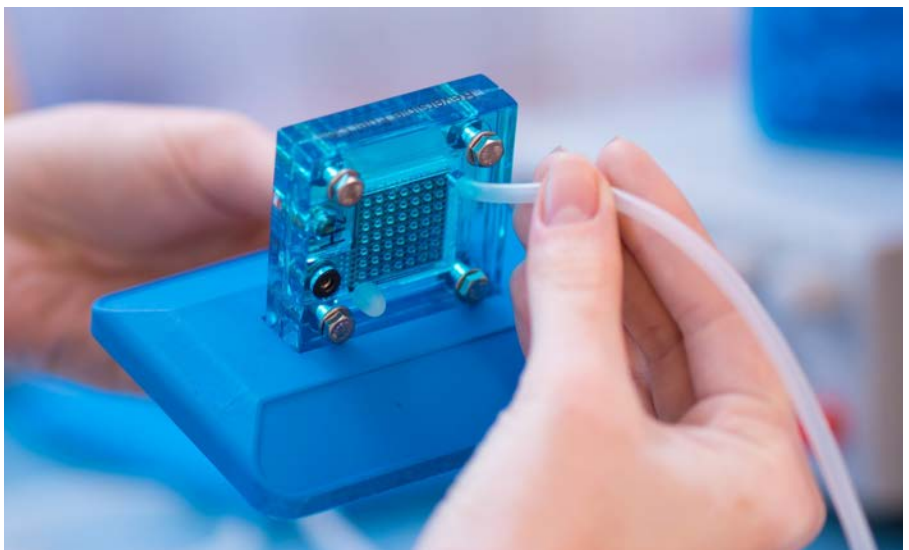


## Fuel Cells for Stationary Power Applications

Fuel cells generate electricity through a mechanism that doesn't require combustion. This means they produce fewer pollutants than conventional, combustion-based power generation technologies. Fuel cells are also highly efficient, producing more power per unit of fuel. As a result, fuel cells offer an alternative to traditional power generation with significant health, reliability and environmental benefits.



Fuel cells can be used for many purposes, including as stationary power units for primary power, backup power, or combined heat and power (CHP). Because stationary fuel cells can be sized to power anything from a laptop to a single family home or even larger needs (200 kW and higher), they make sense for a wide range of markets including retail, data centers, residential, telecommunications, and many more.

### BENEFITS OF FUEL CELLS

- **EFFICIENCY** – Hydrogen-powered fuel cells are two to three times more efficient than traditional combustion technologies. A conventional combustion-based power plant typically generates electricity at efficiencies of around 35 percent, while fuel cell systems can easily generate electricity at efficiencies up to 60 percent (and even higher with cogeneration).
- **FUEL FLEXIBLE** – Fuel cells can be powered by natural gas, biogas, and renewable power such as solar and wind.
- **LOW MAINTENANCE** – Fuel cells require less maintenance (e.g., oil changes, etc.) than traditional combustion engines since there are so few moving parts.
- **QUIET** – Fuel cells operate at very low noise levels.
- **EMISSIONS AND AIR QUALITY BENEFITS** - Using hydrogen as a form of energy can not only reduce our dependence on imported oil, but also benefit the environment and air quality by reducing emissions.

✓ **Efficient**
✓ **Uses domestic fuels**

**Combustion-based**  
POWER PLANTS

**Fuel cell-based**  
POWER PLANTS

**Efficiency**

- Natural gas
- Biomass
- Water (electrolysis)
- Waste Products

✓ **Reliable**
✓ **Quiet**
✓ **Clean**

Non-stop backup power  
in emergencies

No noise in operation

Zero tailpipe emissions

✓ **Versatile and easily scalable**

*Graphic credit Department of Energy.*

## Applications

### Primary Power

Fuel cells are compatible with other conventional and renewable primary power sources on both the customer and utility side of the meter to create optimal energy systems. The always-on nature of fuel cells provides reliability and can be used to fill intermittency gaps. For example, stationary fuel cells can be co-located with resources such as wind turbines, solar panels, or batteries at discrete customer sites, like retail stores or corporate campuses.

