FUEL CELLS 2000
www.fuelcells.org

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The Business Case for Fuel Cells:
Why Top Companies are Purchasing Fuel Cells Today

Authors and Acknowledgements

This report was written and compiled by Sandra Curtin and Jennifer Gangi of Fuel Cells 2000, an activity of Breakthrough Technologies Institute in Washington, D.C., with assistance from Elizabeth Delmont. Support was provided by the U.S. Department of Energy's Fuel Cell Technologies Program.

About this report

In this report, we profile a select group nationally recognizable companies and corporations that are deploying or demonstrating fuel cells. These businesses are taking advantage of a fuel cell's unique benefits, especially for powering forklifts and providing combined heat and power to their stores and headquarters. This report focuses on companies installing or using fuel cells in warehouses, stores, manufacturing facilities, hotels, and backup power for telecommunications sites.

Our list is by no means exhaustive – thousands of fuel cells have been installed around the world, for primary or backup power, for decades now. There are many other companies in the United States and worldwide using fuel cells that we didn't profile. Outside of the business world, fuel cells are being used by hospitals and nursing homes, universities, recreational facilities such as National Parks, zoos, aquariums and museums, as well as federal, state and local government agencies and facilities. In Asia and Europe, thousands of fuel cells have been installed at homes to provide heat and power and in the U.S., real estate developers are starting to incorporate fuel cells into their multi-family residential projects.

There are many other applications for fuel cells which are also being researched, demonstrated and deployed by numerous organizations around the world. This report profiles several companies leasing fuel cell vehicles, but there are hundreds of fuel cell vehicles from all the major automakers on the road around the world, and numerous fuel cell buses on almost every continent.

The information contained in this report has been obtained from public sources and via contact with fuel cell manufacturers and the companies themselves. Please contact Fuel Cells 2000 at info@fuelcells.org or 202-785-4222, ext. 17 with any corrections, updates or questions.

Front Cover Photos:

Top left: UTC Power fuel cells at a Cabela's retail store in Connecticut
Bottom left: FuelCell Energy fuel cells at Gills Onions in California, part of the company's Waste-To-Energy recovery system
Top right: IKEA's GM/Opel Hydrogen3 fuel cell vehicle deployed in Germany
Bottom right: Fuel cell powered forklift that was tested at Air Canada, Vancouver International Airport

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Acronyms Used In This Report:

ADG	Anaerobic digester gas
ARRA	American Recovery and Reinvestment Act
CCEF	Connecticut Clean Energy Fund
CHP	Combined heat and power
CO_2	Carbon dioxide
DLA	Defense Logistics Agency
DoD	U.S. Department of Defense
DoE	U.S. Department of Energy
DoT	U.S. Department of Transportation
ERDC-CERL	Engineer Research and Development Center, Construction Engineering Research Laboratory (U.S. Army Corps of Engineers)
FAA	U.S. Federal Aviation Administration
ITC	Investment Tax Credit (federal)
kW	Kilowatt
kWh	Kilowatt hour
MCFC	Molten carbonate fuel cell
MW	Megawatt
MWh	Megawatt-hours
NYSERDA	New York State Energy Research and Development Authority
PAFC	Phosphoric acid fuel cell
PEM	Proton exchange membrane
SGIP	Self Generation Incentive Program (California)
SOFC	Solid oxide fuel cell
sq. ft.	Square foot

Introduction – Why Fuel Cells?

In today's marketplace, people are spending their green on green. Companies making or selling environmentally-conscious products and services are finding that consumers are responding. By greening corporate offices, retail sites and distribution centers, companies show their sustainability commitment to customers, employees, the local community and the world.

Energy efficiency and alternative power play a big role in sustainability. One sustainable energy technology attracting increasing attention for its efficiency and environmental performance is the fuel cell. Fuel cells are being used by major corporations today – in applications varying from local generation of heat and electricity to materials handling to transportation. Companies that try fuel cells like them, including major grocery chains, hotels, distributors, telecom companies and manufacturers, among many others.

Why Fuel Cells?

Fuel cells generate electricity with low to zero emissions and provide not only environmental savings, but also productivity improvements: time, cost and manpower savings. No other energy generating technology offers the product range and combination of benefits that fuel cells can.

Efficiency

Fuel cells are fundamentally more efficient than combustion systems, achieving 40% to more than 50% fuel-to-electricity efficiency when using hydrocarbon fuels such as natural gas or pure hydrogen, depending on the type of fuel cell and the application. High efficiency is an inherent advantage for fuel cells because they use the chemical energy of a fuel directly, without combustion. Hybrids, such as systems that combine high temperature fuel cells with a turbine, can operate at electrical efficiencies estimated at more than 60%, higher than even the most efficient combined cycle turbine plants now available.

When the fuel cell is sited near the point of use, waste heat can be captured for cogeneration, where it can be used to provide hot water, space heating, or cooling. This combined heat and power (CHP) installation can deliver 80% to 90% overall fuel efficiency. Heat can also be used for refrigeration using absorption chillers, as supermarkets installing fuel cells are opting to do. In buildings, fuel cell cogeneration units can reduce facility energy service costs by 20% to 40% compared to conventional energy technologies.

In this report, we profile 38 nationally recognizable companies and corporations that are deploying or demonstrating fuel cells. Eleven are Fortune 500 companies.

The 38 profiled companies have ordered, installed or deployed:

- More than 1,000 fuel cell forklifts
- 58 stationary fuel cell systems totaling 14.916 megawatts (MW) of power
- More than 600 units at telecom sites

Notable savings reported by these companies include:

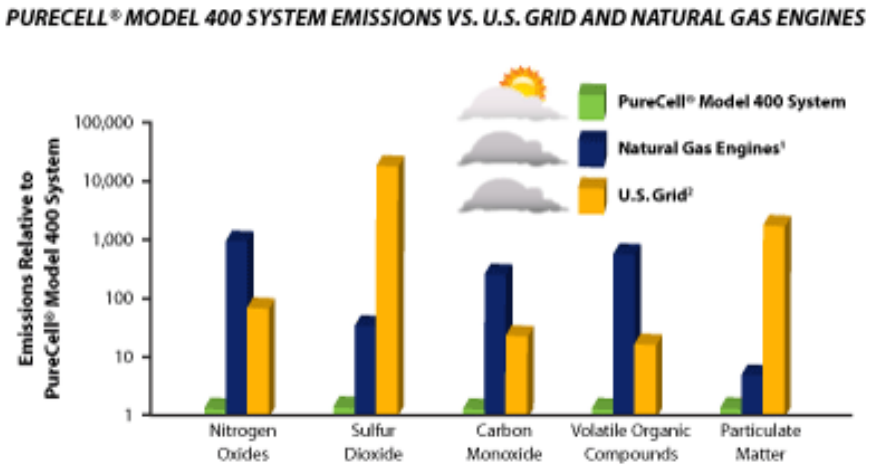
- More than $2 million a year in electricity costs from 4.2 MW of fuel cell power (6 companies aggregate)
- $700,000 a year in labor and insurance cost savings (3 companies aggregate)
- 43,122 tons of carbon emissions per year, roughly the same as removing 8,983 passenger vehicles from the road each year* (20 companies aggregate)
- 35 staff hours/day previously spent on recharging forklift batteries allowing reassignment of 6-7 employees to other work (Nissan North America)

*calculated using U.S. Department of Transportation fuel economy numbers

Green Power

Fuel cells are extremely clean. Since there are typically no combustion related emissions from the fuel cell itself, emissions depend on the choice of fuel. When using pure hydrogen, the emissions are zero. When using natural gas, the emissions are still very low, much lower than fuel combustion. Based on measured data, a fuel cell power plant may create less than one ounce of pollution per 1,000 kilowatt-hours of electricity produced - compared to the 25 pounds of pollutants for conventional combustion generating systems (see Figure 1 from UTC Power).

Figure 1.



Power Quality

Fuel cells generate high quality electricity power which is extremely important for mission critical applications such as banking operations and data centers. These businesses require a power supply that is free of the surges, spikes and outages that can disrupt transaction processing and can cost a company millions of dollars per hour.[1] Fuel cells can deliver this level of computer grade power - analysis of fuel cells operating at a Nebraska bank have shown their system is capable of delivering power at 99.999995% availability[2], while the utility power grid is less than 99% reliable.

[1] A 2005 study by the U.S. Department of Energy (DoE) Lawrence Berkeley National Laboratory estimates $80 billion annual cost of power interruptions; a 2002 study by DoE'sPacific Northwest National Laboratory found electric power interruption costs of about $6.5 million/hr. for brokerage operations and $2.5 million/hr. for credit card operations.

[2] http://www.govenergy.com/2008/pdfs/technology/TierneyTech6.pdf

A fuel cell is an electro-chemical device that combines hydrogen and oxygen electrochemically, with no combustion, to produce electricity. The only byproducts are heat and water. A fuel cell has a structure similar to a battery, but a battery stores electricity, while a fuel cell generates electricity from fuel. The fuel cell does not run down or require recharging. It will produce energy in the form of electricity and heat as long as fuel is supplied.

Fuel cells are being tested and trialed in many applications and are entering early markets:

Portable – military markets, consumer electronics, auxiliary power units

Vehicles – cars, buses, trucks, material handling equipment, shuttles, golf carts, wheelchairs, bicycles, motorcycles, scooters, boats, submarines, airplanes, trains, mining vehicles, military all-terrain vehicles, unmanned vehicles

Power Generation – hospitals, hotels, municipal buildings, breweries, data centers, wastewater treatment plants, schools, police stations, food production facilities, cell phone towers, E-911 towers, airports

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

Reliability

Fuel cells that provide primary power also ensure that a company can operate when other businesses are down due to grid outages. Preventing service disruption is especially important to distribution centers and grocers, who can keep refrigerators and freezers operating to prevent costly food spoilage. Several major grocery chains have recognized these benefits and have installed fuel cell power at retail stores.

Backup Power

With hurricanes and other natural disasters causing power outages and network interruptions, not to mention the ever-growing demand for power, there is an increasing need for more reliable power than is available from the current electric grid or battery backup systems.

Fuel cell systems are being used by major telecommunications companies to provide long-running, primary or backup power for telecom switch nodes, cell towers, and other electronic systems that require reliable, on-site, direct DC power supply. Fuel cells are also extremely durable, providing power in sites that are either hard to access or are subject to inclement weather. With smaller siting requirements than conventional power generators, fuel cell power systems can fit in more locations.

Identification and Characterization of Near-Term Direct Hydrogen Proton Exchange Membrane Fuel Cell Markets, a 2006 study by Battelle for the U.S. Department of Energy (DoE), assessed the market opportunity for fuel cells for backup power for state and local emergency response agencies. The report found that fuel cells offer lower lifecycle costs than batteries for applications less than 5 kilowatts (kW) for extended backup runtimes. Fuel cells offer longer, continuous runtime, have lower maintenance requirements, can be monitored remotely, maintain steady voltage, and are more durable in harsh environments.[3]

Another report, *Switch Signals: Fuel Cells in Distributed Telecom Backup*, a report published by Citigroup, shows that fuel cells are 32% and 35% less expensive than battery backup power solutions based on 10- and 15- year useful life and a five year battery replacement cycle, including tax credits. Without the credits, the fuel cell life cycle costs are 12% and 18% less expensive.

[3] Summary presentation can be found here – http://www.hydrogen.energy.gov/pdfs/review08/fcp_9_mahadevan.pdf

Fuel Cell Benefits

- Increased productivity
- Cost savings via high electrical and overall efficiency
- Fuel flexibility: operation on conventional or renewable fuel
- High quality, reliable power
- Exceptionally low/zero emissions
- Modularity/scalability/ flexible installation
- Not dependent on the power grid
- Silent operation
- Lightweight
- Rugged
- Can be used with or instead of batteries and diesel generators
- Can partner with solar/wind and other renewable technologies
- Fuel flexibility

Fuel cells can use a variety of energy sources, including:

- **Hydrogen**
- **Hydrogen rich fuels -** Hydrogen is separated from these fuels using steam and heat:
  - ***Traditional* -** natural gas, gasoline, diesel, propane, jet fuel
  - ***Renewable* -** methanol, ethanol, landfill gas, biogas, methane, ammonia
- **Renewable energy sources -** water via solar, wind, geothermal electrolysis, algae

Warehouse Operations

Fuel cell forklifts are beginning to be deployed at a rapid pace. Fuel Cells 2000 estimates more than 1,000 have been deployed with many more orders in place for the remainder of 2010 and early 2011. A study by Argonne National Laboratory, *Full Fuel-Cycle Comparison of Forklift Propulsion Systems* estimates that fuel cell lift trucks produce 63% less greenhouse gas emissions than battery systems, but that's not the only savings. Batteries are heavy and take up a lot of storage space while only providing up to 6 hours of run time. Fuel cells last more than twice as long (12-14 hours) and eliminate the need for battery storage and changing rooms, leaving more warehouse space for products. The greatly reduced fueling times, one or two minutes by the forklift operator compared to 20-30 minutes or more for each battery swap, saves the forklift operator valuable time and increases warehouse productivity.

Passenger Vehicles

Fuel cell vehicles provide consumers with the same driving experience as conventional internal combustion engine vehicles, with two to three times more efficiency. In fact, fuel cell passenger vehicles are nearly 60% efficient, much higher than conventional engines, yielding 60 to 70 miles per gallon equivalent. Fuel cell-powered vehicles also offer exceptionally low emissions, with the potential to be the major factor in reducing transportation-related greenhouse gases. Many fuel cell vehicles are already on the road, either in demonstration and testing trials or leasing programs, placed with both individuals and companies, including major corporations like IKEA, FedEx, Hilton Hotels and Coca-Cola. Many of the major automakers, including Honda, Toyota, Daimler, General Motors and Hyundai-Kia have publicly declared 2015 as their fuel cell vehicle commercialization date.

Fuel Cells at Work

Fuel cells are available for purchase today (see the U.S. Fuel Cell Council's Commercially Available Fuel Cell Product list)[4] and the market is steadily growing. An analysis by Fuel Cell Today indicates that approximately 24,000 fuel cell units shipped in 2009, an increase of 41% compared to 2008.[5] Early market applications include fuel cell power for materials handling equipment, backup power, telecommunication towers, data servers, and primary or backup power for retail sites and commercial buildings.

[4] Download the *Commercially Available Fuel Cell Product List* on the U.S. Fuel Cell Council's website: http://www.usfcc.com/resources/outreachproducts.html

[5] Source: Fuel Cell Today

A fuel cell is located where?

- NASDAQ sign in Times Square
- New York Aquarium
- Bronx Zoo
- Los Angeles
- Yale University
- Google Headquarters
- Yellowstone National Park
- Phipps Conservatory and Botanical Garden

Fuel cells have provided power to:

- 2010 Olympic Rings
- 2010 Oscar ceremony
- Trafalgar Square Christmas Tree lights
- California State Capitol Christmas Tree lights
- Drive-in Movie Theater at Tribeca Film Festival
- Cape Henry Lighthouse

The U.S. Postal Service has two fuel cell-powered delivery vans, one in service in Irvine, California and the other in Washington, D.C. that have delivered more than one million pieces of mail since entering service in August 2008 and February 2009, respectively.

In September 2009, General Motors' Project Driveway fuel cell vehicle program surpassed 1 million miles of real world driving.

For a complete listing of fuel cell installations and vehicle demonstrations, please visit http://www.fuelcells.org/info/statedatabase.html (U.S.) or http://www.fuelcells.org/info/databasefront.html (Worldwide)

In several applications, fuel cells are becoming cost-competitive with other power-generating technologies. Where there is a capital cost differential, companies are finding that the equipment's lifetime costs, including operating costs, are much lower than competing technologies. The many benefits that fuel cells provide – low-to-no emissions, lower maintenance costs, high reliability, silent operation, faster fueling, and constant, high-quality, uninterrupted power – also tip the balance in favor of fuel cells. Where there is a large initial price differential, federal, and sometimes state tax credits and grants[6], can help. Fuel cell providers and users say customers can expect a payback of three to five years, sometimes even less, depending on the application, duty cycle, local energy prices, financing structure and other variables.

Once larger fuel cell markets are established, economies of scale in production will allow prices to fall further.

Payback: Profiting from "Greening" Operations

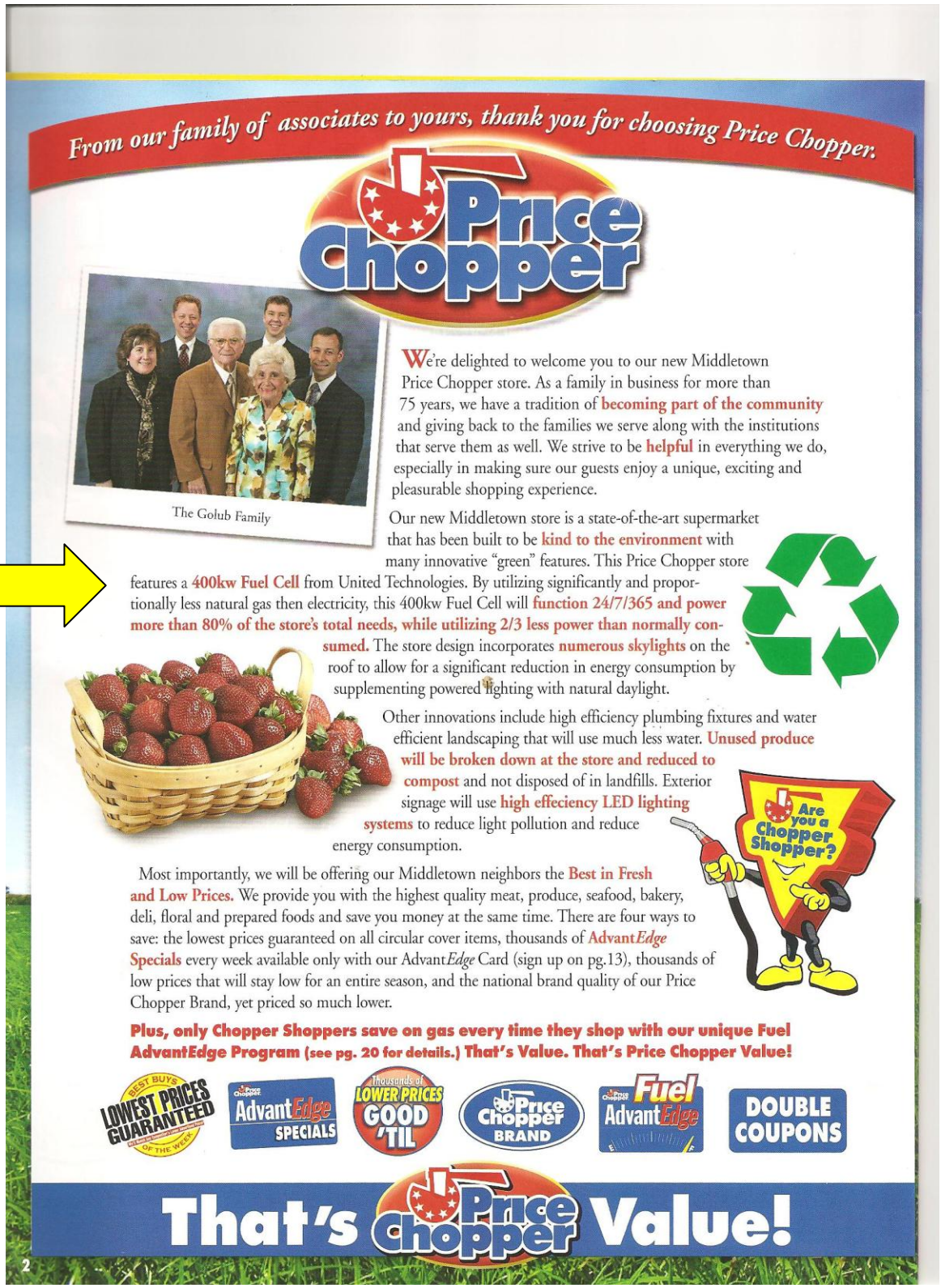
Practicing responsible energy stewardship both through greener products and greener processes benefits the Earth and future generations. It can also deliver benefits to a company's bottom line, with results that are both apparent and measurable. Fuel cell-based sustainability efforts provide rewards through operational cost savings and increased productivity, lower energy costs, greater supplier competitiveness, and increased customer loyalty and attraction. Each has an impact on a company's profitability.

