READINESS FOR RESILIENCE

Clean Energy Solution Case Studies

The Business Council for Sustainable Energy®

Joint Base San Antonio

DOE ENERGY SAVINGS PERFORMANCE CONTRACT FOCUSED ON RESILIENCY

AMERESCO
Green • Clean • Sustainable

Ameresco designed and is implementing 17 comprehensive energy conservation measures in over 900 buildings.

Location: Joint Base San Antonio, Texas: including Lackland main, Fort Sam Houston, Randolph, Kelly and Medina Annex**.**

DEMAND REDUCTION

- 140,000 LED upgrades; enhanced central plant control; upgraded distribution systems with enhanced controls; extended thermal storage capacity; and upgraded direct digital control system.

ONSITE ENERGY GENERATION

- Solar PV and CHP measures provide more than 20 MW of combined electricity generation annually, or 12% of the current electricity consumption, providing capacity for sustained electrical supply during utility outages.

JOINT BASE SAN ANTONIO
PARTNERSHIP IN EXCELLENCE

Joint Base San Antonio

DOE ENERGY SAVINGS PERFORMANCE CONTRACT FOCUSED ON RESILIENCY

AMERESCO
Green • Clean • Sustainable

ENERGY STORAGE SYSTEMS

- 4MW/8MWh energy storage systems provide reliable and fast responding power and can support islanding from the utility.

MICROGRID SOLUTIONS

- The microgrid system integrates advanced and intelligent load control systems, energy storage, and on-base generation assets to manage the JBSA Mission-determined prioritizing of loads based on the criticality of the mission to the AF and to JBSA operations in fulfillment of mission

IMPLEMENTATION PRICE:
$133.5 million

O&M CONTRACT OVER 22 YEARS:
$34.8 million

SAVED ANNUALLY:
$8.7 million

ELECTRIC ENERGY USE REDUCTION:
24%

To learn more, read this press release and visit: federal.ameresco.com/

Marine Corps Recruit Depot (MCRD)

AMERESCO
Green • Clean • Sustainable

Installation of new onsite energy systems by Ameresco will offset electricity purchases from the grid and will provide energy security and resiliency.

Location: Parris Island, South Carolina, to be completed summer 2019

DEMAND REDUCTION

- 29,000 high-efficiency LED based fixtures, upgrades to the controls system, heating ventilation and air conditioning, chillers, cooling towers, lighting controls, water fixtures and steam traps.

ONSITE POWER GENERATION

- New fully automated natural gas-fueled Combined Heat and Power (CHP) plant capable of producing 3.5 MW of electricity and the full steam load.

Marine Corps Recruit Depot (MCRD)

AMERESCO
Green • Clean • Sustainable

ENERGY STORAGE SOLUTIONS & MICROGRID SYSTEMS

- 10 MW of new onsite electrical generation to support the site's critical energy load and mission-critical systems.
- The microgrid system will include the new CHP plant, 6.7 MW-DC of solar photovoltaic generation assets integrated with an 8.0 MWh battery energy storage system and a microgrid control system capable of optimized dispatch and fast load shedding.

ESPC Contract:
$ 91.1 Million, Awarded 2017

SCOPE: 8,095 acres, 121 Buildings

EXPECTED SAVINGS:
Utility Energy Demand 79%,
Water Consumption: 27%

To learn more, read this press release and visit: federal.ameresco.com/

Portsmouth Naval Shipyard

AMERESCO
Green • Clean • Sustainable

Ameresco has been working with Portsmouth Naval Shipyard since 1998 on a three-phase ESPC to make much needed improvements to the shipyard's heating, cooling, electric and infrastructure. A microgrid enhances the security and reliability of electric service to the base. This partnership is helping the U.S. Navy to meet its energy, water and carbon dioxide reduction goals.

Location: Kittery, Maine

Project Description: Integrated microgrid, since 2015

- Includes Microgrid Control Systems (MCS) and Battery Energy Storage Systems with on-site generation, including a Combined Heat & Power Plant.
- Funded by the DOD's Environmental Security Technology Certification Program.
- Provides valuable ancillary services to the electric grid Independent System Operator, generating a potential new revenue stream for the U.S. Navy.

Total ESPC Project investment: $47.2 million
First year energy savings: $4.1 million

To learn more, visit the Ameresco project's page.

City of Hartford, CT

Climate Action Plan for Cleaner, Cheaper, More Reliable Energy

Bloomenergy®

Bloom Energy deployed a microgrid to power a community through power outages.

