hours in urban and residential areas. For food delivery vehicles, no power to the truck's refrigeration system when stopped for deliveries means risking food spoilage. Fuel cells are currently being evaluated to power transport refrigeration units (TRUs) in trials overseen by the U.S. Department of Energy's (DOE) Pacific Northwest National Laboratory. Participants include trucking companies Carrier Transicold and ThermoKing, food distributor Sysco, and grocery chain H-E-B. In the future, quiet, zero-emission fuel cells may be able to provide continuous power to the TRU's refrigeration system when the diesel engine is turned off to prevent spoilage while avoiding localized emissions and meeting noise regulations.

Water Savings

With the ongoing drought in California and some western and southern states, coupled with an increasing demand from a growing population, water has become a precious resource.

According to Sandia National Laboratories,[14] the electricity industry is the second largest user of water in the U.S. Coal currently accounts for 52% of U.S. electricity generation, and each kWh generated from coal requires withdrawal of 25 gallons of water. This adds up fast. The average U.S. coal plant uses 1.1 million gallons per 200 kW annually, and efficient combined cycle natural gas plants use 416,100 gallons per 200 kW annually.[15]

Fuel cells, however, help conserve water while generating energy. Most fuel cells require less than a gallon per MWh. Bloom Energy's fuel cells don't require any water beyond a 240-gallon injection at start-up.[16] Another fuel cell manufacturer, Doosan Fuel Cell America, claims that each of its Model 400

(400-kW fuel cell system) saves about 1.6 million gallons of water per year compared to the U.S. electric grid.[17] Some companies are touting these savings:

- Taylor Farms Retail installed a 1-MW Bloom Energy fuel cell system at its Salinas, California, salad processing plant in 2012 and claims that each unit of electricity generated uses 99.99% less water than a conventional power plant.[18]
- With its 500-kW fuel cell installation at the LPL Financial building in San Diego, California, real estate developer Hines will save 3.4 million gallons of water each year compared to the U.S. grid, while reducing carbon emissions by 4.5 million pounds.
- Compared to the average water demands of California power plants, Honda estimates that its 1-MW fuel cell at its Torrance, California, campus will save more than 3.25 million gallons of water per year.

Power When You Need It

Because fuel cells do not have to be connected to the electrical grid, they are a form of distributed generation (power generated at the point of use) that can allow companies and municipalities to move away from reliance on high voltage central power generation, which is vulnerable to power outages and natural disasters.

Acumentrics fuel cell at wind farm in Finland.

Fuel cells are rugged – they can be sited in harsh terrain, extreme climates, and rural areas without infrastructure to generate power for buildings, communication (including cell phone towers) and mission critical equipment. Today, fuel cells are helping telecommunications, microwave and radio network providers extend their network into remote areas without costly grid extensions or redesigns. Fuel cells are also being trialed by military forces in the field, for portable electronic soldier power.

Ballard ElectraGen™-ME systems provide backup power for a telecom network in East Timor.

Because they need little maintenance, can be remotely monitored and are more efficient than diesel generators or internal combustion engines, fuel cells are also finding a toe hold in energy exploration markets – powering monitoring equipment for wind measurement equipment (LIDAR and SODAR) as well as chemical injection pumps at oil and natural gas well head sites. The fuel cell's higher efficiency adds up to savings. One fuel cell manufacturer serving this market predicts cost savings on propane to equal $2,790 per site per year.[19]

Meeting Sustainability Goals

Many companies are deploying fuel cells to help meet their sustainability goals. Walmart has installed fuel cells at 35 retail sites (and counting) and soon will boast the world's largest collective fleet of MHE. Walmart is working toward a 100% renewable energy supply at its facilities and is also working with suppliers to lower their respective carbon footprints.

Fuel cells are helping companies qualify for U.S. Green Building Council Leadership in Energy and Environmental Design (LEED) certification, in most cases adding 4-6 points to the scorecard to boost customers toward Gold or Platinum status.

Verizon wants to reduce its carbon intensity by 50% by 2020 and aims to earn LEED status at 225 stores by the end of 2015.[20] As a company that invested early in fuel cell trials and installations, Verizon has already invested $100 million in the deployment of 25 MW of fuel cell and solar power (See Appendix 4).[21] Verizon is also encouraging suppliers to do the same, and has established a goal of devoting 55% of its supplier spending by the end of 2015 to firms that measure and set targets to lower their own GHG emissions.[22]

Food product distributor Sysco has deployed over 700 fuel cell forklifts at seven U.S. distribution centers and proudly states that, "fewer acid batteries are making their way to landfills due to our conversion to hydrogen fuel cell-powered equipment at seven of our operating companies."[23]

A local government leading by example is Alameda County, California, which has committed to reducing GHG emissions by 80% by 2050,[24] and has installed a 1-MW fuel cell at its jail.

Energy companies in both the U.S. and South Korea have begun to deploy MW-scale fuel cell systems that deliver electricity to customers and the power grid. Fuel cells also help electric utilities fulfill Renewable Portfolio Standards (RPS), as fuel cells qualify in many states as a renewable energy source.

"As part of our commitment to being an environmentally responsible company, our goal is to source 50% of our annual electricity from on-site generation. This is the first Bloom Box we've installed which will power one-third of our electricity on campus. We will continue to investigate opportunities to deploy energy efficient technologies to our facilities around the world."

– Chris Page, Yahoo! Global Director of Energy and Sustainability Strategies

"Fuel cell forklifts can be a financially attractive proposition that increases productivity while helping us reach our sustainability vision. Our internal analysis shows that we can not only achieve the sustainability benefits, but can also achieve an attractive rate of return on our investment at the same time."

– Stefano Zenezini, vice president, Procter & Gamble Global Family Care Product Supply and Global Product Supply Sustainability

"To date, we've deployed approximately 500 hydrogen fuel cells in our network. This technology will provide backup power for our network and could extend to other industries as well."

– Bob Azzi, chief network officer at Sprint

"PHI (Pepco Holdings, Inc.) is committed to meeting state goals on renewable energy and achieving environmental sustainability, power reliability and cost-effectiveness for the communities we serve. Our commitments are consistent with state laws that require PHI utilities to annually increase the amount of energy from renewable resources in our total power procurements."

– Pepco Holdings, Inc.

PHI's subsidiary, Delmarva Power, operates 30 MW of fuel cells that generate power for Delaware customers.

"LPL Financial at La Jolla Commons is one further step in our objective to put new building strategies and technologies into practice in an economically viable way, using our experience to continually reset our own standards of quality."

– Jeffrey C. Hines, President and Chief Executive Officer of international real estate firm, Hines, speaking about the new net-zero emission building in Los Angeles (leased by LPL Financial) that includes fuel cell power generation

"We must explore our energy alternatives to support advancements in technology and the escalating demand for network and IT infrastructure. Bloom's clean fuel cells offer a way for businesses like CenturyLink to promote the continuing evolution of technology without sacrificing their sustainability commitments."

– David Meredith, senior vice president and global general manager for Savvis

Repeat Customers

For all the reasons mentioned, the list of repeat fuel cell customers is growing, and not just longer, but wider, as companies purchase fuel cells for different applications such as MHE and power generation. Since our last report, there have been several major announcements and new location details from Fortune 500 companies such as Walmart, AT&T and Verizon, all ramping up their investments in fuel cells.

A number of these companies started small, testing fuel cells at a few sites (often with the assistance of the DOE, which is helping to move the fuel cell and other renewable energy industries toward greater commercialization). Once fuel cells proved their mettle, these companies came back for more – purchasing hundreds of additional fuel cells and many megawatts of fuel cell power.

Fuel Cells Deliver Reliable Performance and Savings

Food retailer **Kroger** has embraced fuel cell technology. Kroger first conducted a six-month fuel cell pilot program in 2010 at its Delaware, Ohio, warehouse using Plug Power GenDrive fuel cells to power six pallet jacks and one lift truck. The fuel cells successfully operated in a range of temperature zones, including the hot outdoors and in cold storage conditions.

With this success, Kroger deployed a full fuel cell fleet at its Compton, California, distribution center, ordering 174 GenDrive fuel cells to replace lead-acid batteries that powered its class 1, 2, and 3 lift and reach trucks. The Compton site accrued a number of benefits, including:

- decreasing maintenance costs;
- ROI of approximately 20% to-date;
- run times that are 1.5-2 times longer than lead-acid batteries;
- the ability to operate equipment at consistent speed and power (battery performance typically sags as the charge is drained); and
- fueling in only 1-4 minutes, regaining useful time over the 10-20 minutes that had been required to change a battery.

Impressed with the fuel cell operation and benefits, Kroger has ordered additional GenDrive fuel cells for deployment at distribution centers in Stapleton, Colorado and Louisville, Kentucky, in 2014. Kroger also plans to roll out fuel cells at additional facilities in 2015 and beyond.

