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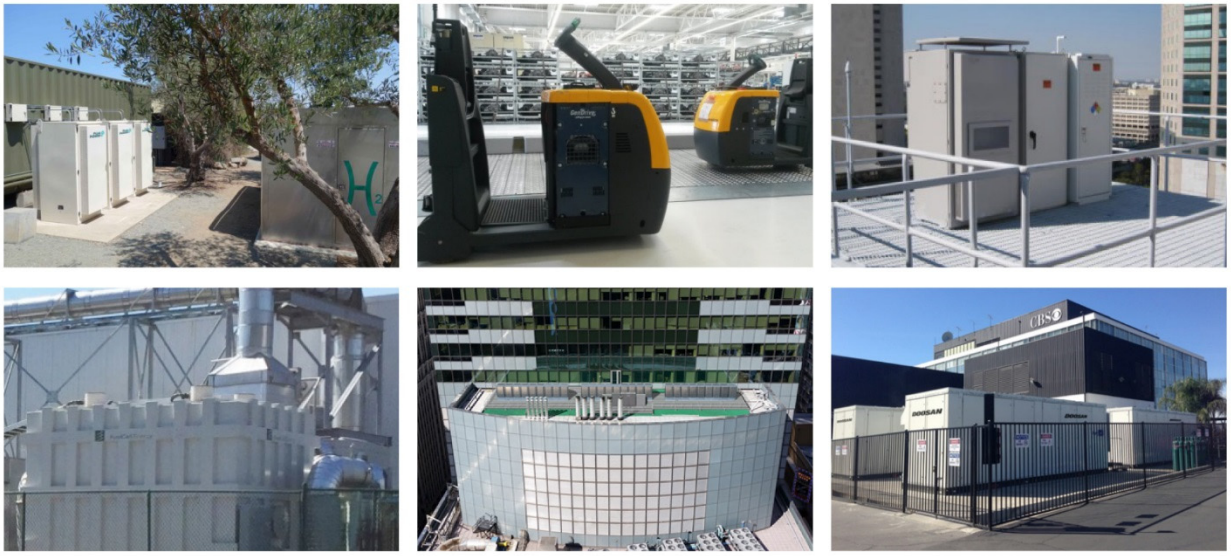
ANL-17/08

The Business Case for Fuel Cells: Delivering Sustainable Value

7th Edition

Argonne National Laboratory



All images were approved for use by the relevant fuel cell manufacturer or customer.
Photo sources for images in the report are listed in Appendix 2.

Top left: Plug Power GenSure units at Stone Edge Farm in Sonoma Valley, California. Photo Courtesy of Plug Power.
Top middle: Plug Power GenDrive fuel cells powering forklifts at a Volkswagen manufacturing facility in Kassel, Germany. Photo courtesy of Plug Power.
Bottom right: Altergy Freedom Power fuel cell units on a Florida rooftop. Photo courtesy of Altergy Systems.
Bottom left: FuelCell Energy systems at Pepperidge Farm. Photo courtesy of FuelCell Energy.
Bottom middle: Bloom Energy fuel cell system at Morgan Stanley headquarters in New York City, New York. Photo courtesy of Bloom Energy.
Bottom right: Doosan Fuel Cell America, Inc. units at CBS Studios. Photo courtesy of Doosan Fuel Cell America, Inc.

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The Business Case for Fuel Cells: Delivering Sustainable Value

7th Edition

by
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June 2017

About This Report

The report provides an overview of recent private sector fuel cell installations at U.S. businesses as of December 31, 2016. Based on the success of early stage research and development (R&D) activities under U.S. Department of Energy (DOE) programs, including those at national laboratories, monitoring early private sector fuel cell installations can provide valuable feedback to guide further R&D activities. Over the past few decades, hundreds of thousands of fuel cells have been installed around the world, for primary or backup power, as well as in various other applications including portable and emergency backup power. Fuel cells have also been deployed in other applications such as heat and electricity for homes and apartments, material handling, passenger vehicles, buses, and remote, off-grid sites. This list is by no means exhaustive.

Argonne National Laboratory (ANL) has supported the DOE's Fuel Cell Technologies Office (FCTO) in hydrogen and fuel cell technology evaluation and analysis for over two decades and has worked with the national trade association and fuel cell stakeholders for expertise in fuel cell technology. The information on applications and installations contained in this report was gathered from public sources and through personal contact with fuel cell manufacturers, customers and organizations.

Authors and Acknowledgements

This report was written and compiled for ANL by Sandra Curtin and Jennifer Gangi of the Fuel Cell and Hydrogen Energy Association (FCHEA) in Washington, D.C.

Notice

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Contents

Acronyms

CHP	Combined heat and power
CO_2	Carbon dioxide
DOE	U.S. Department of Energy
FCV	Fuel cell vehicle
kW	Kilowatt
kWh	Kilowatt-hour
lbs.	Pounds
MHE	Material handling equipment
MW	Megawatt
sq.-ft.	Square feet

Fuel Cells Deliver Powerful Benefits

The business case for fuel cells is growing. With the industry rapidly emerging as a multibillion dollar market opportunity, the United States is staking a leadership role in technology development, manufacturing, and economic impact. A main reason for this success is the increasing investment by the private sector and business community.

Highlights since last report

- **Home Depot** now country's largest stationary fuel cell customer, with more than 140 sites
- **IKEA** installing fuel cells at 4 more stores in California and one in Connecticut
- **eBay** adding 3.75 MW to its Utah data center, bringing it to ~10 MW
- More than **15,000** fuel cell-forklifts in operation or on order

While the government, primarily through the U.S. Department of Energy, has focused on early stage research and development, industry has been successfully commercializing and deploying cutting edge technologies in fuel cells and hydrogen that are now demonstrating tangible benefits.

Today, fuel cells are utilizing domestically produced natural gas to power to retail stores, data centers, production sites and other company facilities, greatly reducing emissions and doing so at a cost that can be competitive with the local electric grid in some states.[1, 2] By producing power onsite, facilities can continue their essential operations, even when grid power goes down.

Fuel cells are also competing in the material handling market, with companies finding value in improved operational efficiency and cost savings using fuel cells in forklifts and other vehicles over battery units –

About Fuel Cells

A fuel cell generates electricity using an electrochemical reaction, not combustion, and, depending on the fuel source, produces zero or near-zero polluting emissions. Fuel cells offer a unique combination of proven benefits that make them ideally suited for a number of applications.

Benefits for Stationary Applications

- Can be primary or backup power source
- Operate in tandem or independent of electric grid
- High efficiency
- Low to zero emissions
- Fuel flexible (conventional or renewable fuels)
- Rugged and quiet
- Operate in water balance
- Modular and scalable

Benefits for Material Handling Equipment

- Zero emissions
- Long runtime
- Minutes to refuel
- Constant power (no voltage sag)
- Cold storage operation
- Eliminates need for battery charging room
- Increased worker productivity
- Lower operational costs

eliminating the need for, and space dedicated to, battery charging and swapping. Fuel cells also allow for quicker refueling, which saves time, and full-power operation throughout the shift, without any voltage sag or challenges when operating in refrigerated warehouse environments.

In addition, telecommunications companies worldwide are turning to fuel cells to provide reliable primary or backup power and longer run times, while simultaneously benefitting from lower emissions. The reliability of fuel cells and freedom from the need for daily refueling at remote locations makes this a competitive technology in this application.

There are many reasons why companies choose fuel cells for stationary and motive power applications. The long list of benefits are outlined above and discussed at length in previous editions of this report, continue to make this technology an attractive option for new customers, as well as for companies choosing to expand their portfolio to dozens, hundreds, and even thousands of fuel cells. Fuel cells enable customers to attain not only environmental benefits, but also economic, operational, and other savings, as well.

Corporate Commitments

Corporate environmental goals are not just internalized within company walls. Many corporations are joining collaborative initiatives to publicly hold themselves more accountable. These include the Science Based Targets Initiative[3], where companies pledge to adopt targets in line with the science on how to keep global warming below two degrees. There are now more than 170 corporations committed, including fuel cell users Coca-Cola, Procter & Gamble, Walmart, Kellogg Company, Pfizer, and Carrefour, as well as automotive companies BMW, Honda, Daimler, Toyota, and Nissan, most of which have fuel cell forklifts deployed at manufacturing facilities, and all developing fuel cell light duty vehicles.

Another global initiative, the Climate Group's RE100[4], includes influential businesses committed to transitioning to 100% renewable electricity, including biomass and biogas, geothermal, solar, water and wind – either sourced from the market or self-produced. The 100% renewable energy goal can be achieved by producing power either on or off-site at its facilities, or from procuring power via contracts with utilities, Power Purchase Agreements (PPAs) or renewable electricity certificates.

Many of the companies involved in RE100 operate fuel cells, including ones fueled by biogas, in some capacity, including: IKEA, Adobe, Apple, Bank of America, Equinix, Google, Johnson & Johnson, Coca-Cola, BMW, GM, Procter & Gamble, Walmart, as well as international users, La Poste, Marks & Spencer, Colruyt Group, and Tata Motors.

The Climate Group estimates that, when all of its participating companies are operating with 100% renewable energy, they will create demand for 90.1 terrawatt hours of renewable electricity, saving around 56 mega-tonnes of CO_2 annually.

There is also the Renewable Energy Buyers Alliance (REBA)[5], formed by four non-governmental organizations to empower multinational companies to deploy renewable energy in the United States, with the goal of 60 gigawatts by 2025. REBA includes fuel cell users Adobe, BD, eBay, Equinix, FedEx, GM, Honda, IBM, Johnson & Johnson, Kaiser Permanente, Marriott, Microsoft, Owens Corning, Sprint, Time Warner Cable, Whole Foods, and Yahoo!.

According to the Business Council for Sustainable Energy's 2016 Sustainable Energy in America Factbook[6], corporations, including fuel cell users Walmart, Johnson & Johnson, Google and others, have doubled their investment in cleaner energy over the past two consecutive years.

The list of customers continues to grow, and since the last Business Case report, there have been some real standouts in the corporate world, becoming champion fuel cell advocates by purchasing, installing and deploying fuel cells in different applications, at multiple facilities around the country.