Green technologies can save money – Reducing a company's use of fossil fuels and grid electric power can save money. A survey of nearly 200 retailers by Prenova, Inc. found that 45% consider sustainability a "key component" of their overall business strategy, with 60% saying that cost saving was their primary reason for pursuing sustainable business practices.[7] Fuel cells have shown that they can reduce costs. Fuel cell-powered forklifts, for example, can reduce operational costs and increase productivity through shorter refueling times, smaller infrastructure requirements, longer run times, and greater worker productivity. In power generation, fuel cells reduce dependence on the grid and offer power stability, important to businesses such as

Figure 2: Sheraton San Diego's clean and quiet fuel cells are located next to the hotel's tennis courts

[6] See Fuel Cell 2000's State Fuel Cell Database to learn about fuel cell and hydrogen policy in your state – grants, low-interest loans, tax credits, and other incentives: www.fuelcells.org/dbs
[7] http://www.energycentral.com/functional/news/news_detail.cfm?did=15894485

Figure 3. Publicizing its green efforts: Price Chopper promotes its fuel cell in this advertisement



data centers where power outage costs are measured in the millions of dollars, or food retailers that can lose refrigerated or frozen foods during power outages. Fuel cell power can also cost less, a lot less where utilities charge extra for power at times of peak demand.

Green companies can retain old customers and attract new ones – Surveys have shown that purchasing decisions of more than two-thirds of respondents are influenced by a company's environmental values,[8] giving a competitive edge to "green" companies. Sheraton San Diego (see Figure 2), which uses a fuel cell system to supply 60% to 80% of its power and supplement the hotel's hot water requirements, says that more than 1,000 rooms were booked over a one year period due to customer interest in the fuel cell system[9], and the company's reputation for environmentally-friendly practices. Price Chopper, a New York based grocery chain, features its fuel cell and new green building in its advertising (see Figure 3).

Green policies may be required when competing for contracts – Walmart is reducing greenhouse gas emissions and is extending this goal beyond its corporate borders, requiring suppliers to reduce their emissions, too. Similarly, Sprint is working toward a goal of having 90% of its suppliers comply with the company's environmental standards by 2017. So far, according to the Prenova survey, only 21% of companies are using renewable sources to meet a portion of their energy needs.[10] By deploying ultra-low emission fuel cells – to power forklifts or cars, to generate electricity, heat, cooling and hot water for buildings, or to provide highly reliable continuous or back-up power – corporations can begin to meet these new "green" requirements and can stand out from their competitors.

Gills Onions promotes how it is generating electricity using onion waste to power its fuel cells

As more companies recognize the opportunities that corporate sustainability offers, fuel cell products on the market now can provide environmental and cost savings, and competitive advantage.

Help is Available: Tax Credits and Funding

Many companies are taking advantage of federal and state grant and credit programs to help offset the initial cost of purchasing a variety of renewable energy technologies, including fuel cell systems. The federal government has made available an Investment Tax Credit (ITC) for businesses that can be applied towards the purchase of fuel cells, such as stationary fuel cells and fuel cells that power forklifts and telecommunications equipment. The tax credit is available through 2016, covering 30% of fuel cell costs, up to $3,000 per kilowatt. The tax credit is also available for 30% of hydrogen infrastructure equipment costs, to a maximum of $200,000. For more information, see the **U.S. Fuel Cell Council's Q&A**.[11] At this writing, Congress is considering changes that would benefit fuel cell customers.

[8] The Business Case for Environmental Sustainability (Green); *A 2009 HPS White Paper by Brett Wills*
[9] http://www.fuelcellenergy.com/files/FCE_SheratonSanDiego_120808LR.pdf
[10] http://www.energycentral.com/functional/news/news_detail.cfm?did=15894485
[11] http://www.usfcc.com/ITC-Tax9-2009.pdf

In addition to the ITC, the federal government, through several of its agencies, has provided funding over the years to support fuel cell system deployment into commercialization. The DoE funds research and development and some system installations. It also runs a Technology Validation program, sponsoring demonstrations to evaluate hydrogen and fuel cell systems for transportation, infrastructure, and electric generation, in real world settings. The U.S. Department of Transportation (DoT) provides some funding to fuel cell buses and the U.S. Department of Defense (DoD), through the branches of the military, is involved in research, development and deployment of fuel cell systems.

The DoD oversaw several fuel cell programs in the 1990s and early 2000s through its U.S. Army Corps of Engineers Engineer Research and Development Center (ERDC) Construction Engineering Research Laboratory (CERL) geared towards moving fuel cells out of the lab and into the field. The PAFC Demonstration Program installed phosphoric acid fuel cells at 30 bases; the PEM Residential Program installed 91 small-scale proton exchange membrane fuel cells at 56 military sites. The Climate Change Rebate Program was a competitive, cost-shared, incentive project that provided up to $1,000 per kW of power plant capacity. Some of the recipients of the Climate Change Rebate Program include Sheraton, Pepperidge Farm, Johnson & Johnson, Verizon and Chevron. DoD's latest program is the PEM Backup Power Demonstration to deploy PEM fuel cell technology at federal facilities. The Defense Logistics Agency (DLA), DoD's combat support agency, one of the largest distribution networks in the world, is deploying fuel cell-powered forklifts at two of its jumbo distribution centers to evaluate the business case, with two additional centers adding fuel cell forklifts in the coming year.

American Recovery and Reinvestment Act

In April 2009, DoE allocated $41.9 million from the American Recovery and Reinvestment Act (ARRA or Recovery Act) for the deployment of nearly 1,000 fuel cell systems for emergency backup power and materials handling. The awards went to many of the companies profiled in this report, including Sprint Communications, FedEx, Sysco and GENCO. The complete list can be found in Appendix 2.

State Funding

Many states also offer tax credits and funding, some through state policy and legislation, such as California with its Self Generation Incentive Program (SGIP), others via development agencies and public benefit funds, like the New York State Energy Research and Development Authority (NYSERDA), Massachusetts Green Energy Fund and the Connecticut Clean Energy Fund (CCEF). These states claim the most fuel cell installations as a result.[12] See our State Fuel Cell and Hydrogen Database[13] for more information on stationary installations, vehicle demonstrations, hydrogen fueling stations as well as policies, tax incentives, initiatives and legislation in the United States.

[12] See State of the States: Fuel Cells in America Report http://www.fuelcells.org/statereport.html
[13] http://www.fuelcells.org/info/statedatabase.html

Companies Profiled in this Report

	Fuel Cell Stationary Power	Fuel Cell Forklifts	Fuel Cell Vehicles
Production, Distribution & Retail			
Production Facilities			
Coca-Cola	√	√	√
Gills Onions	√		
Nestlé Waters		√	
Pepperidge Farm	√		
Sierra Nevada Brewery	√		
Super Store Industries		√	
Bridgestone-Firestone		√	
Nissan North America		√	
Kimberly-Clark		√	
Michelin	√		√
Distribution Facilities			
Martin-Brower		√	
Sysco		√	
United Natural Foods Inc.		√	
U.S. Foodservice		√	
FedEx	√	√	√
UPS	√		√
Retail & Grocery Stores			
Cabela's	√		
IKEA			√
Staples	√		
Walmart	√	√	
Central Grocers		√	
H-E-B		√	
Price Chopper	√		
Safeway	√		
Star Market	√		
Wegmans		√	
Whole Foods Market	√	√	
Telecom			
Sprint	√		
Verizon	√		
Motorola	√		
Hospitality			
Hilton Hotels	√		√
Starwood Hotels and Resorts	√		
Corporate Headquarters & Data Centers			
eBay	√		
First National Bank of Omaha	√		
Fujitsu	√		
Cox Enterprises	√		
Chevron	√		
Cypress Semiconductor	√		

Fuel Cells In Action: Major Companies Are Turning to Fuel Cell Power

Fuel cell forklifts at a Central Grocers warehouse (Ballard Power fuel cells).

Fuel cell power at Deer Park, New York McDonald's (demonstration completed). McDonald's recently purchased a ClearEdge Power fuel cell.

Google has installed Bloom Energy fuel cells to provide power at its headquarters in Mountain View, California

Production, Distribution & Retail

Fuel cells are making an impact in every stage of the industrial process – providing reliable and green electricity to manufacturing, processing and production facilities, powering the forklifts used at distribution and storage warehouses, and providing electricity, heating and cooling to the retail and grocery stores selling the finished product. Some are even using fuel cell cars for deliveries and promotional events. Whatever the application, businesses are finding that fuel cells not only reduce their carbon footprint, but help boost their bottom line.

*In **2008**, a new Whole Foods Market store in Glastonbury, Connecticut, became the first supermarket to generate most of its power onsite with a fuel cell. Other grocery chains have followed suit – Safeway, Star Market, Price Chopper, Stop & Shop, Albertsons and two other Whole Foods – are, or will be, using fuel cells to provide reliable power, hot water and refrigeration to their stores.*

Electricity, Heating and Cooling

Fuel cells can provide primary power, backup power and combined heat and power (CHP) to a facility. Since they can be installed as part of the electric grid, or in parallel to it, fuel cells can provide reliable power without disruption due to grid failure or blackouts. This allows a store to continue its operations, and grocers to keep refrigerators and freezers running to prevent the expensive spoilage of goods.

While fuel cells significantly reduce emissions and are extremely quiet, it's the CHP potential that generally offers the largest financial return for businesses. The byproducts of a fuel cell include useful heat that can be harnessed to provide hot water or space heating to a facility, or run air conditioning systems and refrigeration units. This greatly increases overall energy efficiency: a fuel cell can harness up to 80% or even 90% of the energy in a fuel, while the electricity grid is only about 33% efficient. Stores can generate almost 100% of their hot water needs from an on-site fuel cell.

***1998** - Japanese beer companies Kirin, Asahi and Sapporo install fuel cells at their respective breweries running off the ADG from the brewing effluent.*

***2002** - Füchschen Brewery in Düsseldorf, Germany follows suit.*

***2005** - Sierra Nevada in Chico, California installs four fuel cells.*

***2009** - Erdinger Weißbräu brewery in Erding, Germany installs a fuel cell.*

***2010** - Napa Wine Company in Oakville, California, becomes the first winery to install a fuel cell, generating hydrogen using naturally-occurring bacteria and a small amount of electricity from the wastewater it generates from winemaking and other processes.*

Waste Not, Want Not

Food and beverage processing plants using anaerobic digester processes generate methane gas, which is also called anaerobic digester gas (ADG). It usually is considered to be a renewable fuel since it is an organic waste product. Several fuel cell manufacturers are installing large systems that capture the waste gas that would normally be released into the atmosphere and utilizing it for power at the facility. When installed as CHP systems, the fuel cells are achieving 85% efficiency. UTC Power, one of the two main manufacturers involved in this market (FuelCell Energy being the other one), estimates that fuel cells running on ADG release only 72 pounds of emissions into the environment per year, compared to more than 41,000 pounds of pollutants from the average coal- or oil-fired plant.

Materials Handling

In a warehouse or distribution center, time and space are at a premium. Fuel cell forklifts can lower total logistics cost since they last longer, require minimal refilling and need less maintenance than electric forklifts. Bill Ryan, the vice president and general manager of the material handling division of LiftOne, a division of Carolina Tractor and a material handling dealership, states that the cost of maintaining a fuel cell-powered forklift is about half that of battery forklifts, saving a high-volume location 15% annually.[14]

A Battelle study found that fuel cell forklifts on a lifecycle cost basis require approximately 48% to 50% less investment than battery-powered ones in high-throughput applications. It also showed that while PEM fuel cell-powered forklifts require more capital investment than incumbent alternatives, they provide significant savings in operation and maintenance. The federal government offers a tax credit of $3,000/kW to help offset the initial cost.

Fuel cells also ensure constant power delivery and performance, eliminating the reduction in voltage output that occurs as batteries discharge and the numerous interruptions in current input and output electric forklifts experience due to the frequent starting and stopping during use. Because of the productivity gains and reduced down time, one customer of fuel cell manufacturer Plug Power estimates they could potentially save $200,000 - $250,000 per year on each fuel cell-powered forklift.[15]

Batteries are heavy and provide on average six hours of run time, while fuel cells last more than twice as long (12-14 hours). Warehouses and distribution centers can install their own hydrogen fueling station in house and fuel cell forklifts only take one to two minutes to refuel – *by the forklift operator* – compared to the half hour or longer it takes to change out a battery. This also eliminates the need for battery storage and changing rooms, leaving more warehouse space for products.

Another key advantage that fuel cell forklifts have over battery-powered ones, in relation to the grocery and food distribution industry, is the ability to perform in freezing temperatures. Several companies have purchased fuel cell-forklifts to operate in their freezer facilities.

Finally, on the emissions front, fuel cell forklifts can help companies with their 'green image' - a recent study by Argonne National Laboratory[16] estimates that fuel cell lift trucks produce 63% less greenhouse gases than battery-powered systems.

[14] http://www.dcvelocity.com/articles/20090601technologyreview
[15] http://www.fuelcelltoday.com/media/pdf/events/2009-NHA-Event-Report.pdf
[16] http://www.transportation.anl.gov/pdfs/TA/537.pdf

Production Facilities

Coca-Cola

Fuel Cell Activities:

The Coca-Cola Company has committed to hold its overall worldwide manufacturing carbon emissions flat through 2015 from its 2004 level. Fuel cells are helping Coca-Cola to meet this goal:

- ✓ **Coca-Cola will operate fuel cell forklifts at one of its production centers**
- ✓ **Stationary fuel cells will provide primary power at two of Coca-Cola's production facilities**
- ✓ **A Coca-Cola bottling plant is leasing a fuel cell car from Nissan and Coca-Cola Germany has also demonstrated a fuel cell car from GM/Opel**

Fuel cell forklifts:

- Third party logistics provider, GENCO, has been awarded Recovery Act funding to demonstrate the economic benefits of large fleet conversions of lift trucks from batteries to fuel cell power. A Coca-Cola bottling facility is one of five locations where GENCO will deploy the technology.
  - The nation's second largest Coca-Cola bottler is installing 40 Class-1 sit down counterbalanced fuel cell-powered forklifts at its Charlotte, North Carolina production center in 2010.

Fuel cell vehicles:

- Coca-Cola's Sacramento bottling facility is leasing a Nissan X-Trail Fuel Cell Vehicle (FCV).
- Coca-Cola Germany is participating in a project with GM/Opel and Berlin's Clean Energy Partnership project to demonstrate a HydroGen4 fuel cell vehicle in real-world applications.

Fuel cell combined heat and power:

- Coca-Cola will operate two 400-kW UTC Power PureCell® fuel cell systems that will provide on-site electricity and heat for Coca-Cola Enterprises' production facility in Elmsford, New York.
  - Together, the fuel cells will generate enough energy and heat for 30% of the facility's overall operational needs and will serve as a backup source of power in the case of a utility power outage.
  - NYSERDA is providing $2 million for the project.

Fuel cell primary power:

- Coca-Cola will test fuel cells powered by biogas to power its Odwalla juice packaging plant in Dinuba, California. Five Bloom Energy

	Server fuel cells will be installed in late 2010 to provide 30% of the plant's power needs.
What Coca-Cola is saying about fuel cells:	**Fuel cell forklifts:** *"With these fuel cell materials handling units, we will be able to maintain productivity, decrease operating costs and lower greenhouse gas emissions by 30%. We assessed many different technologies for our materials handling fleet and believe the Plug Power fuel cell units give us the best overall solution."* – **Lauren C. Steele, Spokesman, Coca-Cola Consolidated** [17] **Fuel cell vehicles:** *"We are delighted to have this opportunity to team up with Nissan to employ zero-emissions technology in a real life business setting."* **– Don Quinn, Director of Operations, Sacramento Coca-Cola** [18] *"This is a big step in furthering our commitment to environmental sustainability. We are really excited about the promise of fuel cell technology."* **– said Bob Brown, executive vice president of Sacramento Coca-Cola** [19] **Fuel cell combined heat and power:** *"At Coca-Cola Enterprises, corporate responsibility and sustainability are integral to our overall business strategy. The fuel cell systems at our Elmsford facility will help us further our environmental commitment to our local communities, reducing our carbon footprint and our use of the local power grid."* **– Ron Lewis, Vice President of Supply Chain, Coca-Cola** [20] **Fuel cell primary power:** *"This new fuel cell technology has great promise and represents an important step for Coca-Cola in continuing to grow our business without growing the carbon footprint. The Coca-Cola Company has committed to hold its overall worldwide manufacturing carbon emissions flat through 2015 from its 2004 level. We intend to do this while actually reducing emissions in the U.S. and other developed markets, improving energy efficiency and using cleaner forms of energy, like these fuel cells."* **– Brian Kelley, President and General Manager, Coca-Cola North America Still Beverages and Supply Chain** [21]
Benefits:	**Emissions benefits:** **Fuel cell primary power:** • The Odwalla bottling plant fuel cells, which will run on re-directed

[17] http://www.plugpower.com/newsroom/pressreleases.aspx?action=details&newsid=299
[18] http://www.prnewswire.com/news-releases/nissan-announces-first-fuel-cell-vehicle-lease-in-north-america-coca-cola-zeror-x-trail-fcv-promotes-zero-emissions-72576897.html
[19] http://www.motortrend.com/features/newswire/47894/index.html#ixzz0sMf5bop5
[20] http://www.utcpower.com/fs/com/Attachments/PR_070109.pdf
[21] http://www.thecoca-colacompany.com/presscenter/nr_20100224_odwalla_bloom_energy.html

	biogas, are expected to provide 30% of the plant's power needs while reducing its carbon footprint by an estimated 35%, which is over 5 million pounds of carbon dioxide (CO_2) annually.[22] [23]
Sacramento Coca Cola's Nissan Fuel Cell Vehicle [24]	

[22] http://www.thecoca-colacompany.com/presscenter/nr_20100224_odwalla_bloom_energy.html
[23] http://www.bloomenergy.com/customers/customer-story-coke
[24] http://www.prnewswire.com/news-releases/nissan-announces-first-fuel-cell-vehicle-lease-in-north-america-coca-cola-zeror-x-trail-fcv-promotes-zero-emissions-72576897.html

Gills Onions

Fuel Cell Activities:

Gills Onions promotes the concept of "Waste Not, Want Not." Here is how they are living this creed:

✓ **Gills Onions uses a stationary fuel cell in its Waste-To-Energy recovery system**