Source: http://www.plugpower.com/News/blog/post/2014/06/13/Kroger-Sustainability-Program-Finds-Hydrogen-Fuel-Cell-Technology-Is-Robust-Reliable-Safe.aspx

Examples of Repeat Customers with Recent (2013/2014) Fuel Cell Purchases					
Legend Material Handling; Hydrogen Station; Telecom; Building, Data Center, Manufacturing Facility, or Retail Facility					
Company	**2010** or earlier	**2011**	**2012**	**2013** (announcement of installation or purchase)	**2014** (announcement of installation or purchase)
Ace Hardware				65 (CA)	65 (TX) 65 (OH)
Associated Wholesale Grocers				297 (MO) 203 (LA)	
AT&T	1995: 200 kW (NJ) 2010: 431 fuel cells at 180 sites (AZ, CA, CO, FL, IL, IN, KY, MI, NM, UT)	11 sites, 7.5 MW (CA)	17 sites, 9.6 MW (CA, CT)		8 sites, 7.9 MW (CA, NJ, NY)
BMW	2010: 100+ (SC)			175 (SC)	
Central Grocers	2009: 220 (IL)	14 (IL)			182 (IL) (replacement units)
Kroger			174 (CA)		# unannounced (CO, KY)
Life Technologies			1 MW (CA)	1 MW (CA)	

Examples of Repeat Customers with Recent (2013/2014) Fuel Cell Purchases					
Legend Material Handling; Hydrogen Station; Telecom; Building, Data Center, Manufacturing Facility, or Retail Facility					
Company	**2010** or earlier	**2011**	**2012**	**2013** (announcement of installation or purchase)	**2014** (announcement of installation or purchase)
Sysco	2010: 102 (TX)	102 (VA) 95 (PA)	170 (MA) 50 (NY) 110 (TX)	105 (CA)	
Verizon	2005: 1.4 MW (NY)			1 MW at 3 sites (CA) 8 MW at multiple sites (CA, NJ, NY)	
Walmart	2007: 254 (OH) 2010: 95 (Canada)			174 (Canada)	2,069 at 7 sites (unspecified)
	2009-present: 11.4 MW at 35 sites (CA)				
WGL Holdings			200 kW (VA)		2.6 MW (CA)

"BMW continues to complement its sustainable production model by adding alternative, efficient technology. Successful implementation, and ultimately expansion, of our hydrogen fuel cell material handling fleet has provided a sustainable energy source that exceeds our expectations."

– Josef Kerscher, President of BMW Manufacturing

"A key differentiator for fuel cells compared to other forms of alternative power is that fuel cell electricity production is virtually constant. They provide steady recurring electricity production at a relatively predictable cost, replacing the traditional electricity bill, which can be volatile."

– John Schinter, AT&T's Senior Energy Director

"We are pleased with the performance of the hydrogen fuel cells that we have been operating and are excited to expand our program with Plug Power."

– Jeff Smith, Senior Director for Walmart Logistics

Utilities Expand Power and Portfolios

Electric utilities are becoming fuel cell customers, with several major companies using multi-MW fuel cell systems to deliver clean and reliable power to grid customers in Connecticut, Delaware and California. These utilities are also integrating smaller fuel cell systems (1-10 kW) into network infrastructure – providing backup power to substation controls and telecommunication networks which are critical if a substation loses power or there is an equipment malfunction.

In addition, electric utilities are adding fuel cells to their portfolios as a distributed energy option to their customers. Electric utilities are also helping to finance projects to encourage sales and installations, or may purchase the fuel cell themselves and sell the power output and high quality heat to the customer under a long-term PPA.

In July 2014, Exelon Corporation, a leading competitive energy provider, announced it will provide equity financing for 21 MW of Bloom Energy fuel cell projects at 75 commercial facilities in California, Connecticut, New Jersey and New York for AT&T and one other unnamed customer. [25]

14.9-MW Dominion Bridgeport fuel cell in Bridgeport, Connecticut, operated and maintained by FuelCell Energy.

Also in July, NRG Energy, dual-based in New Jersey and Texas, serving almost 3 million residential and commercial customers throughout the country, invested $35 million in Connecticut fuel cell manufacturer FuelCell Energy.[26] NRG established a new $40 million revolving construction and term loan facility to accelerate project development by FuelCell Energy and its subsidiaries and will also market FuelCell Energy's fuel cell power plants to its customers.

This partnership is already bearing fruit. In September 2014, FuelCell Energy agreed to sell a 1.4-MW fuel cell power plant currently being installed at the University of Bridgeport in Connecticut, to NRG Energy.

"We are fully invested in issues affecting the environment because it means we are investing in the future of our City. Through the generation of ultra-clean power, produced in a highly efficient and environmentally-friendly manner, the fuel cell installation exemplifies the City's commitment to instituting sustainability practices and improving the environmental integrity of New Haven."

– Toni Harp, Mayor of New Haven, Connecticut, referring to the planned 5.6-MW UI fuel cell power plant announced in July 2014

"This project highlights Connecticut's new approach to clean energy, which focuses on using limited ratepayer dollars to leverage private capital and to get the greatest possible ratepayer benefit per dollar of public funds expended."

– Daniel Esty, Connecticut Department of Energy and Environmental Protection Commissioner, speaking about the 14.9-MW Dominion Bridgeport fuel cell power plant

The ownership of the project will transfer to NRG Energy and the University of Bridgeport will buy the electricity and heat produced by the fuel cell power plant under a multi-year PPA. Commercial operation is expected in early 2015.

"As a strong proponent of customer choice and innovation, Exelon is always looking for ways to support business customers who want to take control of their energy usage….we are committed to meeting the growing demand for distributed generation with Bloom Energy's clean, reliable, non-intermittent [fuel cell] power solution."

– Chris Crane, president and CEO of Exelon

"NRG is continuously looking to grow our portfolio of distributed generation assets that provide customers with cleaner, sustainable, and more resilient ways to meet their energy needs. The FuelCell Energy installation meets that criteria, and importantly, increases our customer resilience and sustainability."

– Mauricio Gutierrez, Chief Operating Officer, NRG Energy, Inc.

"The Dominion Bridgeport fuel cell is another important step in our efforts to identify and develop opportunities to produce clean energy that is reliable and cost effective. This project supports Connecticut's clean energy goals while producing significant economic development benefits for the State and the City of Bridgeport."

– Thomas F. Farrell II, Dominion chairman, president and chief executive officer

Municipal Facilities

Fuel cells are not just good business for corporations. Local governments are also adding fuel cells to municipal facilities to help meet GHG reduction goals, improve reliability, and save taxpayer dollars.

The business case for fuel cells applies as much to municipalities as it does to corporations, since government officials must account for expenditures of public funds, showing cost savings or other benefits accruable to the public good. Mature fuel cell technology is proving its mettle with both corporate and municipal customers seeking high quality, reliable primary power, long-lasting backup power, improved energy efficiency, significantly lower emissions, and cost savings. These qualities help municipalities keep government buildings open and public services operating when power goes down, and allows treatment plants to use methane as a biofuel, rather than release it to the environment – all while delivering cleaner air and, in areas where power costs are high, saving dollars.

Fuel cells are not new to municipalities. Early fuel cell technology was demonstrated at municipal sites as far back as the early 1990s, installed at government offices, jails, schools, wastewater treatment plants, landfills, firehouses, police stations, and community facilities around the country (as well as at other public sites, such as hospitals and schools). These early installations were crucial to help manufacturers improve the technology and familiarize stakeholders with the logistics of installation, citing and maintenance.

Government Offices and Public Buildings

Fuel cells are becoming more visible, generating low-emission power to publicly-accessible government buildings. Fuel cells help ensure that these buildings are able to reliably provide critical services to local citizens.

A 200-kW fuel cell installed in 2009 at the Perry B. Duryea, Jr. State Office Building in Hauppauge, New York, generates 25% of the building's electricity and saves more than $267,000 in energy costs annually. In 2013, a 100-kW fuel cell system from Bloom Energy was installed at New York's City Hall to power most of the building (the grid supplies additional power during peak use). Officials anticipate savings of approximately $45,000 in annual energy expenses.

"The installation of this fuel cell is yet another example where doing the right thing environmentally has also made the most sense financially."

– John DeStefano Jr., Mayor of New Haven at the time of the City Hall fuel cell installation

"The fuel cell is a Class I renewable energy source under the state Renewable Portfolio Standards. It supports the City's commitment to get its energy from more renewable sources; helps mitigate air pollution; and provides significant savings to the City. Whichever way you look at it, it's a win-win."

– Christine Tang, Director of the Office of Sustainability at the time of the City Hall fuel cell installation

New Haven, Connecticut, also has installed a 400-kW fuel cell at its City Hall that powers both the City Hall and the Hall of Records. The fuel cell started operation in 2012, providing almost all of the electricity for both buildings and approximately half of the heating and cooling needs. It is projected to save the City between $500,000 and $1 million over the next 10 years, depending on long term electricity and gas prices.

Sonoma County officials with their 1.4-MW FuelCell Energy power plant.

In 2011, the Sonoma County, California, government installed a 1.4-MW FuelCell Energy system to power 12 buildings at the publicly-accessible County Administration Center. The fuel cell provides 90% of the energy used at the facility and utilizes the technology's waste heat to provide heating. The overall energy plan is expected to reduce GHG emissions by more than 4,000 tons per year, and will save the county between $40 million and $50 million over the course of 25 years. The county expects the fuel cell to pay for itself within seven years.

In March 2014, WGL Holdings, Inc., through its subsidiary, Washington Gas Energy Systems (WGESystems), announced it will install 2.6 MW of Bloom Energy fuel cells at four county facilities in Santa Clara County (SCC). WGESystems will finance, build, own and operate the fuel cell system and will sell all energy generated to SCC under a 20-year power PPA. The fuel cells will use natural gas and biogas, reducing the County's carbon emissions by nearly 5 million pounds each year.