The Home Depot

Since our last report, The Home Depot has emerged as the leading corporate customer of stationary fuel cells, installing 200-kilowatt (kW) systems at stores in California, Connecticut and New York. The Home Depot began installing fuel cells in 2014 and, by late 2016, is using fuel cells to generate power at 140 of its U.S. retail locations.[7]

Although the Home Depot has already deployed about 28 megawatts (MW) of fuel cell power generation, it isn't done yet – the company intends to add fuel cells to more stores for a total of 170 retail sites operating fuel cell for power generation.[8]

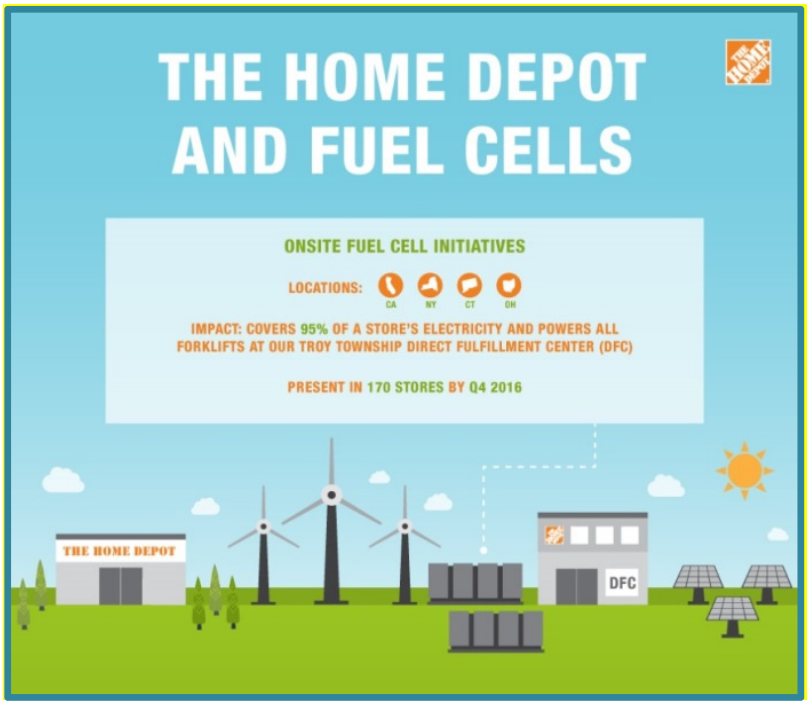
The Home Depot reports that the fuel cells provide electricity at a lower cost than the electric grid and, when stores have low power needs, it can send energy back to the grid.[9]

Carol Tome, The Home Depot's Chief Financial Officer, said "We look at the value of fuel cells in two ways. First, productivity – where we have the fuel cells installed, we see that our electricity costs are 15 to 20 percent less than they would be if we bought off the grid, so that's a good thing. And then, sustainability, because the fuel cells take natural gas and convert it to electricity without combustion, we see lower levels of carbon dioxide emissions. In fact, since 2014, our carbon dioxide emissions have been reduced by 50 million pounds. That's equivalent to removing 4800 cars off the roads and we're thrilled."[10]

Other benefits include huge water savings – each 200 kW fuel cell system saves 31 million gallons of water annually.

Craig D'Arcy, the Home Depot's director of Energy Management stated, "Perhaps the biggest driver that made fuel cells the right fit for the stores we've done so far is that they eliminate the concern over aging roofs. A solar install requires that the roof stay in place for at least 15 years, otherwise you significantly erode the financial benefit by incurring costs to remove and reinstall the solar system after the roof has been replaced."[11]

The Home Depot is also investing in fuel cells for material handling. In the last report, we detailed the Troy Township, Ohio, location, where the company deployed more than 175 fuel cell-powered forklifts are operating in its new 1.6 million-sq.-ft. distribution center. The Home Depot is now set to introduce another fleet of fuel cell forklifts at a Savannah, Georgia, distribution center.[12]



IKEA

Swedish furniture retailer IKEA expanded its fuel cell investment in 2016 by announcing it is adding fuel cells at four more California stores (see chart, next page) and one in New Haven, Connecticut. This will bring IKEA's total fuel cell fleet, including the 300-kW fuel cell installed in 2015 at its Emeryville, California, store, to more than 1.5 MW of power.

Christof Stein, IKEA's New Haven store manager, says that, "similar to our rooftop solar array, this fuel cell system will greatly reduce our carbon footprint and the store's reliance on the power grid as well as contribute to our vision of creating a better everyday life for the many."[13]

One of IKEA's Bloom Energy fuel cell systems at California store

IKEA's history with fuel cells goes back even further, more than a decade, when the company partnered with Opel, a subsidiary of General Motors, to demonstrate the Open Zafira fuel cell vehicle in Berlin, Germany, in 2005. In 2010, IKEA tested the fourth generation of the Zafira.

And in 2014, IKEA deployed a fleet of 20 forklift trucks at its distribution center in Saint-Quentin-Fallavier, France. The site also features a hydrogen station from Air Liquide to refuel the forklifts.

IKEA U.S. President Lars Petersson also says that, "fuel cells represent another way we can contribute to our goal of generating renewable energy equal to the amount of power we consume worldwide."[14]

Details on IKEA's recent fuel cell announcements [15]

Retail Store Locations	Fuel Cells	Anticipated Annual Electricity Production	Emissions Reduction Equivalent
New Haven, Connecticut	250-kW Bloom Energy Server. The store's 940.8-kW solar array, combined with the fuel cell, will generate a majority of the store's energy onsite.	2,081,376 kilowatt hours (kWh)	1,218 tons of carbon dioxide (CO_2)
Costa Mesa, California (installed), and East Palo Alto, California	300-kW Bloom Energy Servers	2,497,651 kWh	1,315 tons of CO_2
Covina, California (installed), and San Diego, California	200-kW Bloom Energy Servers	1,665,101 kWh	877 tons of CO_2

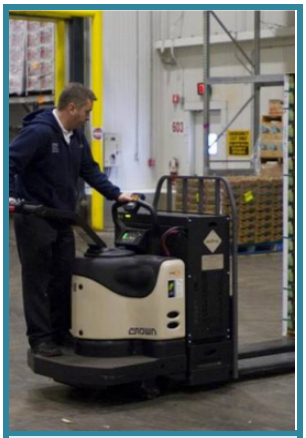
Walmart

Walmart has a goal to be supplied 100% by renewable energy. The company's efforts to meet this goal include the use of fuel cells both for onsite power generation and power for forklifts operating in the company's distribution centers.

Bloom Energy fuel cell server at a Walmart retail site

In 2016 alone, Walmart installed 4.8 MW of Bloom Energy fuel cells to provide onsite power generation at seventeen of its California retail stores. This builds on Walmart's 2015 fuel cell installations, which include a total 1 MW of fuel cell power generation in California (five retail stores), 400 kW in Connecticut (two retail stores), and a 250-kW fuel cell system supplying power at a New Jersey store.

In total, Walmart has installed fuel cells at more than 60 of its retail sites in California, Connecticut, and New Jersey, to provide 40-60% of the electricity needed by these facilities.[16, 17] When grid power goes down, these fuel cells are capable of supplying power to keep a store's refrigeration equipment, lighting, and cash registers in operation, preventing food spoilage and allowing a store to continue serving customers during weather-related and other outages.[18] Walmart also reports that its fuel cells supply energy at prices lower than the cost of energy from local utilities.[19]


Forklift operating at a Walmart distribution center

Walmart also uses Plug Power GenDrive fuel cells to power to forklifts at 19 of its North American distribution centers, including locations in Illinois, Indiana, Minnesota, New York, Ohio, Pennsylvania, Texas, and in Alberta and Ontario, Canada. In aggregate, the company operates more than 3,000 fuel cell-powered forklifts at its sites, along with the hydrogen fueling infrastructure to support these deployments.

Walmart states in its 2016 Global Sustainability Report that it is committed to expanding its development of off- and onsite power from fuel cells, solar, wind, and other technologies in an effort to meet its goal of procuring 7 billion kWh of renewable energy generation by the end of 2020.[20]

Stop & Shop

Northeast grocery chain Stop & Shop, and its parent company Ahold, already uses fuel cells at three of its grocery stores to generate power onsite: two in New York – Peekskill (200-kW Bloom Energy Server, installed in 2015) and Mt. Vernon (250-kW Bloom Energy Server, installed in 2014), and a store in Torrington, Connecticut (400-kW Doosan Fuel Cell America system, installed in 2011).

The company also operates gas stations at several of its retail sites and has agreed to host a hydrogen refueling pump at its Mansfield, Massachusetts, grocery store. The proposed hydrogen station is one of 12 hydrogen stations in development by Toyota and Air Liquide to support the expansion of fuel cell vehicles into the northeast U.S., and recently received permit approval by the town's zoning board.[21] The hydrogen supplied by Air Liquide will be produced off-site and delivered to the station, which is anticipated to be operable in 2017.[22]

More Businesses and Services Relying on Fuel Cells

These select companies are just the tip of the technology iceberg. What follows is a chart that highlights businesses and services customers use and frequent every day, or that work behind the scenes to ensure everyone is connected and communicating. This list is not exhaustive, but shows that some of the world's leading companies, ones people trust with some of the most important facets of their lives, trust fuel cells – in some cases, powering entire facilities without grid connection, relying on fuel cells, in conjunction with renewables, to fully support operations.

The chart is divided into different market sectors and provides an update on any savings and progress since our last report, including new customers. This includes Retail Shopping; Grocers, Food & Logistics; Industrial & Consumer Products; Technology & Telecommunications; Financial Services; Real Estate; Healthcare & Biotechnology; Entertainment & Sports; Hotels; Transportation; and Utilities. The update section in the chart also includes new or unreported information discovered through research and discussions with fuel cell manufacturers, fuel providers, and customers.

Retail Shopping

Retail chains are taking advantage of fuel cells for power for their stores and material handling equipment (MHE) in their warehouses. Two of the leading fuel cell customers, Home Depot and Walmart, have more than 200 stores and 3,500 forklifts utilizing fuel cells collectively.

Onsite fuel cells can provide primary power, backup power and combined heat and power (CHP) to retail sites and warehouses. Since the systems can operate independently from the power grid, they can supply power without disruption due to grid failure or blackouts. The fuel cell's excess heat can also be captured to provide hot water or space heating, increasing the fuel cell's efficiency.

The benefits of converting material handling fleets to fuel cells are many, outlined in the introduction as well as in previous reports. For the retail sector, the main advantage of using fuel cells for MHE could arguably be the elimination of battery storage, changing, and charging areas, allowing that space to be regained and utilized to hold more products.

Examples of Companies that Rely on Fuel Cells: Retail Shopping

COMPANY	BACKGROUND	UPDATE
CVS	CVS operates more than 65 forklifts powered by Plug Power fuel cells at its LEED-certified distribution center in Waverly, New York, which opened in 2011.	The distribution center takes advantage of the fuel cells' water byproduct – repurposing the water for use in cleaning processes, rather than discharging it.[23]
The Home Depot 	The Home Depot began installing 200-kW Bloom Energy Servers in 2014 and now has fuel cells at more than 140 retail stores in California, Connecticut and New York. The Home Depot also operates more than 175 fuel cell-powered forklifts at an Ohio distribution center.	The Home Depot plans to add a fleet of fuel cell-forklifts at its Savannah, Georgia, distribution center as well as increasing the number of store installations to 170 by the end of 2016.[24] Since 2014, The Home Depot reported that its stationary fuel cell fleet has reduced its carbon dioxide emissions by 50 million pounds. [25]

Examples of Companies that Rely on Fuel Cells: Retail Shopping		
COMPANY	**BACKGROUND**	**UPDATE**
IKEA 	IKEA installed a 300-kW fuel cell from Bloom Energy at a store in Emeryville, California, in 2015. IKEA also operates a fleet of fuel cell forklifts at a distribution center in Saint-Quentin-Fallavier, France. In addition, IKEA has tested fuel cell vehicles in Germany, including both an Opel (GM) HydroGen3 and a HydroGen4.	IKEA's Emeryville fuel cell reduces CO_2 emissions by an estimated 823,000 lbs. annually.[26] In July 2016, IKEA announced plans for Bloom Energy fuel cells at four additional California stores – Costa Mesa, Covina, East Palo Alto, and San Diego.[27] In August 2016, IKEA also stated that its first east coast Bloom Energy fuel cell system will be located at its New Haven, Connecticut, store. When completed, IKEA will have a portfolio of more than 1.5 MW of stationary fuel cells.[28]
Macy's 	In 2013, Macy's installed a 600-kW Bloom Energy Server fuel cell system to provide baseload 24x7 power to its Cheshire, Connecticut, online fulfillment center.	Macy's is tracking[29] its fuel cell's energy generation and the emissions reductions it is helping to achieve. The company reports that in one month (Mar.-Apr. 2016), the fuel cell generated more than 17,560,000 kilowatts per hour and avoided more than 9,800,000 lbs. of CO_2 emissions.

