RESILIENT POWER CASE STUDY SERIES

FUEL CELLS FOR CELL PHONE TOWERS

Fuel Cells Keep Mobile Communications Services Running

Power outages at cell phone towers can impact service for thousands of customers, as was seen during Hurricane Irene in 2011. The storm wiped out power to 6,500 cell towers along the East Coast, leaving more than 1 million people without cell phone service. Vermont reported the highest rate of service loss among all affected states, at 44 percent, with Connecticut and Rhode Island following at 35 percent and 31 percent, respectively. As cell phones increasingly replace landline phones, a loss of cell service can cut off access to emergency services like 9-1-1, and that can hinder the ability of first responders to effectively respond to a disaster.

Most cell phone towers run on electricity from the grid, although they often also have onsite backup power, like diesel generators or batteries. But as Hurricane Irene demonstrated, these backup systems sometimes fail. In contrast, there were many cell phone towers that continued to function during Hurricane Irene because they were powered by fuel cells. For example, ReliOn fuel cells provided seamless backup power at 56 Sprint cell towers, where grid outages averaged 16 hours per site, with one outage lasting 50 hours. Today, more than 6,000 fuel cell systems have been installed at cell phone towers across the United States, including at towers owned by Sprint, T-Mobile, Verizon, and AT&T.

© Plug power

Fuel cells at communications towers provide reliable mobile communications services for emergencies, as was seen in Hurricane Irene in 2011.

Technology Overview

Fuel cell systems at cell phone towers include a range of technology and fuel types. Ballard Power Systems, for example, has installed its 5-kW ElektraGen ME proton membrane exchange fuel cells, powered by a mixture of methanol and water, at cell towers across the Bahamas. These fuel cells provided reliable power during widespread outages caused

OVERVIEW

FACILITY TYPE
Cell Phone Towers

TECHNOLOGY
Hydrogen, Solid Oxide, Proton Exchange Membrane Fuel Cells

FUEL
Hydrogen, Methanol, Natural Gas

CAPACITY
5, 10, 15 kW

YEAR INSTALLED
Varies

LOCATION
Nationwide

PROJECT PARTNERS
US Dept. of Energy, Ballard, and ReliOn

ReliOn fuel cells provided seamless backup power at 56 Sprint cell towers, where grid outages averaged 16 hours per site, with one outage lasting 50 hours.

by Hurricane Sandy in 2011, while diesel generators at other cell towers failed. AT&T uses hydrogen fuel cells as backup power at 431 sites in its mobile network. Sprint has installed several hundred backup power fuel cell systems at cellular towers with public and private funds.

Fuel cells are a great technology solution for cell phone towers because they can be sited in harsh terrain, extreme climates, and rural areas, and they have the benefit of operating for days without intervention.

Environmental Benefits

AT&T's fuel cells are part of the company's mission to reduce its environmental impact and dependence on fossil fuels. Compared to conventional electricity generation, fuel cells reduce emissions of nitrous oxides and sulfur dioxide, which contribute to the production of acid rain and smog, greenhouse gases that contribute to global climate change, and reduce emissions of particulate matter, which are small particles and droplets that can be inhaled deep into the lungs and cause human health problems.

As storms increase in severity and frequency, it is good to know that fuel cell technology is available to keep cell phone communications up and running during a power emergency.

More than 6,000 fuel cell systems have been installed at cell phone towers across the United States. © ReliOn

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RESILIENT POWER CASE STUDY SERIES

FUEL CELLS FOR EMERGENCY RESPONDERS

A New York City Police Precinct Turns to Fuel Cells

This series covers several examples of fuel cells used in facilities that must continue to operate even during a power outage, such as hospitals and public emergency shelters. But municipal departments and emergency first responders are also important parts of emergency response.

A great example of fuel cells in this setting was the Central Park Precinct of the New York City Police Department. Though the fuel cell is no longer operational, it was installed in 1999 as a cost-effective option for providing power to this remote facility. But it wasn't until the New York City blackout of 2003 that the fuel cell showed its full value.

On August 14, 2003, at 4:39pm, a software bug caused the world's second largest blackout. More than 14.3 million people in New York City and surrounding areas alone lost power. Transportation, communications, waste-water treatment, and other critical services went down, and 9-1-1 services even went down several times.

A fuel cell power plant at New York Police Department's Central Park Precinct kept the building powered for emergency response during the 2003 blackout that affected 14.3 million people. © BigStock Photos

OVERVIEW

FACILITY TYPE
Police Station

TECHNOLOGY
Hydrogen Fuel Cell

FUEL
Natural Gas

CAPACITY
200kW

YEAR INSTALLED
1999

LOCATION
Central Park, Manhattan, New York

PROJECT PARTNERS
New York Power Authority, US Departments of Defense and Energy, ONSI Corporation/ Doosan

The Central Park Station remained fully operational during the blackout. Staff at the facility didn't even know about the blackout until they looked outside and saw all the lights were off.