- Gills Onions generates up to 300,000 lbs. of waste per day. 75% is expressed as juice and the other 25% is compressed and sold as high-value cattle feed.
- In 2009, Gills Onions installed an Advanced Energy Recovery System (AERS) that extracts juice from the onion waste, converts it to biogas via anaerobic digestion, and then conditions it for use in two FuelCell Energy 300-kW fuel cells. The fuel cells provide 100% ultra-clean, 24/7, baseload power for the processing facility.
- Project cost was $10.8 million, with an estimated payback on investment of less than six years. Gills received assistance in financing the installation:
  - $2.7 million ($4,500 per kW) from California's SGIP
  - $499,000 grant from California Energy Commission
  - $2 million from federal ITC
- The Gas Technology Institute (GTI) has been awarded $106,000 from the California Energy Commission (CEC) to study the biogas produced at Gills Onions.
- Awards that Gills Onions has received for the Advanced Energy Recovery System/Sustainability:
  - American Council of Engineering Companies (ACEC) 2010 Golden State Engineering Excellence Award (the highest honor of an engineering achievement in the state of California) and the ACEC's National 2010 Grand Conceptor Award
  - Green Summit Award, 2010 Winner in the Category of Waste Management
  - GEELA Governor's Environmental and Economic Leadership Award, 2009 Recipient
  - McDonald's 2010 Best of Sustainability Supply Chain, won in the categories of Climate/energy and waste management
  - Energy Solutions Center 2009, Partnership Award for Innovation Energy Solutions
  - Cool Planet Project, 2008
  - Food Plant of the Year 2010
  - Pacific Coast Business Times 2009 Company of the Year

What Gills Onions is saying about fuel cells:	*"Gills is now able to 'peak shave'[25] its electrical demand when rates are highest. Also they will significantly reduce standby charges, generating impressive savings and a quick payback on the project"* **– Bill Deaton, AERS Project Manager, Gills Onions**
Benefits:	**Emissions, cost and electricity savings[26]:** ➢ Estimated annual savings of $700,000 in electricity costs (the company spends $120,000 to $160,000 a month on electricity, mostly for air conditioning). ➢ Annual savings of $450,000 on labor, diesel and insurance immediately saved from eliminating the application of the onion waste. ➢ Eliminates up to 14,500 tons of CO_2 equivalent emissions per year.
Top: Two FuelCell Energy fuel cells at Gills Onions ***Bottom: One of Gills Onions fuel cells*** ***Page 18 top: Biogas conditioning and Anaerobic digester at Gills Onions*** ***Page 18 bottom: Onion waste***	 

[25] To understand "peak shaving", see http://www.energy.ca.gov/distgen/background/peak_shaving.html
[26] http://www.gillsonions.com/media/newsletters/issue_51.pdf

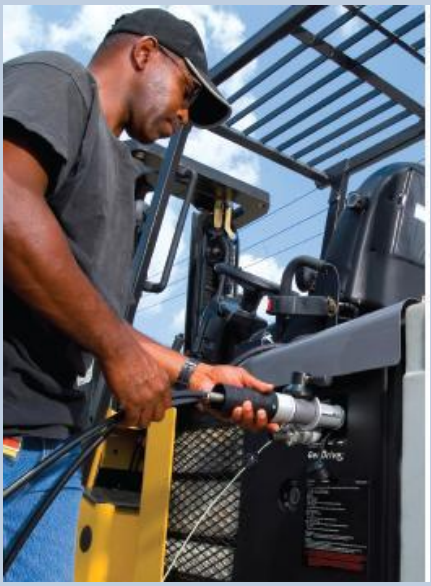
Nestlé Waters

Fuel Cell Activities:	**Nestlé Waters is committed to reducing water use, energy use, and emissions across the organization. Here is one way the company is meeting this goal:** ✓ **Nestlé Waters is replacing an entire materials handling fleet at one facility with fuel cell-powered lift trucks** • Nestlé Waters has replaced its entire sit-down counterbalanced lift truck fleet at its Dallas, Texas bottling facility with a new fleet of 32 Yale electric lift trucks powered by Plug Power GenDrive™ fuel cell units.
What Nestlé Waters is saying about fuel cells:	*"This project is consistent with our commitment to environmental stewardship and sustainable 'green' solutions for which Nestlé Waters North America, Inc. aspires. We look forward to this site proving the viability of future conversions."* **– Christopher Lyon, Process Improvement Manager, Nestlé Waters Fleet Services** [27]
Benefits:	**Efficiency and emissions savings:** • Both fuel cells and lead-acid batteries were evaluated as potential replacements for Nestlé Waters' fleet power source. The GenDrive fuel cell power units allowed them to make the full site conversion without incurring heavy labor and equipment costs associated with buying, storing, maintaining and charging batteries. • The fuel cells have given Nestlé Waters lower operational costs and increased worker productivity over traditional lead-acid batteries. ➢ The fuel cell units can be refueled in as little as three minutes ➢ More time is spent on the floor moving product, less time is spent swapping batteries • The fuel cells have eliminated exhaust emission issues associated with internal combustion engines.

[27] http://www.plugpower.com/userfiles/file/NestleWaters_WebPDF.pdf

Top: ***Lift trucks being refueled and in operation at Nestlé Waters' Dallas bottling facility*** [28]

Bottom: ***Nestlé Waters' hydrogen fueling station by Air Products*** [29]



[28] http://www.plugpower.com/userfiles/file/NestleWaters_WebPDF.pdf
[29] http://www.airproducts.com/Products/MerchantGases/HydrogenEnergy/Projects/MaterialHandlingProjects.htm

Pepperidge Farm

Fuel Cell Activities:	**Pepperidge Farm, and its parent company, Campbell Soup, have a commitment to environmental sustainability. Pepperidge Farm is leading the way with its large-scale stationary fuel cell installation:** ✓ **Pepperidge Farm has deployed more than 1.4 MW of fuel cell power at its Connecticut bakery** • In 2006, Pepperidge Farms installed a 250-kW FuelCell Energy fuel cell at its Bloomfield, Connecticut plant. The fuel cell supplies about 13% of the total electrical needs for the 260,000-square foot (sq. ft.) plant. • In 2008, Pepperidge Farms installed a second, larger, 1.2- MW fuel cell, also manufactured by FuelCell Energy, which supplies about 57% of the total electrical needs for the bakery. Together, the two fuel cells provide about 70% of the required electricity and generate onsite electricity 24/7. • The project cost was $6 million. Pepperidge Farm received: ➢ $3.5 million from Connecticut Clean Energy Fund (CCEF) ➢ $500,000 from the DoD Climate Change Rebate Project
What Pepperidge Farm is saying about fuel cells:	*"We are already seeing the benefits of this investment in our bakery, and it supports the clean energy goals of both our home state of Connecticut and our parent Campbell Soup."* **– Robert Furbee, Senior Vice President, Operations, Pepperidge Farm** [30]
Benefits:	**Emissions and efficiency savings:** • Emissions avoided (in lbs):[31] ➢ CO_2 - 11.4 million ➢ CO - 7,511 ➢ NO_x - 5,990 ➢ SO_2 - 23,206 • Excess heat from the larger fuel cell is channeled to support bakery processes, which helps to reduce the amount of fuel needed for plant boilers.

[30] http://www.ct-si.org/news/press/item.html?id=4082

[31] http://www.ctcleanenergy.com/YourBusinessorInstitution/CommercialInstallations/ManufacturingInstallations/PepperidgeFarms/tabid/462/Default.aspx

Fuel cells power Pepperidge Farms' Bloomfield, Connecticut bakery

Sierra Nevada Brewery

Fuel Cell Activities:	**Sierra Nevada Brewery is committed to energy efficiency and reducing the company's environmental impacts. The company evaluated many alternatives and chose to embrace fuel cells:** ✓ **Sierra Nevada has installed 1.2 MWs of stationary fuel cell power at its California brewery** • In 2005, Sierra Nevada installed four 300-kW co-generation fuel cell systems at its Chico, California, brewery to supply electric power and heat to the brewery. • Each fuel cell is capable of blending biogas with natural gas. Biogas is currently being collected and fed into Sierra Nevada's boilers to offset the natural gas required to run the systems. The company's long term goal is to have only the biogas running in the fuel cells. • Total project cost: $7 million. Sierra Nevada received: ➢ $2.4 million (40% of funding) from California's SGIP ➢ $1 million from the DoD Climate Change Rebate Project ➢ 15% from the ITC • Combined with the 1.9 MW of solar electricity arrays installed on the Sierra Nevada campus, the brewery produces enough electrical power to provide 100% of its power needed during peak times of the year and about 80 to 85% of the power needed all year long. • Named one of 12 "Top Plants" worldwide by *Power Magazine* in 2006. • Named 2009 Sustainable Plant of the Year by *Food Engineering Magazine.*
What Sierra Nevada Brewery is saying about fuel cells:	*"... Sierra Nevada is very close now to being energy independent."* **– Sierra Nevada founder Ken Grossman** *"The fuel cell power plant provides us with reliable, 24/7 electricity and helps make our energy self-sufficiency a reality."* **– Sierra Nevada founder Ken Grossman**
Benefits:	**Emissions, efficiency and cost savings:** • Sierra Nevada's decision to use fuel cell power was based on dramatically lower emissions than conventional power generation, minimal electrical line transmission loss, and the ability to co-generate and use the waste heat in its brewing process: ➢ Overall energy efficiency is double that of grid-supplied power ➢ Air emissions are significantly reduced ➢ Gas produced in the digester reduces the amount of fuel used in the power plant. Using ADG reduces the company's fuel costs by

25 to 40%

- The company saves $400,000 a year in electricity costs[32]
- When the fuel cells generate more power than the brewery requires, Sierra Nevada can send excess electricity back to the grid system and receives credit for a portion of its generation costs

Top: Sierra Nevada's four 300-kW fuel cell installation – a total of 1 MW of power [33]

Bottom: Closer look at fuel cell

[32] http://www.chpcentermw.org/rac_profiles/pacific/SierraBrewery_v1_2.pdf
[33] http://www.sierranevada.com/environment/fuelcells.html

Super Store Industries

Fuel Cell Activities:	**Manufacturer and distributor Super Store Industries (SSI) believes it is possible to be economically profitable while still being environmentally friendly. One of their sustainable projects involves fuel cells:** ✓ **SSI has deployed fuel cell forklifts operating in a warehouse freezer** • In 2009, SSI began to commercially deploy Oorja Protonic's methanol fuel cells (OorjaPac) for the material handling fleet operating at its Lathrop, California facility's freezer to increase efficiency. • Less than six months later, SSI ordered additional Oorja fuel cells for the facility, converting a significant portion of the facility's materials handling vehicles to fuel cell power.
What Super Store Industries is saying about fuel cells:	*"The cost and productivity savings that we have gained have been so significant that we have already converted a large number of our material handling vehicles, even in this economy. As OorjaPac takes less than one minute to refuel and supplies enough power for an entire shift, this greatly impacts our 24/7, 365-day operation."* **– Tom Hughes, Warehouse Manager, Super Store Industries** [34]
Benefits:	Efficiency benefits: • OorjaPac has substantially reduced the vehicle and labor downtime due to vehicle battery pack charging and swapping. This results in: ➢ optimized operational productivity ➢ increased runtime for batteries on a single charge ➢ ultimately minimizing the need to purchase multiple batteries per vehicle ➢ eliminating multiple battery swaps throughout a full day of operation

[34] http://www.oorjaprotonics.com/oorja/docs/yahoo%20finance.pdf

Bridgestone-Firestone North American Tire

Fuel Cell Activities:	**Bridgestone-Firestone North American Tire's (BFNT) concern for the environment in material selection, production processes and logistics continually improves the company's environmental performance. One project that reflects this:** ✓ **Bridgestone-Firestone has replaced its battery-powered forklift fleet with fuel cell-powered units in one of the company's plants** • The Aiken County, South Carolina plant replaced 23 forklifts in 2008 and 20 in 2009 to use Plug Power fuel cells and create an all-hydrogen fleet. • The project expands on a previous BFNT demonstration operating fuel cell-powered material handling equipment at its Warren County, Tennessee manufacturing plant.
What Bridgestone-Firestone is saying about fuel cells:	*"We are very excited about this new green initiative. This is a natural step for a technology-focused company like Bridgestone. Using this cutting-edge technology in a practical way helps our teammates and plant visitors get familiar with this clean, alternative energy. We're proud to be among the first in the neighborhood to use this green, clean fuel in our material movers."* **– Mike Rose, Plant Manager, Bridgestone-Firestone** [35] *"The fuel cells are a direct replacement that last longer than batteries, take less time to change or refuel and only emit water vapor."* **– Mike Rose, Plant Manager, Bridgestone-Firestone** [36]
Benefits:	**Efficiency savings:** • Bridgestone-Firestone's current hydrogen-powered vehicles run two to three times as long and take one-fourth of the time to refuel compared with battery-powered vehicles. [37]

[35] http://www.bridgestone-firestone.com/news/news_index.asp?id=2008/080331a
[36] http://www.plugpower.com/newsroom/pressreleases.aspx?action=details&newsid=203
[37] http://www.bridgestone-firestone.com/news/news_index.asp?id=2008/080331a

Nissan North America

Fuel Cell Activities:	**Nissan's environmental goals include lowering CO_2 emissions. Here is how they are achieving this goal:** ✓ **After two successful trials, Nissan North America is deploying 60 fuel cell-powered tugs at an assembly plant** • In 2007, Nissan North America deployed Plug Power's fuel cell-powered lift trucks for a five-month trial at its Smyrna, Tennessee assembly plant to transport vehicle parts in their 5.4 million sq. ft. building. • The Smyrna plant also conducted an 18-month field trial testing fuel cell tugs equipped with Oorja Protonics' methanol fuel cells. • In 2009, following the two demonstrations, Nissan moved forward with the use of fuel cells, leasing 60 fuel cell units from Oorja to retrofit onto their tugs.
What Nissan North America is saying about fuel cells:	*"We love them [Plug Power fuel cell lift trucks]. The performance is great and you don't have to worry about recharging once or twice a shift. These units are simple to operate, easy to refill and, best of all, they're good for the environment."* **– Dennis Sisco, Nissan Forklift Driver, Smyrna, Tennessee Plant** [38] *"The methanol fuel cells* [Oorja Protonics] *have made us more productive by saving us almost 35 hours a day that were spent by employees changing out batteries. There's no changing out of low or dead batteries, which involves a battery technician and 15 to 20 minutes. Now the tug driver can refill the fuel cell in less than one minute and they're on their way."* **– Mark Sorgi, Material Handling Manager, Nissan North America** [39]
Benefits:	**Emissions, efficiency and cost savings:** • The 2007 trials showed that fuel cell-powered units ran 18 hours between refuelings, while batteries ran just 4-6 hours. **Oorja forklifts:** • Nissan has eliminated more than 70 electric battery chargers that use almost 540,000 kilowatt-hours (kWh) of electricity annually, for a net savings of $225,000 a year.[40] • The plant will regain around 35 staff-hours/day spent on recharging batteries and can reassign 6-7 employees to other work.[41]

[38] http://www.ballard.com/files/pdf/Case_Studies/Material_Handling_Case_Study_041510.pdf
[39] http://www.oorjaprotonics.com/oorja/docs/ABC_news.pdf
[40] http://www.oorjaprotonics.com/oorja/docs/SSI.pdf
[41] http://www.oorjaprotonics.com/oorja/docs/ABC_news.pdf

	• The Smyrna assembly plant had been using a fleet of 340 battery-powered forklifts and tugs, storing more than 1,000 of the 2,000 pound batteries in charging racks that occupied 13,000 sq. ft. of space across three charging areas.[42] [43] • The use of fuel cells will cut more than 300 tons of CO_2 emissions.[44]
A Nissan North America employee pumps hydrogen into the forklift's Plug Power fuel cell power pack [45]	

[42] http://www.greencarcongress.com/2009/08/nissan-oorja-20090825.html
[43] http://www.oorjaprotonics.com/oorja/docs/ABC_news.pdf
[44] http://www.oorjaprotonics.com/oorja/docs/ABC_news.pdf
[45] http://www.ballard.com/files/pdf/Case_Studies/Material_Handling_Case_Study_041510.pdf

Kimberly-Clark

Fuel Cell Activities:	**As part of its longstanding commitment to environmental sustainability, Kimberly-Clark is always looking for innovative ways to operate more efficiently and become a more responsible steward of the environment.** **The company has partnered with third-party logistics provider, GENCO Supply Chain Solutions, who continually implements innovation to increase productivity and enhance environmental sustainability. One of these efforts includes:** ✓ **Kimberly-Clark's purchase of hydrogen fuel cell-powered lift trucks for one of its distribution centers** GENCO has been awarded American Recovery and Reinvestment Act funding to demonstrate the economic benefits of converting large fleets of lift trucks from batteries to hydrogen fuel cell power. Kimberly-Clark is one of five companies where GENCO is deploying the technology. ➢ 25 Plug Power GenDrive™ hydrogen fuel cell units will power lift trucks at a 450,000 square foot distribution center in Graniteville, South Carolina that GENCO operates for Kimberly-Clark [46] ➢ GENCO has been operating a two-unit fuel cell pilot program at the same Kimberly-Clark facility[47]
What Kimberly-Clark is saying about fuel cells:	*"Kimberly-Clark continues to explore new ways to increase safety in the workplace and minimize the impact of our operations on the environment. Our pilot at the Graniteville site has been very successful, and we're pleased to be able to partner with GENCO and Plug Power in expanding hydrogen fuel cell technology to the entire lift truck fleet at this facility."* – **Joe DeYoung, Kimberly-Clark distribution operations manager for North American Consumer Products** [48]
Benefits:	**The hydrogen fuel cell powered lift trucks are:** • More environmentally-friendly (exceptionally low emissions). • Safer and more efficient (no battery disposal and less risks to leaks). • Increased productivity (reduced time for refueling and speed is better maintained). • More comfortable and operator-friendly (easier to use and less heat generation).

[46] http://www.genco.com/Press-Releases/2010/100323_GENCO-Purchases-25-Hydrogen-Fuel-Cell-Units.php
[47] http://www.genco.com/Press-Releases/2010/100323_GENCO-Purchases-25-Hydrogen-Fuel-Cell-Units.php
[48] http://www.genco.com/Press-Releases/2010/100323_GENCO-Purchases-25-Hydrogen-Fuel-Cell-Units.php

Fuel cell forklift at Kimberly-Clark

Michelin

Fuel Cell Activities:	**Michelin is committed to enhancing the environmental performance of mobility and more environmentally-friendly products and services. Fuel cells are helping Michelin accomplish these goals:** ✓ **Michelin is powering a tire production plant with fuel cells** ✓ **Michelin demonstrated fuel cell forklifts** ✓ **Michelin developed a fuel cell vehicle** **Fuel cell combined heat and power:** • In 2002, Michelin installed a 250-kW MTU CFC Solutions (now MTU Onsite Energy) HotModule molten carbonate fuel cell (MCFC) in its tire production facility in Karlsruhe, Germany. The fuel cell delivers electrical power and waste heat is used in vulcanizing truck tires (thermal capacity is 180 kW). **Fuel cell forklifts:** • Michelin tested two fuel cell forklifts at its Columbia, South Carolina plant. **Fuel cell power:** • Michelin has developed a 20-kW fuel cell that providing power in an experimental aircraft. The German Aerospace Agency, in collaboration with Airbus and Michelin, have integrated Michelin's fuel cell system into an Airbus A320 research aircraft to provide emergency power for the electric motor pump, the backup hydraulic circuit and the ailerons. **Fuel cell vehicle:** • In 2007, Michelin unveiled its concept FCHV (Fuel Cell Hybrid Vehicle).
What Michelin is saying about fuel cells:	**Fuel cell forklifts:** Michelin is the first customer to accept the new units to evaluate their performance and their capabilities. *"The promise of hydrogen-powered equipment has long been a dream of many of our customers looking to find more environmentally-friendly ways of doing business. Here today that promise has become more of a reality."* **– Bill Ryan, General Manager, LiftOne**
Benefits:	• The fuel cell is located inside the plant and produces very low noise emissions. • Waste heat from MTU's HotModule fuel cell installed at the Michelin tire plant is used to produce process steam for vulcanizing tires. The tire plant operates on a three-shift system, and is therefore in continual need of steam.