Fire Departments and Law Enforcement

Local governments have also begun to take advantage of fuel cells to generate continuous or backup power to critical agencies and facilities, such as fire and police stations.

Fuel cell at Central Park Police Station in New York City.

The most well known installation is at the Central Park Police headquarters in New York City, a facility that is completely off the power grid. The station obtains all of its power from a 200-kW fuel cell that was installed in 1999 and is still operational. The station was one of the few buildings in New York City to remain in operation during the 2003 Northeast blackout that put the rest of the city in darkness.

Over the years, fuel cells have also been demonstrated or installed at the Denver, Colorado, Washington Park Fire Station (2003), the East Anaheim, California, Police Department and Community Center (2005), and the Hillsboro, Oregon, Fire Department - Ronler Acre's Fire Station (2006).

> *"We weren't affected by the blackout at all. We were still shining."*
>
> **– Dave Giordano, community affairs officer at the Central Park Precinct in Manhattan at the time of 2003 northeast power outage**

In Connecticut, several projects are under way. The state is providing $3 million for a microgrid project that includes a 400-kW fuel cell for the police station, fire station, Department of Public Works, town hall and high school in Woodbridge. The project is being developed under the state's 2012 natural disaster and storm response laws.

The Hartford Public Safety Complex is now operating a 400-kW fuel cell system to power a new facility that houses police, fire and emergency response services. The complex is capable of serving as a command post during a regional catastrophic event such as a terrorist attack or biohazard incident.

Prisons also require reliable, round-the-clock power. In 2006, the Santa Rita Jail (Dublin, California) installed four 250-kW fuel cell units from FuelCell Energy, totaling 1 MW, to meet 50% of the jail's electricity needs. The fuel cells help to supplement power provided by the jail's 1.2-MW solar array and together the technologies produce 80% to 90% of the facility's power requirement during peak demand. The heat byproduct from the fuel cell is captured and provides 18% of the jail's hot water needs, and is also used for space heating, domestic hot water, laundry and kitchen equipment. Alameda County estimates its savings to be more than $250,000 per year, saving the taxpayers money and eliminating around 3,200 tons of GHG per year.

Wastewater Treatment Plants

Onsite power generation can be advantageous at municipal wastewater treatment plants (WWTPs) given that the large quantity of power drawn from the grid by WWTPs represents a substantial expense. According to the U.S. Environmental Protection Agency (EPA):

Fuel cell system located at an unspecified wastewater treatment plant.

- Drinking water and wastewater plants are often a municipal government's largest energy consumer, comprising 30% to 40% of total energy consumed.[27]
- Drinking water and wastewater plants comprise 3% to 4% of U.S. energy use and emit over 45 million tons of GHGs annually.[28]
- The U.S. national average energy consumption at WWTPs is 1,200 kWh per million gallons of wastewater generated.[29]

Fuel cell power can help meet a WWTP's energy needs. The savings can be substantial – some WWTPs report that the cost of fuel cell-generated power is lower than the cost of electricity purchased from the local utility.[30]

At WWTPs, fuel cells take advantage of an on-site energy resource – the anaerobic digester gas (ADG, also called biogas) that is a byproduct of the wastewater treatment process. Many sites dispose of the gas by combusting it into the atmosphere in an open flame (a flare), while others burn it as fuel in their boilers. Although ADG is considered carbon-neutral since it is derived from an organic (non-fossil) source, flaring or burning leads to releases of direct and indirect GHGs and other air pollutants. Stringent state-based air quality regulations, such as those in California, have led many municipal WWTPs to consider the use of highly efficient, low-polluting fuel cell power plants.

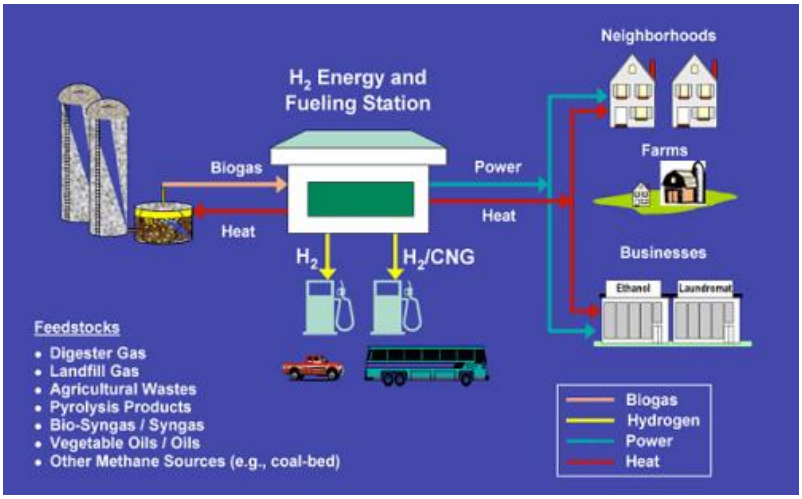
Many states consider fuel cells as a clean energy technology, and ADG as a renewable fuel source, under renewable portfolio standards (RPS) and utility green power programs. State agencies encourage such resources and may offer grants, low-interest loans, or other assistance to encourage deployment of these technologies.

Today, fuel cells are operating in WWTPs in California and New York, including deployments at the Eastern Municipal Water District (Moreno Valley and Perris Valley), San Jose/Santa Clara Regional Wastewater Facility, Tulare Water Reclamation Plant, and Point Loma Wastewater Treatment Plant (San Diego) in California, and several

EMWD's digester gas-driven fuel cells will allow the District to run some of its Moreno Valley and Perris Valley Regional Water Reclamation facilities during peak hours virtually free of charge, with no toxic emissions, cutting greenhouse gases by more than 10,600 tons annually.

– Eastern Municipal Water District (EMWD) fact sheet

locations around New York City (Bronx, Brooklyn, and Staten Island).



Schematic for a FuelCell Energy and Air Products trigeneration system.

A recent demonstration took place at the Orange County Sanitation District's wastewater treatment plant located in Fountain Valley, California. The project, which was supported by the DOE, California Air Resources Board, Orange County Sanitation District, academia, and private industry, used an ADG-powered fuel cell to generate not only power and heat, but also hydrogen, making it the world's first demonstration of "tri-generation" at a WWTP. The hydrogen supplied an onsite hydrogen fueling station that is accessible to the public and sufficient to provide fuel for 25 to 50 fuel cell electric vehicles per day. This demonstration highlighted the potential for tri-generation systems to serve as a "bridge" technology in supporting the development of hydrogen vehicle refueling infrastructure.

There is also potential for the expansion of ADG-powered fuel cells in related markets, such as wineries, breweries, confined animal feeding operations (CAFOs), and other sites processing organic waste via anaerobic digestion. One such fuel cell system is operated by Gills Onions (Oxnard, California), which uses biogas obtained from onion waste.

Landfills

Trash can be a powerful fuel source, too. Biogas generated from solid municipal waste is another emerging opportunity for fuel cells.

Landfills are the third-largest human-related source of methane in the U.S., accounting for 17% of all methane emissions in 2009.[31] Like ADG, landfill gas (LFG) is a potential energy resource that could be used to generate power and heat, especially where there are strict landfill emissions restrictions.

An example of this is an LFG-powered fuel cell operated successfully at two landfills in California and Connecticut during the 1990s as part of an EPA-sponsored demonstration project. Although the LFG contaminants and levels varied widely between the two sites, the gas cleanup system was able to remove LFG contaminants to a level

"Part of our corporate strategy is to be a highly sustainable and responsible steward of natural resources. We are excited to be participants in the fuel cell landfill gas project to ascertain its benefits both to our business by converting harmful waste gas into food grade carbon dioxide, as well as other business opportunities coming out of other value streams from the landfill waste gas."

– Jonathan Bos, Development Director, Village Farms International, Inc.

acceptable for fuel cell use during the short trial period.

Internationally, fuel cells have been operated on gas generated at solid waste treatment facilities in Japan (fermentation of pulverized wood and plastic waste) and South Korea (plasma gasification of organic solid waste).

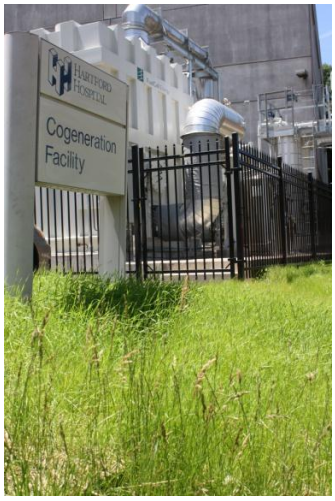
In an upcoming demonstration, FuelCell Energy will operate a tri-generation stationary fuel cell power plant in Vancouver, Canada, that will be fueled by landfill gas. The fuel cell's heat will be used to generate hot water and will be supplied to Village Farms, a hydroponic greenhouse operator, and renewable hydrogen will be exported for vehicle fueling or industrial applications.

Other Public Sites

In addition to installations at municipal facilities run by states and cities, fuel cells are helping power facilities and equipment that serve the public in a wide variety of ways. As we have covered here and in our past Business Case reports, corporations of every stripe are purchasing and deploying fuel cells at headquarters, offices, data centers, retail sites, distribution centers and communications networks. Fuel cells are showing up in other arenas as well, including: healthcare, education, recreation, and transportation.