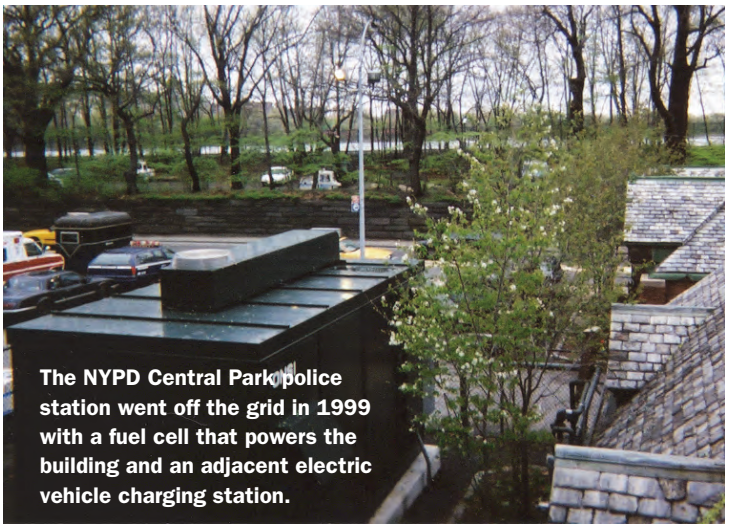
But the Central Park Station remained fully operational during the blackout. Staff at the facility didn't even know about the blackout until they looked outside and saw all the lights were off, according to Detective Walter Burnes.[1] With its fuel cell supplying uninterrupted power, the Central Park Station was able to supply its full range of emergency response, which was critical during the blackout as city officials added 1,000 firefighters, 50 ambulances, and hundreds of paramedics and dispatchers to handle the emergency.

Technology Overview

The Central Park Precinct's 200-kW fuel cell, manufactured by ONSI Corporation[2] of South Windsor, Connecticut, is powered by natural gas and generates electricity through an electrochemical reaction rather than combustion. It generates enough power to run all of the facility's office and electrical equipment, a new electronic booking system, and air conditioning; in addition, the waste heat it generates is captured to heat the station in the winter. The fuel cell also produces enough energy to run an electric vehicle charging station adjacent to the building.

Environmental Benefits

There are several environmental benefits associated with the fuel cell power plant in Central Park. The installation of this technology has reduced the carbon emissions of the precinct by 1,100 tons per year, thereby reducing the facility's impact on global climate change. The fuel cell also saves 4 million gallons of water for every 1 MW of electricity generated, according to the fuel cell's manufacturer. The emissions of critical air pollutants are also reduced, like nitrous and sulfur oxides, both of which contribute to the formation of acid rain and smog, by 40,000 pounds each year.



The NYPD Central Park police station went off the grid in 1999 with a fuel cell that powers the building and an adjacent electric vehicle charging station.

© FCHEA

Other Benefits

In addition to its resilient power and environmental benefits, the installation of this fuel cell has also cut the cost of providing police services to the city. The fuel cell was paid for with the assistance of grant money from the U.S. Departments of Defense and Energy.

The fuel cell installation at the Central Park Station proves that fuel cells can provide needed power 24x7, 365 days per year, and can be invaluable during a power emergency or grid-disrupting natural disaster.

1 "During the Blackout, One NYC Police Station Kept its Cool", *PureCell Solution Case Study.* *www.fuelcellmarkets.com/content/images/articles/PP0103_CentralPark.pdf*

2 ONSI Corporation is now operating as Doosan Fuel Cell America.

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RESILIENT POWER CASE STUDY SERIES

FUEL CELLS IN HOSPITALS

Fuel Cells Help Provide Life-Supporting Services

Hospitals provide critical medical technology and support for their patients, such as life support, operating rooms, and refrigerated blood and medicine. They must be able to deliver these services even when the power goes out. Because of this, hospitals are required to have 24 hours of back-up power on-site. Most accomplish this with diesel-powered rooftop generators. But this technology is prone to failure, as was seen at hospitals and nursing homes in Louisiana during Hurricane Katrina in 2005 and throughout the Northeast during Superstorm Sandy in 2011.