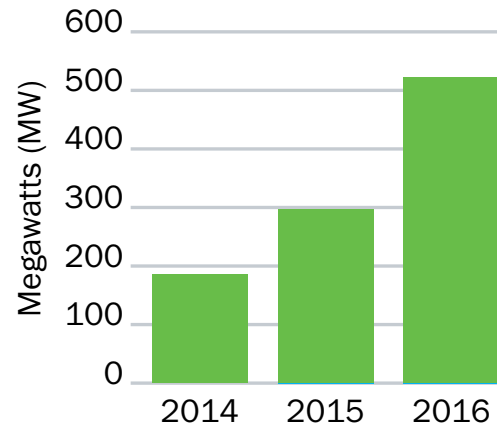
### Backup Power

Recognizing the vulnerabilities of grid dependency, organizations are looking at fuel cells as an attractive option for reliable backup power. After Hurricane Sandy slammed the Caribbean and the East Coast in 2012, fuel cells provided emergency backup power to telecommunications towers operating for hundreds of hours in both the Bahamas and the Northeast United States. Fuel cells can offer significant cost advantages over battery-generator systems when shorter run-times of three days or less are sufficient. As part of an interagency partnership, the DOE and U.S. Department of Defense are also testing how fuel cells perform in real world operations, identifying improvements manufacturers could make to enhance the value proposition, and highlighting the benefits of fuel cells for various applications. Roughly 200,000 fuel cells have been deployed in Japan and major companies like Panasonic are emerging as leading suppliers of fuel cells for residential or backup power.

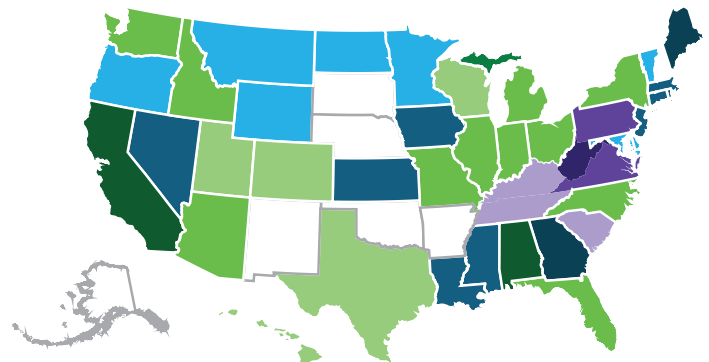
### Combined Heat and Power

Fuel cells are often implemented as part of a CHP system, where the thermal energy from the fuel cell exhaust is recovered and used to heat or cool industrial facilities, district energy systems and commercial buildings. The CHP configuration can increase overall system efficiency and reduce emissions of carbon dioxide and other pollutants by decreasing boiler operations. Thermal energy recovered from fuel cells is most often used to satisfy hot water or space heating demands, although in some cases fuel cells have been integrated with absorption chillers to provide space cooling.

## Megawatts of Fuel Cells Shipped Worldwide



## Fuel Cells are Used for Backup Power IN MORE THAN 40 STATES



- Telecom, Government, Railroad, Utility sites
- Telecom, Government, Railroad sites
- Telecom, Government sites
- Government, Railroad, Utility sites
- Telecom sites
- Government sites
- Railroad sites
- Utility sites
- Government, Railroad, sites
- Telecom, Railroad sites

Source: DOE State of the States: Fuel Cells in 2016 Report

## Stationary Power Users

Fuel cell customers include computing organizations, government agencies, retail and warehouse operations, utilities, and telecommunications companies. This list of fuel cell customers continues to grow as more municipal and corporate entities realize that transitioning from the grid to clean, onsite power production has many benefits, including lower energy costs, improved efficiency, guaranteed resiliency, and reduced emissions. Fuel cells now provide power in stationary or mobile applications in at least 43 states<sup>1</sup>.