Top: ***Fuel cell powering Michelin's tire production facility in Karlsruhe, Germany*** [49]

Bottom: ***Michelin's fuel cell vehicle*** [50]

[49] http://www.fuelcell.no/fc_in_germany_eng.htm
[50] http://jcwinnie.biz/wordpress/?p=2193

Distribution Facilities

Martin-Brower	
Fuel Cell Activities:	**Distributor Martin-Brower is the world's largest distributor of products to the world's largest restaurant company, McDonald's. The company is committed to energy conservation and fuel cells are helping to attain this goal:** ✓ **Martin-Brower is deploying fuel cell forklifts at one of its distribution center** • Oorja Protonics has sold 15 of its fuel cells to power Martin-Brower's Class 3 forklifts in their Stockton, California food distribution facility. The OorjaPac will operate as an on-board battery charger on the vehicles.
What Martin-Brower is saying about fuel cells:	*"Innovation has driven Martin-Brower's operations for nearly 75 years and today it's fueling our commitment to energy conservation. Embracing fuel cells is a natural progression of our plan to green the supply chain for our customers and one that we expect will payback on its investment in less than 11 months."* **– Steve Domokos, Vice President of Martin-Brower's US Operations** [51]
Benefits:	**Efficiency and emissions savings:** • OorjaPac is anticipated to eliminate demand for approximately 338 million watts per hour of electricity from the grid, while also reducing CO_2 emissions by over 1 million pounds each year.

[51] http://www.oorjaprotonics.com/oorja/press_releases/MartinBrower_OOrja_Jun_17_2010_release.pdf

Sysco

Fuel Cell Activities:	**Sysco is reducing its carbon footprint by focusing its efforts throughout the supply chain. One method of accomplishing this is by reducing the pollutants created and the energy consumed by the movement of Sysco's goods. Here's how fuel cells are helping:** ✓ **Sysco is deploying fuel cell-powered forklift fleets at three of its distribution centers** • Sysco Houston has received Recovery Act funding to deploy fuel cell systems as battery replacements for forklifts at a new distribution center in Houston. The entire warehouse fleet - 72 pallet trucks and 26 forklifts – is powered by Plug Power's GenDrive™ hydrogen fuel cell power units. • Third party logistics provider, GENCO, has also been awarded Recovery Act funding to demonstrate the economic benefits of large fleet conversions of lift trucks from batteries to fuel cell power. The Sysco Philadelphia distribution center is one of five locations where GENCO will deploy the technology. Twenty-five Class 2 and 70 Class 3 fuel cell-powered lift trucks will operate at this facility. • Sysco Vancouver is currently testing fuel cells for pallet moving equipment to reduce emissions. • Success at the distribution centers may lead to further fleet conversions at some or all of Sysco's other 169 distribution centers. • Sysco had earlier demonstrated fuel cell-powered Class 3 pallet trucks at distribution centers in Canton, Michigan (30 Class 3 forklifts) and Grand Rapids (11 Class 3 forklifts). The projects were part of a DoD-funded project.
What Sysco is saying about fuel cells:	**Discussing Sysco Houston's fuel cell deployment***: "Sysco is committed to energy and operational efficiency, and consistently strives to find a greener way of doing business. We are proud to introduce our first installation without battery infrastructure for a pallet truck fleet, and hope that this may lead to further conversions at other facilities.***" – Larry Pulliam, Executive Vice President, Foodservice Operations, Sysco** [52]
Benefits:	**Efficiency and Cost Savings:** **Sysco Houston:** • Sysco calculates that it is saving about $24,000 per quarter on labor costs that would have been associated with changing out lead-acid batteries during each shift change. [53]

[52] http://www.marketwatch.com/story/photo-release-advanced-hydrogen-fuel-cell-power-solutions-highlighted-at-inauguration-of-new-sysco-houston-warehouse-2010-06-17?reflink=MW_news_stmp

[53] http://www.energyempowers.gov/post/hydrogen-fuel-cells-sysco.aspx

- This distribution center has improved operator productivity due to elimination of battery degradation and charging time.

Top: ***Forklifts capable of operating in hot or cold conditions are ready for use at a Sysco warehouse in Houston*** [54]

Middle: ***Sysco's Air Products hydrogen fueling station*** [55]***, and Pdc diaphragm hydrogen compressor system supplied to Linde for fork lift application at Sysco Canton*** [56]

Bottom: ***Hydrogen refueling at a Michigan Sysco distribution center*** [57]

[54] http://www.nrel.gov/features/20100603_fuelcell.html
[55] http://www.airproducts.com/Products/MerchantGases/HydrogenEnergy/Projects/MaterialHandlingProjects.htm
[56] http://www.pdcmachines.com/fuel-cell-tech/recent-projects.php
[56] www.imageresourcesgroup.com/MEDIA/SyscoPictures.zip
[57] http://www.waterstofvereniging.nl/_dl/activiteiten/Linde_McGowan_5nov09.pdf

United Natural Foods, Inc. (UNFI)

Fuel Cell Activities:

As part of its culture of social responsibility and its commitment to using clean energy, as well as to improve efficiency, productivity and reliability, UNFI is expanding the use of renewable technologies. Part of this initiative:

- ✓ **UNFI is replacing lead-acid batteries and their associated charging equipment with fuel cells at a distribution center**
- UNFI will use 65 fuel cell-powered lift trucks at its 352,000 sq. ft. Sarasota, Florida, distribution center, which serves as a regional distribution hub for customers in the southeastern United States.
  - ➢ UNFI added 29 new hydrogen fuel cell-powered lift trucks to its fleet and 36 existing lift trucks will be retrofitted to hydrogen fuel cell technology.

What United Natural Foods is saying about fuel cells:

"We consider environmental stewardship an essential component in every facet of our business. This hydrogen fuel cell project is further proof of UNFI's leadership as an environmentally-conscious organization by advancing the use and development of alternative-fuel technologies." **– Steve Spinner, President and Chief Executive Officer, UNFI** [58]

"Hydrogen fuel cells not only provide greater productivity and lower operating costs, but will be an important component of a clean energy future." **– Tom Dziki, Senior Vice President of Sustainable Development, UNFI** [59]

"We're pleased to successfully complete this project, which retrofitted 36 existing lift trucks to hydrogen fuel cell technology and added 29 new hydrogen fuel cell-powered lift trucks to our fleet. We are happy to be pioneering the use of this technology in Florida as hydrogen fuel cells not only provide greater productivity and lower operating costs but will be an important component of a clean energy future." **– Tom Dziki, Senior Vice President of Sustainable Development, UNFI**

Benefits:

Emissions and cost savings:

- This fuel cell project is expected to create annual energy savings of approximately 640,000 kWh.[60]
- By converting UNFI's Sarasota lift truck fleet to hydrogen fuel cells, the company expects carbon emissions will be reduced by approximately 132 metric tons annually, an amount equivalent to the annual emissions of 35 automobiles.[61]

[58] http://www.unfi.com/HydrogenFuelCells_SAR.aspx
[59] http://www.unfi.com/HydrogenFuelCells_SAR.aspx
[60] http://www.unfi.com/HydrogenFuelCells_SAR.aspx
[61] http://www.unfi.com/HydrogenFuelCells_SAR.aspx

U.S. Foodservice

Fuel Cell Activities:	**U.S. Foodservice has an ongoing commitment to conservation. Fuel cells are part of this commitment:** ✓ **US Foodservice has purchased fuel cells to power forklifts at a distribution facility** • U.S. Foodservice-San Francisco purchased 40 Oorja Protonics methanol fuel cells to retrofit onto pallet jacks in its Livermore, California food distribution facility.
What U.S .Foodservice is saying about fuel cells:	*"We are always trying to identify new ways to make every step of the path to the plate as environmentally friendly as possible. Green technology is constantly evolving, providing us with opportunities to optimize our operations while dramatically reducing our impact on the environment. Environmental sustainability and continued economic growth should be a priority for every business."* **– Phil Collins, president of U.S. Foodservice-San Francisco** [62]
Benefits:	**Efficiency and emissions savings:** • U.S. Foodservice expects to save 620,000 kilowatt-hours annually and reduce its carbon emissions by 540,000 pounds. • U.S. Foodservice is also gaining significant operational efficiencies as the fuel cells eliminate the need for a battery swap mid-shift. This translates to an estimated four hours of productivity savings per day or about 920 hours per year, which greatly accelerates the return on investment. • After a month-long trial period, U.S. Foodservice saw demonstrably increased productivity using the methanol fuel cells. With longer charges than traditional batteries, the fuel cells outlast their predecessors, running for a full eight hours, versus an average four to six hours.

[62] http://www.usfoodservice.com/about/media/PR_2010/USF_SF_Fuelcells_07-15-10.pdf

FedEx

Fuel Cell Activities:

FedEx supports the growth of renewable energy use through commitments to use renewable power sources in their operations, use of innovative technologies in their transportation fleet, and diversifying its energy supply whenever possible. Here are several ways fuel cells are helping FedEx meet this commitment:

- ✓ **FedEx has deployed a Bloom Energy fuel cell system to provide power to one of the company's service centers**
- ✓ **FedEx will retrofit fuel cells into an entire fleet of lift trucks at another service center**
- ✓ **A FedEx freight tractor, equipped with a fuel cell-electric hybrid drive, will be tested for one year**
- ✓ **FedEx has also operated a fuel cell-powered GM van that was used in daily delivery service in Tokyo**

Fuel cell forklifts:

- FedEx Freight East will deploy 35 fuel cell systems as battery replacements for a complete fleet of electric lift trucks at an existing FedEx service center in Springfield, Missouri. The fuel cell forklifts will be used in a cross-dock operation, unloading freight from a trailer and moving the freight to another location on the dock.
  - ➢ The project has been partially funded through the Recovery Act
  - ➢ Success at this service center could lead to further fleet conversions at some or all of FedEx's other 470 service centers
- The company had previously demonstrated Hydrogenics' fuel cell-powered forklifts at a FedEx Canada logistics hub at the Toronto International Airport.

Fuel cell primary power:

- FedEx is evaluating Bloom Energy's fuel cell solution to complement a solar power system at its Oakland, California hub. FedEx has installed five 100-kW Bloom Energy Servers at the package sorting facility.

Fuel cell vehicle:

- FedEx teamed with GM to test a fuel cell-powered delivery van for one year (2003-2004). The HydroGen3 was operated under normal delivery schedules in Tokyo, Japan, under demanding, real-world commercial driving conditions.

Fuel cell hybrid freight tractor:

- FedEx Freight will test a tractor powered by a zero emission plug-in

	electric/hydrogen fuel cell hybrid Tyrano™ drive train. The vehicle will be tested for one year in certain operations to evaluate the operational suitability of the technology.
What FedEx is saying about fuel cells:	**Fuel cell primary power:** *"FedEx understands the importance of leading in areas of innovation, such as energy. [Fuel cell manufacturer] Bloom Energy is a pioneer in distributed energy, the concept behind the next paradigm in how industry could be powered."* **– Rob Carter, FedEx Chief Information Officer, FedEx** [63] **Fuel cell forklifts:** *"The vehicles will be emission-free and will provide the benefits of electrical power forklifts without having to plug them in to recharge the battery."* – **Dennis Beal, Vice President of Physical Assets, FedEx Freight** [64] **Fuel cell hybrid freight tractor:** *"It is our goal to be involved in projects such as this to further the advancement of alternative fuels that both reduce our dependence on foreign oil and are good for the environment. We are excited about technological advancements we see today in transportation and look forward to what the future holds in this arena."* **– Douglas G. Duncan, President and CEO, FedEx Freight** [65]
Benefits:	**Emissions, efficiency and cost savings:** **Fuel cell primary power:** • The Oakland package sorting facility project is expected to achieve a return on investment in five years and reduce carbon dioxide emissions by about 30%.[66] **Fuel cell forklifts:** • FedEx expects the change to fuel cell-powered forklifts at the service center will lower maintenance and downtime and increase productivity.[67]

[63] http://www.bloomenergy.com/customers/customer-story-fedex
[64] http://www.energyempowers.gov/post/FedEx-Freight-hydrogen-forklifts-recovery-act.aspx
[65] http://www.businesswire.com/portal/site/home/permalink/?ndmViewId=news_view&newsId=20091116006063&newsLang=en
[66] http://www.bloomenergy.com/customers/customer-story-fedex
[67] http://www.energyempowers.gov/post/FedEx-Freight-hydrogen-forklifts-recovery-act.aspx

Above: ***Bloom Energy fuel cells located at a California FedEx package sorting facility*** [68]

Middle: ***Indoor hydrogen fueling station used to fuel FedEx's fuel cell forklifts*** [69]

Bottom: ***FedEx's fuel cell-powered delivery van from GM***

[68] http://www.bloomenergy.com/customers/customer-story-fedex
[69] 2010 Vehicle Technologies and Hydrogen Programs Annual Merit Review and Peer Evaluation Meeting – ARRAH2009, King, FedEx Freight East: 7B: Fuel Cell-Powered Lift Truck, FedEx Freight Fleet Deployment

UPS

Fuel Cell Activities:

United Parcel Service (UPS) has a strong commitment to environmental stewardship. Fuel cells are helping this effort:

- ✓ **UPS has used fuel cell-powered delivery vans in daily operations**
- ✓ **UPS has tested a fuel cell to provide power at a distribution facility**

Fuel cell power:

- In 2009, UPS completed testing of a first-generation Bloom Energy fuel cell at its Anchorage, Alaska distribution facility.
  - The fuel cell produced more than 300,000 kilowatt-hours of electricity in 2009.

Fuel cell vehicles:

- EPA, DaimlerChrysler and UPS formed a technical partnership to conduct a fuel cell vehicle testing program. Zero-emission fuel cell powered package delivery vehicles were placed in daily commercial service, the first such demonstration in the US. The partners achieved all of the goals of the program and have brought the testing to a successful conclusion.
  - Two fuel cell-powered DaimlerChrysler Sprinter vans were placed in service in 2004, deployed in Long Beach, California, and Ann Arbor, Michigan
  - The Fuel Cell Delivery Vehicle Testing Program accumulated over 12,000 miles

What UPS is saying about fuel cells:

Fuel cell vehicles:

"Test programs showed the on-road reliability of fuel cell vehicles is excellent, equivalent to our current fleet. But what's truly exciting is how fast the technology is progressing. Shifting away from a fossil fuel based economy to a hydrogen economy would be a great environmental and technological achievement. We will continue the rapid application of this technology in hopes that in the near future, we can deploy zero-emission engines across our fleet of 88,000 vehicles." **– Chris Mahoney, UPS Vice President for Transportation Services** [70]

Discussing alternatively-fueled vehicles during an interview on PBS' Frontline: *"My engineers think hydrogen fuel cells are the answer."* – **Bob Stoffel, UPS Senior Vice President of Engineering, Strategy, Supply Chain and Sustainability** [71]

[70] http://msnbc.msn.com/id/5829841
[71] http://www.pressroom.ups.com/About+UPS/UPS+Leadership/Speeches/Bob+Stoffel/Frontline+Interview

Benefits:	**Fuel cell power at the UPS distribution facility:** • CO_2 emissions were reduced by 170 metric tonnes (167.3 tons).[72]
DaimlerChrysler fuel cell-powered delivery van used by UPS [73]	 

[72] http://www.environmentalleader.com/2010/07/27/ups-sustainability-report-sets-goal-to-improve-fuel-efficiency-by-20
[73] http://www.epa.gov/fuelcell/fuelcell2006-000816.pdf

Retail & Grocery Stores

Cabela's	
Fuel Cell Activities:	**Cabela's is a leading specialty retailer, and the world's largest direct marketer, of hunting, fishing, camping and related outdoor merchandise. One way the company is showing its commitment to the environment:** ✓ **Cabela's has installed fuel cells to provide power at one of its largest retail locations** • High electricity rates in the Northeast led Cabela's to investigate alternative energy options. Cabela's installed four UTC Power 200-kW fuel cells (800 kW total) at a newly-constructed store at Rentschler Field in East Hartford, Connecticut. The fuel cells provide 100% of the required building power.
What Cabela's is saying about fuel cells:	*"Our business is based on the responsible use of the outdoors, therefore Cabela's values practical conservation efforts. In addition to the environmental benefits fuels cells have to offer, this opportunity was a practical business decision that provided a return on investment that simply could not be ignored."* – **David Hampton, Corporate Facilities Manager**
Benefits:	**Emissions and cost savings:** • The fuel cell system reduces carbon emissions by 1,800 tons annually, equivalent to planting 380 acres of forest. [74] • The fuel cells reduce nitrogen oxide emissions by 7 tons each year, equivalent to removing 370 cars from the road.[75] • When there is an excess, Cabela's is able to sell electricity back to the grid. • Cabela's entered a 15-year power purchase agreement with UTC Power, locking in a fixed rate for electricity which saves the company money and relieves the heavily strained grid.

[74] http://www.utcpower.com/fs/com/Attachments/PR_092007.pdf
[75] http://www.utcpower.com/fs/com/Attachments/PR_092007.pdf

Fuel cells provide 100% of the power at Cabela's 185,000 sq. ft. retail location in East Hartford, Connecticut [76]

[76] http://www.utcpower.com/fs/com/bin/fs_com_Page/0,11491,0229,00.html

IKEA	
Fuel Cell Activities:	**IKEA has many sustainable initiatives and is planning that all IKEA Group company cars will be "green" by 2010. One way green technology that IKEA is putting on the road:** ✓ **IKEA is operating a fuel cell-powered service vehicle in Germany in partnership with GM** • IKEA has partnered with GM/Opel for the real-world testing of the HydroGen4 fuel cell vehicle. The fuel cell vehicle will be used by the Berlin-Spandau branch of the IKEA furniture store to make service calls to customers. • This is IKEA's second partnership – the company has also tested a GM HydroGen3 fuel cell vehicle from 2005 to 2007.
What IKEA is saying about fuel cells:	*"The frugal and efficient use of energy and resources is one of our core points in our sustainability program. We are very pleased to be able to support Opel in testing this vehicle and, in doing so, do our part in helping to achieve environmentally friendly mobility."* **– Petra Hesser, CEO, IKEA Germany** [77] *"IKEA's basic principle regarding the environment is to keep any environmentally harmful effects in all areas of activity as low as possible. We are therefore very pleased that by using this vehicle for IKEA Spandau service trips, we can contribute to bringing this technology a step closer to day-to-day suitability. We see a great need for environmentally friendly cars. If we are able to use hydrogen as an energy carrier on a large scale in the future, then motoring will be made far more environmentally compatible. IKEA is happy to support this goal."* **– Peter Betzel, Deputy Managing Director, IKEA Germany** [78]
Benefits:	**Emissions and efficiency savings:** • Fuel cell vehicles are not only two-to-three times more efficient than internal combustion engine vehicles, but have zero tailpipe emissions.