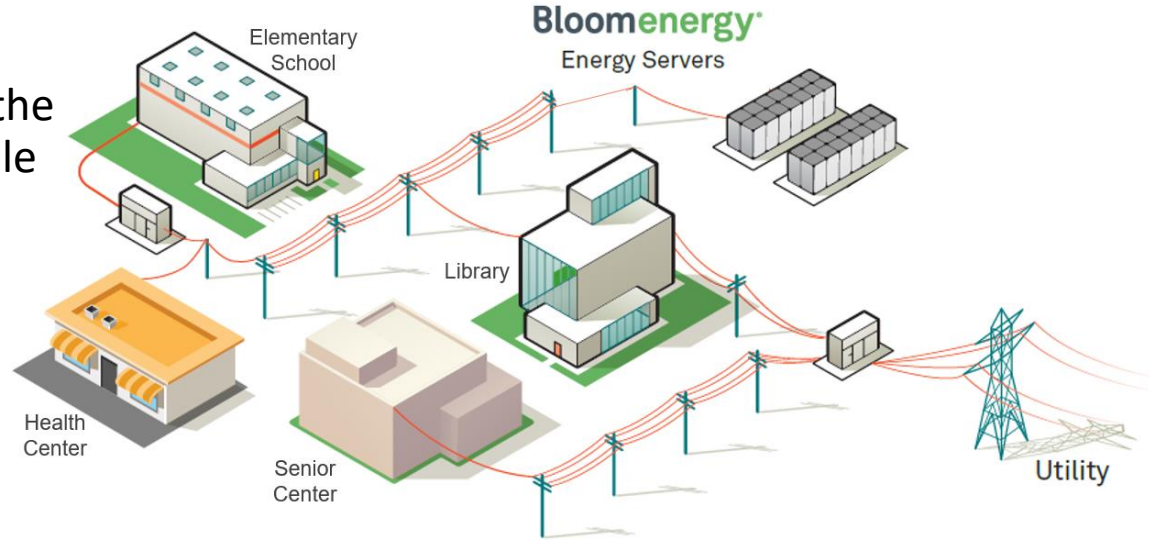
Location: Parkville neighborhood in Hartford, CT

MICROGRID DETAILS

- The Parkville neighborhood microgrid provides power 24/7. With the ability to disconnect from the grid during an outage, Parkville is able to continuously power critical facilities in the community.

PERFORMANCE

- The microgrid supports a supermarket, a gas station, a community center, and an elementary school. Since 2017, the system has supported the community through 7 power outages.



Bloom Energy Fuel Cells

- The systems is comprised of 800kW of Bloom Energy fuel cells. The fuel cells produce power 24/7 and can operate independent of the utility grid. Bloom systems have been proven through harsh winter storms, hurricanes and earthquakes.