Hospitals/Healthcare Facilities

If the power goes out at a hospital, it truly can be a matter of life and death. Operating and Emergency rooms, vital machines and instruments, computers, refrigeration for medicine and blood, and heating and cooling are all reliant on steady and uninterrupted electricity. Backup power is critical in hospitals, where patients' lives could be threatened if power is lost for life support, operating rooms, and medicine refrigeration.



1.4 MW fuel cell power plant at Hartford Hospital in Connecticut

In states where hospitals are required to have at least 24 hours of backup power, many rely on diesel generators usually placed on the roof. Even with regular testing and maintenance, these generators have a spotty track record of providing emergency backup power. During the 2003 blackout, half of the 58 metropolitan hospitals in New York had failures in their backup power generators.

In the late 1990s, several Air Force and military hospitals around the country installed fuel cells as part of a Department of Defense demonstration program, on bases in Arkansas, California, Florida, Louisiana and Texas. Most operated for 3-4 years providing electricity and heat for hot water, air conditioning

and laundry services. These installations provided valuable data that helped improve the technology but even in these early demonstrations, the potential for savings were shown. In California, the Twentynine Palms Marine Corps Base Naval Hospital fuel cell system operated from 1996-2000 and reported energy bill savings of $57,000 per year.[32]

Fuel cells are providing critical backup power at several U.S. hospitals today. St. Helena's Hospital in Napa Valley in California has had a 400-kW fuel cell operating since 2009 to supply electricity as well as hot water and space heating for three of the hospital's buildings. The Chino Valley Medical Center in Southern California installed 600 kW in March 2014. The fuel cell system reduces the facility's carbon footprint by 22%. In October 2014, the Sutter Medical Center is opening its new $284 million dollar hospital, Sutter Santa Rosa Hospital that will include 375 kW of Bloom Energy fuel cells to generate about 70% of the hospital's electricity needs.

In Connecticut, St. Francis Hospital has two sites in its network running on 400-kW fuel cells. In 2012, the hospital installed one at its Mount Sinai Rehabilitation Hospital campus and replaced an older generation 200 kW fuel cell at its main campus in Hartford. Also in Connecticut, the 867-bed Hartford Hospital installed a 1.4-MW fuel cell to supply close to 60% of the hospital's power needs and most of the facility's heat requirements. Any excess heat is being harnessed and utilized by a nearby school system.

"With fuel cells on each campus, it allows for a reliable power source on-site. In addition, the high efficiency of the power plants is a way to save energy while promoting a healthy environment."

– Robert J. Falaguerra, Saint Francis Hospital's vice president of facilities, support services and construction

"The University of California is a national leader in sustainability and effective actions to reduce greenhouse gases as we work towards carbon neutrality by the year 2025. This fuel cell installation fits perfectly with our ambitious goals of adopting alternative energy sources, embracing energy efficiency, and supporting California's carbon Cap and Trade Program, all while enhancing our power reliability with on-site power generation."

– Morris Frieling, chief financial officer, UC Irvine Medical Center

As listed in the Recent Fuel Cell Installations and Orders section of this report (page 30), more are on the way for several hospitals in California. This market is also extending into healthcare administrators, medical device suppliers and biotechnology companies. Kaiser Permanente has 4.3 MW currently installed in California, at seven sites. The company claims that its fuel cells, combined with on-site solar installations, helped reduce its GHG by more than 17,700 metric tons in 2013.[33]

Companies such as Becton Dickinson (BD) and Life Technologies have also installed fuel cells. Life Technologies has 1-MW installations at both its Pleasanton and Carlsbad, California, campuses, protecting valuable inventory and priceless scientific research in its laboratories and large freezers and refrigerators.

Public Schools/Universities

Schools are another great application for fuel cells. Several local school districts have demonstrated or deployed fuel cells at their elementary, middle and high schools for a dual purpose – supplying the building with power and useful heat, as well as providing reliable, grid-independent power to the community during emergencies.

One of the earliest sites to install a fuel cell was South Windsor High School in Connecticut, which provided crucial emergency services as a shelter during a big snowstorm and power outage in 2011. The 200-kW fuel cell kept the power and heat on, allowing 200 hundred people to take shelter in the high school for several nights; more than 600 people came to the school for hot meals and showers, and to charge their cell phones. The fuel cell system, which operated from 2002 to 2013, saved the school $80,000 in electrical costs and reduced carbon emissions by 780 tons annually.[34]

Fuel cell installation at Robert Clemente Leadership Academy and Hill Central School (New Haven, Connecticut)

Connecticut has helped to fund a number of additional school fuel cells, providing grants through the Connecticut Energy Finance Investment Authority (CEFIA). In 2008, Middletown High School installed a 200-kW fuel cell to provide about half of the building's estimated baseload electricity, as well as supplying heat to the swimming pool and the school's space heating system. This fuel cell also can be operated in a grid-independent mode to support the school's function as a community emergency shelter at times when the electric grid is unavailable.

Hamden High School's fuel cell system (Hamden, Connecticut)

A 400-kW fuel cell also provides energy to Roberto Clemente Leadership Academy and Hill Central School in New Haven, Connecticut, powering both schools and producing thermal energy that is used in Clemente's heating and cooling system. The fuel cell, which was installed in 2010, is expected to more than pay back the cost in energy savings (expected savings of $2 million) within 10 years. Hamden High School also installed a 400-kW fuel cell in 2011 that generates power and hot water. Anticipated annual net savings are $51,000.

"Sustainable and affordable energy is an increasingly important component of the new energy mix at the University of Bridgeport. Our Renewable Energy Research Lab evaluates technologies in energy conversion, utilization and storage in fuel cells, solar, wind, and hybrid systems. This lab is motivated by the strong need to prepare the next generation of inter-disciplinary engineers with a comprehensive background in sustainable energy and this fuel cell installation will help us achieve our goals by enabling us to practice what we teach."

– Neil Albert Salonen, President, University of Bridgeport

In Liverpool, New York, the Onondaga-Cortland-Madison Board of Cooperative Educational Services (OCM BOCES) installed a 200-kW fuel cell in 1996 to power its data center. Prior to the installation and operation of the fuel cell, the facility experienced considerable computer interruption and downtime attributed to normal utility grid fluctuation, causing significant time loss and financial expense. After the system was installed, OCM BOCES did not experience a single critical loss of its computer system. The fuel cell was operated until 2008, when the building was renovated. Liverpool High School also operated a 200-kW fuel cell in a grid-independent mode, which kept the lights on during power outages and allowed the high school to serve as a community emergency shelter.

The University of California, San Diego has a 2.8-MW fuel cell incorporated into a microgrid, generating 8% of the campus' total energy needs. The fuel cell-solar-cogeneration microgrid received a U.S. Environmental Protection Agency Energy Star Award and was named SDG&E's 2013 Energy Grand Champion. Nearby Point Loma Wastewater Treatment Plant provides the purified methane for the fuel cell, which is injected into an existing gas pipeline to supply the UC San Diego fuel cell and two other San Diego fuel cell sites.

An added bonus of school-based fuel cells is the potential to incorporate the fuel cell into the school's curriculum. Fuel cell technology fits into a wide range of science classes, including earth sciences, chemistry, physics, and even biology, not to mention environmental or engineering courses. Several schools in Connecticut, such as Liverpool High School and South Windsor High School, have introduced fuel cells into the curriculum.

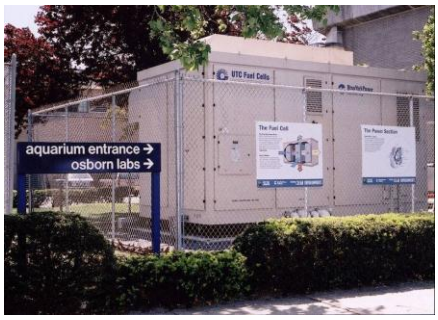
Fuel cells have also been deployed at dozens of public and private colleges and universities across the country, including a number of recent installations at major California and Connecticut universities. Since 2011, more than 13 MW of fuel cell power have been deployed, or are soon planned for installation, on U.S. campuses.[35] See Appendix 3 for more details.

The California State University, San Bernardino, installed a 1.4-MW fuel cell power plant in December 2012. The school reports*:

- **The power plant currently uses natural gas piped from the local utility as its fuel source, but it could substitute biofuels (gases from food processing and wastewater treatment) in the future, or be modified to utilize plant-based fuels such as ethanol, further reducing our dependency on finite and more costly resources.**
- **Only negligible NOx and SOx are produced through this process, and its CO_2 emissions are much lower than combustion of coal or natural gas.**
- **It's more efficient. The electric conversion efficiency of a fuel cell is 47% to 80%, compared to only 25%-35% for a turbine/engine system.**
- **By locating the fuel cell adjacent to the San Bernardino central plant, the university is able to utilize its by-products at no cost. Waste heat from the fuel cell process supplements baseload campus heating and hot water needs and significantly reduces related fossil fuel combustion.**

*http://sustainability.csusb.edu/Projects/Cogeneration%20Fuel%20Cell.html

Zoos/Parks/Gardens



New York Aquarium's fuel cell system

Many cities can boast zoos, botanic gardens, parks, and other recreational sites operated for the enjoyment of local citizens and visitors. All have facilities that require energy and many are moving toward the use of onsite renewable and non-polluting energy generation.