Examples of Companies that Rely on Fuel Cells: Retail Shopping		
COMPANY	**BACKGROUND**	**UPDATE**
Staples 	Staples' first 300-kW Bloom Energy fuel cell installation was installed in 2009, at the company's 400,000-sq.-ft. Ontario, California, distribution center. In 2011, Staples added another fuel cell, a 600-kW Bloom Energy Server to its 740,000-sq.-ft. distribution center in Rialto, California.	Staples reports that the Bloom Energy fuel cell, along with a solar power system, contributes more than 90% of the energy for their 400,000-sq.-ft. Ontario, California, fulfillment center.[30] Together, the company's Ontario and Rialto fuel cell systems provide 6.5 gigawatt hours of power annually.[31] The Ontario and Rialto sites are achieving an annual estimated 820,000 lbs. and 1,600,000 lbs. of CO_2 reductions respectively.[32]
Target 	In 2012, Target installed 200-kW Bloom Energy Servers at its Pasadena and Richmond, California, retail stores.	Both the Pasadena and Richmond site are eliminating an estimated 540,000 lbs. of CO_2 emissions a year.[33]
URBN (Urban Outfitters) 	URBN installed a 600-kW Bloom Energy server in 2012 to supply 60% of the electricity needed at its main campus in Philadelphia, Pennsylvania. When installed, it was URBN's largest green initiative.	The fuel cell at URBN is helping reduce CO_2 by an estimated 5,100,000 lbs. annually.[34]

Examples of Companies that Rely on Fuel Cells: Retail Shopping		
COMPANY	**BACKGROUND**	**UPDATE**
Walmart 	Walmart is the largest user of fuel cell-powered forklifts, operating more than 3,000 units that are powered by Plug Power GenDrive fuel cells. They are located at 19 distribution centers in North America, including Illinois, Minnesota, New York, Ohio, Pennsylvania, Texas, and Canada. Walmart also uses stationary fuel cells to provide power to retail stores in California, Connecticut, and New Jersey.	Walmart is committed to be 100% renewable and sustainable, with an interim goal to produce or procure 7 billion kWh of renewable energy by the end of 2020. Walmart's Vice President of Energy, Mark Vanderhelm, has stated that the main focus currently is solar, and that wind and fuel cell storage are next on the list.[35]
Williams-Sonoma	William-Sonoma installed a 600-kW Bloom Energy Server in 2012 to provide power to its Rocklin, California, data center.	Williams-Sonoma's fuel cell system is reducing its CO_2 emissions by an estimated 1,600,000 lbs. a year.[36]
Additional Companies	**BACKGROUND**	
	Ace Hardware deployed lift trucks outfitted with 80 Plug Power GenDrive fuel cells at a new Retail Support Center in Wilmer, Texas, in 2013. In 2014, the company added fuel cell-powered reach trucks and pallet jacks, plus a floor scrubber at a Retail Support Center in West Jefferson, Ohio. Together, the two sites have more than 130 hydrogen-powered vehicles in operation. Both sites use Nuvera's PowerTap™ on-site hydrogen generation and fueling system. **Lowe's** deployed more than 200 lift trucks equipped with Plug Power fuel cells at its Adairsville, Georgia, regional distribution center in 2012. Earlier, the company conducted pilot projects of fuel cell MHE at regional distribution centers in California and Connecticut.	

Grocers, Food & Logistics

From supermarkets to the companies that provide the goods to stock them, fuel cells are becoming a 'greenlight' special in the grocery, food and beverage industry.

Fuel cells can provide uninterrupted power, even when the grid is down, while helping grocery stores and food packaging facilities reduce overall emissions. The heat fuel cells generate as a byproduct can be used for space heating, hot water, or run through an absorption chiller for air conditioning or refrigeration, providing increased efficiency for stores that have to keep food cold or fresh.

Fuel cell-powered forklifts are currently in operation at logistics facilities, distribution centers, and grocery warehouses around the country, replacing incumbent battery-powered and combustion vehicles due to their advantages of longer runtime, faster refueling, higher efficiency, and constant power, especially in freezers and cold storage facilites.

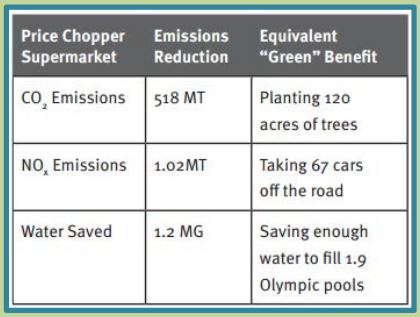
Examples of Companies that Rely on Fuel Cells: Grocers, Food & Logistics

COMPANY	BACKGROUND	UPDATE
Americold	Cold storage company Americold uses a 600-kW Bloom Energy server at its Salinas, California, facility.	Americold reports the fuel cell generates more than 600,000 kWh annually.[37] It also saves an estimated 1,600,000 lbs. of CO_2 emissions per year.[38]
Coca-Cola  	Coca-Cola operates: • A 1-MW Bloom Energy fuel cell at its American Canyon, California, bottling facility. • A 500-kW Bloom Energy fuel cell at a Dinuba, California, Odwalla production facility. • Two Doosan Fuel Cell America PureCell units (800 kW) at its Elmsford, New York plant. • An 800-kW Doosan fuel cell system at its East Hartford, Connecticut, bottling facility.	The fuel cells at Coca-Cola's California facility eliminate an estimated 2,700,000 lbs. of CO_2 annually, while the California Odwalla production facility project achieves an estimated 1,300,000 lbs. of CO_2 reductions a year.[39]

Examples of Companies that Rely on Fuel Cells: Grocers, Food & Logistics		
COMPANY	**BACKGROUND**	**UPDATE**
Coca-Cola cont'd	In 2012, Coca-Cola deployed a fleet of 56 fuel cell forklifts at a California bottling plant and, in 2014, 50 fuel cell-powered forklifts were deployed at a North Carolina production center. Both sites use Plug Power fuel cells.	
FreezPak Logistics	FreezPak Logistics operates 40 Plug Power fuel cell forklifts at its "around-the-clock" cold storage distribution freezer warehouse in New Jersey.	In August 2016, FreezePak was named one of Food Logistics' 2006 Top 3PL & Cold Storage Providers.[40]
Kellogg Company	The 1-MW Bloom Energy Server generates approximately half of the annual electrical consumption at Kellogg's San Jose, California, Eggo bakery and uses less water to generate this power than if it had been supplied by the utility grid.	Kellogg says of their fuel cell experience: "This is the first time Kellogg has explored this sort of thing and it was motivated directly by the emissions reduction target. …we are looking to replicate it at another facility."[41] The project has led to an estimated 2,700,000 lbs. of CO_2 reductions a year.[42]

Examples of Companies that Rely on Fuel Cells: Grocers, Food & Logistics		
COMPANY	**BACKGROUND**	**UPDATE**
Newark Farmer's Market	In 2011, Newark Farmer's Market deployed more than 100 Plug Power GenDrive fuel cell-powered forklifts at its refrigerated warehouse and distribution center in Newark, New Jersey. In 2014, 110 new GenDrive fuel cells and a GenFuel hydrogen fueling system were added at its new state-of-the-art food distribution center, bringing its fuel cell MHE fleet to more than 240.	Newark Farmer's Market ordered 96 next generation Plug Power GenDrive units to replace its original fuel cell material handling fleet in July 2016.[43]
Pacific Cheese	Pacific Cheese uses a 300-kW Bloom Energy fuel cell system to produce power at its Hayward, California, site.	The use of Bloom Energy fuel cells has resulted in an estimated 820,000 lbs. of CO_2 reductions per year at Pacific Cheese.[44]

Examples of Companies that Rely on Fuel Cells: Grocers, Food & Logistics

COMPANY	BACKGROUND	UPDATE
Pepperidge Farm  	Pepperidge Farm purchased a 1.4-MW FuelCell Energy fuel cell plant for its Bloomfield, Connecticut, flagship bakery in 2015 to supplement an existing fuel cell power plant installed in 2008. The power is used by the facility and the high quality heat is used by the baking ovens.	Pepperidge Farm added the 1.4-MW fuel cell due to savings in both energy spending and greenhouse gases realized on its existing 1.2-MW fuel cell. The fuel cell heat recovery potential increases efficiency and overall cost savings. The two fuel cells have helped Pepperidge Farm achieve its corporate sustainability goals.[45] In October 2016, Pepperidge Farm was honored with an International Baking Industry Exposition B.E.S.T. (Becoming Environmentally Sustainable Together) in Baking Award.[46]
Price Chopper	Price Chopper installed a 400-kW Doosan Fuel Cell America fuel cell system to supply both a primary and emergency power to its Colonie, New York, supermarket in 2010. In 2011, Price Chopper added its second 400-kW fuel cell to its Schenectady, New York, store.	

Price Chopper Supermarket	Emissions Reduction	Equivalent "Green" Benefit
CO_2 Emissions	518 MT	Planting 120 acres of trees
NO_x Emissions	1.02MT	Taking 67 cars off the road
Water Saved	1.2 MG	Saving enough water to fill 1.9 Olympic pools

Examples of Companies that Rely on Fuel Cells: Grocers, Food & Logistics		
COMPANY	**BACKGROUND**	**UPDATE**
Ramar Foods	Ramar installed a 200-kW Bloom Energy Server at its Pittsburg, California, manufacturing and packaging facility in 2013. The system provides 65% of the electricity needs for the facility, which manufactures the company's brands of Filipino and Asian frozen foods.	The use of the Bloom Energy fuel cell has resulted in an estimated 540,000 lbs. of CO_2 reductions at Ramar Foods annually.[47]
Safeway	In 2010, a new Safeway Santa was opened in Santa Cruz, California, featuring two 100-KW Bloom Energy Server fuel cells and a solar array on its roof.	This project has resulted in an estimated 540,000 lbs. of CO_2 reductions per year for Safeway.[48]
Sierra Nevada Brewery	Sierra Nevada utilized 1 MW of fuel cells to provide power at Chico, California, brewery from 2005 until 2015.	Sierra Nevada Brewery now uses Altergy fuel cells to provide backup power for refrigeration systems in beer trailers. The fuel cells help eliminate noise and pollution for guests at their events.[49] [50]

Examples of Companies that Rely on Fuel Cells: Grocers, Food & Logistics		
COMPANY	**BACKGROUND**	**UPDATE**
Stone Edge Farm  	In 2011, Stone Edge Farm, an organic farm and winery located in Sonoma Valley, California, installed its first 5-kW fuel cell system to provide CHP to the winery's estate and vineyard, helping reduce the energy required to run the irrigation system and lights and warm the 11,000-gallon lap pool.	Stone Edge now operates its own state-of-the-art micro-grid to provide sustainable energy for facility operations. The micro-grid includes 26 kW of Plug Power GenSure fuel cells to help power servers, fiber, Ethernet, gates, alarms and security lighting. The hydrogen is generated renewably from a Millennium Reign Energy system via solar-power electrolysis and also provides fuel for the winery's multiple fuel cell vehicles.[51] To help promote its zero emission micro-grid solution to other regional wineries, Stone Edge Farm hosted an open house, featuring a Luxfer-GTM fuel cell mobile lighting system.
Stop & Shop 	Grocer Stop & Shop installed a Doosan Fuel Cell America 400-kW fuel cell system at its Torrington, Connecticut, store to generate more than 90% of the store's electrical power. In 2014, Stop & Shop added its second fuel cell system, a 250-kW Bloom Energy Server, at its Mt. Vernon, New York, grocery store.	The Mt. Vernon project has led to an estimated 1,300,000 lbs. of CO_2 reductions annually.[52]