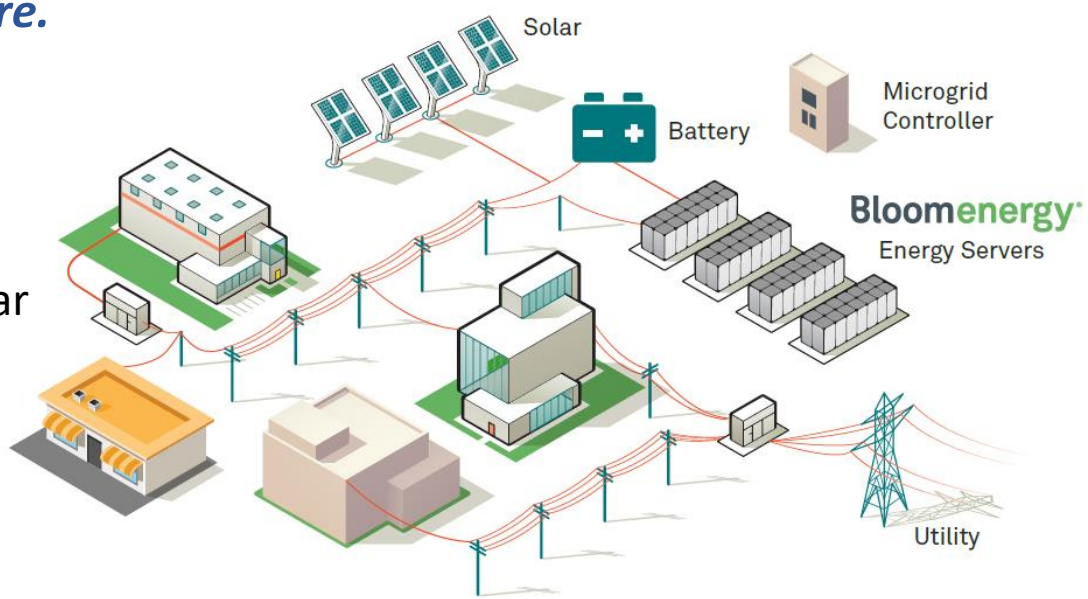
Keysight Technologies

California Manufacturer Microgrid

Bloomenergy®

Bloom Energy deployed a microgrid to power critical infrastructure.

Location: Santa Rosa, CA



MICROGRID DETAILS

- The microgrid provides high-quality power to sensitive production machinery and maintains business continuity through outages. Solar is integrated into the fuel cell-based microgrid.

PERFORMANCE

- During the 2019 CA fire season, the microgrid powered the facility through a 5.5 day outage.

Bloom Energy Fuel Cells

- The systems is comprised of 4.3MW of Bloom Energy fuel cells. 2.8MW of the system are considered Mission Critical. The fuel cells produce power 24/7 and can operate independent of the utility grid. Bloom systems have been proven through harsh winter storms, hurricanes and earthquakes.

Fuel Cells in Utility Microgrids: Woodbridge, Connecticut

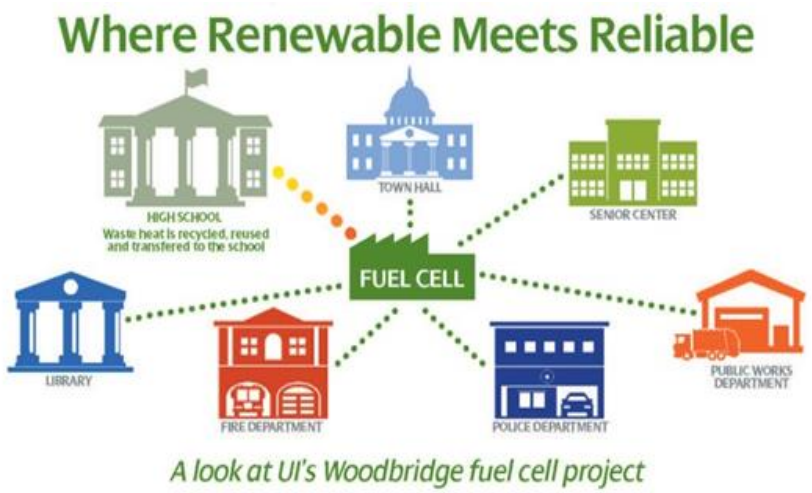
California Stationary Fuel Cell Collaborative
CaSFCC

United Illuminating (UI) has completed the Woodbridge microgrid, a project funded through Connecticut's Microgrid Pilot Program. A $3 million grant funded the project, which will power police, fire and shelter services during storms, blackouts and other emergencies.

Location: Woodbridge, Connecticut

- Fuel cell microgrid supplies grid and maintains power during outage for 6 critical town buildings
- 2.8 MW system has blackstart capability and provides heat to a local high school
- Critical loads are sequenced by microgrid controller and inverter follows microgrid load

For more information, read this project press release.



Large-Scale Fuel Cell Systems For Resiliency, Grid Services and Clean Air

California Stationary Fuel Cell Collaborative
CaSFCC

Utilities in both the U.S. and South Korea are embracing large-scale stationary fuel cell systems

Location	Utility	Size	Delivers
Bridgeport, Connecticut	Dominion Energy	14.9 MW	Resiliency and power for 15,000 homes
Newark, Delaware	2 Delmarva sub-stations	30 MW	Power for 22,000 homes
Brookhaven, New York	PSEG/ Long Island Power Authority	39.8 MW	Resilient combined cooling, heat and power and small footprint
Hwaseong City, South Korea	Gyeonggi Green Energy	59 MW	Supplies grid power and district heating, 5.2 acres
Daesan, South Korea	Hanhwa Energy, Korea East West Power	50 MW	Direct hydrogen for combined heat and power to local utility
Incheon, South Korea	KOSPO	20 MW	Combined Heat and Power
Busan, South Korea	Korea South East Power	30.8 MW	District heating and power for 71,500 homes

Fuel Cells for Campus Decarbonization

The University of California (UC) is a national leader in sustainability and is taking actions to reduce greenhouse gases, towards the UC system's goal of carbon neutrality by the year 2025. In 2014, at the UC Irvine Medical Center, FuelCell Energy installed a 1.4 MW fuel cell power plant and absorption chiller microgrid system.