Zoos have a wide-range of energy needs, including lights and electricity for shops, offices and other facilities. Each exhibit is unique, created to simulate the animal's natural habitat. Some require warmer temperatures, some cold, for both land and aquatic animals. Over the years, fuel cells have been installed at zoos in California (Los Angeles), Nebraska (Henry Doorly Zoo in Omaha) and New York's Bronx Zoo. A fuel cell is also operating at the New York Aquarium. In addition to supplying electricity, the fuel cell's excess heat is used to warm water in ponds, provide humidity and even provide hot water for restaurants and other facilities.

Several botanic gardens installed fuel cells to generate both power and byproduct heat and steam for their greenhouses. In 2005, the Memphis Botanic Garden installed a 5-kW fuel cell to supply heat and power to maintain a tropical environment at its conservatory greenhouse. In 2006, the Phipps Conservatory & Botanic Garden in Pittsburgh, Pennsylvania, followed suit and installed a 5-kW fuel cell for its 12,000 square foot tropical forest conservatory.

After these successful installations, similar organizations took notice and followed suit.

One of the most prominent is California State University, Northridge (CSUN), where a 1-MW fuel cell was installed in 2007 to help meet university goals for greater energy independence, capital growth, cost management and increased use of green power. The fuel cell generates base load electricity for the university's facilities and surplus heat for hot water. The university also routes exhaust from the heat exchanger into an adjacent greenhouse and arboretum to enhance photosynthesis, boosting plant growth and harvests by 10% to 40%.

The fuel cell is providing 18% of the total campus demand and reduces GHG emissions by 69%, eliminating more than 6,400 tons of CO_2 per MW-year. The installation is projected to save the university $7 million over the next 15 years.[36]

The California State University, Northridge subtropical rainforest (top image) uses wastewater from the fuel cell (bottom image) for irrigation

The federal National Park System hosts more than 275 million people from the United States and around the world every year. The parks offer visitors picturesque landscapes and escape from the loud hustle and bustle of the city, so reducing noise and emissions from generating electricity helps ensure that serene settings aren't disrupted. Fuel cells have been demonstrated at several National Parks over the years, providing clean and quiet power to visitor centers, entrance operations, and administration buildings, as well as serving an educational purpose. These demonstrations occurred at major tourist attractions such as Yellowstone National Park, Yosemite National Park and Kenai Fjords National Park. Fuel cells are rugged and can operate independent of the grid, so they are ideal for remote locations with rough terrain or weather. Fuel cells can also operate on a wide variety of fuels – all three of the demonstrations listed above used propane.

Roadways

Fuel cell electric vehicles (FCEVs) are already in the hands of the first customers and automakers such as Toyota, Honda and Hyundai aim to introduce commercial production vehicles at the end of 2014 and into 2015. These vehicles will offer customers the feel, range and fast refueling they are accustomed to without any harmful tailpipe emissions or routine maintenance such oil changes or replacing spark plugs. Fuel cells are also being demonstrated in municipal bus fleets around the world, many in revenue service, carrying customers to work every day. Other motive applications where fuel cells are being demonstrated and deployed include delivery trucks, material handling vehicles in warehouses, ports and airports, and by railroads that pass through our cities.

Transit Buses

There are fuel cell buses in operation around the world, and several transit agencies in the U.S. have integrated fuel cell buses into revenue service.

California has the most fuel cell buses deployed through several agencies. AC Transit boasts the largest fleet with 12 fuel cell buses, and is working with a group of regional transit agencies (Golden Gate Transit, SamTrans, VTA, and Muni) on a Zero Emission Bay Area (ZEBA) initiative to encourage more deployments of zero-emission transit. SunLine Transit Agency in Thousand Palms received two new fuel cell buses and it was announced that the Stark Area Regional Transit Authority (SARTA) in Ohio is set to receive two fuel cell buses in 2015. Hawaii's Mass Transit Agency will obtain a 25-passenger fuel cell plug-in shuttle bus in early 2015.

The Federal Transit Administration has been helping fund many of the fuel cell bus projects around the country and together with the National Renewable Energy Laboratory (NREL), reports that, "each fuel cell bus put into service in the U.S. could reduce the amount of carbon released into

the atmosphere by 100 tons annually and eliminate the need for 9,000 gallons of fuel every year over the life of the vehicle. For buses currently running on diesel fuel, this translates into a savings of more than $37,000 per year, per vehicle."[37] According to NREL, there are currently more than 25 buses in testing or operation around the country.

"We want to get eight miles per gallon instead of the four or five we were getting with normal diesel buses. We've been moving to reduce our carbon footprint as much as possible. Fuel cells are a way to continue down that path. Ours is a pinnacle project that can create a whole new market for fuel cells. If we can support economic growth and job development as a public agency, it's something we should do."

– **Kirt Conrad, CEO of Stark Area Regional Transit Authority (SARTA) (Stark County, Ohio)**

"The reliability and performance of this bus in revenue service shows the maturity of the fuel cell hybrid technology. We're excited to build on the success of the first AFCB [American Fuel Cell Bus] with these next generation fuel cell buses."

– **Tommy Edwards, Deputy Chief Performance Officer for SunLine Transit Agency,** speaking about two new fuel cell buses, delivered to the agency in June 2014

"This new fuel cell electric bus is the first tangible step in realizing our vision of transforming the County of Hawaii public bus system into one that is powered by our island's incredible renewable energy resources. Instead of exporting our citizen's hard-earned dollars offshore, we will be able to keep this money in our local economy creating new jobs and protecting us from the swings of the fossil fuel markets. We would also like to thank the Governor for investing in this project and allowing us to lead the way for the rest of the State of Hawaii."

– **Billy Kenoi, Hawaii Island Mayor**

Delivery Vehicles

Global delivery companies Federal Express and UPS have long been involved in fuel cell demonstrations over the years, with both companies working with automakers to test fuel cell vehicles in 2003 and 2004 to deliver packages in Tokyo (FedEx), Germany (UPS) and Michigan (UPS). FedEx also has had 35 fuel cell-powered lift trucks operating at FedEx Freight's service center in Springfield, Missouri, since 2009, funded in part by the American Recovery and Reinvestment Act (ARRA).

Federal Express fuel cell delivery van.

Currently, both companies are involved in DOE-funded projects. In January 2014, the agency announced a $3 million award for FedEx to develop a hydrogen fuel cell delivery truck with a range of up to 150 miles per fueling and to test 20 of these trucks at FedEx facilities in Tennessee and California. DOE also announced a $3 million award for the Center for Transportation and the Environment (CTE) to develop a fuel cell hybrid electric walk-in delivery van also with a 150-mile range per fueling. That project will retrofit 15 UPS delivery vans with fuel cell hybrid power trains and test them at UPS distribution facilities across California.

Overseas, residents in the Franche-Comté region in eastern France will start receiving their mail delivered via a vehicle using a fuel cell as a battery range extender. La Poste (the French postal service) is testing three Renault Kangoo Z.E. electric mail delivery vehicles fitted with fuel cells from French fuel cell manufacturer, Symbio FCell. The fuel cells will double the range of the battery vehicles and testing will also be expanded to include vans, light trucks and heavy trucks.

DOE is currently funding two fuel cell truck refrigeration unit (TRU) demonstration projects, to power the trailers that carry refrigerated and frozen goods to grocery stores and restaurants. The demonstrations include two fuel cell companies, Plug Power and Nuvera Fuel Cells, and corporate partners Sysco, H-E-B, Carrier Transicold and Thermo King. NYSERDA is also funding a TRU project with Plug Power.

Airports

There are almost 20,000 airports in the U.S., transporting passengers and cargo as an essential part of the global economy. Airports have a large impact on the surrounding environment, consuming tremendous amounts of fuel and producing large amounts of particulate matter emissions, nitrogen oxides, and volatile organic compounds, all of which reduce air quality and affect human health. Aside from the airplanes themselves, baggage movers, maintenance and security vehicles, and passenger shuttles all contribute to airports' energy consumption and emissions. Airports also contribute to noise and light pollution in surrounding communities and use a lot of electricity to power communications networks, security, and all of the stores, restaurants and other facilities housed inside.

Fuel cells can help resolve many of the challenges airports face, and are being demonstrated in various applications at airports around the world. This includes baggage tow tractors (BTT), auxiliary power units that allow aircraft to move without using engine power, shuttle buses and backup power for radio transmitter/receiver (RTR) and air traffic control sites. The leading airplane manufacturers, Boeing and Airbus, are also researching and demonstrating fuel cells for use on planes, both for propulsion and for auxiliary power.

Fuel cells have a long history in the aviation industry, having been used on all 18 manned space shuttle missions from 1966 to 2010, including the first lunar landing. The fuel cells provided the shuttle's onboard electric power as well as drinking water for the astronauts.