Examples of Companies that Rely on Fuel Cells: Grocers, Food & Logistics		
COMPANY	**BACKGROUND**	**UPDATE**
Sutter Home Winery	Sutter Home Winery, the fifth largest winery in U.S., installed two 200-kW Bloom Energy fuel cells in 2011 at its St. Helena, California, winery to offset the baseload electricity usage on two utility meters.	The fuel cell helped Sutter Home save $192,437 in energy costs during its first year of operation.[53] The winery also reduces its CO_2 emissions by an estimated 1,000,000 lbs. per year.[54]
The Wonderful Company	The Wonderful Company has installed Bloom Energy fuel cells at its six primary locations in California, including a 250-kW fuel cell its headquarters in Los Angeles; 2 MW at two facilities in Delano, including a Paramount Citrus Wonderful Company Halos packinghouse facility; 400 kW at Paramount Farms in Lost Hills; and 400 kW at its POM Wonderful facility in Del Rey.	Annually, The Wonderful Company is reducing its CO_2 emissions by an estimated 8,000,000 lbs.[55]

Examples of Companies that Rely on Fuel Cells: Grocers, Food & Logistics

Additional Companies

Top to bottom: Fuel cell-powered forklift and hydrogen fueling at a Sysco site; Bloom Energy fuel cell system at Taylor Farms, Doosan fuel cell system at a Whole Foods store

BACKGROUND

Kroger trialed Plug Power's fuel cell systems on forklifts at an Ohio facility in 2010, then ordered 182 fuel cells to replace batteries in forklifts at a California distribution center. In 2014, Kroger ordered more fuel cells for distribution centers Colorado and Kentucky.

Sysco, a marketer and distributor of foodservice products, operates more than 800 fuel cell-powered forklifts at seven distribution facilities in the U.S. In a DOE-sponsored project, Sysco, with Plug Power, Carrier Transicold and Air Products, performed four 400 hour demonstrations of a fuel cell-powered auxiliary power unit on a multi-temperature trailer, replacing diesel engines.

Taylor Farms, a producer of fresh-cut fruits and vegetables, generates power using a 1-MW Bloom Energy fuel cell system that reduces the facility's carbon footprint by up to 30% and water used by 99.99%.

UNFI operates 83 Plug Power fuel cell forklifts at a Florida distribution center.

Wegmans retail service center in Pennsylvania operates 315 forklifts powered by Plug Power fuel cell systems.

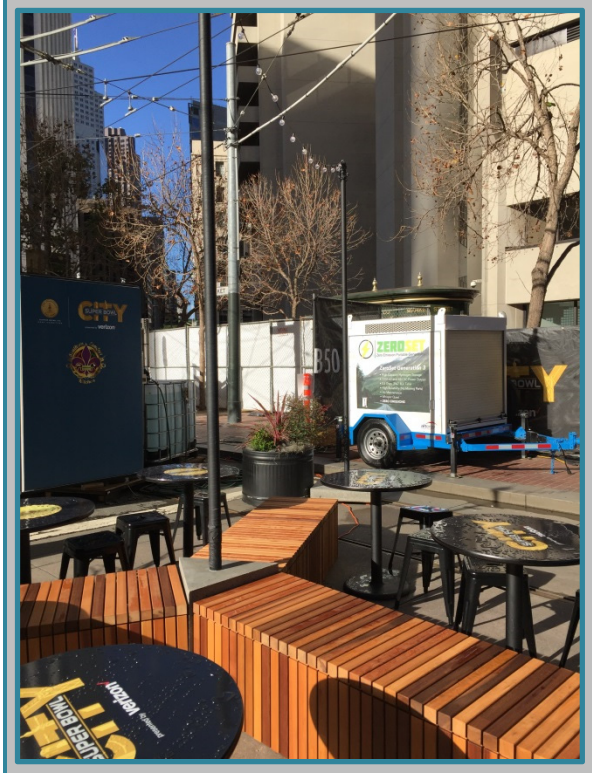
WinCo Foods' distribution center in Modesto, California, operates 161 forklifts powered by Plug Power GenDrive fuel cells. The site uses Air Products' hydrogen fueling technology and infrastructure.

Whole Foods operates a 400-kW Doosan system, installed in 2011, at its Fairfield, Connecticut, retail site to generate 90% of the store's electricity needs, with byproduct thermal energy used for store heating, cooling and refrigeration. Whole Foods also uses a 400-kW Doosan system to provide power at its San Jose, California, store. In addition, Whole Foods operates more than 50 fuel cell-powered forklifts supplied by Plug Power, in its Landover, Maryland, distribution center.

Spotlight on Super Bowl 50

As featured in the State of the States: Fuel Cells in America 2016 report, Super Bowl 50, held in Santa Clara, California, showcased sustainability by having fuel cells play a big role in lighting the streets and stages of Super Bowl City.

Fuel cells also helped the Sonoma Wine Lounge and Market Street Bistro in Super Bowl City keep fans fed and happy for nine days leading up to the main event. Luxfer-GTM provided its Zero-Set mobile fuel cell generators, using renewably-generated hydrogen sourced from the Stone Edge Farm winery's micro-grid.



"It was quite exciting to be able to build our clean energy initiatives around Super Bowl City with the help of Luxfer-GTM and the Zero Emission Generators. With the addition of this technology, we were able to power SBC 100% away from dirty diesel. We had over a million guests in the 9-day course of our event, and many of them were pleased to learn about hydrogen fuel cell generators and see them in action on a large scale event. It was exciting for us and for the community who came to enjoy Super Bowl City."

John Mitchell
Director of Event Production
San Francisco Bay Area Super Bowl 50 Host Committee

Industrial & Consumer Products

Fuel cells are helping support the industry that supports industry. Companies that manufacture machinery, materials, and components for use in further processing by other industries are installing fuel cells to help reduce emissions and provide reliable power.

Similarly, companies making products for distribution to retail stores across the country are using fuel cells for onsite power generation, as well as power for material handling vehicles used to move goods in manufacturing facilities.

Examples of Companies that Rely on Fuel Cells: Industrial & Consumer Products

COMPANY	BACKGROUND	UPDATE
Baker Hughes	In 2012, Baker Hughes, an oilfield services company, installed a 300-kW Bloom Energy fuel cell system to supply 60 percent of the power to the main office, laboratories, and vehicle maintenance workshop at its new 70-acre integrated campus in Shafter, California.	Baker Hughes was the first company to install a fuel cell at an industrial site. The company reported that it invested $2.7 million with a payback period of ~3 years based on incentives and reduced electricity costs. Baker expected "to realize electricity cost savings of approximately a half million dollars per year, or 45% over a standard facility of this size."[56]
Bridgestone-Firestone	Since 2008, the Graniteville, South Carolina, and Morrison, Tennessee, tire manufacturing plants have utilized Plug Power GenDrive fuel cells to power material handling equipment. The facilities operate 25 and 48 units respectively.	In addition to being a fuel cell customer, Bridgestone announced in March 2016 that its ECOPIA brand of tires are featured as standard equipment on the Honda Clarity fuel cell vehicle.[57]

Examples of Companies that Rely on Fuel Cells: Industrial & Consumer Products		
COMPANY	**BACKGROUND**	**UPDATE**
Maxim Integrated 	Maxim Integrated, a manufacturer of analog and mixed-signal integrated circuits, installed a 1-MW Bloom Energy fuel cell system at its San Jose, California, headquarters in 2014.	Maxim reports that the fuel cell reduces the site's carbon footprint by ~20%.[58]
Owens Corning 	In 2011, Owens Corning installed two 200-kW Bloom Energy Servers that provide ~65% of the Compton, California, plant's power annually. In 2012, Owens Corning received $1.2 million in funding through the New Jersey CHP-Fuel Cell Program for its Kearny, New Jersey, 525-kW fuel cell installation.	The fuel cell in Compton, California, has resulted in more than 1,000,000 lbs. of CO_2 reductions per year (estimated).[59]
TaylorMade-Adidas Golf Company	TaylorMade-Adidas added a 300-kW Bloom Energy Server to generate power at its manufacturing facility in Carlsbad, California.	The Adidas Group's "Green Company Performance Analysis 2014" report notes: "The fuel cell in Carlsbad reforms natural gas into electricity at an efficiency rate of 52-60%, which is considerably more efficient than the traditional electricity grid (~30%), and reduces carbon emissions from electricity at the site."[60] The Bloom Energy fuel cell system has led to an estimated 820,000 lbs. of CO_2 reductions per year.[61]

Examples of Companies that Rely on Fuel Cells: Industrial & Consumer Products	
	BACKGROUND
Additional Companies	**Aerojet Rocketdyne**, a defense and aerospace propulsion systems provider, deployed a 400-kW Doosan Fuel Cell America fuel cell system in 2012 to generate power at its facility in Canoga Park, California. **Amgraph Packaging**, a supplier of flexible packaging, installed an 800-kW Doosan Fuel Cell America system at its Sprague, Connecticut, facility in 2015. **Carter's**, manufacturer of children's clothing, opened a 1.1 million-sq.-ft. distribution center in Braselton, Georgia, in 2012. The center operates 72 forklifts powered by Plug Power GenDrive fuel cells. **Kimberly-Clark**, a supplier of personal and healthcare products, has 28 fuel cell forklifts in operation at its Graniteville, South Carolina, manufacturing facility. The fuel cells were provided by Plug Power. **LeGrand North America**, a global specialist in electrical and digital building infrastructures, installed a 500-kW Bloom Energy fuel cell in April 2016 to supply up to 88% of the power used at the West Hartford, Connecticut, headquarters and manufacturing campus. The company anticipates that carbon emissions could be lowered by half and the fuel cell will save Legrand up to $2.4 million over the next decade. **Pratt & Whitney**, an aerospace manufacturer, installed two Doosan Fuel Cell America fuel cells to generate power at its Middletown, Connecticut, facility in 2011. **Procter & Gamble**, manufacturer of family, personal and household care products, operates more than 400 fuel cell-powered forklifts at 4 different manufacturing facilities: Oxnard, California; Pineville, Louisiana; Greensboro, North Carolina; and Mehoopany, Pennsylvania. Plug Power supplied the fuel cells. **SC Johnson**, manufacturer of household cleaning supplies and other consumer chemicals, will use a 400-kW Doosan Fuel Cell America system to supply power at its Sturtevant, Wisconsin, facility.

Examples of Companies that Rely on Fuel Cells: Consumer & Industrial Products	
	BACKGROUND
Additional Companies	**Stihl**, a power equipment manufacturer, deployed 33 Plug Power fuel cells to power forklifts at its Norfolk, Virginia, site in 2012. **Uline,** a family-owned distributor of shipping, industrial and packaging materials, deployed more than 130 Plug Power GenDrive-powered lift trucks at two Pleasant Prairie, Wisconsin, facilities in 2014, along with a Plug Power GenFuel hydrogen system with eight dispensers.

Technology & Telecommunications

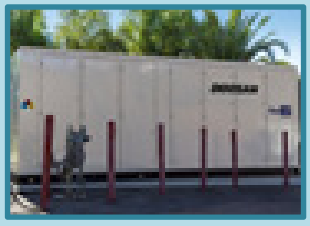
The technology companies customers rely on daily are, in turn, relying on fuel cells to provide uninterrupted power to the data and call centers that protect private information and process countless global transactions. They are also installing fuel cells at headquarters to keep daily operations running smoothly while reducing emissions.