[77] http://media.gm.com/content/media/intl/en/news/news_detail.brand_opel.html/content/Pages/news/intl/en/2010/OPEL/05_11_opel_neue_partner

[78] http://archives.media.gm.com/archive/documents/domain_82/docId_15523_pr.html

Top: ***IKEA's GM HydroGen4 fuel cell vehicle***

Bottom: ***IKEA's HydroGen3 fuel cell vehicle***[79]

79 http://media.gm.com/content/media/intl/en/news/news_detail.brand_opel.html/content/Pages/news/intl/en/2010/OPEL/05_11_opel_neue_partner

Staples

Fuel Cell Activities:	**Staples is reducing its energy consumption through conservation and the use of energy efficient technologies and supports the development of renewable energy technologies to reduce greenhouse gas emissions. One way Staples is doing this:** ✓ **Staples has demonstrated fuel cell power at a distribution center, and wants to deploy more in the future** • Staples has been an early demonstrator of fuel cell technology. A 300-kW Bloom Energy fuel cell, installed in December 2008, provided power at Staples' Ontario, California Distribution Center. ➢ In the first year alone, the project generated over 2 million kilowatt-hours (kWh) of power with availability above 99% ➢ Staples is considering ways that Bloom can play a bigger part in providing power to their large facilities and distribution centers
What Staples is saying about fuel cells:	*"The business decision becomes easy when you find a truly reliable, clean, and affordable solution, and Bloom Energy has delivered all three."* **– Mark Buckley, Vice President of Environmental Affairs**[80] *"Staples' partnership with Bloom marks an exciting next step in our ongoing commitment to environmental leadership. Through our relationship with energy leaders like Bloom, Staples is not only able to reduce our operating costs but we are reducing our environmental footprint in the local communities in which we operate."* **– Mark Buckley, Vice President of Environmental Affairs** [81]
Benefits:	**Emissions savings:** • The fuel cell resulted in a reduction of 2.5 million pounds of carbon dioxide during the first year of operation. [82]
Fuel cells power a Staples distribution center [83]	

[80] http://www.bloomenergy.com/customers/customer-story-staples
[81] http://www.bloomenergy.com/customers/customer-story-staples
[82] http://www.bloomenergy.com/customers/customer-story-staples
[83] http://www.bloomenergy.com/customers/customer-story-staples

Walmart

Fuel Cell Activities:

Walmart's environmental goals include being supplied 100% by renewable energy and creating zero waste. Fuel cells are helping Walmart accomplish this:

- ✓ **Walmart is deploying fuel cell-powered pallet trucks and lift trucks at several distribution centers**
- ✓ **Fuel cells have provided primary power at two Walmart retail sites**

Fuel cell-powered pallet trucks and lift trucks:

- Walmart participated in alpha field trials of four fuel cell-powered pallet trucks for two weeks in 2005, demonstrating the vehicles at a Walmart food distribution center in Missouri. The pallet jacks used Cellex[84] fuel cell power units powered by Ballard fuel cell stacks.
- Walmart continued to support the Cellex/Ballard beta field trials of 12 fuel cell-powered pallet trucks over a four-month period in 2006 at two Walmart distribution centers in Ohio.
  - The trucks were in continuous operation and logged more than 18,500 hours of operation
  - 2,100 indoor hydrogen fuelings took place
  - The high pressure fuelings were performed by the pallet operators using a quick connect nozzle, each fueling took less than two minutes
  - The indoor hydrogen dispensing system required just 200 sq. ft. of warehouse space, vs. the 4,000 sq. ft. of warehouse space required for a lead-acid battery room
- In 2007 Walmart ordered 55 Class 3 Plug Power GenDrive™ fuel cell-powered pallet trucks for commercial service at its food distribution center in Washington Court House, Ohio. The fuel cells replaced lead-acid battery units.
- Walmart Canada is investing in its first sustainable refrigerated distribution center, which is anticipated to open in Balzac, Alberta, in the fall of 2010. The cutting-edge distribution center will be one of the most energy-efficient distribution facilities of its kind in North America – an estimated 60% more energy-efficient than Walmart's traditional refrigerated distribution centers.
  - The center will include a pilot project of fuel cell technology - 60 to 75 lift trucks powered by fuel cells from Crown Equipment, Plug Power and Ballard Power Systems. The lift truck fleet will be the first in Canada to be powered entirely by fuel cells.

[84] In 2007, Cellex Power Products was acquired by Plug Power.

	➢ The Plug Power GenDrive™ freezer lift truck units will operate in conditions as low as -20°F (-29°C) **Fuel cell primary power at Walmart retail locations:** • Walmart has been seeking an energy solution that could make a major contribution to their greenhouse gas targets while contributing to lower costs, and providing the potential to supply continuous power to stores even during critical grid outages. The company chose two 400-kW Bloom Energy systems to provide power at two southern California Walmart retail locations.
What Walmart is saying about fuel cells:	**Fuel cell pallet trucks and lift trucks:** *"Cellex's fuel cell power units provided us the opportunity to gain insight into the potential of fuel cell power. We were impressed with the operational benefits. Working with Cellex enables Walmart to forge ahead on its environmental leadership by embracing new technologies such as fuel cells."* **– Rollin Ford, Executive Vice President of Logistics and Supply Chain, Walmart** [85] *"We've seen how fuel cells can improve efficiency in our distribution centers while enabling us to be more responsible global citizens."* **– Johnnie Dobbs, Executive Vice President of Logistics and Supply Chain, Walmart** [86] *"We really put these Cellex-powered vehicles to the test in our pallet truck applications and they did the job. Our pallet truck operators were most pleased with their performance and the ease of use. We now understand that operationally this new technology can be utilized in this application."* **– Johnnie Dobbs, Executive Vice President of Logistics and Supply Chain, Walmart** [87] **Fuel cell primary power:** *"At Walmart, our goal is to be supplied by 100% renewable energy. To do this, we are considering a number of emerging technologies, including Bloom Energy [fuel cells], to ensure they work for our business, help lower costs for our customers, and reduce our impact on the environment. We hope to use our scale to help bring these technologies to market in a fast and cost effective way."* **– Bill Simon, Chief Operating Officer, Walmart U.S.** [88]
Benefits:	**Emissions and cost savings:** **Fuel cell forklifts:** • Greenhouse gas and carbon dioxide (CO_2) emissions have been reduced noticeably – Walmart's commercial purchase of fuel cell-

[85] http://walmartstores.com/pressroom/news/5300.aspx
[86] http://www.ballard.com/files/pdf/Case_Studies/Material_Handling_Case_Study_041510.pdf
[87] http://findarticles.com/p/articles/mi_m0FZX/is_4_73/ai_n19041535
[88] http://www.businesswire.com/portal/site/home/email/headlines/?ndmViewId=news_view&newsLang=en&div=-564504432&newsId=20100224005647

powered forklift units to date [4/15/2010] is equivalent to removing of approximately 60 cars from Ohio roads.[89]

- Walmart's planned Balzac distribution center will use hydrogen that is trucked from Quebec to Alberta about every two weeks. The savings are anticipated to outweigh transportation costs: *"With fuel cells, we won't need a battery area and can eliminate the associated electrical wiring."*[90]

➢ The Walmart Canada distribution center fuel cells will cut GHGs by 1.2 million pounds and save $2 million in operating costs over seven years.[91]

Top: ***Bloom Energy fuel cells providing stationary power at a Walmart retail location in California*** [92]

Middle: ***Fueling equipment at Walmart's Washington Courthouse distribution center*** [93]

Bottom: ***Pdc diaphragm hydrogen compression system supplied to Linde for fork lift application at Walmart*** [94]

[89] http://www.ballard.com/files/pdf/Case_Studies/Material_Handling_Case_Study_041510.pdf
[90] http://mhmonline.com/green-material/leading-change-0410
[91] http://mhmonline.com/green-material/leading-change-0410
[92] http://www.bloomenergy.com/customers/customer-story-walmart
[93] http://www.waterstofvereniging.nl/_dl/activiteiten/Linde_McGowan_5nov09.pdf
[94] http://www.pdcmachines.com/fuel-cell-tech/recent-projects.php

Central Grocers

Fuel Cell Activities:	**Central Grocers wanted to ensure maximum productivity in its new, 934,340 sq. ft. Joliet, Illinois Greenfield distribution center. One way it is accomplishing this:**
	
	✓ **Central Grocers is deploying 220 fuel cell-powered pallet trucks at a new distribution center**
	
	• In 2008, Central Grocers placed a commercial order for 220 Plug Power fuel cells to power its Joliet, Illinois distribution center's entire pallet truck fleet.
	  ➢ 140 Class 3 Plug Power GenDrive™ power units (115 GD-3M24-390 and 25 GD-3M24-310F "Freezer" units) were deployed in Yale lift trucks in 2008
	  ➢ An additional 80 Class 2 GenDrive fuel cell power units are being supplied in 2010
	  ➢ Central Grocers retired 170 battery-powered forklifts

What Central Grocers is saying about fuel cells:	*"Hydrogen fuel cells run longer, don't lose power as they operate and are refueled more quickly than batteries."* **– Jim Denges, CEO, Central Grocers** [95] **CEO Jim Denges has also said that** *fuel cell forklifts are more expensive in up-front costs, but will pay for themselves through higher efficiency and being better for the environment.*[96]
Benefits:	**Efficiency and cost savings:** • Central Grocers chose fuel cells over lead-acid batteries – the decision was made prior to building the distribution center, eliminating the need to build an electric changing and charging infrastructure, reducing capital investment and opening up valuable floor space within the distribution center.

[95] http://www.plugpower.com/userfiles/file/CentralGrocers_WebPDF.pdf
[96] http://www.willcountyced.com/Public_Documents/Central%20Grocers%20Inc%20headquarters%20open.pdf

Top: ***Central Grocers uses 140 Plug Power Class 3 GenDrive™ power units at their Joliet, Illinois distribution center's freezer*** [97] [98]

Bottom: ***Central Grocers' hydrogen fueling station by Air Products*** [99]

[97] http://www.plugpower.com/blog/post/2009/04/02/Plug-Power-participates-in-Central-Grocers-grand-opening.aspx
[98] http://www.h2andyou.org/forkliftsGrocers.pdf
[99] http://www.airproducts.com/Products/MerchantGases/HydrogenEnergy/Projects/MaterialHandlingProjects.htm

H-E-B

Fuel Cell Activities:	**H-E-Butt Groceries (H-E-B) is committed to business strategies that continually improve their use of natural resources, minimize waste, conserve energy and water, and protect air quality. One way they are meeting this commitment:** ✓ **H-E-B has deployed 14 fuel cell-powered reach trucks at a distribution center** • H-E-B has deployed 14 Nuvera PowerEdge™ fuel cell systems for Class 2 reach trucks, along with a PowerTap™ Hydrogen Generator and Hydrogen Station at in San Antonio, Texas San Antonio Perishables Distribution Center. Funding was provided to Nuvera from the Recovery Act. • The project will enable H-E-B to validate lifecycle cost projections, productivity gains, and environmental benefits of the fuel cell forklifts and fueling infrastructure.
Benefits:	**Emissions savings:** • Carbon emissions are expected to decline – it is anticipated that each battery-powered reach truck will be emitting 38% more CO_2 from charging batteries from the Texas grid as compared to reach trucks powered by hydrogen that is generated onsite from natural gas.[100]
H-E-B's forklifts and fueling station [101]	 

[100] http://www.nuvera.com/blog/?p=724

Price Chopper

Fuel Cell Activities:	**Price Chopper is actively seeking to be an environmental leader in the supermarket business. One way they are doing this:**
	
	✓ **Price Chopper is powering a retail store with a fuel cell**
	
	• Price Chopper's recently opened retail store in Colonie, New York is a showcase for many innovations, including a fuel cell.
	  ➢ Price Chopper looked into the use of fuel cell power in 2007 when electricity rates rose in the northeastern U.S.
	  ➢ The new Colonie store supplies its own power on-site using a UTC Power PureCell Model 400 fuel cell system. This fuel cell system is capable of providing 400 kW of standby power if there is a grid failure, enabling the store to operate without disruption.
	  ➢ Waste heat generated during fuel cell operation is used to heat reception areas and sidewalks
	  ➢ Price Chopper partnered on the project with NYSERDA, who provided incentives through the New Construction and Combined Heat and Power Demonstration programs
	• The company is planning to install a fuel cell at a second Price Chopper store.

What Price Chopper is saying about fuel cells:	*"After meeting with the UTC folks, we decided to go with a fuel cell since a combined heat and power system is more efficient and had a positive cash flow. We're producing at a much more effective cost due to the combined heat and power."* **– Benny Smith, Vice President of Facilities for Golub Corp., which owns Price Chopper** [102] *"The UTC Power fuel cell technology serves as both a primary and emergency power source at our 69,000-sq. ft. Colonie store location. With our ongoing goals of achieving greater efficiencies at our stores, we fully expect the fuel cell unit to reduce our overall utility costs as well as the store's carbon footprint."* **– Benny Smith, Vice President of Facilities for Golub Corp., which owns Price Chopper** [103]

[102] http://www.prnewswire.com/news-releases/price-chopper-supermarket-first-to-power-store-with-400-kilowatt-fuel-cell-unit-82247472.html
[103] http://www.prnewswire.com/news-releases/price-chopper-supermarket-first-to-power-store-with-400-kilowatt-fuel-cell-unit-82247472.html

Benefits:	**Efficiency and cost savings:** • The fuel cell will keep the store operational during a power outage. **Benny Smith states that**, "a big benefit is that it will help maintain our refrigeration in the store so people can keep shopping." [104] • The store anticipates reducing energy costs by 27%, saving the Price Chopper store $150,000 per year.[105]
Price Chopper's fuel cell reduces utility costs and the store's carbon footprint [106]	

[104] http://www.prnewswire.com/news-releases/price-chopper-supermarket-first-to-power-store-with-400-kilowatt-fuel-cell-unit-82247472.html
[105] http://blog.timesunion.com/business/nyserda-gave-price-chopper-more-than-315000-for-new-store/20143
[106] http://green.blogs.nytimes.com/2010/01/27/albany-grocery-powered-by-a-fuel-cell

Safeway

Fuel Cell Activities:	**Safeway says that its efforts in leveraging emerging technologies such as fuel cells, coupled with the thoughtful use of natural resources, will allow the company to lead the way on a broad range of green and sustainable initiatives.** ✓ **Safeway has installed two fuel cells to provide power at a retail site** ➢ Safeway has installed two 100-kW Bloom Energy fuel cells at a new, 60,000 sq. ft. retail site in Santa Cruz, California. The store uses 100% renewable energy: the fuel cells will provide 60-70% of the store's power and 896 solar panels on the roof will deliver 30-35% of power. The store is LEED certified.
What Safeway is saying about fuel cells:	*"We've come a long way to reduce our carbon footprint and improve our sustainability."* **– Teena Massingill, Director of Corporate Public Affairs, Safeway**[107] *"We have purchased fuel cells from the Bloom Energy Company under an agreement which includes maintenance and upgrades for ten years. This installation is a prototype to determine the cost savings, the ongoing maintenance, and intangibles like payback which has been estimated to be about four to five years. This installation will test the use of fuel cells as emergency power and how it will work with our solar panels installed at the site. Also how the two systems work with the local grid power at the site. We hope to achieve net-neutral electrical energy use at this store."* *"We are actually purchasing the Bloom boxes from the company [Bloom Energy], but it handles the maintenance and upgrades for ten years." The reason for prototypes is, "to determine the cost, the maintenance and those intangibles...The payback on these systems is something like four or five years, as long as you can use the power and don't have to sell it back. What we did is create a sweet spot of how much we're producing and how much we're able to produce from this site itself."* **– Jim Gibbon, architectural coordinator, corporate construction and design, Safeway** [108]

[107] http://www.santacruzsentinel.com/localnews/ci_14942878
[108] Personal contact with Safeway

Star Market

Fuel Cell Activities:	**Shaw's/Star Market's parent company, SUPERVALU, has a commitment to environmental sustainability and is working to reduce their carbon footprint over the next five years. One way it is doing this:** ✓ **SUPERVALU has installed a fuel cell to provide power in one of its Shaw's/Star Market grocery stores** • Shaw's/Star Market in Chestnut Hill, Massachusetts is a pilot project incorporating several sustainable features - LED lighting, a low carbon-emitting refrigeration system, and a UTC Power 400-kW fuel cell that delivers 90% of the store's energy. The hot water by-product is used to heat the store and is run through an adsorption chiller and used to improve the efficiency of the store's air conditioning system. • SUPERVALU is working to establish a second fuel cell store in the future.
What Star Market is saying about fuel cells:	*"What it allows us to do is save energy and save money, and it allows us to show our commitment to environmental stewardship."* **– Holly Angell, Director of Engineering, SUPERVALU** [109] *"Our investment in this energy efficient store will be returned several times over, both in terms of cost savings and environmental improvements. Our customers, the local community and our environment all win as a result of this project."* **– Mike Witynski, President, Shaw's and Star Markets**
What the EPA is saying about Star Market:	*"This store sets a new standard for environmental responsibility for others in the industry to work to match. Star Market's achievements in reducing the store's impact on climate change and our earth's ozone layer have made the company a champion of environmental protection."* **– Drusilla Hufford, director of EPA's Stratospheric Protection Division** [110]
Benefits:	**Efficiency and emissions savings:** • The store anticipates the fuel cell and additional energy efficiency features can reduce carbon emissions by about 5 million pounds, the equivalent of removing 539 cars from the road each year.[111] • Total energy consumption within the store is expected to decline by 211,000 kilowatt-hours per year.[112]

[109] http://www.boston.com/lifestyle/green/articles/2008/09/10/eco_friendly_energy_to_power_revamped_star_market
[110] http://www.supervalu.com/sv-webapp/downloads/SUPERVALU_Corporate_Social_Responsibility_2010.pdf
[111] http://www.boston.com/lifestyle/green/articles/2008/09/10/eco_friendly_energy_to_power_revamped_star_market
[112] http://www.boston.com/lifestyle/green/articles/2008/09/10/eco_friendly_energy_to_power_revamped_star_market

Star Market in Chestnut Hill, Massachusetts

Wegmans

Fuel Cell Activities:	**Wegmans' Pottsvillle, Pennsylvania warehouse has a goal of nearly doubling the amount of produce shipped through the facility in 2010. As part of its sustainability commitment, the company is also reducing energy consumption. Fuel cells are helping Wegmans to meet both of these goals**: ✓ **Wegmans is converting an entire warehouse lift truck fleet to fuel cell power, and is planning to add fuel cell forklifts at additional facilities** • Third party logistics provider, GENCO, was awarded Recovery Act funding to demonstrate the economic benefits of large fleet conversions of lift trucks from batteries to fuel cell power. A Wegmans warehouse is one of five locations where GENCO will deploy the technology. ➢ The entire Wegmans lift truck fleet at the Pottsville, Pennsylvania warehouse will be converted to fuel cells, replacing units powered by lead-acid batteries. During the first phase of the project, the company is purchasing 50 Crown pallet trucks and 9 Crown stand-up forklifts powered by Plug Power's GenDrive™ fuel cells. ➢ Throughout 2011 and 2012, Wegmans plans to expand its use of hydrogen fuel cell technology at the Pottsville warehouse. When the project is complete, up to 150 pieces of equipment will be powered by hydrogen fuel cells. ➢ The project is being facilitated with a $1 million grant from the Pennsylvania Energy Development Authority (PEDA) that is offsetting a portion of the costs associated with the installation of an on-site hydrogen infrastructure. Fifty percent of fuel cell costs are being offset by Recovery Act funding. • Wegmans is also planning a new refrigerated warehouse in Highridge, Pennsylvania by 2012 that *"will be built with fuel cells in mind."* [113]
What Wegmans is saying about fuel cells:	*"In terms of sustainability, energy reduction is one of our top priorities. We are thrilled that PEDA recognized the importance of this project. This investment in fuel cell technology will help our employees, our business, and our community."* **– Mike Cullen, Vice President of Distribution Planning, Wegmans** [114]

[113] http://republicanherald.com/news/wegmans-upgrades-fleet-with-hydrogen-fuel-cells-1.574974
[114] http://www.wegmans.com/webapp/wcs/stores/servlet/PressReleaseDetailView?storeId=10052&catalogId=1&langId=-1&productId=675114