Charlatte CT5E BTT fuel cell tow tractor

A DOE-funded ground service equipment demonstration with FedEx Express, fuel cell manufacturer Plug Power, Charlatte America and the Memphis-Shelby County International Airport began in January 2013 to develop a fuel cell-powered BTT. Plug Power integrated its fuel cell into a Charlatte CT5E BTT, a hydrogen fueling system will be installed at the Memphis-Shelby County Airport and the next phase will deploy 15 BTTs at the

airport. The project goal is to demonstrate how fuel cells will help airport vehicles reduce diesel fuel consumption, which will not only greatly lower emissions, but also save costs via the decrease in fuel used. The 15 fuel cell-powered BTTs that will be in service for two years will save more than 175,000 gallons of diesel fuel and eliminate more than 1,700 metric tonnes of CO_2.[38]

Ports/Goods Movement

There are more than 100 ports in the U.S.; moving goods as an essential part of the global economy, and many are owned by the municipality where they are located. With increasing scrutiny and regulation of ports and their emissions from not only the ships entering them, but the vehicles on the shore used for goods movement, maintenance and logistics, fuel cells offer solutions for a wide range of applications for ports and harbors. Fuel cells can also provide clean, reliable power to port warehouses and buildings, security communications systems, closed-circuit video cameras, and guard gates, and refrigerated containers stored onsite.

A fuel cell at the Port of Los Angeles powers the Administration building.

Several ports around the world are already involved in demonstration projects to determine the feasibility and benefits of using fuel cells. The Port of Hamburg in Germany was the first, followed by the Port of Helsinki in Finland, the Ports of Long Beach and Los Angeles in California and the Port of Houston in Texas. These projects ranged from fuel cells powering APUs on the ship to forklifts, buildings and telecommunications services on the docks and fuel cell-battery hybrid rig trucks.

In March 2014, the Port of Honolulu in Hawaii was chosen as the site for a demonstration project of the Maritime Administration (MARAD), DOE and Sandia National Laboratories to explore the potential cost savings and emissions reductions through the use of hydrogen fuel cells to provide electrical power to ships at berths. MARAD is providing $700,000 to support the construction of a 100 kW portable fuel cell power system to help power vessel on-board systems pier side for ships, tugs, and barges operating between the Hawaiian Islands, mainly for refrigerated containers.

Railroads

Railroads have been an integral part of goods movement across the U.S. for more than two hundred years. While there is a lot of research and demonstration around the world using fuel cells to power locomotives or hydrogen-fueled trains (hydrail), there are many applications in the rail yard and along train routes where fuel cells are providing backup or remote power today. These include switches, signals, railway crossings, monitoring and

ReliOn E-200 fuel cells at a Florida railroad crossing.

communications equipment, even powering security cameras at the rail yard. Fuel cell manufacturer ReliOn, which became a Plug Power company in 2014, has fuel cells installed at more than 200 locations with several railroad customers, including CSX, for backup power applications at key signal and communication sites.

These are just a handful of applications in our daily life where fuel cells are helping make a difference, saving money for companies and municipalities across the country while reducing emissions and power outages for the citizens around them. These markets, and ones adjacent to them, are expanding as the demand for clean, reliable electricity grows both here in the United States and internationally.

Recent Fuel Cell Installations and Orders

Since our last report, there have been many new orders, deployments and installations from a wide variety of customers, both repeat and new. There have also been a few fuel cells that were installed last year but recently made public. The following list includes customers that fit into both categories.

Ace Hardware

After using fuel cells to power class-2 and class-3 lift and reach trucks at its 450,000 square foot Wilmer, Texas, Retail Support Center, Ace Hardware was so impressed with the efficient run-time results that the company has moved forward with the deployment 70+ fuel cells for forklifts that are now operating at new state-of-the-art Retail Support Center in West Jefferson, Ohio. The fleet consists of 35 fuel cell-powered reach trucks and 36 fuel cell pallet jacks running a single 10-hour shift, five days a week, plus a floor scrubber. The fuel cells are expected to result in electrical consumption savings for Ace of 330,115 kWh annually[39] and are fueled by a Nuvera Fuel Cells' PowerTap™ PT-50 on-site hydrogen generator and fueling solution. The system produces and dispenses up to 50 kg/day of high-purity hydrogen.

AT&T

AT&T already has 16.7 MW of Bloom Energy fuel cells powering offices and facilities at various sites in California and Connecticut and hundreds of smaller fuel cells from ReliOn, providing backup power to cellular towers around the country. Recently, the company was awarded funding from NYSERDA for two installations in New York – for 500 kW in Rego Park and 1.5 MW for two buildings in White Plains.

Central Grocers

In 2009, Central Grocers participated in a year-long trial of fuel cell-powered forklifts at its 970,000-square-foot Joliet, Illinois, distribution center to help alleviate its battery maintenance issues. The company deployed a fleet of 234 fuel cell MHE, a mix of reach trucks, stand-up counterbalanced units,

sit-down counterbalanced units and center control pallet trucks. After the year-long trial was over, Central Grocers was so impressed with the efficiency of the vehicles, and a reported an uptime rate of 98%, that the company kept the fleet in operation.

In May 2014, Central Grocers announced it was replacing this original fleet after more than 2 million hours of operation. The company bought 182 new fuel cells from Plug Power and signed a 5-year GenCare service contract for the GenDrive fleet.

Chino Valley Medical Center

Chino Valley Medical Center, voted one of the top 100 hospitals in the nation by Truven Health Analytics for both 2012 and 2013, installed a 600-kW Bloom Energy fuel cell system in March 2014. The fuel cell reduces the facility's carbon footprint by 22%.

Communication Infrastructure Corporation

The Communication Infrastructure Corporation (CIC USA) installed a 400-watt ReliOn fuel cell as part of a 39-site microwave network on top of a mountain in Pennsylvania, providing primary power to its customer's equipment since April 2014. This project, "Providing a Reliable, Cost-Effective and Green Remote Off-Grid Power Solution," won 2nd place in the Green Telecom & Networks division of CTIA's annual Emerging Technology (E-Tech) Awards (September 2014).

DreamWorks Animation SKG

In January 2013, DreamWorks Animation SKG installed a 750-kW Bloom Energy fuel cell system at its Glendale, California, studio that consists of a six-acre campus and 460,000 square-feet of office space.

FedEx Express

In December 2013, FedEx Express was selected for a $3 million award from DOE to develop a hydrogen fuel cell delivery truck with a range of up to 150 miles per fueling. FedEx will test 20 of these trucks at its facilities in Tennessee and California. The company is working with Plug Power and Smith Electric Vehicles on the project.

Ghirardelli Square

A 10-kW fuel cell from ReliOn is now providing telecommunications backup from a rooftop in Ghirardelli Square in San Francisco, California. The unit was installed in July 2014.

Hines/LPL Financial

LPL Financial LLC opened its new San Diego headquarters, Tower II at La Jolla Commons, which is believed to be the largest net-zero energy commercial office building in the United States. In addition to a host of green features and technologies, the 13-story, 415,000-square-foot office tower, managed by real estate developer Hines, has 500 kW of Bloom Energy fuel cells and energy meters located throughout the building. The surplus power generated is delivered back to the grid through San Diego Gas & Electric.

Kroger

Kroger tested fuel cell forklifts in its Delaware, Ohio, location in 2010 and in 2012 deployed 174 fuel cells for forklifts at its Compton, California, distribution center. Pleased with the performance of Plug Power GenDrive fuel cells, Kroger has placed follow-on orders for fuel cells and hydrogen refueling systems for its Stapleton, Colorado, and Louisville, Kentucky, locations.

NASCAR

At the Daytona 500 race held in February 2014, NASCAR, in partnership with DOE and as part of its NASCAR Green initiative, used fuel cells to power broadcast cameras and lighting. Fuel cell manufacturer Acumentrics redesigned its product to fit NASCAR's requirements and provided two 250-watt fuel cells to power remote broadcast cameras and two 1-kW fuel cells to power the lights in pit row. Powered by propane, the fuel cells used less fuel and lasted longer than the gas-powered generators NASCAR currently uses at races. They are also quiet and have very low noise vibration, important for media quality purposes – video streams are more stable and interviews can be conducted closer to the equipment without disruption. NASCAR calculated that it saved more than $2,100 on the race weekend and estimates switching to fuel cells could save around $77,000 per season in fuel. On top of that, the fuel cells only have to be fueled once per weekend, which not only saves time but is a lot safer.

National Security Administration (NSA)

In June 2014, the Department of Defense (DOD) installed a 1.6-MW Bloom Energy fuel cell system at the NSA Campus in Fort Meade, Maryland.

Pacific Cheese Company

Pacific Cheese Company, a premier manufacturer and supplier of fine quality cheese, has installed a 300-kW Bloom Energy fuel cell system at its Hayward, California, facility.

SoftBank

In 2013, SoftBank, a Japanese technology investment firm, joined with Bloom Energy to form a joint venture, Bloom Energy Japan. Later that year, the company installed a 200-kW fuel cell at its M-Tower in Fukuoka, Japan, to provide 75% of the building's energy. This was Bloom Energy's first installation outside of the U.S. The fuel cell was installed in the building's atrium.

In June 2014, Bloom Energy Japan installed its second unit at SoftBank's headquarters at the Tokyo Shiodome Building in Tokyo, Japan. The 200-kW fuel cell provides 14% of the buildings' overall electricity needs. The electricity generated by the fuel cell is also being used for the EV charging stations installed in the underground parking garage of the building, and can also be directed to streetlights and public power outlets in the case of an emergency.

Stop & Shop

Stop & Shop received funding in 2013 from NYSERDA to install a 300-kW Bloom Energy fuel cell system at its store in Mt. Vernon, New York. In June 2010, the company installed a 400-kW fuel cell at its supermarket in East Torrington, Connecticut.