Telecommunications companies have deployed fuel cells all at sites across the world to ensure consitent primary or backup power for a range ofsystems that require reliable, on-site, direct DC power supply. The reasons are many – for backup power, fuel cells provide a better total cost of ownership, are clean and quiet, fuel flexible, and boast longer runtimes than batteries. They also use less space and are lighter than batteries or generators, so are able to be sited on rooftops, and are rugged and durable, allowing for siting off the beaten path in rural and remote areas.

Examples of Companies that Rely on Fuel Cells: Technology & Telecommunications

COMPANY	BACKGROUND	UPDATE
Adobe 	In 2010, Adobe installed 1.2-MW of Bloom Energy Servers at its San Jose, California, headquarters. In 2011, Adobe added a second Bloom Energy site with a 400-kW fuel cell installation at its downtown San Francisco, California, offices.	Adobe reports the amount of fuel cell electricity produced during the fiscal year (Nov. 29, 2014–Nov. 27, 2015) was 9,780 MWh, with fuel cell-generated power comprising 12.1% of the company's energy use.[62] The San Jose fuel cell system is reducing CO_2 emissions by an estimated 3,200,000 lbs. annually, while the San Francisco project achieving 1,000,000 lbs. of CO_2 reductions per year.[63]

Examples of Companies that Rely on Fuel Cells: Technology & Telecommunications		
COMPANY	**BACKGROUND**	**UPDATE**
Apple	Apple's Maiden, North Carolina, iCloud data center has gone completely off the grid by combining a 10-MW Bloom Energy fuel cell system with solar generation.	Apple announced it will also be powering part of its new Cupertino, California, campus with Bloom Energy fuel cells.[64] The building will be powered by 100% renewable energy, generated by 4 MW of fuel cells and 16 MW of rooftop solar.
AT&T   Refueling hydrogen tanks for backup power (top right); AT&T cellular tower site with fuel cells for backup power. *ReliOn, Inc.*	At the end of 2015, AT&T's alternative energy portfolio included 20.9 MW of onsite fuel cell power from Bloom Energy fuel cell servers across four states (California, Connecticut, New Jersey, New York). AT&T also uses Plug Power (formerly ReliOn) fuel cells at cell towers to provide backup power, ensuring that they will function when grid power goes down. The company has 180 fuel cell systems deployed at towers across 10 states: Arizona, California, Colorado, Florida, Illinois, Indiana, Kentucky, Michigan, New Mexico, and Utah.	During 2015, AT&T added Bloom Energy servers at three additional sites in California and two in New Jersey, totaling 4.35 MW of onsite fuel cell power generation.[65] As of September 2016, all of AT&T's fuel cell projects have resulted in a total of 76,624,904 lbs. of CO_2 reductions.[66]

Examples of Companies that Rely on Fuel Cells: Technology & Telecommunications		
COMPANY	**BACKGROUND**	**UPDATE**
CenturyLink 	In 2014, communications and data company CenturyLink installed a 500-kW Bloom Energy fuel cell. The system produces nearly 4.4 million kWh of annual electricity and helps to power cloud, and managed hosting and colocation services housed within the Irvine, California, data center.	The project has resulted in an estimated 1,300,000 lbs. of CO_2 reductions annually.[67]
Comcast	A 400-kW Bloom Energy fuel cell system was installed in 2015 to power Comcast's Western New England Regional Headquarters in Berlin, Connecticut.	Comcast's Connecticut fuel cell has reduced CO_2 each year by an estimated 1,400,000 lbs.[68]
Cox Communications 	Cox uses fuel cells to provide power at California sites. These include: Bloom Energy installations in Oakland (400 kW) and El Cajon (600 kW). Doosan Fuel Cell America installations in San Diego (800 kW) and Santa Margarita (800 kW).	The Bloom Energy fuel cell fleet is reducing Cox's CO_2 emissions by an estimated 2,700,000 lbs. per year.[69]

Examples of Companies that Rely on Fuel Cells: Technology & Telecommunications		
COMPANY	**BACKGROUND**	**UPDATE**
eBay 	eBay generates power at its LEED Gold-certified headquarters building in San Jose, California, using a 500-kW Bloom Energy Server, installed in 2009. In 2013, eBay opened its data center in South Jordan, Utah, which included 6 MW of Bloom Energy Servers and uses the electric utility grid as backup.	In 2015, eBay added 3.75 MW to its Utah data center, bringing its fuel cell installation to 9.75 MW.[70] The San Jose, California, installation lowers CO_2 emissions each year by an estimated 1,300,000 lbs. The Utah project now achieves an estimated 79,700,000 lbs. of CO_2 reductions annually.[71]
Equinix 	Equinix, a global interconnection and data center company, generates power using 1 MW Bloom Energy fuel cells at its SV5 International Business Exchange™ (IBX®) data center, located in Silicon Valley, California.	Bloom Energy features an Equinix customer profile video on their website.[72]

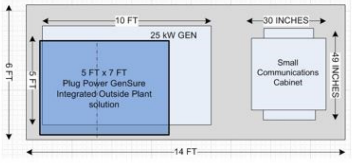
Examples of Companies that Rely on Fuel Cells: Technology & Telecommunications		
COMPANY	**BACKGROUND**	**UPDATE**
Google 	Google was one of Bloom Energy's pilot customers, installing 400-kW of Bloom Energy Servers in 2007 at Google's main campus in Mountain View, California. In 2015, Google installed a 400-kW Bloom Energy fuel cell system at the same location.	Google's website states: "We believe that by putting our dollars and resources behind a promising new technology—or allowing companies to use our campus as a testing ground—the technology will have a better chance of making it to market and scaling. For example, in 2007, we hosted the first installation of a promising new fuel cell technology that has the potential to use biogas. The company, also based in the Bay Area, was able to more quickly evolve the technology by having a working real-world pilot nearby."[73] The 400-kW fuel cell saves an estimated 1,300,000 lbs. of CO_2 emissions per year.[74]

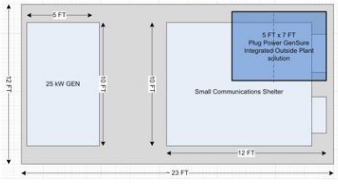
Examples of Companies that Rely on Fuel Cells: Technology & Telecommunications		
COMPANY	**BACKGROUND**	**UPDATE**
Intuit	Software company Intuit installed a 500-kW Bloom Energy Server to generate power at its payment services facility in Woodland Hills, California, in 2012.	Intuit reports: "in 2011, Intuit's Workplace Services team met to discuss installing fuel cells at the Woodland Hills site. After researching options, the team discovered that using Bloom Energy technology would save Intuit $.04 per kWh. The gas used to power the fuel cells is cheaper than electricity from the Los Angeles Department of Water and Power, which meant that after state and federal incentives for renewable energy, the Bloom Boxes would be better for the environment and cheaper for Intuit."[75] The Woodland Hills project has resulted in an estimated 1,300,000 lbs. of CO_2 reductions per year.[76]
Juniper Networks	Juniper Networks, a network developer, has 1 MW of Bloom Energy fuel cells operating at its Sunnyvale, California, corporate campus.	Juniper Networks' fuel cells, combined with 300 kW of solar panels and other energy saving technologies, are helping Juniper save more than $120,000 on the electric bill.[77] The project at Juniper Networks has led to an estimated CO_2 reduction of 2,700,000 lbs. annually.[78]

Examples of Companies that Rely on Fuel Cells: Technology & Telecommunications

COMPANY	BACKGROUND	UPDATE
Nokia Siemens 	Nokia has operated a 400-kW Bloom Energy fuel cell system powering its Sunnyvale, California, headquarters since 2011.	Nokia Siemens has Altergy Freedom Power fuel cell systems installed in Texas, Washington, and Idaho, providing extended run times to sites.[79]
Southern LINC 	SouthernLINC, a wireless communications network company backed by Southern Company, uses Plug Power GenSure fuel cells to offer mission critical 4G LTE Advanced data services to Southern Company utilities and to local businesses and government in the utilities' service territories. As announced in 2015, the company is deploying fuel cells at up to 500 sites over the next five years.	The diagram below shows the smaller footprint of Plug Power's fuel cell system compared to sites with combustion generators. This system, initially developed for SouthernLINC, won first place in the Wireless Access Network (WAN) division at the CTIA's annual Emerging Technology (E-Tech) Awards.[80]

58% FOOTPRINT SAVINGS USING PLUG POWER'S GENSURE INTEGRATED OSP SOLUTION COMPARED TO A SMALL COMMUNICATIONS CABINET AND COMBUSTION GENERATOR





87% FOOTPRINT SAVINGS USING PLUG POWER'S GENSURE INTEGRATED OSP SOLUTION COMPARED TO A SMALL COMMUNICATIONS SHELTER AND COMBUSTION GENERATOR

Examples of Companies that Rely on Fuel Cells: Technology & Telecommunications		
COMPANY	**BACKGROUND**	**UPDATE**
Sprint 	Sprint has about 500 Plug Power GenSure (formerly ReliOn) and Altergy fuel cells providing backup power at telecom towers and rooftop systems nationwide. Sprint's 56 fuel cell backup power systems in New York, New Jersey and Connecticut provided more than 72 hours of continuous operation during power outages caused by Hurricane Irene.	Sprint also has Altergy Freedom Power fuel cell systems installed at numerous wireless cell tower sites in California, Texas, New York and New Jersey. Sprint aims to make renewable sources 10% of the total electricity used by 2017 and this effort includes continuing its leadership in hydrogen fuel cells. Headquartered in Kansas, Sprint reports that, in 2014, it provided testimony to the Kansas House Subcommittee to help expand the use of fuel cells as a back-up power option for Sprint and other companies.[81] [82]
Time Warner Cable	In 2010, Time Warner Cable installed a 30-kW Altergy Freedom Power fuel cell at its Palm Springs, California, distribution hub facility. Time Warner Cable utilizes a time-saving, fill-in-place system, which enables the replacement of hydrogen in the fuel cells without switching cylinders.	Time Warner Cable deployed additional Altergy Freedom Power fuel cells for backup power to their cable head end operations in California and North Carolina, eliminating generators and greatly reducing the use of batteries.[83]

Examples of Companies that Rely on Fuel Cells: Technology & Telecommunications		
COMPANY	**BACKGROUND**	**UPDATE**
Verizon  *Doosan fuel cell system at Verizon's Basking Ridge, NJ location*	8.8-MW of Doosan Fuel Cell America systems provides grid-parallel power for Verizon's central offices, datacenters and administration. These are located at 11 facilities in California, New Jersey, and New York. Bloom Energy fuel cell systems are located two call-switching centers in Los Angeles and San Francisco, California, and at a data center in San Jose, California.	Doosan reports that its fuel cells at Verizon facilities have reduced greenhouse gas emissions by about 6000 metric tons annually. The overall efficiency of the fuel cell power plants is 42-65%.[84]
Xilinx 	Computing solutions company Xilinx installed 1-MW of Bloom Energy fuel cells in 2012 to provide power at its San Jose, California, facility.	The fuel cell system at Xilinx reduces CO_2 emissions by an estimated 2,700,000 lbs. per year.[85]
Yahoo! Inc. 	Yahoo! installed 1-MW of Bloom Energy fuel cells in 2014 to generate power at its Sunnyvale, California, headquarters. The fuel cells reduce the facility's grid energy use by 33%.	Yahoo! is reducing its CO_2 emissions in Sunnyvale annually by an estimated 2,700,000 lbs.[86]

Examples of Companies that Rely on Fuel Cells: Technology & Telecommunication

	BACKGROUND
Additional Companies 	**Fujitsu America**, a business technologies, cloud services and computing platform company located in Sunnyvale, California, uses a Doosan Fuel Cell America PureCell Model 200 fuel cell to generate power for the facility. **Motorola**, a data communications and telecom company, added Altergy Freedom Power fuel cell systems to sites in Illinois, New York and Florida, to provide backup power to first responders, replacing batteries and generators. **NTT America**, a global information and communication technology (ICT) provider, has operated a 500-kW Bloom Energy fuel cell system at its San Jose, California, data center since 2011. **Ponderosa**, a technology service provider offering voice and internet services to California customers, uses Plug Power fuel cells to provide backup power to their network. **T-Mobile (formerly Metro PCS)** has Altergy Freedom Power fuel cell systems installed at numerous wireless cell tower sites in Florida, California, New York, New Jersey, and Connecticut. The company reports longer runtimes as well as significant operating and capital expenditure cost savings. **Windstream Communications**, a voice and data network company, installed Altergy Freedom Power fuel cell systems in the Southeastern U.S. to provide extended runtime to network sites.