Location: Irvine, California

Project Results:

- Generates ~30% of the facility's power needs
- Supplies 200 refrigeration tons of cooling (800 kW)
- Avoids the annual emission of:
  - 28 tons of nitrogen oxide (NOx)
  - 64 tons of sulfur dioxide (SOx)
  - 3,000 pounds of particulate matter (PM10)
  - 7,000 tons of CO2

For more information, please see this press release.

California Stationary Fuel Cell Collaborative
CaSFCC

Fuel Cells Provide Seamless Load Transfer & Backup Power in Connecticut

October 2012 Hurricane Sandy

- All 23 fuel cells in the impacted areas remain operational during the storm
- CT Juvenile Training Facility operates continuously

CT October 2011 Winter Storm Alfred

- South Windsor, CT High School serves as community shelter
- Whole Foods Market avoids costly food spoilage
- CT Juvenile Training Facility operates continuously

For more information:
http://www.doosanfuelcell.com.

Fuel Cells Provide Critical Power at Supermarket

During a widespread power outage in Southern California in September 2011, Albertson's Supermarket in San Diego was one of the few retail stores operating in the valley and was able to provide essential services and goods to the community, because it was operating an on-site fuel cell power system by Doosan.

Location: San Diego, CA

Project features:

- 400 kW fuel cell system
- Electric load-following with net metering
- Heat recovery for space heating, space cooling, domestic hot water
- Backup power for refrigeration – perishable inventory protected

For more information: http://www.doosanfuelcell.com.

Hail or Shine: Ensuring Resilient Operations

Denver International Airport (DIA), one of the busiest airports in the country, is in an area east of the Rocky Mountains known as "Hail Alley." The Rocky Mountain Insurance Information Association says the area experiences three to four hailstorms a year categorized as "catastrophic", causing at least 25 million dollars in damage. The airport is the site of daily round-the-clock operations with ongoing public activity.

Location: Denver, Colorado

Project Description: To improve its damaged roof after a moderate hailstorm in June 2001, a new material: 90-mil black EPDM membrane was selected for the roof because of its durability and high resistance against punctures. EPDM, which stands for Ethylene Propylene Diene Monomer, is a synthetic rubber derived from oil and natural gas.

For more information, read this July 2016 article or visit https://epdmroofs.org.

The Importance of a Roof for Structural Resilience at a Hospital

During extreme weather events, including storms and floods, hospitals are critical infrastructure in the community and the entire building envelope must be resilient. During a crisis, hospitals must continue operating to ensure wellbeing of existing patients, receive new patients injured during a storm or flood and serve as emergency command centers.

Location: Hospitals and healthcare facilities across the country.

The Role of a Roof, Examples and Opportunities

- In any building, the continued functioning of the roof is essential to protect the interior from water or wind damage, and to maintain a comfortable level of heating or cooling for the interior space.
- In wake of Hurricane Katrina, Tulane Medical Center had to create makeshift helipad on a parking garage roof to evacuate patients and personnel.
- Hospitals in flood-prone regions are placing critical infrastructure on the roof and electromechanical distribution systems are fed from the roof downward.
- Department of Health & Human Services (HHS) has produced a U.S. Climate Resilience Toolkit, including a chapter on Building Health Care Sector Resilience, which includes specific design and structural considerations for roofs.

For more information, visit https://epdmroofs.org.

Tulane University

Johnson Controls

Hurricane Katrina flooded Tulane's uptown and downtown campuses. Just five months after the hurricane, Tulane worked with Johnson Controls through a $40 million restoration project of its campuses, to reopen the campus by the Spring semester.