At Johnson Memorial Center in Stafford, Connecticut, for example, 43 critically ill patients, including those in intensive care, had to be evacuated during Superstorm Sandy when the hospital's back-up diesel generator failed. New York University Langone Medical Center, in New York City, also had to perform a harrowing evacuation of 200 patients during Superstorm Sandy when its backup generators began to fail. Throughout the storm, critical units like the emergency rooms, labor and delivery rooms, and refrigeration lost power. Babies and critically ill patients were evacuated first, including 20 babies from neonatal intensive care, some of whom had to be placed on battery-powered respirators. Critically ill patients were carried down as many as 13 flights of stairs because elevators could not function without electricity, and nurses were manually squeezing bags of oxygen to replace respirators that were without power.

As a result of the widespread and catastrophic failure of diesel generators during recent storms, hospital administrators in the Northeast have looked for more reliable ways to provide emergency backup power, and several have turned to fuel cells. St. Francis Hospital in Hartford, Connecticut installed a 400-kW fuel cell at its Mount Sanai campus in 2012. This was its second fuel cell; a 200-kW unit was installed on its main campus in 2003, which was later upgraded to a 400kW unit. In 2013, Hartford Hospital installed a 1.4-MW fuel cell.

Technology Overview

The fuel cell at St. Francis Hospital's main building, a Power PC25 that was provided by UTC Power[1] of South Windsor, Connecticut, meets 10 percent of the facility's electrical needs. The newer PureCell Model 400 fuel cell at the Mount Sanai campus meets 42 percent of that building's electrical needs. Importantly, the fuel cells provide backup power to the operating

1 UTC Power is now operating as Doosan Fuel Cell America.

OVERVIEW

FACILITY TYPE
Hospital

TECHNOLOGY
Hydrogen Fuel Cells

FUEL
Natural Gas

CAPACITY
400kW–1.4MW

YEAR INSTALLED
2003–2013

LOCATION
Connecticut

PROJECT PARTNERS
Hartford Steam Company, Low Emission Renewable Energy Credits Program, UTC Power/Doosan, Fuel Cell Energy, Inc.

Superstorm Sandy caused power outages at hospitals across the northeastern United States, leading to the evacuations of hundreds of patients. Several hospitals have now installed fuel cells to provide backup power for critical services like operating rooms, labor and delivery rooms, intensive care, and refrigeration for medicine and blood.

room among other critical energy loads, but other, non-critical loads are dropped during grid outages. Both buildings are also heated by the by-product heat generated by the fuel cells. The fuel cells save the hospital $10,000 per year on electricity costs.

The 1.4-MW DFC1500 fuel cell at Hartford Hospital, which was provided by Danbury, Connecticut-based FuelCell Energy Inc., provides 60 percent of the hospital's power needs, and the by-product heat provides all of the building's space heat. When excess heat is generated, it is sent to a nearby school that is connected to the same heat distribution system. It was installed at no upfront cost to the hospital, and is owned and operated by Hartford Steam Company, which sells the electricity and heat to the hospital under a long-term power purchase agreement. Hartford Steam receives renewable energy credit payments for producing this clean power through Connecticut's Low Emission Renewable Energy Credits (LERC) program.

Environmental Benefits

Fuel cells create energy through an electrochemical reaction. Because no combustion is involved, fuel cells reduce the emissions of dangerous air pollutants. The fuel cells at St. Francis Hospital's two campuses are reducing annual emissions of nitrous oxides (NOx) by 826 pounds, and sulfur dioxide (SO2) by 3,201 pounds per year. Both of these pollutants contribute to acid rain and smog formation. Emissions of greenhouse gases by the hospital, which contribute to global climate change, have been reduced by 122 tons per year.

Four hospitals in Connecticut, including Hartford Hospital, use fuel cells to provide backup power to critical services like operating rooms, respirators, and medicine refrigeration. © BigStock Photos

The fuel cell at Hartford Hospital is reducing the annual emissions of NOx by 57,000 pounds, and SO2 by more than 3,000 pounds. It is also reducing the emissions of greenhouse gases by 6,700 tons per year. Particulate matter—tiny particles and liquid droplets emitted during combustion that can be inhaled deep into the lungs causing human health problems—is a harmful byproduct of fossil fuel combustion. The fuel cell at Hartford Hospital has reduced particulate emissions by 3,000 pounds, as compared to traditional power plants.

Fuel cells are able to provide critical resilient power and reduce harmful emissions at locations where health care is a primary concern.

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FUEL CELLS FOR SCHOOLS

A School's Fuel Cell Saves Money and Provides Emergency Shelter

Hamden High School, in Connecticut, installed a fuel cell in 2011 to provide power to the facility during power outages. As a designated public emergency shelter, this school's technology selection was inspired by a similar story at another school in the state.