Financial Services

According to the U.S. Department of Energy, there are about 3 million data centers in the United States, consuming 100 billion kWh of electricity a year and comprising more than 2% of all U.S. electricity use.[87] Ongoing strong growth in the data center market could strain existing grid resources and impact power reliability, with power outages costing data centers over $7,000 per minute, and more than half a million dollars per occurrence.[88]

Fuel cells can help to mitigate this problem. Financial services companies and banks are trusting fuel cells to generate high quality, reliable power for data centers and mission critical applications. Resilient, onsite fuel cells are able to provide assured power at a high efficiency, helping meet sustainability goals while ensuring financial transactions and operations will continue, regardless of circumstances.

Examples of Companies that Rely on Fuel Cells: Financial Services

COMPANY	BACKGROUND	UPDATE
Bank of America 	In 2011, Bank of America installed a 500-kW Bloom Energy fuel cell system at one of its largest call centers in Calabasas, California. Bloom Energy and Bank of America Merrill Lynch also have teamed to offer a leasing program for business customers to finance Bloom Energy fuel cell systems. The program streamlines customer deployment and eliminates the need for an upfront capital investment.	The fuel cell in Calabasas has resulted in an estimated 1,300,000 lbs. of CO_2 reductions per year.[89]
Franklin Templeton	Investment firm Franklin Templeton has operated a 1-MW Bloom Energy fuel cell system at its San Mateo California, site since 2011.	The fuel cell at Franklin Templeton has resulted in an estimated 2,700,000 lbs. of CO_2 reductions annually.[90]

Examples of Companies that Rely on Fuel Cells: Financial Services		
COMPANY	**BACKGROUND**	**UPDATE**
JPMorgan Chase	Financial services company JPMorgan Chase installed a 500-kW Bloom Energy fuel cell system in 2013 to power its Newark, Delaware, data center.	The fuel cell reduces an estimated 3,000,000 lbs. of CO_2 per year.[91]
Morgan Stanley 	Financial services company Morgan Stanley installed a 250-kW Bloom Energy fuel cell to generate power at its headquarters facility in Purchase, New York, in 2014.	In 2016, Morgan Stanley installed its second fuel cell system, a 750-kW Bloom Energy fuel cell, to supply power at its global headquarters in New York City. The fuel cell is located on a rooftop setback on the eighth floor. The 250-kW fuel cell located in Purchase, has led to an estimated 1,300,000 lbs. of CO_2 reductions per year.[92]
Additional Companies	**BACKGROUND**	
	First National Bank of Omaha was the first U.S. company to use fuel cell technology as its primary power source. The Doosan Fuel Cell America system was installed in 1999 to provide primary power to the bank's Omaha, Nebraska, data center. In its first 10 years of operation, the fuel cell provided 89,000 hours of operation and reduced heating bills by more than $1 million. Availability of the fuel cell system exceeded 99.9999%. In 2013, First National Bank of Omaha replaced its first fuel cell, which provided power to its data center for 14 years, with a new 400-kW Doosan Fuel Cell America fuel cell system.	

Real Estate

Since fuel cells are scalable to multi-megawatt sized units, the technology is showing up in larger facilities, like shopping centers, office parks and towers, and multi-use retail/residential buildings, as well as the data centers, corporate campuses, sports arenas, and warehouses described above. These fuel cells keep the buildings up and running by providing power and heat, even when bad weather hits, and do so while lowering carbon emissions and providing energy cost savings.

Examples of Companies that Rely on Fuel Cells: Real Estate		
COMPANY	**BACKGROUND**	**UPDATE**
Becker + Becker  *Doosan Fuel Cell America fuel cell system t The Octagon in New York City(*	Architectural firm Becker + Becker has incorporated fuel cells into several of its projects including: In 2010, a 400-kW unit from Doosan Fuel Cell America was installed to supply power and heat at the 360 State Street retail and residential tower in New Haven, Connecticut. The fuel cell also supplies power to electric vehicle chargers at the building. In 2011, a 400-kW Doosan Fuel Cell America system was installed for Bentall Kennedy in The Octagon, a historic property in New York City that was converted to apartments. In 2015, a 400-kW Doosan Fuel Cell America system was installed at 777 Main Street in Hartford, Connecticut, to supply power and heat at the mixed use apartment building.	In July 2015, Connecticut's Public Utilities Regulatory Authority approved submetering of tenants at 777 Main Street. This allows the facility to sell electricity, which is generated onsite by fuel cells, to the building's tenants.[93] Customer Bentall Kennedy reports that, after Hurricane Sandy, when buildings around The Octagon were without electricity and heat, property management at The Octagon managed to reroute its fuel cell to provide both working water pumps and elevators for its residents.[94]

Examples of Companies that Rely on Fuel Cells: Real Estate		
COMPANY	**BACKGROUND**	**UPDATE**
Hines/LPL Financial 	In 2013, real estate company Hines installed a 300-kW Bloom Energy fuel cell system at a San Diego, California, office building leased to tenant LPL Financial. The 13-story office tower, which is the largest net-zero energy commercial office building in the U.S., is LPL Financial's headquarters facility.	The project at Hines has resulted in an estimated 820,000 lbs. of CO_2 reductions per year.[95]
JMB Realty/ Constellation Place 	A 400-kW Bloom Energy fuel cell system was installed in 2011 to power one-third of JMB Realty's Constellation Place office tower in Century City, California.	JMB is reducing its CO_2 emissions by an estimated 1,000,000 lbs. of CO_2 reductions annually.[96]
The Ratkovich Co./The Alhambra 	A 500-kW Bloom Energy fuel cell generates over 25% of the electricity used at The Alhambra office park in Alhambra, California.	In 2013, the Bloom Energy system saved The Alhambra more than $200,000 in electrical costs, over 10% of the total annual electrical budget.[97]

Examples of Companies that Rely on Fuel Cells:
Real Estate

Additional Companies

Bloom Energy Server at Macerich's Danbury Fair Mall

BACKGROUND

Tishman Construction installed Doosan Fuel Cell America systems in 2010 to supply power at Tower 3 (three fuel cell systems) and Tower 4 (three fuel cell systems) of the new World Trade Center in New York City.

Macerich and WGL, through its subsidiary, Washington Gas Energy Systems, installed 750-kW Bloom Energy fuel cell to power the 1.3 million-sq.-ft. Danbury Fair Mall in Connecticut. The project is expected to reduce the facility's carbon emissions by nearly 3 million pounds each year.

Healthcare & Biotechnology

Reliability is critical to healthcare facilities, to keep hospitals and treatment facilities up and running, and protecting life-saving vaccines, research and above all, patients. Onsite fuel cell power generation keeps essential services operating, even when other sites lack power.

In addition to onsite power supply, fuel cells can provide additional benefits. A fuel cell's byproduct heat can be recovered for use in facility heating, provision of hot water and, when run through an absorption chiller, for facility cooling.

Fuel cells also provide a bonus in a hospital setting since they operate quietly, producing about 60-70 decibels of sound (the typical level of a conversation) allowing patients to heal without the intrusion of unwanted noise.

Like corporations, healthcare and biotech companies use fuel cells to generate power at their corporate and research campuses. Fuel cells are helping both hospitals and biotech facilities meet emission reduction goals while saving on energy and water costs.

Examples of Companies that Rely on Fuel Cells: Healthcare & Biotechnology

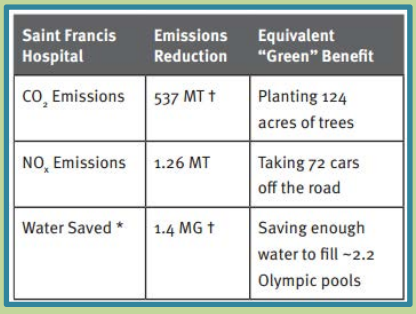
COMPANY	BACKGROUND	UPDATE
BD (Becton, Dickinson & Company) 	In 2011, medical technology company BD (Becton, Dickinson & Company) installed an 800-kW Bloom Energy fuel cell system to generate power at its BD BioSciences facility in San Jose, California.	The fuel cell system at BD Biosciences has resulted in an estimated 2,100,000 lbs. of CO_2 reductions per year.[98]

Examples of Companies that Rely on Fuel Cells: Healthcare & Biotechnology		
COMPANY	**BACKGROUND**	**UPDATE**
Johnson & Johnson  *Fuel cell system at the Irvine J&J ASP facility*	In 2015, Johnson & Johnson Advanced Sterilization Products (ASP) installed a 500-kW Bloom Energy Server to provide 25% of the Irvine, California, facility's daily energy consumption. The company anticipates that the fuel cells will save an estimated $10 million over the 20 year life of the project. Also in 2015, Johnson & Johnson's cardiac catheters company Biosense Webster, added a 375-kW Bloom Energy fuel cell to supply power at its Irwindale, California, site.	J&J reports that its two fuel cell systems supply 2% of the energy used by the company worldwide, providing 26 terajoules of energy in 2015.[99] The Irvine project has led to an estimated 1,300,000 lbs. of CO_2 reductions annually, while the Irwindale project has resulted in an estimated 1,000,000 lbs.[100]
Life Technologies 	Biotech company Life Technologies installed 1-MW of Bloom Energy fuel cell systems at its California facilities in Carlsbad (2012) and Pleasanton (2013).	The two installations, totaling 2 MW, reduce CO_2 emissions by an estimated 5,400,000 lbs. annually.[101] Bloom Energy features a Life Technologies customer profile video on their website.[102]

Examples of Companies that Rely on Fuel Cells: Healthcare & Biotechnology

COMPANY	BACKGROUND	UPDATE
Medtronic 	Medtronic's Santa Rosa, California, site supports the Coronary and Structural Heart business as well as the Aortic and Peripheral Vascular business. Bloom Energy Servers (400 kW) provide 96% of the electrical requirement for the building.	Medtronic reports that each year the fuel cell will save $2.3 million and reduce electricity-related water usage by more than 3 million gallons.[103] The fuel cell system reduces CO_2 emissions by an estimated 1,000,000 lbs. per year.[104]
Additional Companies	**BACKGROUND**	
	J+D Labs, a nutraceutical manufacturing company, installed a 400-kW Doosan Fuel Cell America fuel cell system in 2012 to supply power at its Vista, California, facility. Pharmaceutical company **Pfizer** had added a 5.6-MW FuelCell Energy fuel cell system to supply electricity and steam to its 160-acre research and development campus in Groton, Connecticut, under a power purchase agreement. The two 2.8-MW fuel cell plants will generate electricity independently from the electric grid, enhancing Pfizer's power reliability by allowing the facility to remain up and running in the event of an extended outage or grid disturbance. **Roche Molecular Diagnostics** added a 400-kW Doosan Fuel Cell America system in 2011 to supply power at its Pleasanton, California, site.	