	"When we really looked at the math, and the finances involved, it worked out - even though the initial sticker didn't." **– David DeMascole, Retail Service Center General Manager, Wegmans** [115] *"How change affects our employees is an important consideration in every decision we make. Enabling employees to refuel quickly as needed gives them more control of their time and will improve their work environment."* **– David DeMascole, Retail Service Center General Manager, Wegmans** [116] *"Our folks tested the equipment early last year, and could immediately see what it would mean to equipment performance and productivity."* **– Dave Allar, Retail Service Center Maintenance Manager, Wegmans** [117] *"As long as I've been in maintenance there's some things I've never liked about lead-acid batteries, and that's lead and acid. You use a lot of electricity to charge them daily and it took eight hours to charge one. The new hydrogen fuel cells take about two minutes to charge, and they're more environmentally friendly. They don't emit anything but water and a little bit of heat."* **– Dave Allar, Retail Service Center Maintenance Manager, Wegmans** [118] **Allar compares the operation of hydrogen-powered equipment to that of driving a car, and contrasts it to battery power:** *"Whether a gas tank is full or down to a quarter tank, a car will travel at 60 mph. Not so when battery power is used; performance diminishes as the battery discharges."* **– Dave Allar, Retail Service Center Maintenance Manager, Wegmans** [119] *"They're great. The hydrogen lasts twice as long as the battery charge. The weight doesn't bog it down."* **– Dave Kloos, Employee, Wegmans** [120]
Benefits:	**Emissions, efficiency and cost savings:** • Fuel cells pallet jacks are refilled quickly and workers can now fill orders round-the-clock. The Pottsville facility had been hampered by the need to charge lead-acid batteries for eight hours before an eight-hour work shift. To be able to accommodate 24-hour pallet truck use, Wegmans would have had to invest in a costly expansion of lead-acid battery recharging and allow more space to house extra batteries. • By converting the lift equipment in just the produce area of its facility to hydrogen fuel cells, carbon emissions will be reduced by an

[115] http://www.publicbroadcasting.net/wxxi/news.newsmain/article/0/0/1666111/WXXI.Local.Stories/Fuel.Cell.Forklifts.Leading.Hydrogen.Push

[116] http://www.wegmans.com/webapp/wcs/stores/servlet/PressReleaseDetailView?storeId=10052&catalogId=1&langId=-1&productId=675114

[117] http://www.airproducts.com/PressRoom/CompanyNews/Current/AreaOfInterest/Markets/HydrogenEnergy/26Apr2010.htm

[118] http://republicanherald.com/news/wegmans-upgrades-fleet-with-hydrogen-fuel-cells-1.574974

[119] http://www.airproducts.com/PressRoom/CompanyNews/Current/AreaOfInterest/Markets/HydrogenEnergy/26Apr2010.htm

[120] http://www.philly.com/philly/business/95243969.html

	amount equivalent to removing 134 cars off the road each year.[121] • The fuel cell project will offset 4,064,445 kWh of energy over its lifetime. [122]
Lift truck being fueled at the Wegmans Pottsville, Pennsylvania Retail Service Center [123]	

[121] http://www.wegmans.com/webapp/wcs/stores/servlet/PressReleaseDetailView?storeId=10052&catalogId=1&langId=-1&productId=675114
[122] http://www.wegmans.com/webapp/wcs/stores/servlet/PressReleaseDetailView?storeId=10052&catalogId=1&langId=-1&productId=675114
[123] http://republicanherald.com/news/wegmans-upgrades-fleet-with-hydrogen-fuel-cells-1.574974

Whole Foods Market

Fuel Cell Activities:

Whole Foods Market is working to reduce their impact on the earth and its resources and is investing in alternative energies. Fuel cells are a part of this plan:

- ✓ **Whole Foods Market is using fuel cells to power, cool and heat three retail locations**
- ✓ **Whole Foods is deploying fuel cell forklifts at a distribution center**

Fuel cell combined heat and power:

- A newly-constructed Glastonbury, Connecticut Whole Foods Market (opened in 2008) became the first supermarket in the world to obtain most of its power using a fuel cell.
  - The fuel cell generates 50% of the electricity and heat and nearly 100% of the hot water needed to operate the store on-site using UTC Power fuel cell technology.
  - The fuel cell is configured for grid-independent operation and is capable of providing 200 kW of standby power if there is a grid failure, which will enable the store to operate without disruption.
- A newly-constructed Whole Foods Market in Dedham, Massachusetts generates approximately 90% of its electricity and nearly 100% of its hot water using a 400-kW UTC Power fuel cell.
  - The fuel cell system captures its waste energy for local cooling and heating. It is also capable of providing standby power if there's a grid failure to allow the store to operate without disruption and to avoid costly food spoilage.
- A new store, to be constructed in San Jose, California, will be the third Whole Foods Market to be powered by a fuel cell.
  - The UTC Power fuel cell system will generate 90% of the store's electricity needs
  - The fuel cells' thermal energy byproduct will be used for store's heating, cooling and refrigeration needs
  - Overall fuel cell efficiency will be approximately 60%, nearly twice the efficiency of the U.S. electrical grid

Fuel cell pallet jacks and lift trucks:

- Third party logistics provider, GENCO, has been awarded Recovery Act funding to demonstrate the economic benefits of large fleet conversions of lift trucks from batteries to fuel cell power. A Whole Foods distribution center is one of five locations where GENCO is

	deploying the technology. ➢ Whole Foods has deployed 61 Plug Power GenDrive™ fuel cell-powered forklifts (45 class-3 pallet jack and 16 class-2 standup reach trucks) at its Landover, Maryland distribution center.
What Whole Foods is saying about fuel cells:	**Fuel cell combined heat and power:** *"We are always looking to reduce our impact on the environment. Together with UTC Power and the Connecticut Clean Energy Fund, we've designed a combined cooling, heating and power system for our new Glastonbury store using a quiet, highly energy-efficient fuel cell that will reduce our carbon footprint dramatically."* **– Kathy Loftus, Global Leader of Sustainable Engineering, Maintenance and Energy, Whole Foods Market** [124] *"Whole Foods Market is excited to be able to use this clean and highly efficient technology at our new Dedham store to help reduce our impact on the environment and lessen our overall energy demands from traditional sources. We strongly believe in green power for the long term, so installing the larger fuel cell is ideal - it works with the vision of all involved, especially the community it will serve."* **– Kathy Loftus, Global Leader of Sustainable Engineering, Maintenance and Energy, Whole Foods Market** [125] **Fuel cell pallet jacks and lift trucks:** *"Whole Foods Market is committed to healthy food and a healthy planet. We are fulfilling that commitment by choosing to use greener technology in our own operations that will improve our productivity and lower our long-term costs."* **– Joe Strong, Facility Team Leader, Whole Foods** [126]
Benefits:	**Emissions, efficiency and cost benefits:** **Fuel cell combined heat and power:** • The Glastonbury, Connecticut fuel cell power plant has carbon dioxide-mitigating benefits equal to planting more than 21 acres of forest and reductions in nitrogen oxide emissions equal to removing 100 cars from the roadways per year.[127] • The Dedham, Massachusetts Whole Foods Market's use of a fuel cell system versus a conventional power plant has carbon dioxide-mitigating benefits equal to planting more than 175 acres of trees and reductions in nitrogen oxide emissions equal to removing more than 90 cars from the roadways per year.[128] • By generating most of its power on-site with a fuel cell, the Whole

[124] http://www.utcpower.com/fs/com/Attachments/PR_031008.pdf
[125] http://www.utcpower.com/fs/com/Attachments/PR_040809.pdf
[126] http://www.progressivegrocer.com/progressivegrocer/content_display/features/equipment/e3ib38cebd2d45985ddee1eedbf0b967701
[127] http://www.utcpower.com/fs/com/Attachments/PR_031008.pdf
[128] http://www.utcpower.com/fs/com/Attachments/PR_040809.pdf

Foods Market San Jose store will prevent the release of more than 370 metric tons of carbon dioxide annually – the equivalent of planting more than 85 acres of trees. The reductions in nitrogen oxide emissions compared to a conventional power plant are equal to the environmental benefit of removing 92 cars from the road.[129]

Fuel cell pallet jacks and lift trucks:

- The Maryland warehouse fuel cell-powered pallet jacks have allowed the center to reduce carbon footprint by the amount of greenhouse gas emissions associated with the use and charging of lead-acid batteries – up to 80% of emissions – roughly the equivalent of removing two passenger vehicles from the road per year for each forklift truck powered by fuel cells. [130]
- Whole Foods' blog reports the Maryland distribution center averages 14,000 battery changes in a year, totaling about 4000 labor hours. Refueling a fuel cell takes under one minute and only 250 labor hours per year.[131]

Fuel cell system supplies power, heating and cooling to several Whole Foods Markets, including this one in Glastonbury, Connecticut [132]

[129] http://www.utcpower.com/fs/com/Attachments/PR_020110_Whole_Foods.pdf
[130] http://blog.wholefoodsmarket.com/2009/11/hydrogen-fuel-cell-powered-forklifts
[131] http://blog.wholefoodsmarket.com/2009/11/hydrogen-fuel-cell-powered-forklifts
[132] http://www1.eere.energy.gov/hydrogenandfuelcells/adoption.html

Telecommunications

With more and more consumers using cellular phones, wireless laptops, Blackberrys and other 3G devices, telecommunications companies are meeting the need by installing towers and substations at a phenomenal rate worldwide.

Fuel cell systems are currently being used by major telecommunications companies to provide long-running, primary or backup power for telecom switch nodes, cell towers, and other electronic systems that require reliable, on-site, direct DC power supply. They are quiet, rugged and durable, providing power in sites that are hard to access, or are subject to inclement weather.

In addition to the major telecommunications companies highlighted in this report, T-Mobile and AT&T Wireless are also both using fuel cells. T-Mobile has around 35 units installed in Florida and AT&T has about 100 sites with fuel-cell back-up power and another 180 sites planned.[133] AT&T received two awards totaling $8.6 million through the Recovery Act to deploy 180 ReliOn fuel cells at sites throughout several states with a new refillable 72-hour fuel system and another 25 units in central and northern California through PG&E.

The Federal Aviation Administration (FAA) is also a big potential customer of fuel cells. FAA has a network of about 15,000 towers at more than 19,000 airports. FAA is interested in extending backup power to 72 hours for critical sites, remote sites, and sites where grid power is unreliable, and launched a program in 2009 to deploy fuel cell backup units at 26 sites across FAA's three service centers.

There is also tremendous activity going on in Denmark (see Motorola profile), as well as South Africa, Indonesia and India due to lack of an infrastructure or landline network (see chart below).

Country	Partner Co.	Fuel Cell Co.	# of Units
Australia	Telstra	IdaTech	One installed at headquarters
Germany	O2	P21 GmbH	Seven, with more planned
India	ACME Telepower	Ballard, IdaTech	310 units, potential for more
India	Telecommunications Consultants India Ltd. (TCIL)	Plug Power	Unknown
India	Wireless TT Info Services Limited (WTTIL)	Plug Power	200 units, set to increase to 1000 by end of 2010
Indonesia	Working through Cascadiant, a network integrator, with several wireless companies, including PT Hutchinson CP Telecommunications	IdaTech	Has installed more than 100 systems around Indonesia, completed sale of 154 additional units
Indonesia	Working through Consistel, with several wireless companies, including PT Hutchinson CP Telecommunications and PT Telkomsel (Telekomunikasi Selular)	ReliOn	200 (PT Hutchinson)
Russia	Beeline	Dantherm Power	One tested, Dantherm signed with Russian distributor
South Africa	Clean Energy Investments	Altergy Energy	N/a
South Africa	IST Holdings	Plug Power	Initially 400 with 120 added

[133] http://www.rcrwireless.com/ARTICLE/20100226/INFRASTRUCTURE/100229971/green-initiatives-bring-green-to-bottom-line

Sprint Nextel

Fuel Cell Activities:

Sprint is committed to reducing its greenhouse gas emissions by 15% and to securing 10% of its energy from renewable sources by 2017. Fuel cells are helping Sprint attain this goal.

✓ **Since 2005, Sprint has installed approximately 250 hydrogen fuel cells to provide backup power to cell sites across the U.S., and more are planned**

- Sprint's network consumes about 80% of its total energy use. Hydrogen fuel cells have proven to be a successful, environmentally-friendly alternative energy source to provide emergency power to critical Sprint facilities.
- Sprint owns 15 hydrogen fuel cell patents.
- In 2009, Sprint Nextel received a $7.3 million grant from the Department of Energy as part the Recovery Act for expansion of hydrogen fuel cell deployment. This project will help Sprint:
  - Deploy 260 new fuel cells in California (100), Connecticut (30), New Jersey (65) and New York (65)
  - Upgrade 70 in-service fuel cells in Louisiana and Texas to a permanent, refillable Medium Pressure Storage Solution (facilitating on-site refueling), from a Low Pressure Hydrogen Storage Solution (requiring bottle swap and removal).
- Sprint will also demonstrate the viability of packaged 1-kW to 10-kW fuel cell systems with 72 hours of on-site fuel storage for backup power to communication infrastructure used by state and local first responders and by public safety answering points (911 centers).

What Sprint is saying about fuel cells:

"Sprint gets it – this alternative source of energy for mobile communications will not only help stimulate the nation's economy and rebuild America, but also help lead to a greener cleaner environment." ***– Bob Azzi, Senior Vice President of Network, Sprint*** [134]

"This HFC deployment is the tip of the iceberg for us. The recent DOE grant is helping us to double the number of hydrogen fuel cells deployed across the U.S., as we continue to examine opportunities to green our network. We are making great progress in pursuing environmentally-sound alternative energy solutions to power our network." **– Sarabeth Patch, Sprint Environmental Sustainability Communications Manager** [135]

[134] http://investors.sprint.com/phoenix.zhtml?c=127149&p=irol-newsArticle_newsroom&ID=1277707&highlight=
[135] Personal contact with Sprint.

Benefits:	Hydrogen fuel cells are an environmentally-friendly solution to meet cell site energy needs without creating greenhouse gas emissions (GHG). In addition to being a cleaner energy source, fuel cells[136]: • Have a longer life span – approximately 20 years – which reduces waste associated with system replacement from battery or diesel powered systems. • Require low maintenance – reducing required site visits. • Need smaller battery reserve power (8 minutes versus 2 hours) than traditional back-up generator or battery solutions – reducing the number and size of lead acid batteries, which on average require replacement every three years. • Support Sprint's ambitious environmental priorities, which include reducing greenhouse gas (GHG) emissions by 15 percent and securing 10 percent of Sprint's energy needs from renewable sources by 2017.
ReliOn fuel cell system powering a Sprint cell phone tower	

[136] Personal contact with Sprint.

Verizon

Fuel Cell Activities:

Verizon has established energy efficiency standards that require new network equipment to be at least 20% more energy efficient than the equipment being replaced. Here's how fuel cells are helping:

- ✓ **Since the early 2000s, Verizon has conducted field trials of fuel cell critical power systems at remote switching stations and at other sites within its system**
- ✓ **A major Verizon call routing center/office building uses 1.4 MW of fuel cell power to power, heat and cool the building**

Fuel cell combined heat and power at Verizon Headquarters:

- Following several costly power outages and interruptions between 1999 and 2001, Verizon created an energy team to investigate alternative solutions to bolster electric reliability, optimize the company's energy use, and reduce costs in an environmentally responsible manner.
  - Verizon spends $500 million/year on electricity
- In 2005, Verizon deployed seven 200-kW fuel cells that operate on natural gas, providing about 1.4 MW to the Central Office in Garden City, New York, in parallel with the electric grid.
  - The system provides as much as 80% of the facility's power load when all seven fuel cells are activated
  - Waste heat from the fuel cells generates 75% of the energy required to heat the facility and one-third required for cooling
  - In 2008, the U.S. Environmental Protection Agency and U.S. Department of Energy awarded Verizon their prestigious Energy Star Combined Heat and Power Award for the Central Office fuel cell system.
  - Cost to upgrade the Central Office and install the fuel cell system was about $13 million. Verizon received:
    - $3.2 million from the U.S. Department of Energy
    - $425,000 from the NYSERDA

Fuel cell critical and backup power:

- In December 2001, Verizon and Nuvera Fuel Cells initiated a project to demonstrate the ability of a 5-kW fuel cell to provide critical power to a remote switching station in Woburn, Massachusetts. The switching station serves about 200 telephone customers, and service reliability is of paramount interest to Verizon. This was the

	first project of its kind.[137] • Verizon participated in other fuel cell trials and demonstrations, including six fuel cell trials at outdoor plant locations in Daggett and Barstow, California; Anacortes, Washington; Sandpoint, Idaho; Albany, New York; and West Chester, Pennsylvania. Verizon tested a medium-sized fuel cell in Rome, New York and a DC to DC system at Verizon Labs in Waltham, Massachusetts. Verizon also uses fuel cells on a smaller scale to provide emergency backup power in telephone switching offices in Missouri, New York, Texas and Washington.
What Verizon is saying about fuel cells:	**At the Garden City, New York fuel cell's dedication:** *"The fuel cells we are using here today help Verizon provide customers even more reliable communications services, whether for phone calls or high-speed data transmission, and at the same time the power is environmentally friendly and efficiently produced."* **– Ivan Speidenberg, Chairman and CEO, Verizon** [138] *"We have been very pleased with the fuel cell power system. It has proven totally reliable, which of course is of paramount importance for us, but has also produced quite admirable environmental benefit."* **– Tom Donnelly, New York Real Estate Operations Supervisor, Verizon Communications**
Benefits:	**Emissions, efficiency and cost savings:** **Fuel cell combined heat and power at Verizon Headquarters:** • During the first year of operation, Verizon had anticipated saving $250,000, but exceeded this estimate by saving ~$680,000 by not having to obtain power from the commercial power grid.[139] [140] • Heat byproduct from the fuel cells is used to heat the Garden City building in winter, reducing heating oil consumption by almost 30,000 gallons a year.[141] • Verizon estimates that the Garden City fuel cells annually eliminate 5,440 metric tons of carbon dioxide that otherwise would have been released into the atmosphere, or the equivalent of 1,200 passenger cars not driven during one year.[142] **Fuel cell critical and backup power:** • Fuel cell technology will help Verizon Business maintain reliable backup power resources and avoid having to install conventional batteries, which would require the allocation of more space, and

[137] http://www.masstech.org/renewableenergy/verizon_profile.pdf
[138] http://www.ens-newswire.com/ens/sep2005/2005-09-22-09.html
[139] http://newscenter.verizon.com/press-releases/verizon/2007/promoting-green-power.html
[140] http://news.cnet.com/Verizon-heeds-call-of-fuel-cells---page-2/2100-1033_3-6102552-2.html?tag=mncol
[141] http://content.techrepublic.com.com/2346-1035_11-30501-5.html?tag=content;leftCol
[142] http://newscenter.verizon.com/press-releases/verizon/2007/promoting-green-power.html

	additional heating and cooling.[143]
Top: ***1.4 MW of fuel cells power Verizon's Garden City, New York call center***	
Bottom: ***Verizon Communications' 5-kW Plug Power fuel cell installation at the Albany International Airport in Albany, New York***	

[143] http://newscenter.verizon.com/press-releases/verizon/2008/verizon-business-helps-custome.html

Motorola

Fuel Cell Activities:	**Motorola is boosting energy efficiency across its product range and learning how to best integrate alternative energy into its infrastructure deployments. Fuel cells are part of this effort:** ✓ **Motorola has deployed more than 100 fuel cells to provide backup power to a public safety communications network** • Motorola has expanded the SINE network, a Motorola-owned and operated public safety network in Denmark, and deployed fuel cells at more than 100 of the SINE base stations. The fuel cells replace diesel generators to provide crucial backup power to the emergency system if the main power supply fails. • Motorola is continuing to investigate the additional potential of fuel cell technology. • Motorola is also extremely active in research and development of fuel cells for consumer electronics such as cellular phones and laptop computers.
What Motorola is saying about fuel cells:	*"Loss of power should never be an issue to professionals working in mission-critical or emergency environments, and Motorola has continued to invest in environmentally-friendly backup power systems for TETRA. We are delighted that the SINE rollout has been such a success and we look forward to rolling out further hydrogen powered fuel cells in critical locations across Northern Europe."* – **Jens Kristiansen, Vice President and General Manager, TETRA Global Products and Solutions, Motorola** [144] *"Motorola has deployed the largest-ever number of TETRA base stations using hydrogen fuel cells for backup power. This demonstrates that alternative fuels can be used effectively to support public safety networks."* **– Motorola website** [145]
Benefits:	• The diesel generators were replaced since they emit greenhouse gases, take longer to start up, are noisy in operation, are less reliable and require more maintenance. ➢ "Fuel cell technology offers a no carbon, low acoustic alternative to match the needs for TETRA base stations in challenging locations. They are proven in critical power back-up situations and can run for extended periods limited only by the supply of the hydrogen, and the only emission is water." [146]

[144] http://mediacenter.motorola.com/content/detail.aspx?ReleaseID=11526&NewsAreaId=2
[145] http://responsibility.motorola.com/index.php/environment/products/energy
[146] http://mediacenter.motorola.com/content/detail.aspx?ReleaseID=11526&NewsAreaId=2

Fuel cell used to provide backup power at one of SINE's network communication sites in Denmark

Hospitality

There are currently about 30,000 hotels in the United States, not to mention tens of thousands of motels and hundreds of casino hotels. Thousands more are expected to be built over the next few years. Fuel cells are the perfect hotel employee: quiet, clean, efficient and hard working.