Sutter Santa Rosa Hospital

Sutter Medical Center is opening its newest $284 million dollar hospital, Sutter Santa Rosa Hospital on October 25, 2014. The new facility will include 375 kW of Bloom Energy fuel cells that will generate about 70% of the hospital's electricity needs. The total output of electricity will be about 3 million kWh annually. The hospital plans to buy natural gas from PG&E and

sell back any excess electricity. The fuel cell will assist the state-of-the-art hospital in achieving a Silver LEED certification. The fuel cell is expected to pay for itself in six years.[40]

UC Irvine Medical Center

FuelCell Energy, Inc. will install a 1.4-MW fuel cell system at the University of California, Irvine, Medical Center to generate about 30% of the facility power needs. The excess heat produced will be used in a direct exhaust absorption chiller to produce 200 tons of cooling for an office building and associated institutional requirements.

UPS

In December 2013, DOE announced a $3 million award to CTE of Atlanta, Georgia, to develop a fuel cell hybrid electric walk-in delivery van with a 150-mile range per fueling. CTE will retrofit 15 UPS delivery vans with fuel cell hybrid power trains and test them at UPS distribution facilities across California.

United Illuminating

United Illuminating (UI), a Connecticut energy provider, is installing 2.8-MW of fuel cell power plants at two of its sites (5.6 MW total) in Bridgeport and New Haven. The Bridgeport location will be a former landfill and will also include 2.2 MW of solar power to create a renewable energy park. The New Haven installation will be in the port area of the city near an electrical substation owned by UI and will provide continuous power to the substation.

Verizon

Since our last report, several locations of Verizon's 9+ MW of planned fuel cell installations were revealed. The company installed 2 MW (five fuel cells) and solar panels to provide 66% of the energy at its flagship operations center in Basking Ridge, New Jersey. In December 2013, two installations were completed at Verizon Data Center facilities in San Jose (800 kW) and West Sacramento (1.2 MW). The West Sacramento project runs the excess hot water through an absorption chiller to create 135 tons of chilled water which is then fed into Verizon's existing electric chilled water system to reduce the load.

Verizon also received NYSERDA funding to install units at office buildings in New York. They include 1.6 MW in Brooklyn (two buildings), 800 kW in Jamaica and 400 kW in Staten Island. All sites qualify for NYSERDA's maximum capacity $200,000 incentive. The sites also qualify for performance payments for three years post installation with a maximum total incentive of $1,000,000.

Walmart

With more than 11 MW of stationary fuel cells installed at 35 sites in California, including its Sam's Club chain, Walmart is one of the leading proponents of fuel cell technology in the retail sector. The company was also one of the early adopters of fuel cells for MHE, participating in several trials in Ohio and also deploying units at its sustainable refrigerated distribution centers at two sites in Canada and one in Oklahoma. Walmart's Balzac, Canada, fresh food distribution center has 95 fuel cell-powered forklifts deployed and Walmart Canada projects the fleet will reduce operating costs by $1.1 million over seven years, compared to using battery-powered forklifts.[41] To fuel the vehicles, the hydrogen is generated from hydro-electric electrolysis in Québec, and even when factoring in transportation of the fuel to Alberta, 530 tonnes of CO_2 emissions are avoided every year, earning the facility the title of the most energy-efficient distribution facility of its kind in North America.

In February 2014, Walmart made big headlines by ordering 1,738 GenDrive fuel cells from Plug Power to power electric lift trucks at six of its North American distribution centers. Included in the order was GenFuel infrastructure to supply hydrogen for the vehicles and a six-year service contract for each site. At the end of July 2014, Walmart expanded the order to include a seventh site, upping the fuel cell number to more than 2,000, with 286 GenDrive units to be deployed at a site in Sterling, Iowa.

At its Pottsville, Pennsylvania site, the first site under the original order, Plug Power fuel cells were installed in approximately 300 class 2 and class 3 electric lift trucks, and both indoor and outdoor hydrogen dispensers were built. Since their deployment in the second quarter of 2014, the units have accumulated more than 100,000 hours of run time and the GenFuel infrastructure has dispensed more than 9,900 kg of fuel. The second site, located in Johnstown, New York, is in the final stages of GenDrive deployment, and is already supported by an on-site GenFuel hydrogen infrastructure.

Washington Gas Energy Systems/WGL Holdings

Washington Gas Energy Systems/WGL Holdings bought a 2.6-MW system from Bloom Energy and will finance, build, own and operate the fuel cell system and sell all energy generated to Santa Clara County in California under a 20-year power purchase agreement.

Yahoo!

Yahoo! installed a 1-MW Bloom Energy fuel cell system at its LEED Gold certified Sunnyvale, California, global headquarters to provide one-third of the electricity for the campus.

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

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

Appendix 2: Fuel Cell Financing

One of the most asked questions is, "How much does a fuel cell cost?"[1] The answer isn't that simple, as many installations aren't direct off-the-shelf purchases, instead using innovative financing mechanisms and state and federal tax incentives to fund them. Our last report had an in-depth look at Power Purchase Agreements (PPAs) and other financing mechanisms.[xlii]

Fuel cells are also 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 2017 (the ITC is set to expire at 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.[2]

At the state level, the most active and generous policy helping stimulate fuel cell purchases and installations is California's Self-Generation Incentive Program (SGIP), which provides $1.83/watt for combined heat and power or electric-only fuel cells. Some states have tax credits or favorable policies in place, while others have active industry associations or public agencies helping secure funding or loans for installations.[xliii]

[2] A $30,000 tax credit is also available for hydrogen fueling infrastructure through the end of 2014.

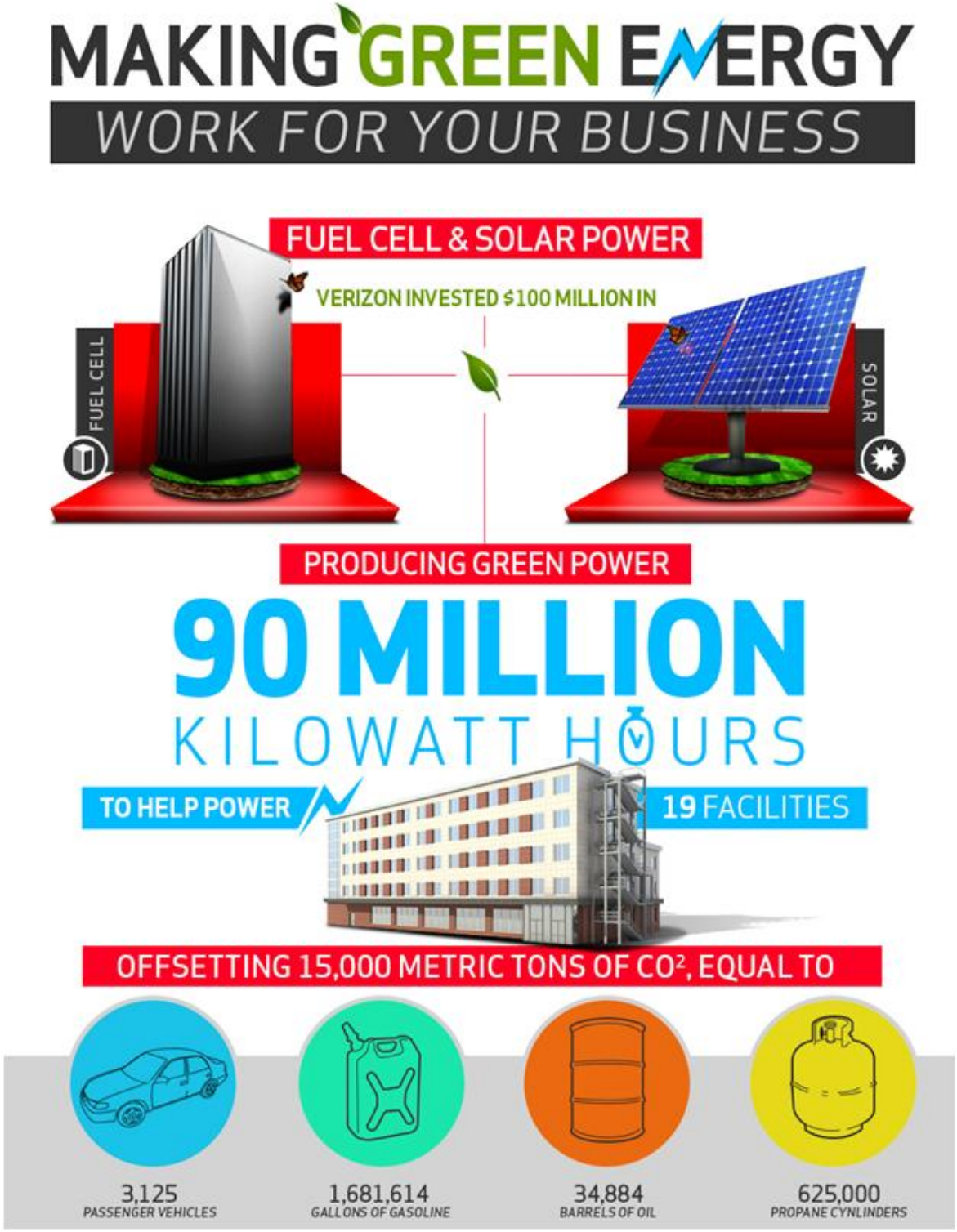
Appendix 3: Examples of Fuel Cell Installations