Examples of Companies that Rely on Fuel Cells: Healthcare Facilities

HEALTHCARE FACILITY	BACKGROUND	UPDATE
Prime Healthcare 	Prime Healthcare's Chino Valley Medical Center in Ontario, California, generates power using a 600-kW Bloom Energy Server.	The fuel cell at Chino Valley Medical Center reduces CO_2 emissions annually by an estimated 1,600,000 lbs.[105]
Kaiser Permanente 	Kaiser Permanente has operates Bloom Energy fuel cells at seven of its California facilities, cumulatively totaling 4.3 MW of power generation.	Kaiser's fleet of fuel cells are saving an estimated 11,800,000 lbs. of CO_2 emissions per year.[106]
St. Francis Hospital 	Saint Francis Hospital and Medical Center, Main Campus in Hartford, Connecticut, installed a 400-kW Doosan Fuel Cell America PureCell system in 2013, replacing a 200-kW PureCell that had been in operation since 2003. The fuel cell provides continuous-duty baseload operation with back-up power for non-emergency electrical loads and heat recovery for space heating and domestic hot water. St. Francis' Mt. Sinai Rehab Hospital Campus, located in New Haven, Connecticut, also utilizes a 400-kW PureCell fuel cell system from Doosan Fuel Cell America.	

Saint Francis Hospital	Emissions Reduction	Equivalent "Green" Benefit
CO_2 Emissions	537 MT †	Planting 124 acres of trees
NO_x Emissions	1.26 MT	Taking 72 cars off the road
Water Saved *	1.4 MG †	Saving enough water to fill ~2.2 Olympic pools

Examples of Companies that Rely on Fuel Cells: Healthcare & Biotechnology		
COMPANY	**BACKGROUND**	**UPDATE**
St. Helena Hospital	One 400 kW, continuous-duty Doosan Fuel Cell America PureCell system was installed in 2010 at the St. Helena, California, hospital campus, to generate power for the facility. The PureCell Model 400 additionally provides heat recovery for space heating and domestic hot water.	The hospital conserves 1.2 million gallons of water while achieving an energy savings of $170,000 per year.[107]
Sutter Health/Sutter Santa Rosa Regional Hospital 	Sutter Santa Rosa Regional Hospital in Santa Rosa, California, generates power using a 375-kW Bloom Energy Server. The fuel cell was installed in 2014.	The project at Sutter Health achieves an estimated 1,000,000 lbs. of annual CO_2 reductions.[108]
Veterans Administration Hospital	The Veterans Administration (VA) Hospital in Loma Linda, California, operates an 800-kW Doosan Fuel Cell America fuel cell system. The PureCell Model 400 system provides continuous power generation with heat recovery for space heating and domestic hot water.	The VA Hospital's Doosan fuel cell system has an overall efficiency averaging 70% and provides CO_2 savings of 705 metric tons per year, NO_x savings of 3.0 metric tons per year, and water savings of ~1 million gallons per year.[109]

Additional Healthcare Facilities

FuelCell Energy power plant at Hartford Hospital

BACKGROUND

Hartford Hospital in Hartford, Connecticut, installed a 1.4-MW FuelCell Energy system in 2013 and the heat byproduct is to produce steam and enhance efficiency.

The **University of California Irvine Medical Center** utilizes a 1.4 MW FuelCell Energy CHP fuel cell power plant that provides ~30% of the facility's power needs and supplies heat for a direct exhaust absorption chiller to produce 200 tons of cooling.

Entertainment & Sports

People love to be entertained, and to cheer on their favorite team, especially at live events. When power outages occur, the cheering can quickly turn to boos. In 2013, at Super Bowl XLVII in New Orleans, the Mercedes-Benz Superdome went dark for 34 minutes[110], leaving fans both in their seats in the stadium and watching at home, powerless.

To avoid a repeat performance, several stadiums and arenas in California have installed fuel cells to make sure operations continue running, despite any unforeseen outages. Television, movie, and news studios are also casting fuel cells to not only keep us entertained without interruption, but in case of emergency, to provide power for up-to-the-minute news alerts and public service announcements.

Examples of Companies that Rely on Fuel Cells: Entertainment & Sports

COMPANY	BACKGROUND	UPDATE
Beacon Capital Partners/News Corp. 	In 2012, Beacon Capital Partners installed a Doosan Fuel Cell America fuel cell at its headquarters at 1211 Avenue of the Americas in New York to produce power for their main tenant, News Corporation, supplying a major portion of the power requirement for their television studios. The fuel cell provides 100% of electric output used by Fox News (24x7), 25% of hot water output used in non-heating months, and 100% of hot water output used in heating months. It also provides emergency power to lobby, covered arcade, the lobby level restaurant, and to an outdoor Fox News ticker for news updates and public service announcements.	Beacon Capital reports minimal outages and 93% availability of the fuel cell.[111]

Beacon Office Building	Emissions Reduction	Equivalent "Green" Benefit
CO_2 Emissions	600 MT	Planting 138 acres of trees
NO_x Emissions	1.31 MT	Taking 75 cars off the road
Water Saved	1.4 MG	Saving enough water to fill 2.2 Olympic pools

Examples of Companies that Rely on Fuel Cells: Entertainment & Sports		
COMPANY	**BACKGROUND**	**UPDATE**
CBS Studios 	CBS Studio Center, which is home to a production and office facility with 18 sound stages, uses 1.2 MW of Doosan Fuel Cell America fuel cells to meet 40% of its power needs. CBS Television City also uses a 1.2-MW Doosan fuel cell system to provide 60% of the power to the site's eight sound stages and office space.	CBS reports that, "In 2014 four passive photovoltaic arrays and six fuel cells generated 22,148,313 kWh of electricity at the CBS-Television City and Studio Center facilities near Los Angeles, California. Since the CBS studios are frequently leased to outside production companies, these third parties are able to avoid greenhouse gas emissions through the use of CBS assets."[112]
Disney Pixar	A 1-MW Bloom Energy fuel cell produces power at Disney's Pixar Animation Studios in Emeryville, California.	The Disney Pixar fuel cells have annually eliminated an estimated 2,700,000 lbs. of CO_2.[113]
DreamWorks Animation 	A 750-kW Bloom Energy fuel cell system is installed at a DreamWorks facility in Glendale, California. Annually, the system provides more than 6 million kWh electricity of for the six acre campus and 460,000-sq.-ft. of office space.	The project has resulted in an estimated 2,000,000 lbs. of CO_2 reductions per year.[114]

Examples of Companies that Rely on Fuel Cells: Entertainment & Sports		
COMPANY	**BACKGROUND**	**UPDATE**
Honda Center	The Honda Center, located in Anaheim, California, uses a 750-kW Bloom Energy Server that provides more than half of the power required by the sports and entertainment facility each year. The venue is home to the Anaheim Ducks of the National Hockey League.	The fuel cell at Honda Center provides an estimated 2,000,000 lbs. reduction of CO_2 emissions per year.[115]
NBCUniversal	In April 2011, NBCUniversal installed 20 kW of fuel cells at the production kitchen at Universal Studios Hollywood. The natural gas-powered fuel cells supplied both electricity and hot water to the food production kitchens.	In April 2016, NBCUniversal installed a 250-kW Bloom Energy server at a new NBC 7 San Diego/ KNSD two-story, 52,000 sq.-ft. state-of-the-art broadcast facility.[116]
SAP Center/Shark's Ice 	Sharks Sports & Entertainment (SSE), owner of the SAP Center in San Jose, California, installed a 400-kW Bloom Energy Server at the sports and entertainment facility in 2012. SAP Center is home to the San Jose Sharks of the National Hockey League. Also in 2012, SSE installed a 500-kW Bloom Energy Server at Shark's Ice, a public recreational ice facility owned by the City of San Jose and managed by SSE.	The project at SAP Center has saved an estimated 1,000,000 lbs. in CO_2 emissions per year. The project at Shark's Ice has led to an annual estimated reduction of 1,300,000 lbs. of CO_2.[117]

Examples of Companies that Rely on Fuel Cells: Entertainment & Sports		
COMPANY	**BACKGROUND**	**UPDATE**
AEG/Staples Center 	In November 2015, AEG/Staples Center, a sports and entertainment complex in Los Angeles, California, installed a 500-kW Bloom Energy server to provide 25% of the facility's energy.[118]	Bloom Energy features a Staples Center customer profile video on their website.[119]

Hotels

Hotels were among the first businesses to try out fuel cells, implementing early demonstration units more than two decades ago, beginning in 1992 when a Hyatt Hotel used a demonstration 200-kW Doosan Fuel Cell America fuel cell to meet 20% of the hotel's power needs, with waste heat from the process used to heat water for guests and for the laundry.

Since that time, hotels located in California, New Jersey, New York, and Washington, have utilized fuel cells including: Double Tree Inn, Sheraton, Westin, Hilton, and the Mohegan Sun Casino and Hotel.

After more than a decade, these early fuel cells are no longer in operation. But in late 2015, Hyatt added a Bloom Energy fuel cell to its energy portfolio to supply onsite power and reduce carbon emissions.

Examples of Companies that Rely on Fuel Cells: Hotels

COMPANY	BACKGROUND	UPDATE
Hyatt Hotels 	On December 30, 2015, Hyatt installed a 500-kW Bloom Energy Server at the Hyatt Regency Greenwich in Connecticut. The fuel cell provides up to 75% of the hotel's energy load, generating significant cost savings and reducing carbon emissions by 40% compared to electricity purchased from the grid.	Hyatt reports that the company has been looking at innovative energy technologies for some time. The company already has solar photovoltaic and solar thermal installations and fuel cells were an innovative solution that the company wanted to try.[120] The fuel cell project is reducing CO_2 emissions by an estimated 1,800,000 lbs. annually.[121]

Transportation

Major automakers are investing in fuel cells, and today, customers in California and other parts of the world are able to buy or lease fuel cell vehicles from several, with more entering the marketplace by the end of this year and next. These car manufacturers are also using fuel cells to help move the parts to build many other vehicles, with fuel cell-powered forklifts operating in automotive manufacturing plants around the country. This began more than ten years ago, in 2005, with General Motors (GM), testing 19 forklifts powered by Hydrogenics fuel cells at its Oshawa, Canada, car assembly plant.

Today, BMW, Honda, Mercedes-Benz, and Volkswagen all use fuel cell-powered forklifts at assembly and manufacturing facilities. This transportation section also covers logistics and delivery companies, railroads, and features a spotlight on a company utilizing fuel cell-powered mobile lighting to help repair crews fix the ferry dock at Alcatraz Island.