When both electricity and heat are utilized, fuel cells are to 80-90% energy efficient, compared to 33% from today's electric power grid. CO_2 emissions are reduced by 20% to 40% for combined heat and power fuel cell systems operating on natural gas, and up to 100% when using renewable fuel. The fuel cell's heat can be used for the hotel's hot water or space heating needs, reducing the need for boilers or water heaters on the property, or to heat swimming pools, steam rooms or saunas.

In 1992, the Hyatt Hotel in Irvine, California pioneered this fuel cell application, installing a 200-kW UTC Power fuel cell that provided 20% of the hotel's power needs. Waste heat from the process was used to heat water for guests and for the laundry. In 1997, a 200-kW UTC Power fuel cell was installed at the Spokane, Washington Double Tree Inn. After 8,668 hours of operation (1,715 megawatt-hours or MWh) that fuel cell system was retired, but several other large hotel chains are reaping the benefits of those experiences.

Starwood Hotel and Resorts Worldwide, the parent group of both the Westin and Sheraton Hotel chains, has installed fuel cells at five Sheratons, as well as a Westin hotel in California. Since fuel cells are extremely quiet, the Sheraton San Diego Hotel and Marina actually installed their four FuelCell Energy fuel cells right next to its tennis courts. The captured heat is directed towards the hotel's three swimming pools and hot water supply. There is also considerable interest from hotel guests who appreciate the "green" aspect the fuel cells provide. Sheraton estimates it has booked more than 1,000 additional rooms in the last year because of the fuel cell system.[147] The DoD Climate Change Rebate Program provided partial funding to most of Starwood's installations, and for the Mohegan Sun, among others.

In 2002, the Mohegan Sun Casino and Hotel in Uncasville, Connecticut, installed two UTC Power 200-kW fuel cells to provide combined heat and power. The hotel also uses a hydrogen fuel cell-powered golf cart to serve as a vehicle for the Mohegan Transportation Department. This GEM (Global Electric Motorcar) vehicle was modified by students from Worcester Polytechnic Institute who added an Anuvu 3-kW fuel cell. In September 2005, the U.S. Environmental Protection Agency (EPA) and the Department of Energy (DoE) presented the Mohegan Tribe with its Energy Star Combined Heat and Power Award. From 2002-2007, the fuel cells generated 16,115 MWh of electricity and saved the Tribe $1,247,324 in electrical charges at the Mohegan Tribal Utility Authority rates. The fuel cells also achieved more than $1 million in thermal savings. One fuel cell has been decommissioned and the other is finishing its lifecycle.

The DoD funding program has now been replaced by a federal tax credit. Companies wishing to install a fuel cell can take advantage of the fuel cell Investment Tax Credit, a credit of up to $3,000 per kW of installed fuel cell power.

[147] http://www.fuelcellenergy.com/files/FCE_SheratonSanDiego_120808LR.pdf

Hilton Hotels

Fuel Cell Activities:	**Sustainability is an essential element of Hilton Hotel's culture. The company has a goal of reducing energy consumption from direct operations by 20%, reducing CO_2 emissions and output of waste by 20%, and reducing water consumption by 10%, all by 2014. Fuel cells are part of this commitment:** ✓ **A Hilton Hotel generates heat and power using a fuel cell** ✓ **Hilton is testing fuel cell vehicles** **Fuel cell combined heat and power:** • The largest hotel in Manhattan, Hilton New York, installed a fuel cell in October 2007. The UTC Power PureCell® system provides electric power and hot water throughout the hotel's 2,000 rooms, operating 24/7. The system is nearly three times more energy efficient than the electric grid when used in combined heat and power applications. • Hilton received $200,000 in funding from the DoD Climate Change Rebate Program for this project. • The hotel was the recipient of the 2008-2009 Environmental Recognition Program – "Green Street" Award by the Avenue of the Americas Association in the Energy Efficiency/Sustainability Projects category for "Buildings Over One Million Feet." **Fuel cell vehicles:** • In Europe, Hilton is working with Opel to test fuel cell vehicles.
What Hilton Hotels is saying about fuel cells:	**Fuel cell combined heat and power:** *"It's been working very well. It is so quiet you would not even know it is there. We go through periodic maintenance by UTC. They monitor it online. From our side it is seamless."* **– Mike Smith, Director of Property Operations, Hilton New York** [148] *"The fuel cell at the Hilton New York is one of the more significant ways we can have an impact on energy consumption in one of the largest cities in the world."* – **George Neeson, Vice President of Engineering & Housekeeping, Hilton Hotels Corporation** [149] **Fuel cell vehicle:** *"Protecting the environment is extremely important to Hilton. So we are particularly pleased to be able to participate in a HydroGen4 pilot project. We have been working for years on environmental projects and*

[148] http://www.greenlodgingnews.com/content.aspx?id=4810
[149] http://www.utcpower.com/fs/com/Attachments/project_profiles/PP0116_Hilton2.pdf

	have been able to drastically reduce our energy consumption in our hotels during the three years of our We Care program. Adding a HydroGen4 car to our fleet at the Hilton Berlin is a continuation of our efforts to make the world cleaner." **– Olivier Harnisch, Vice President International Operations, Hilton Hotels - Germany & Switzerland** [150]
Benefits:	**Emissions savings:** **Fuel cell combined heat and power:** • Since the fuel cell's installation in October 2007, it has produced approximately 1.75 million kW of electricity per year for the hotel for a total of nearly 3.5 million kWh to date. That equates to approximately 6% of the hotel's consumption.[151] • The UTC Power fuel cell reduces Hilton New York's carbon footprint by 780 tons each year. To achieve the same positive environmental impact, 160 acres of forest would need to be planted.[152]
UTC Power fuel cell at Hilton New York	

[150] http://www.gmeurope.info/hydrogen4berlin08/downloads/opel/en/pdf/EN_HydroGen4.pdf
[151] http://www.businesswire.com/portal/site/google/?ndmViewId=news_view&newsId=20091029005629&newsLang=en
[152] http://www.utcpower.com/fs/com/Attachments/project_profiles/PP0116_Hilton2.pdf

Starwood Hotels & Resorts Worldwide (Sheraton and Westin)

Fuel Cell Activities:

Starwood Hotels & Resorts Worldwide, parent company of the Sheraton and Westin hotel chains, is committed to integrating leading environmental practices and sustainability principles into its core business strategy. This commitment is illustrated by the company's fuel cell deployments:

✓ **Four Sheraton Hotels and a Westin Hotel have deployed fuel cells to provide power, heat and hot water to the properties**

Sheraton Hotels

- A 250-kW FuelCell Energy fuel cell power plant is located at Sheraton New York Hotel & Towers, the first hotel in Manhattan to use such a system.
  - The fuel cell, located on the fourth floor mezzanine roof overlooking 52nd Street, supplies a portion of the combined heat and power for the hotel
- Similar systems are located at Sheraton Edison Hotel and Sheraton Parsippany, both located in New Jersey.
- 1 MW of fuel cell power was installed at the Sheraton San Diego Hotel and Marina East Tower in 2005. In 2006, because of that success, two more 250-kW units (500 kW total) were installed at the West Tower.
  - Seventy percent of the hotel's power demand is met by the fuel cells
  - Waste heat is used to heat water for the hotel's Bay Tower and the water in the 110,000-gallon swimming pool in the Marina Tower[153]
- Sheraton received funding from the DoD Climate Change Rebate Program for Parsippany, NJ ($125,000), Edison, NJ ($250,000) and San Diego, CA ($700,000). NYSERDA awarded the Sheraton New York $920,000 to install its fuel cell system.

Westin San Francisco Airport Hotel

- Two 250-kW FuelCell Energy fuel cell systems (500 kW total) were installed at the 390-room Westin San Francisco Airport Hotel. The fuel cells generate approximately 100% of the hotel's electricity requirements.
  - Surplus heat from the power plant is captured to provide 40% of

153 http://www.hotelnewsresource.com/article46599Fuel_Cell_Systems_Inch_Their_Way_into_Lodging_Industry___By_Glenn_Hasek.html

	the hotel's thermal requirements for hot water and heating the swimming pool • Pacific Gas and Electric Company, an administrator for California's SGIP program, provided $1.25 million for the project.
What Starwood is saying about fuel cells:	*"The successful completion of our third fuel cell power plant in as many years is a testament to Starwood's commitment to environmental stewardship and energy efficiency."* **– John Lembo, Director of Energy for Starwood** [154] *"Starwood Hotels & Resorts will continue to adopt and implement environmentally safe and friendly practices that save energy and protect the environment. We feel that energy fuel cell technology will play an important role in reducing harmful emissions and reduce the hotels' overall energy costs."* **– John Lembo, Director of Energy for Starwood** [155] **Talking about the hotel's fuel cells:** *"We enjoy having them here. We are pursuing LEED certification. We try to do everything possible that is green. They are a great thing to market. They are great for the environment."* **– David Prost, Director of Engineering, Sheraton San Diego Hotel & Marina** [156] **About the Westin:** "*Our use of fuel cells at Sheraton hotels has successfully reduced our energy costs while offering us quality power with strong environmental benefits, and we are eager to begin applying this formula to our Westin and other brand hotels.*" **–John Lembo, Director of Energy for Starwood** [157]
Benefits:	**Emissions and cost savings:** **Sheraton San Diego:** • Sheraton San Diego Hotel & Marina has been generating electricity at a cost that is 5-10% lower than the local utility charge. • The hotel estimates it books 1,000 rooms a year due to interest in the fuel cell.[158]

[154] http://www.starwoodhotels.com/sheraton/about/news/news_release_detail.html?obj_id=0900c7b98046c951
[155] http://www.pplweb.com/newsroom/newsroom+quick+links/archived+news/2003/August/08_04_2003.htm
[156] http://www.hotelnewsresource.com/article46599Fuel_Cell_Systems_Inch_Their_Way_into_Lodging_Industry___By_Glenn_Hasek.html
[157] http://www.redorbit.com/news/science/261088/starwoods_awardwinning_energy_program_expands_reliance_on_fuel_cell_energy/index.html
[158] http://www.fuelcellenergy.com/files/FCE_SheratonSanDiego_120808LR.pdf

Top: ***Sheraton San Diego's fuel cells up close*** [159]

Bottom: ***Fuel cell at the Sheraton Edison***

[159] http://www.signonsandiego.com/news/2010/mar/07/fueling-the-future

Corporate Headquarters and Data Centers

The explosion of demand for telecommunications and computing capability has created a need for reliable data management, and with it, a market opportunity for fuel cells. Modern communications systems require more reliable power than is available on the electrical grid. Fuel cells, alone or in partnership with other technologies, can provide exceptional reliability. The low emissions of fuel cells offer help companies extend their green efforts to their headquarters, call centers, data centers, and other company facilities. Today's high energy costs make energy efficiency an economic priority and give fuel cells a competitive opportunity. Once installed, fuel cells can produce electricity at a cost lower than grid power – one third lower per kilowatt hour, for one California company. Companies can also arrange purchase agreements that offer a stable price for electricity over the term of the agreement, an advantage in an uncertain energy world.

Data and call centers, in particular, require high quality, reliable power. Power outages collectively cost companies billions of dollars each year, with millions lost by a company for each hour that power is down. In addition, power quality issues, such as voltage sags or surges, can disrupt operations and damage sensitive equipment. Fuel cell technology can meet this need, delivering high quality, reliable power that surpasses the needs of data centers; analysis of the First National Bank of Omaha's fuel cells showed that they are capable of providing 99.999995% availability. The bank's fuel cells were installed in 1999 and the system is still operating today.

First National Bank of Omaha's fuel cells provide high quality, reliable power to their data processing facility

Companies such as eBay, Google, Fujitsu, and Chevron are deploying fuel cells at corporate headquarters and data centers, taking advantage of the unique benefits that fuel cells offer. For example:

- Fujitsu has reported that it expects to achieve a 3.3 year payback based on the lower cost of electricity delivered by its UTC Power fuel cell.
- Google installed a Bloom Energy fuel cell system in 2008. Over the first 18 months, the fuel cells performed at 98% availability and delivered 3.8 million kWh of electricity.

Bank of America also plans to install five fuel cell power units at one of its largest call centers. Hamilton Sundstrand was an early demonstrator, deploying a fuel cell at its Connecticut Data Center in the 1990s through DoD's Climate Change Rebate Project.

eBay

Fuel Cell Activities:

In 2009, eBay committed to reduce its corporate greenhouse gas emissions by 15% by 2012, over a 2008 baseline. Fuel cells are helping eBay meet this challenge:

✓ **eBay reduces its grid energy use by operating fuel cells at its headquarters and data center**

- Bloom Energy fuel cells produce 500 kW of power at eBay's San Jose campus, while taking up just 3,000 sq. ft. of space. The fuel cells were installed in June 2009.
  - ➢ eBay also has 3,246 solar panels located on the building's roof. The company's headquarters is LEED Gold-certified.

What eBay is saying about fuel cells:

"eBay believes in the power of our business model to make a real difference in the world, and that includes how we embrace innovation to reduce our carbon footprint. When Bloom came to us, it was an easy decision to become an early-adopter of their cutting-edge new technology. As a result, we're meeting financial and environmental goals with the project while fueling a more energy efficient global marketplace. That's good for us, our customers and the planet." **– John Donahoe, CEO** [160]

"It's been very successful thus far. [The Bloom Boxes] have done what they said they would do. The five boxes are able to produce five times as much electricity as the 3,248 solar panels that eBay installed on its campus roofs. The footprint for Bloom is much more efficient." **– John Donahoe, CEO** [161]

"The solar panels take 55,000 sq. ft. and at their peak performance take 18% of our electricity use off the grid, but that's not at night or on days when we have rain. Running the two side by side over the course of a year, we will get five times as much energy from the Bloom system." **– Amy Skoczlas Cole, Director of eBay's Green Team** [162]

Discussing the possible addition of more Bloom fuel cells to the campus: *"We're actively in discussion about what more we can do together. It's a terrific new technology that we're really excited to be early adopters of."* **-- Amy Skoczlas Cole, Director of eBay's Green Team** [163]

Benefits:

Emissions and cost savings:

- In the first six months of operation, the fuel cells delivered 2.2 million kWh of power, mitigating more than 650,000 pounds of CO_2.[164]

[160] http://www.bloomenergy.com/customers/customer-story-ebay
[161] http://www.cbsnews.com/stories/2010/02/18/60minutes/main6221135.shtml
[162] http://www.fastcompany.com/1560450/bloom-box-ebay-interview
[163] http://www.fastcompany.com/1560450/bloom-box-ebay-interview
[164] http://www.bloomenergy.com/customers/customer-story-ebay

	• The fuel cells are initially operating on natural gas. After switching the system to operate using biogas, the Bloom Box fuel cells will triple the amount of CO_2 that is mitigated.[165] • The fuel cells led to energy cost savings of more than $100,000 during the first seven months of operation, compared to the cost of grid power.[166] • Amy Skoczlas Cole says the fuel cell system will pay for itself in about three years.[167]
Bloom Energy servers at eBay ***168***	

[165] http://www.bloomenergy.com/customers/customer-story-ebay
[166] http://www.fastcompany.com/1560450/bloom-box-ebay-interview
[167] http://www.fastcompany.com/1560450/bloom-box-ebay-interview
[168] http://www.bloomenergy.com/customers/customer-story-ebay

First National Bank of Omaha

Fuel Cell Activities:	**First National Bank of Omaha was an early adopter of fuel cells in its daily operations:** ✓ **First National Bank of Omaha has powered its credit card and banking transaction data processing center with fuel cells since 1999** • First National Bank of Omaha is one of the nation's largest processors of credit card transactions. The bank had experienced two failures of its backup power systems (using conventional battery UPS for short term outages and voltage sags, and standby diesel generators during longer-term outages), costing the bank millions of dollars. The bank looked to alternatives and chose highly reliable fuel cell primary power to meet its critical power needs. ➢ First National was the first U.S. company to use fuel cell technology as a primary power source. The fuel cell was installed in 1999 and it is still operational. ➢ A life cycle cost analysis proved that, while the fuel cells system capital cost was higher than other power technologies, fuel cells were a better investment over the equipment's lifetime. ➢ The combined electrical and thermal energy efficiency is as high as 81%, when the bank capture's the fuel cell's waste heat to help heat the facility and melt snow around the building in the winter. ➢ The Bank received $200,000 in funding from the Department of Defense's Climate Change Fuel Cell Program.
What First National Bank of Omaha is saying about fuel cells:	**Speaking in 1999:** *"This is a highly reliable power source. Being a large credit card processor, doing $6 million an hour in transactions, our computers have to work."* **– Dennis Hughes, Director of Property Management, First National Bank of Omaha** [169] *"About two weeks ago, we had a series of brown outs. The fuel cells were able to reconfigure and there was no loss of power. They kept right on chugging away with no disruption."* **– Dennis Hughes, Director of Property Management, First National Bank of Omaha** [170]
Benefits:	**Reliability benefits:** • Conventional data center UPS systems deliver power with up to 99.99% availability. The bank's fuel cells can best this, delivering

[169] http://www.cnn.com/NATURE/9906/30/fuel.cell.enn/index.html
[170] http://www.cnn.com/NATURE/9906/30/fuel.cell.enn/index.html

power at 99.999995% availability.