Hospitals

Backup power is critical in hospitals, where patients' lives could be threatened if power is lost for life support, operating rooms, and medicine refrigeration. During the aftermath of Hurricane Katrina, generators failed or ran out of fuel at four hospitals, necessitating extraordinarily difficult evacuation efforts via boat and helicopter.



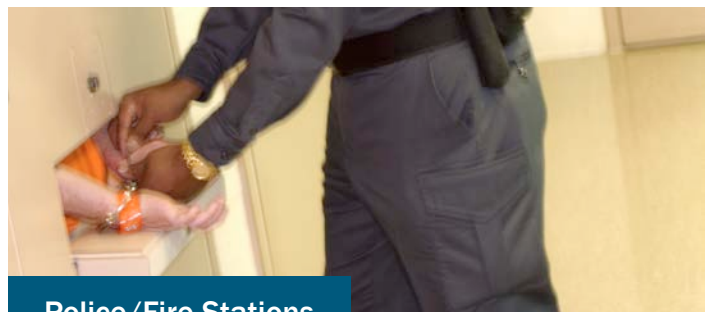
Data Centers

Wireless networks and data centers require an uninterrupted supply of high-quality electricity. A 2012 study estimated that companies lose an average of \$138,000 for every hour their data center is offline, and companies with more than 1,000 employees lose an average of \$1.1M per year.<sup>2</sup>



Grocery and Retail Stores

Grocery stores can suffer substantial losses in spoiled produce and other perishables if grid power is lost for an extended time. Several supermarket chains have invested in fuel cell backup systems at some of their new stores, hoping to mitigate the financial impact of losing power.



Police/Fire Stations

For more than a decade, the New York City Central Park Precinct has had a 200 kW fuel cell on site. The police station was the only building in the area to retain power during the massive blackout that hit the Northeast in 2003. The fuel cell system also saved the police station \$200,000 in capital costs by avoiding the installation of power line extensions.

<sup>1</sup> State of the States: Fuel Cells in America 2015, 6th Edition. U.S. Department of Energy Fuel Cell Technologies Office, December 2015, p 2. ([http://energy.gov/sites/prod/files/2015/12/f28/fcto\\_state\\_of\\_states\\_2015.pdf](http://energy.gov/sites/prod/files/2015/12/f28/fcto_state_of_states_2015.pdf))

<sup>2</sup> Aberdeen Group

<sup>3</sup> Acquired by Plug Power

## Market Transformation

In 2009, three stationary power projects were awarded \$18.5M in American Reinvestment and Recovery Act funding through the U.S. Department of Energy's Fuel Cell Technologies Office in the Office of Energy Efficiency and Renewable Energy for fuel cell deployments in backup power to ReliOn, Inc.<sup>3</sup>; Sprint Nextel; and Plug Power, Inc. ReliOn (with fuel cell deployments at AT&T and Pacific Gas & Electric sites) and Sprint have demonstrated the technical and economic viability of deploying 1 kW to 10 kW polymer electrolyte membrane (PEM) fuel cells with 72 hours of on-site fuel storage to provide backup power for critical cell phone tower sites and utility networks. Data collected from the National Renewable Energy Laboratory showed over 99.5% reliability of the fuel cells.

Based on the success of these projects, more than 7,600 fuel cells for emergency backup power have been installed or are on order with no DOE funding.

The Office of Energy Efficiency and Renewable Energy's Fuel Cell Technologies Office supports early stage R&D in fuel cells for multiple applications. ■

**235MW+**

in

**STATIONARY  
FUEL CELL POWER**  
installed

**8,000**

**BACK UP  
POWER UNITS**  
are deployed or  
on order

**\$1.6  
Billion**

**IN ANNUAL FUEL  
CELL REVENUE**

**60,000**

**FUEL CELL  
UNITS**  
shipped annually  
worldwide



The new World Trade Center is using fuel cells

U.S. DEPARTMENT OF  
**ENERGY**

Office of  
**ENERGY EFFICIENCY &  
RENEWABLE ENERGY**

For more information, visit:  
[energy.gov/eere/fuelcells](http://energy.gov/eere/fuelcells)

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