Examples of Companies that Rely on Fuel Cells: Transportation

COMPANY	BACKGROUND	UPDATE
BMW 	BMW's Spartanburg, South Carolina, manufacturing plant operates more than 350 forklifts with Plug Power fuel cells.	In December 2015, fuel cell forklifts at the plant reached 1 million fuelings using the plant's hydrogen fueling equipment from Linde.[122]

Examples of Companies that Rely on Fuel Cells: Transportation		
COMPANY	**BACKGROUND**	**UPDATE**
FedEx  *Bloom Energy fuel cell system at a FedEx site*	FedEx installed a 500-kW Bloom Energy Server in 2010 to generate power at an Oakland, California, hub. In 2014, a 400-kW fuel cell system was added to a FedEx site in Rialto, California. FedEx also operates 40 fuel cell-powered forklifts in Springfield, Missouri, and is demonstrating 15 fuel cell-powered baggage tow tractors at Memphis Airport in a DOE-sponsored project. Plug Power supplied fuel cell systems for both deployments. FedEx will demonstrate 20 fuel cell extended-range battery electric delivery vehicles in California and Tennessee in another DOE-sponsored project using Plug Power fuel cells.	The FedEx Oakland site tests and implements cutting-edge technologies that set standards for other FedEx locations and airlines. Oakland Hub Director, Robin Van Galder, reports that the site's solar and fuel cell resources are providing 47% of of the facility's energy.[123,] The Oakland and Rialto projects estimated to reduce CO_2 emissions by a combined 2,400,000 lbs. per year.[124]
Volkswagen 	Volkswagen operates 45 forklifts powered by Plug Power fuel cells at its Chattanooga, Tennessee, manufacturing facility.	VW also uses Plug Power GenDrive fuel cells to power forklifts at its Kassel, Germany, facility and is trialing a fuel cell-powered Linde forklift at its Dusseldorf facility that assembles Sprinter vans.[125]

Examples of Companies that Rely on Fuel Cells: Transportation

Additional Companies

Top: Plug Power fuel cell system at a CSX site. Bottom: Bloom Energy fuel cells at American Honda

BACKGROUND

BNSF Railroad uses Plug Power fuel cells for backup power in a number of their PTC (positive train control) and telecommunications networks in several states. BNSF also deployed Altergy Freedom Power fuel for its PTC networks, as well as switching and automated maintenance systems.

CSX uses Plug Power fuel cells at 200+ locations to provide backup power to a network of sensors and communications equipment throughout the CSX rail system.

Honda operates 51 Plug Power fuel cell-powered forklifts, and has two hydrogen dispensers to support them, at its largest manufacturing facility (4 million square feet), located in Marysville, Ohio. Honda also installed 1 MW of Bloom Energy fuel cell systems at its distribution center in Torrance, California.

Mercedes-Benz U.S. International has more than 200 Plug Power GenDrive fuel cell-powered forklifts operating at its Tuscaloosa, Alabama, campus. The automaker first deployed 72 fuel cell units in 2012 for its vehicle assembly plant and purchased an additional 123 more for its logistics hub in 2013.

Union Pacific Railroad replaced generators with Altergy Freedom Power fuel cells for greater reliability and safety at their railroad network sites.

The **U.S. Postal Service** has installed two Nuvera® hydrogen generators plus associated compression, storage, and dispensing equipment at a Capitol Heights, Maryland, Washington Network Distribution Center to supply fuel for its Plug Power fuel cell-powered industrial vehicles.

United Parcel Service (UPS) is working with partners, including fuel cell manufacturer Hydrogenics, on a DOE-funded project to develop a fuel cell hybrid electric walk-in delivery van with a 150-mile range per fueling. The team will then retrofit 17 UPS delivery vans to test at distribution facilities across California.

Lighting up Alcatraz Cruises

Luxfer-GTM Technologies' Zero-Set Lite, a portable hydrogen fuel cell-powered light tower that uses fuel cells from Plug Power, provided critical working light for an overnight barge exchange operation at Alcatraz Island National Park in San Francisco, California. The operation was part of a planned maintenance period for the Island's embarkation dock, which serves approximately 5,000 visitors per day, and was undertaken by Alcatraz Cruises, official National Park Service concessioner for ferry service to Alcatraz Island.

The Zero-Set Lite was transported by boat across the San Francisco Bay and hoisted by crane onto the Island in order to support the operation. While Alcatraz Cruises crew and subcontractors worked throughout the night in inclement weather, the light tower consistently provided bright, clean, and quiet lighting, allowing crews to see and hear each other clearly in the challenging working conditions.

"Until now it has just been a given that if you needed portable light and power, you were also going to get lots of noise and diesel fumes - and what we found is that that's just not true anymore. The hydrogen fuel cell light tower did a great job of lighting up the work area, and it also made it possible to have a normal conversation in the area with no noise or fumes. The light tower also follows the time-honored maritime K.I.S.S. principle, which stands for: 'Keep It Simple Sailor', in that you can power the unit on and off with the simple push of a button, and there is zero chance of a fuel spill."

Julian Rose
Special Projects Manager, Hornblower Cruises and events

*images courtesy of Photography by Robert Kaufman

Utilities

Electric utility companies are turning to fuel cells, which can be scaled in size from watts to multi-megawatts, to generate power for a variety of applications:

- Electricity utilities are using to fuel cells to generate power for the electric grid with fuel cell systems scaled up to 30 MW in size. The world's largest, a 59 MW fuel cell power plant in Korea, could be eclipsed by another planned project in Connecticut that could deliver 63 MW of fuel cell power to the electric grid.
- In the northeast U.S., fuel cells are being selected for micro grid projects to increase power reliability and resilience through storms.
- Utilities also use fuel cells as a backup power supply for radio and supervisory control and data acquisition (SCADA) equipment, power for a natural gas let-down facility, and electricity for customer sites.

In addition, fuel cells and hydrogen are attracting attention for their potential use in energy storage and power-to-gas applications.

Examples of Companies that Rely on Fuel Cells: Utilities

COMPANY	BACKGROUND	UPDATE
Avangrid	Avangrid, formerly United Illuminating (UI), has several FuelCell Energy fuel cell installations around Connecticut - a 2.8-MW system at a Connecticut Natural Gas Corporation pressure reduction facility in Glastonbury; a 2.8 MW plant located next to existing substation in New Haven; and a 2.8 MW plant operating alongside a solar array in Seaside Park, Bridgeport.	Avangrid's fuel cell fleet will grow to 10 MW with a 2.2 MW fuel cell to be located at Amity Regional High School in Woodbridge. The fuel cell will be the sole power source of the town microgrid.

Examples of Companies that Rely on Fuel Cells: Utilities		
Pacific Gas & Electric (PG&E)	PG&E, in collaboration with San Francisco State University, installed a 200-kW Bloom Energy fuel cell in 2011.	PG&E has also added Altergy Freedom Power and Plug Power fuel cells deployed as emergency backup power units and to provide backup power to PG&E's critical radio and SCADA locations.
Washington Gas 	Washington Gas has operated a 200-kW Bloom Energy fuel cell system to provide power at its headquarters facility in Springfield, Virginia, since 2011.	In September 2016, Washington Gas reported that it has exceeded its carbon reduction goals four years ahead of schedule – and the fuel cell system played a key role in this reduction.[126]

Examples of Companies that Rely on Fuel Cells:
Utilities

Additional Companies

Top: Dominion Power fuel cell power park in Connecticut

Bottom: SCE fuel cell plant at the University of California, San Bernardino

BACKGROUND

Con Edison is constructing a microgrid at the Marcus Garvey Apartments in Brooklyn, New York. The project includes 400 kW of rooftop solar, battery storage and a 400-kW Bloom Energy fuel cell.

Delmarva Power operates 30 MW of Bloom Energy Servers in Newark, Delaware to provide power to the utility grid.

Dominion Power installed a 14.9-MW FuelCell Energy power plant, in Bridgeport, Connecticut, in 2013, enough power to supply ~15,000 homes. Dominion sells the output of the fuel cell power station to Eversource under a 15-year power purchase agreement.

Exelon, through its Constellation business unit, is working with Bloom Energy to install fuel cells at 170 customer sites in California and Connecticut.

Southern California Edison (SCE) installed a 1.4-MW FuelCell Energy system in 2013 to provide power and heat at the University of California, San Bernardino.

Southern Company and its subsidiary PowerSecure announced a strategic alliance with Bloom Energy. PowerSecure will acquire ~50 MW of Bloom Energy Servers under long-term power purchase agreements with commercial and industrial customers and will integrate Bloom's Energy Server fuel cell platform with PowerSecure's smart storage solutions. Separately, Southern Company's subsidiary, Alabama Power, is working with FuelCell Energy and ExxonMobil to test a novel fuel cell carbon capture technology.

The Growing Business Case for Fuel Cells

Today fuel cells are contributing to environmental stewardship and helping corporations achieve strategic emissions reduction goals and commitments. Current markets include primary or backup power to facilities or off-grid sites and power supply for MHE. Versatile fuel cells are also beginning to move into other commercial applications.

Oil and gas companies have started using fuel cells to power off-grid equipment; railroads have chosen fuel cells to supply backup power to rail-side equipment, fuel cells are supplying temporary lighting for events, and soldiers use fuel cells to power equipment in the field. Fuel cell vehicles, now available from several major automakers in early global markets, are already operating in taxi and car service fleets in Europe, and, in 2017, the first fuel cell-powered train will debut in Germany.

Several companies are also participating in public-private projects to demonstrate the feasibility and benefits of fuel cells in new applications, such as power for refrigerated containers at port docks (Young Brothers and Sandia National Laboratories), power for airport ground support equipment (FedEx and the Department of Energy), power for aircraft when taxiing (Airbus and the German Aerospace Agency), and as range extenders for battery-powered parcel delivery trucks (FedEx and the Department of Energy).

It is not an overstatement to say that fuel cells have a lot of potential. Stay tuned to the next report for further innovations and for more insight and testimonials on the growing business case for fuel cells.

Appendix 1: Additional Resources

For additional technical and industry information on fuel cells and the various applications and markets they serve, please visit:

- DOE's Fuel Cell Technologies Office
- Fuel Cell and Hydrogen Energy Association

Fuel cell and hydrogen companies included in report:

Air Liquide – www.airliquide.com/science-new-energies/hydrogen-energy
Air Products – www.airproducts.com/industries/Energy/Hydrogen-Energy.aspx
Altergy Systems – www.altergy.com
Bloom Energy – www.bloomenergy.com
Doosan Fuel Cell America – www.doosanfuelcell.com
FuelCell Energy – www.fuelcellenergy.com
Hydrogenics – www.hydrogenics.com
Linde – www.the-linde-group.com/en/clean_technology/clean_technology_portfolio/hydrogen_energy_h2/index.html
Luxfor-GTM Technologies – www.luxfergtm.com
Millennium Reign Energy – residentialhydrogenpower.com/
Nuvera Fuel Cells – www.nuvera.com
Plug Power – www.plugpower.com

Appendix 2: Image Credits

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p. 9 – Photo Courtesy of Air Liquide; photo courtesy of Bloom Energy
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p. 54 – Photos courtesy of Photography by Robert Kaufman
p. 56 – Photo courtesy of Bloom Energy
p. 57 – Photos courtesy of FuelCell Energy

Appendix 3: Endnotes

[1] In its 2015 Annual Report, FuelCell Energy states that the levelized cost of energy production from its fuel cells to be $0.12/kWh on an unsubsidized basis, with natural gas at $4.50MMBtu or $0.11/kWh at $2.50/MMBtu. Source: http://files.shareholder.com/downloads/FCEL/2440061101x0x875451/3FE48C03-2C2C-4289-8E03-60BBDB783BAF/FuelCell_AR2015_FINAL.pdf

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