Location: New Orleans, Louisiana

Project Description: With an eye to the future Tulane entered into two consecutive performance contracts for facility expansion and improvements and conservation measures at both campuses. The first project, completed in ten months at the uptown campus included:

- Expansion of the central plant adding a 4,500 ton YORK chiller, steam system improvements and optimized operation of existing chillers, boilers and cogeneration equipment, increasing cooling capacity by 50% and efficiency by 30%
- Improvements to central plant facility designed to withstand Category 5 hurricane, with built-in campus-wide command center for emergency response

At downtown Health Sciences Campus, the 18-month project included:

- Complete overhaul of medical school's HVAC infrastructure, water conservation measures, campus wide energy management strategies to optimize building performance

Both performance contracts are estimated to deliver savings of $34 million and $37 million over the term of the contracts, while significantly reducing Tulane's impact on the environment, increasing resilience and strengthening the local economy

For more information, download the full Johnson Controls case study.

Town of Fairfield, Connecticut

Schneider Electric

In 2012, Superstorm Sandy pummeled Fairfield, causing power outages and severe flooding. In July 2013, the town received a $1.1 million State-funded grant for the implementation of a microgrid that will sustain operations of police and fire stations and a public shelter, in the event of a natural disaster.

Location: Fairfield, Connecticut (a small coastal town)

Project Description: Schneider Electric installed a microgrid that offers efficient, clean, and reliable energy, which included:

- An increase in capacity of a natural gas-fired generator from 50 to 60 kW
- The replacement of a diesel-fired emergency generator at the police headquarters with a cleaner-burning natural gas generator
- An electrical connection between the shelter and police and fire stations
- The installation of a 20kW solar photovoltaic rooftop system at the shelter and a 27kW solar photovoltaic rooftop system at the fire station
- A state-of-the-art microgrid controls system

For more information, download the full Schneider Electric case study.

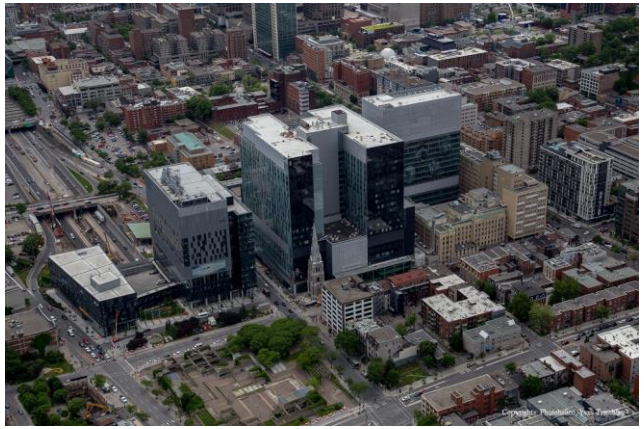
University of Montreal Hospital Center / Centre Hospitalier de L'Univesité de Montréal (CHUM)

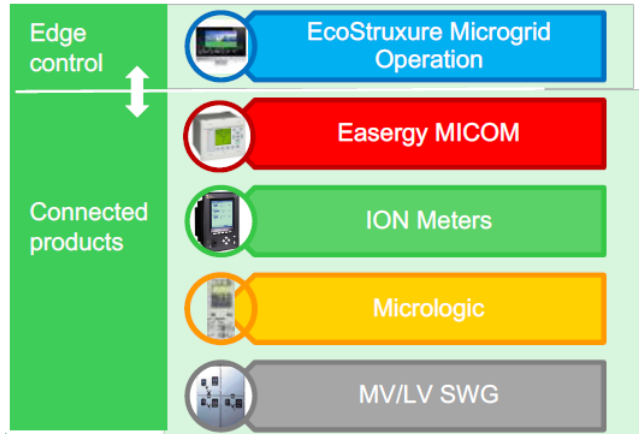
Schneider Electric

At CHUM, one of the largest teaching hospitals in North America, Schneider Electric installed a cutting-edge Load Management System for healthcare facilities in order to improve and secure the power supply to this critical infrastructure.

Location: Montreal, QC, Canada

- **Safe**: load shedding, blackstart, grid re-connection
- **Reliable**: 99.8% availability of the system, combined with functionalities to move the operation of the electrical system from a corrective approach to a preventive approach.
- **Innovative**: Use of IEC61850 standard to reduce considerably the amount of copper cables, therefore total cost of ownership was reduced.
- Compatible with IEC & NERC-CIP cyber-security standards.





Dell Children's Medical Center

Solar® Turbines
A Caterpillar Company

Dell Children's Hospital was looking for an innovative and environmentally friendly approach to their energy program. At the same time, the hospital wanted to improve the reliability of their electricity and reduce power transmission losses.