First National Bank of Omaha's indoor fuel cell system powers its credit card and data processing center [171]

[171] http://www1.eere.energy.gov/hydrogenandfuelcells/education/pdfs/tech_center.pdf

Fujitsu

Fuel Cell Activities:	**Fujitsu is continually striving to reduce the energy used in its operations and atmospheric pollutants emitted. Fuel cells are helping in this effort:** ✓ **Fujitsu uses a fuel cell to help power the cooling system at a California site** • Deployed in 2007, a UTC Power PureCell™ fuel cell provides 50% of the power needed to cool the Fujitsu Sunnyvale campus data center and labs, reducing the amount of fossil fuel that must be burned to maintain operations and easing pressure on the local power grid. ➢ The system has a low sound profile at 60 decibels at 30 feet, and emits no ozone-depleting fluorocarbons
What Fujitsu is saying about fuel cells:	*"Our real-world use of the hydrogen fuel cell is a clear demonstration of the ability of corporations to make a significant and financially responsible investment in reducing harmful impacts on the environment, with the ultimate goal of reversing global warming. With a payback of about three and a half years and a lifespan of about 15 years, hydrogen power is an excellent investment for the company."* **– Tetsuo Urano, Head of American operations, Fujitsu America** [172] *"Because fuel cells are among the cleanest power-generating technologies available today, this installation is only the beginning of our relationship with UTC Power…We are pleased to bring this green alternative energy solution to Silicon Valley and make our contribution to the Valley's critical clean air initiative."* **– Marty W. Engh, Sr., Director of Facilities Services, Fujitsu America** [173]
Benefits:	• The fuel cell produces 35% less CO_2 per MWh than the average fossil fuel-based power plant, and approximately 4,000 lbs per year less NO_x, the equivalent of taking more than 100 average passenger cars off the road. [174] • When compared to conventional power plants, the UTC Power PureCell™ Model 200 system saves at least 800,000 gallons of water per year, which is 12 million gallons of water saved over the 15-year life of the fuel cell system. [175]

[172] http://www.fujitsu.com/us/news/pr/20070817-01.html
[173] www.sobono.com.sg/purecell.html
[174] http://www.fujitsu.com/us/news/pr/20070817-01.html
[175] http://www.fujitsu.com/us/news/pr/20070817-01.html

	• Fujitsu reports the company is on track to achieve a 3.3-year payback based on the lower cost of electricity from the fuel cell (8 cents for the fuel cell vs. 12 cents for utility power).[176]
UTC Power fuel cell provides power at Fujitsu's Fujitsu Sunnyvale, California campus data center and labs	

[176] Personal communication with Fujitsu.

Cox Enterprises

Fuel Cell Activities:	**Cox Enterprises is working to reduce its annual companywide carbon footprint by 20% by 2017. Fuel cells are helping Cox attain this goal:** ✓ **Cox has deployed fuel cells to help power a television station** • A 400-kW Bloom Energy fuel cell was installed in January 2010 at Cox's KTVU television station in Oakland, California. ➢ The installation produces 69% of the main building's energy requirements and is expected to produce more than 3.4 million kWh of energy each year • Cox is starting another fuel cell initiative that will deploy four 4-kW fuel cells. The fuel cells will have a payback period of three years.[177]
What Cox Enterprises is saying about fuel cells:	*"Bloom systems running on biogas offer Cox a 24/7 renewable energy option to meet power demands. By cutting costs and carbon emissions, the Bloom project complements our overall Cox Conserves program."* **– Jim Kennedy, Chairman, Cox Enterprises**
Benefits:	• The fuel cells are anticipated to reduce carbon emissions by over 2,000 tons annually. • The fuel cells generate power at a lower cost than the local utility.
Cox Enterprises' fuel cells [178]	

[177] http://www.cablefax.com/ct/news/ctreports/commentary/Cable-Picks-Low-Hanging-Green-Fruit_41506.html
[178] http://www.bloomenergy.com/customers/customer-story-cox

Chevron

Fuel Cell Activities:

Chevron is one of the world's largest integrated energy companies and is committed to Investing in promising innovative energy technologies:

✓ **Chevron installed the first stationary fuel cell system in the San Francisco area**

Fuel cell combined heat and power:

- In late 2001, Chevron installed the first commercially operating stationary fuel cell power plant in the San Francisco Bay Area, at its worldwide headquarters in San Ramon, California. The UTC Power fuel cell delivers 116 kW of power.[179]
  - The project received $200,000 from the DoD Climate Change Rebate Program and $500,000 from California's SGIP

Assisting in other stationary fuel cell installations:

- Chevron Energy Solutions, a Chevron subsidiary, developed and installed the first MW-class fuel cell in California at Alameda County's Santa Rita jail, the third-largest county detention facility in the state and the fifth largest in the nation.
- Chevron Energy Solutions installed a 250-kW fuel cell at the U.S. Postal Service San Francisco Processing & Distribution Center.

Hydrogen infrastructure:

- Chevron Technology Ventures (CTV), a subsidiary of Chevron, participated in the U.S. Department of Energy's (DOE) "Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Program" – a comprehensive five-year hydrogen refueling demonstration program to test a variety of technologies for using hydrogen as a transportation fuel in the real world. CTV operated hydrogen refueling stations at several locations around the United States. At each station, hydrogen was produced onsite, where it was used to power fleets of fuel cell vehicles and internal-combustion engines.
- Chevron hydrogen fueling stations include:
  - Oakland, California at AC Transit to fuel fleet of fuel cell buses
  - Chino, California, at a Hyundai-Kia America Technical Center
  - Orlando International Airport in Florida
  - Selfridge Air Force Base in Selfridge, Michigan
  - Thousand Palms, California at SunLine Transit
  - Rosemead, California at Southern California Edison Headquarters

[179] http://files.harc.edu/Sites/GulfCoastCHP/CaseStudies/ChevronTexacoSanRamonCA.pdf

	➢ Sacramento, California at the California Fuel Cell Partnership
Benefits:	**Emissions, efficiency and cost savings:** • Fuel cell at San Ramon headquarters provided a reduction of $56,000 in annual energy costs; a reduction in electricity purchases by 1,600,000 kWh per year and a reduction of 4,000 MM Btu annually. **Santa Rita Jail** • The exhaust heat byproduct is captured for heat and water for the jail and combined with the previously installed rooftop solar power array and energy efficiency upgrades, this installation reduces power purchases by as much as 80% during peak-demand summer months. This translates to avoided greenhouse gas emissions of 3,200 tons annually, equivalent to planting approximately 900 acres of trees. The project will save county taxpayers more than $260,000 per year.[180]
Fuel cell at Chevron's San Ramon headquarters	

[180] http://www.chevronenergy.com/case_studies/alameda_county.asp

Cypress Semiconductor Corp.

Fuel Cell Activities:	**Cypress Semiconductor wants its San Jose headquarters to be 100% self-sufficient by 2015, eliminating dependence on the power grid. Here is one way the company is moving toward this goal:** ✓ **Three Bloom Energy fuel cells are providing power at Cypress Semiconductor's San Jose campus** • Cypress Semiconductor presently generates 75% of its own power – 11% from rooftop solar panels and 64% from three Bloom Energy fuel cells that produce 300 kW of power. ➢ The fuel cells provide baseload power, and the solar array adds peak power, at two headquarters buildings housing offices, data centers and labs ➢ The fuel cells presently use natural gas, but could use biogas in the future
What Cypress Semiconductor is saying about fuel cells:	*"In the course of doing business, it sometimes becomes necessary for a company to rethink the bonds that have connected it to other organizations. Until now, the monthly electric bill was seen by California businesses as one of life's certainties. That is no longer the case, thanks to more affordable renewable energy options."* **– T.J. Rodgers, Founder, President and CEO Cypress Semiconductor Corp.** [181]
Benefits:	• The three 100-kW Bloom Energy Servers are expected to pay for themselves in five years, at which point they will be generating nearly "free" electricity for Cypress.

[181] http://www.greentechmedia.com/articles/read/energy-indepence-declared-at-cypress-with-sunpower-and-bloom

Appendix 1. Fuel Cell-Powered Forklifts in North America

ORANGE HIGHLIGHT = ENTIRE MATERIALS HANDLING FLEET IS FUEL CELL-POWERED AT THIS LOCATION

*** = AMERICAN RECOVERY AND REINVESTMENT ACT FUNDING*

N/A = INFORMATION UNAVAILABLE

Company	Location	Site	Year Deployed	# of forklifts
Ace Hardware	n/a	n/a	n/a	6
Bridgestone-Firestone	Aiken County, SC	Manufacturing plant	2008, more added in 2009	43
	Warren County, TN	Manufacturing plant	n/a	n/a
Central Grocers	Joliet, IL	New distribution center	2008, more planned in 2010	220
Coca-Cola	Charlotte, NC	Bottling facility	Planned in 2010	40
Defense Logistics Agency / US Department of Defense	Susquehanna, PA	Distribution depot	2009	40
	Warner Robins, GA	Distribution depot	2010	20
	San Joaquin, CA	Distribution depot	Planned in 2011	20
	Fort Lewis, WA	Distribution depot	Planned in 2010	19
East Penn Manufacturing	Topton, PA	Manufacturing facility	n/a	10
FedEx	Springfield, MO	Service center	2010	35**
	Toronto, ON, Canada	Logistics hub	n/a	n/a
GM	Canada	Car assembly plant	n/a	19
	Oshawa, ON, Canada	Car assembly plant	2005	2
H-E-B	San Antonio, TX	Perishables distribution center	2009	14**
ISOLA Laminates	Ridgeway, SC	Warehouse	2007 completed	2
Kimberly-Clark	Graniteville, SC	Distribution center	Planned	25**
Leigh Fibers	Spartanburg, SC	Warehouse	2007 completed	2
Martin-Brower	Stockton, California	Food distribution Center	Planned	15
Michelin	Columbia, SC	Manufacturing plant	2007 completed	2
Nestlé Waters	Dallas, Texas	Bottling facility	2009	32

New United Motor Manufacturing, Inc. (joint-owned by GM and Toyota)	Fremont California	Manufacturing plant	2007	n/a
Nissan North America	Smyrna, TN	Assembly plant	2009	60
	Smyrna, TN	Assembly plant	2007	n/a
Ozburn-Hessey Logistics	Smyrna, TN	Warehouse	2005	4
PBR	West Columbia, SC	Warehouse	2007, completed	2
The Raymond Corp.	Greene, NY	Manufacturing facility	2007	n/a
Super Store Industries	Lathrop, CA	Warehouse freezer	2009	n/a
Sysco	Houston, TX	Distribution center	Planned	98**
	Philadelphia PA,	Distribution center	Planned	95
	Vancouver, BC, Canada	Distribution center	n/a	n/a
	Canton, MI	Distribution center	n/a, completed	30
	Grand Rapids, MI	Distribution center	n/a, completed	11
United Natural Foods, Inc.	Sarasota, FL	Distribution center	Planned in 2010	65
US Foodservice	Livermore, CA	Distribution facility	Planned	40
Walmart	Balzac, AL, Canada	New refrigerated distribution center	Planned in 2010	60-75
	Washington Court House, OH	Food distribution center	2007	55
	OH	Two distribution centers	2006	12
	MO	Distribution center	2005	4
Wegmans	Pottsville, PA	Warehouse	2010	59**, more planned (entire fleet)
Whole Foods Market	Landover, MD	Distribution center	2010	61**

Appendix 2. American Recovery and Reinvestment Act Recipients, awarded April 2009[182]

FedEx Freight East (Harrison, AR)
This project will deploy 35 fuel cell systems as battery replacements for a complete fleet of electric lift trucks at FedEx's existing service center in Springfield, Missouri. Success at this service center will lead to further fleet conversions at some or all of FedEx's other 470 service centers. **$1.3 million**
Jadoo Power (Folsom, CA)
Jadoo, together with Acumentrics Corporation, NASCAR Media Group, Lynch Diversified Vehicles, California's Police and Fire Departments of the City of Folsom, and Airgas, Inc., will establish the environmental and cost benefits of using a 1-kW fuel cell power system to generate electricity, as opposed to traditional gas/diesel generators and lead acid battery power sources. This demonstration will provide operating data from each field unit at customer sites, as well as degradation analysis and projected system lifetime. **$1.8 million**
University of North Florida (Jacksonville, FL)
The objective of this project is to further integrate and miniaturize the components of a portable power system for use in mobile computing, and analyze failure modes to increase durability. UNF will also conduct a design for manufacturability and assembly review to ensure that the systems meet the cost targets for commercialization. **$2.5 million**
Nuvera Fuel Cells (Billerica, MA)
To accelerate market penetration of fuel cells, Nuvera will deploy 14 fuel cell forklifts in one of HEB's distribution facilities in San Antonio, TX. Fuel will be supplied by Nuvera's natural gas reformer, storage, and dispensing system. **$1.1 million**
Delphi Automotive (Troy, MI)
Delphi will develop, test and demonstrate a 3- to 5-kW solid oxide fuel cell (SOFC) auxiliary power unit (APU) for heavy duty commercial class 8 trucks at their laboratory in Rochester, NY. The demonstration will improve upon Delphi's current generation SOFC technology by increasing net output power and fuel processing efficiency, decreasing heat loss and parasitic power loss, and establishing diesel fuel compatibility. **$2.4 million**
MTI MicroFuel Cells (Albany, NY)
To accelerate fuel cell use in consumer markets, MTI will demonstrate a one-watt consumer electronics power pack. The project will focus on improving reliability to meet the standards required by the electronics market and will include testing of individual components, subsystems and complete direct methanol fuel cell systems. MTI will also develop manufacturing processes

[182] http://www1.eere.energy.gov/hydrogenandfuelcells/awards.html

to improve product yields and reduce overall costs. **$2.4 million**

Plug Power, Inc. (Latham, NY)

This demonstration project will validate the durability of Plug Power's 5-kW stationary combined heat and power fuel cell system and verify its commercial readiness. Plug Power will carry out a three-year project to test its units in residential and light commercial applications in Orange County, California. **$3.4 million**

Plug Power Inc. (Latham, NY)

This project will demonstrate the market viability of the GenCore® rack-mounted fuel cell product that provides clean and highly reliable emergency backup power. Plug Power will install and operate new systems in real-world applications at geographically-diverse sites, providing for as much as 275 kW of backup power. **$2.7 million**

GENCO (Pittsburgh, PA)

This project will deploy over 350 fuel cell systems as battery replacements for fleets of electric lift trucks at five of GENCO's existing distribution centers (Coca Cola in Charlotte, NC; Kimberly Clark in Graniteville, SC; Sysco Foods in Philadelphia, PA; Wegmans in Pottsville, PA; Whole Foods in Landover, MD). Success at these distribution centers will lead to further fleet conversions at some or all of GENCO's other 109 distribution centers. **$6.1 million (six awards)**

Sysco of Houston (West Houston, TX)

Sysco will deploy 90 fuel cell systems as battery replacements for a fleet of pallet trucks at Sysco's new distribution center in Houston, Texas, opened in March 2010. This installation will be the first ever green field installation in the world without battery infrastructure for a pallet truck fleet. Success at this distribution center will lead to further fleet conversions at some or all of Sysco's other 169 distribution centers. **$1.2 million**

Sprint Communications (Reston, VA)

Sprint Nextel will demonstrate the viability of packaged 1-kW to 10-kW fuel cell systems with 72 hours of on-site fuel storage for backup power to communication infrastructure used by state and local first responders and by public safety answering points (911 centers). Sprint will address siting and permitting issues, and will benchmark the lifecycle costs, performance, and operational characteristics against the incumbent technologies (batteries, generators, and diesel fuel). **$7.3 million**

ReliOn Inc. (Spokane, WA)

ReliOn will add reliability to a utility communications network where no backup power was previously available at 205 sites nationwide. They will deploy 180 fuel cells with a new refillable 72-hour fuel system to locations across the AT&T Mobility Network, and an additional 25 with PG&E. This project will provide DOE with installation, fueling logistics, and operating data for fuel cells in voice and data communications networks in mountain, desert, and urban locations. **$8.6 million (two awards)**

Appendix 3. Additional Resources

Fuel Cells 2000

Fuel Cells 2000 is a non-profit education and outreach program of the Breakthrough Technologies Institute and offers numerous resources on its website, www.fuelcells.org, for any audience.

In addition to the basics such as how a fuel cell works, applications, benefits, image galleries, Fuel Cell Library, conference presentations and a free monthly Technology Update, the website includes:

- State Fuel Cell and Hydrogen Database, which includes all US fuel cell installations, vehicle demonstrations, hydrogen fueling stations and state legislation and policies, including tax credits and grants: www.fuelcells.org/info/statedatabase.html
- Worldwide Stationary Installation Database: www.fuelcells.org/info/databasefront.html
- Comprehensive charts, including Fuel Cell Vehicles, Specialty Vehicles, Fuel Cell Buses, Hydrogen Fueling Stations (U.S. and World) and Fuel Cell Equity and Investment: www.fuelcells.org/info/charts.html
- An interactive map and list of Colleges and Universities with fuel cell degrees, courses or research: www.fuelcells.org/ced/career/university.htm
- A report on Worldwide Hydrogen Bus Demonstrations, 2002-2007: www.fuelcells.org/info/busreport.pdf
- Fuel Cell Matchmaker, a free networking and job board: www.fuelcells.org/mm.html
- Links to other resources: www.fuelcells.org/info/links.html

U.S. Fuel Cell Council

The U.S. Fuel Cell Council (USFCC) is the trade association for the fuel cell industry. The USFCC has several useful charts, brochures and information on its website, www.usfcc.com, including:

- Industry Overview 2010
- Chart of Commercial Products
- Fuel Cells for Stationary Power brochure
- Federal Tax Credit Q&A

Database of State Incentives for Renewables & Efficiency

DSIRE provides information on state, local, utility and federal incentives and policies that promote renewable energy and energy efficiency. Established in 1995, DSIRE is financed by the U.S. Department of Energy and managed by the N.C. Solar Center and the Interstate Renewable Energy Council. www.dsireusa.org

U.S. Department of Energy's Fuel Cell Technologies Program

The U.S. Department of Energy (DOE) Fuel Cell Technologies Program supports research addressing the technological, economic, and institutional obstacles to the widespread commercialization of fuel cells and related technologies. The program works with partners in industry, academia, non-profit institutions, and the national labs, and coordinates closely with other programs in four DOE offices—Energy Efficiency and Renewable Energy, Science, Fossil Energy, and Nuclear Energy.

The mission of the program is to enable the widespread commercialization of fuel cells in diverse sectors of the economy—with emphasis on applications that will most effectively strengthen our nation's energy security and improve our stewardship of the environment. http://www1.eere.energy.gov/hydrogenandfuelcells

U.S. Department of Energy Fossil Energy Program

The U.S. Department of Energy's Office of Fossil Energy is partnering with several fuel cell developers to develop the technology for the stationary power generation sector through the Solid State Energy Conversion Alliance (SECA). http://fossil.energy.gov/programs/powersystems/fuelcells/index.html

U.S. Department of Defense

The DoD has played a significant role in the development of fuel cells for power generation. The U.S. Army Corps of Engineers, the Engineer Research and Development Center (ERDC) and Construction Engineering Research Laboratory (CERL), installed and evaluated 30 phosphoric acid CHP systems between 1994 and 1997. Many of the units listed in this report have since been decommissioned. The ERDC-CERL program also managed a PEM demonstration project, which focused on 5-kW units; and the Climate Change Rebate Project, which provided up to $1,000 per kW of power plant capacity up to one-third of the project cost. ERDC-CERL now manages a Backup Demonstration Overview.

The DoD website - http://dodfuelcell.cecer.army.mil/index.php - has information about all of the programs, sites and installations, including contact information, images and final reports where submitted. Also see our Appendix 2, summarizing DoD fuel cell installations.

Fuel Cell Manufacturers Listed In This Report

Altergy Systems:	www.altergysystems.com
Ballard Power Systems:	www.ballard.com
Bloom Energy:	www.bloomenergy.com
ClearEdge Power	www.clearedgepower.com
Dantherm Power:	www.dantherm-power.com
FuelCell Energy:	www.fuelcellenergy.com
Hydrogenics:	www.hydrogenics.com
IdaTech:	www.idatech.com
Nuvera Fuel Cells:	www.nuvera.com
Oorja Protonics:	www.oorjaprotonics.com
P21 GmbH:	www.p-21.de
Plug Power:	www.plugpower.com
ReliOn:	www.relion-inc.com
UTC Power:	www.utcpower.com

Many other fuel companies are offering products to early markets. For a complete list, visit www.fuelcells.org/info/fcdevel.html

Hydrogen Infrastructure Companies Listed In This Report

Air Products and Chemicals, Inc.:	www.airproducts.com
Linde North America LLC:	www.linde.com

For more information about any of the information included in this report, please contact Fuel Cells 2000 at info@fuelcells.org.