When South Windsor High School installed a fuel cell power plant in 2002, it was to save money and do something good for the environment. As a designated regional emergency shelter, the school was also required to have a back-up power system in place that can support the facility's critical loads when the electrical grid is down.

This fuel cell at South Windsor High School is no longer operational, but during its tenure it proved to be a valuable addition. In late October 2011, an unusually early storm dropped record amounts of snow, with more than 12 inches falling in the capital city of Hartford and as much as 24 inches in other parts of the state. The storm was accompanied by hurricane-strength wind. Heavy wet snow fell on trees that still had their leaves, causing record numbers of downed trees and power lines.

More than 830,000 people across the state suffered through power outages that lasted as many as 11 days in some areas. South Windsor High School facilities manager Patrick Hankard estimated that 85 percent of the town's residents were without power for a week or more during and after the storm, as reported in a CleanTechnica article.[1]

The school's fuel cell ran on natural gas, which is delivered through underground pipes and therefore typically much less susceptible to storm damage than electrical lines. Because of this, the school was able to supply itself with electricity and heat during the power outage. The school provided space for 200 people to sleep each night and served 600 hot meals over the course of the 3-day storm. A nurse's station was kept operational, hot showers were available, and power outlets were available to charge cell phones. "It was almost like a hotel," said Town Manager Matt Galligan in a Hartford Courant article.[2]

© Doosan

Using a fuel cell to provide electricity and heat has saved South Windsor High School $80,000 per year.

OVERVIEW

FACILITY TYPE
Public High School and Emergency Storm Shelter

TECHNOLOGY
Hydrogen Fuel Cell

FUEL
Natural Gas

CAPACITY
400kW

YEAR INSTALLED
2011

LOCATION
Hamden, Connecticut

PROJECT PARTNERS
US Dept. of Energy, Connecticut Green Bank, and UTC Power/Doosan

The school provided space for 200 people to sleep each night and served 600 hot meals over the course of a 3-day storm. A nurse's station was kept operational, hot showers were available, and power outlets were available to charge cell phones.

Technology Overview

Hamden High School's 400kW fuel cell, supplied by local company UTC Power, is a combined heat and power system. It meets 90% of the school's electrical demand and heats the school in the winter and the swimming pool year-round. The system has not yet had to weather a major storm like the one experienced at South Windsor High School, but is set up to do so when the time comes.

Environmental Benefits

The environmental benefits of the fuel cell are important to school administrators. Because the fuel cell is fueled by natural gas, which it uses to produce electricity and heat without combustion, the installation of this technology has reduced the carbon emissions of the school by 809 tons per year, thereby lowering the school's carbon footprint and reducing its impact on global climate change. Power generated by fuel cells also saves water, with 3.8 million gallons of water saved for every 1 MW of electricity generated. The emission of nitrous oxides, a contributor to the formation of acid rain and smog, has also been reduced by 3 tons each year.[3]

Other Benefits

South Windsor High School chose a fuel cell for its backup power source because it made financial sense while also benefiting the environment. Additionally, the fuel cell became a component of the curriculum, with real-time data collection that students monitored from their computers.[4]

Using the fuel cell to provide electricity for the school, heat the building, and pre-warm the water for the boiler also saved the school $80,000 per year. Because fuel cells are classified as renewable energy in Connecticut, the South Windsor High School has generated an additional $55,000 per year from renewable credits trading. As an added benefit, installing this technology at these schools supports an important part of the state's economy; more than 3,000 workers in Connecticut have jobs related to fuel cell production.

1 "Fuel Cell System Saves the Day in Connecticut in Wake of Winter Storm Alfred," *CleanTechnica*. Dec. 1, 2011. *http://cleantechnica.com/2011/12/01/fuel-cell-system-saves-the-day-in-connecticut-in-wake-of-winter-storm-alfred*

2 Gary D. LeBeau and John Harrity, "Take State's Fuel Cell Expertise to Next Level," *Hartford Courant*. Dec. 4, 2011. *http://articles.courant.com/2011-12-04/news/hc-op-lebeau-fuel-cells-have-arrived-1204-20111204_1_utc-power-east-hartford-fuel-cell-energy*

3 "Hamden High School to Generate Clean Power On-Site," *Bloomberg*, May 2, 2011. *http://www.bloomberg.com/apps/news?pid=conewsstory&tkr=UTX:US&sid=aPqFp1EaCicQ*

4 "South Windsor High School is Educating the Leaders of Tomorrow," *PureCell Solution Case Study*. *http://www.fuelcellmarkets.com/content/images/articles/PP0105_SWHS.pdf*

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