Location: Austin, Texas **Owner:** Austin Energy

Project Description: Installed a combined heat and power (CHP) plant to provide the hospital with power, chilled water and steam with a state–of-the-art Solar Turbines 4.6 MW Mercury 50 recuperated gas turbine generator set as the heart of the plant.

- CHP system generates electricity, chilled water and steam from the same fuel source, increasing energy efficiency and reducing air pollution.
- Uses reclaimed water for cooling
- Self-sufficient to meet 100% of the hospital's energy needs, even when grid disruption occurs.

Learn more about this project and visit www.solarturbines.com.

Montefiore Medical Center

Solar® Turbines
A Caterpillar Company

In 2003, Montefiore was the only hospital in New York City that continued to operate with full power during the worst electrical blackout in the history of the United States. The operating rooms, emergency room and all ancillary areas continued to operate with air conditioning during the heat wave.

Location: Bronx, New York City, NY

Project Description: Installed combined heat and power (CHP) plant to provide the hospital with its own clean, reliable and efficient power with a Solar Turbines 5.6 MW Taurus 60 Gas Turbine.

- CHP system recovers heat produced and uses it to cool medical center campus
- Overall thermal efficiency of 74.5%
- Lowers fuel and energy costs, reducing emissions 16,675 tons per year

Learn more about this project and visit www.solarturbines.com.

University of Texas Medical Branch (UTMB) Galveston

Solar® Turbines
A Caterpillar Company

In 2008, Hurricane Ike flooded over one million square feet of UTMB campus buildings to depths of six feet. UTMB worked with Affiliated Engineers to secure FEMA funding to re-build with an approach to protect utility sources and distribution; provide 15MW of on-site microgrid combined heat and power to supplement outside electrical utilities and allow islanding; and, introduce district hot water heating in place of steam (retained for research labs). The two new CHP plants can save approximately $3 million annually, compared to conventional systems, with a 5-year simple payback.

For more information, see this project website.

Location: Galveston, TX

RESILIENCE RESULTS

- During 2017's Hurricane Harvey, all systems functioned normally, buildings remained in operation, and patients were accepted throughout the event. There was no significant impact to the institution.
- 15 MW CHP, 50% efficiency improvement

LEED in Practice: Álvarez-Díaz & Villalón Offices

Originally built in the early twentieth century, the building that is home to the offices of the architecture & design firm Álvarez-Díaz & Villalón (AD&V) was renovated in 2013 to maximize sustainability and resilience. After Hurricane Maria hit in 2017, the AD&V office resumed operations within a few days and because of that was able to serve as a community gathering place and a temporary command center.

Location: San Juan, Puerto Rico

Project Description: Critical features of the renovations towards the LEED certification and enhanced resilience include:

- A back-up power generator and satellite internet reduce reliance on ground infrastructure, which was heavily damaged following the storm.
- Air conditioning units with 20 SEER rating minimizes energy consumption, thus facilitating running cooling operations off the generator.
- Solar tube lighting enables people to work without the need for electricity by using natural light.
- Lighting control systems minimize energy use helping reduce the load on the generator.
- A rainwater cistern allows occupants access to running water when municipal systems are compromised.
- Location in a dense area of the city enables many workers to walk to work or use non-motorized transport when vehicles are compromised

For more information, download the USGBC's Profiles of Resilience or check out the project's LEED credit scorecard.

LEED in Practice: GAF Global Headquarters

In 2016, GAF's headquarters building was the first building in the world to earn a LEED pilot credit for resilient design. North America's largest roofing manufacturer, GAF ensured that its LEED certified facility in Parsippany, New Jersey would be resilient in the event of an emergency. Previously offered for a limited time (and now being incorporated into the RELi resilience standard in partnership with USGBC), this pilot credit (IPpc98) required a pre-design hazard assessment, including identification of and specific assessment requirements for potential natural hazards, such as flooding, tornados, high winds, and earthquakes.

Location: Parsippany, New Jersey

Project Description: GAF wanted to ensure the building's resilience in the event of a sever hurricane, akin to Hurricane Sandy in 2012. Some of the project's features include:

- Flood preparation and backup capabilities allow operations to continue during long-term outages
- Roof exceeds local code requirements, meeting FEMA Wind Zone II velocities.
- Site selection process included assessment of floodway mapping of roads for a complete look at all flood-prone areas.
- GAF's Business Continuity Disaster Recovery Plan details chains-of-command, POCs, departments and contact information to access in the event of a disaster event. This implemented plan exceeds LEED pilot credit requirements

For more information, download the USGBC's Profiles of Resilience or check out the project's LEED credit scorecard.