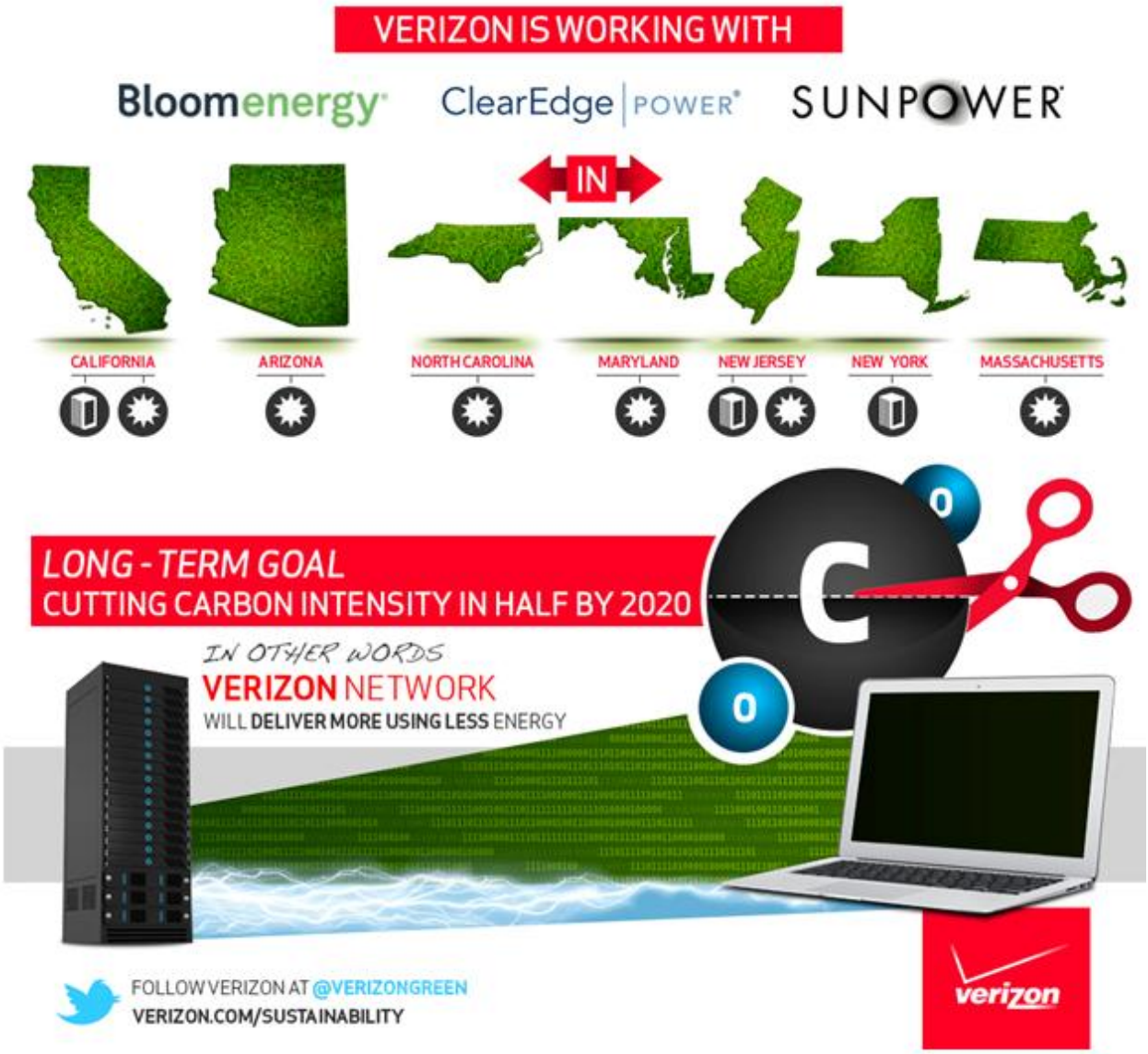
List of Fuel Cell Installations at Universities*				
Location	**Power**	**City**	**State**	**Year**
University of Alaska	N/a	Fairbanks	Alaska	1990s
Arizona State University East Campus, Salt River Project	250 kW	Mesa	Arizona	2005
California State University, East Bay	1.4 MW	Hayward	California	2012
California State University, Northridge	1 MW	Northridge	California	2007
California State University, San Bernardino	1.4 MW	San Bernardino	California	2012
National Fuel Cell Research Center at the University of California, Irvine	220 kW	Irvine	California	2000
San Francisco State University	200 kW	San Francisco	California	2011
San Francisco State University	1.4 MW	San Francisco	California	2011
University of California	200 kW	Santa Barbara	California	1990s
University of California		Davis	California	Planned
University of California, Irvine	1.4 MW	Irvine	California	Planned
University of California, San Diego	2.8 MW	San Diego	California	2011
University of California, Santa Barbara	200 kW	Santa Barbara	California	2012
Center for Clean Energy Engineering, University of Connecticut	40 kW	Storrs	Connecticut	2005
Central Connecticut State University	1.4 MW	New Britain	Connecticut	2011
Eastern Connecticut State University central heating plant	1 MW	Willimantic	Connecticut	2006
Eastern Connecticut State University Science Building	400 kW	Willimantic	Connecticut	2012
University of Bridgeport	1.4 MW	Bridgeport	Connecticut	Planned
University of Connecticut, Depot Campus Microgrid	400 kW	Storrs	Connecticut	Planned
Western Connecticut State University (WCSU)	400 kW	Danbury	Connecticut	2013
Yale University, Environmental Science Center and Peabody Museum	250 kW	New Haven	Connecticut	2003
Michigan Alternative and Renewable Energy Center at Grand Valley State University	250 kW	Muskegon	Michigan	2004
Alcorn State University	200 kW	Lorman	Mississippi	2000
Alcorn State University - ROTC facility	5 kW	Lorman	Mississippi	2006
The College of New Jersey	600 kW	Ewing Township	New Jersey	2004
Ocean County College	250 kW	Toms River	New Jersey	2003
Ramapo College	400 kW	Mahwah	New Jersey	2000
Richard Stockton College of New Jersey	200 kW	Pomona	New Jersey	2003
Hofstra University	15 kW	Hempstead	New York	2002
Nassau Community College	10 kW	Garden City	New York	2004
Southampton College	10 kW	Southampton	New York	2003
SUNY College of Environmental Science and Forestry	250 kW	Syracuse	New York	2006
Union College	5 kW	Schenectady	New York	2009
North Carolina State Agricultural and Technical University - ROTC facility	5 kW	Greensboro	North Carolina	2003
Portland Community College	10 kW	Sylvania	Oregon	2011
University of South Carolina Scoreboard	5 kW	Columbia	South Carolina	2011
University of South Carolina, West Quad Residential Complex	5 kW	Columbia	South Carolina	N/a
University of Tennessee Chattanooga (UTC) SimCenter	5 kW	Chattanooga	Tennessee	2006
Old Dominion University	40 kW	Norfolk	Virginia	1980s
Central Washington University	1 kW	Ellensburg	Washington	2004

***Some fuel cells have been decommissioned.**
N/a = information not available.

List of Fuel Cell Installations at Hospitals*				
Location	**Power**	**City**	**State**	**Year**
Little Rock Air Force Base Hospital	200 kW	Jacksonville	Arkansas	1990s
Cambrian Center (a senior and disabled housing facility)	20 kW	San Jose	California	2011
Camp Pendleton	200 kW	Oceanside	California	1990s
Edwards Air Force Base Hospital	200 kW	Palmdale	California	1990s
Kaiser Permanente Anaheim Medical Center	200 kW	Anaheim	California	1990s
Kaiser Permanente Riverside Medical Center	400 kW	Riverside	California	1990s
St. Helena hospital	400 kW	St. Helena	California	2010
Sutter Hospital	375 kW	Santa Rosa	California	2014
Twentynine Palms Marine Corps Base Naval Hospital	200 kW	Twentynine Palms	California	1990s
Hartford Hospital	1.4 MW	Hartford	Connecticut	2013
St. Francis Hospital	200 kW	Hartford	Connecticut	2003
St. Francis Hospital	400 kW	Hartford	Connecticut	2012
Naval Air Station Naval Hospital	200 kW	Jacksonville	Florida	1990s
Palm Garden skilled nursing facility	5 kW	Largo	Florida	2005
Barksdale Air Force Base Hospital	200 kW	Bossier City	Louisiana	1990s
North Central Bronx Hospital	200 kW	Bronx	New York	2000
Presbyterian Nursing Home	200 kW	Pittsburgh	Pennsylvania	1990s
South County Hospital	200 kW	Wakefield	Rhode Island	1990s
Laughlin Air Force Base Hospital	200 kW	Del Rio	Texas	1990s
***All of the installations at military hospitals in the 1990s have been decommissioned**				

Appendix 4: Verizon Ad





Source: http://newscenter.verizon.com/corporate/news-articles/2013/06-04-bloom-energy-fuel-cell-systems/

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Page 7 – Bloom Energy installation at Sutter Home Winery, image sent by Récolte Energy
Page 8 – Redox Power Systems' fuel cell downloaded via Mtech's public Dropbox folder: https://www.dropbox.com/sh/y8mvgop5ppk5klr/sjXMWO3eEO/Redox
Page 9 – Graphic courtesy of Roger Herron, SBR Energy Group: http://www.sbrenergygroup.com/clean-power-solutions/fuel-cell-technology.html
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