LEED in Practice: Cold Climate Housing Research Center

Located on the campus of the University of Alaska Fairbanks, this project is the world's northernmost LEED Platinum commercial building. The Cold Climate Housing Research Center's Research and Testing Facility (RTF) building is a living laboratory for building technologies for use in circumpolar regions around the world. The RTF is resilient to the effects of extreme subarctic temperatures.

Location: Fairbanks, Alaska

Project Description: The RTF research team is able to research and develop tactics to exhibit resilience to the effects of cold weather – and doing so within a building that demonstrates the effectiveness of many of these features, which include:

- Adjustable foundation enables building to adjust to effects of permafrost
- Ground source heat pump transfers energy from the earth for heating purposes
- Two solar thermal storage systems are self-regulating and heat water for the building, including during a power outage, helping to offset energy demand and related emissions.
- More than 400 sensors throughout the RTF enable monitoring of building system operations and performance
- Rainwater is caught from the roof and stored in two 2500 gallon storage tanks in the basement, to operate all toilets and the fire sprinkler system.

For more information, download the USGBC's Profiles of Resilience or check out the project's LEED credit scorecard.

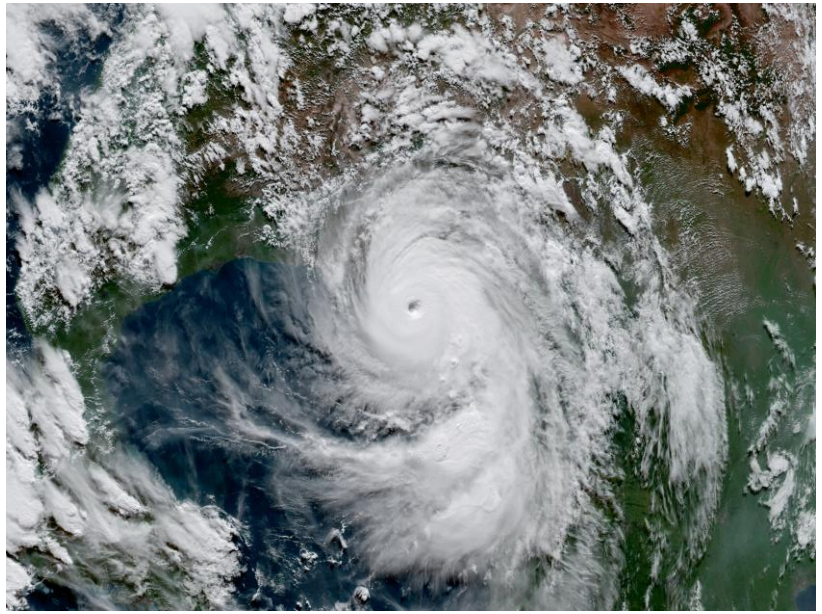
Advanced Metering Infrastructure Helps Hasten Power Recovery

Investments in grid modernization technologies such as advanced metering infrastructure helped utilities restore power in the aftermath of Hurricane Hurricanes Harvey and Irma in 2017.

Locations: Texas and Florida

- After Hurricane Harvey, CenterPoint Energy brought its customers online faster with advanced metering infrastructure technology, **saving an estimated 45 million outage minutes**.

- Within 48 hours of Hurricane Irma, Florida Power & Light had restored power **to 2.7 million customers,** and in just over a week, **all 4.4 million of its customers** were back online – the fastest large-scale restoration in history.



CenterPoint Energy

Itron

For more information: https://gridwise.org.

Enhancing Electric Reliability and Resilience in Hospitals

Investments in grid modernization technologies are enabling hospitals to increase reliability and resilience by providing comprehensive energy and load management systems. Ensuring continuous availability of power to specific locations in hospitals, such as intensive and critical care units and delivery rooms, even in the case of a fault situation – without causing damage to people or connected devices – is vital.

Project Description:

- Many hospitals have installed ABB's programmable logic control systems that control the diesel engines and generators of the emergency power groups and that communicate with other control systems. Many hospitals also install ABB's unique comprehensive load management system.
- These consist of medium-voltage switchgear, transformers, MNS switchgear (i.e., ABB's patented, modular, low-voltage switchgear) with condition monitoring as well as diesel-based emergency power aggregates, control systems, grid control systems and more.

ABB