

# Fuel Cells for Resilience and Decarbonization in California

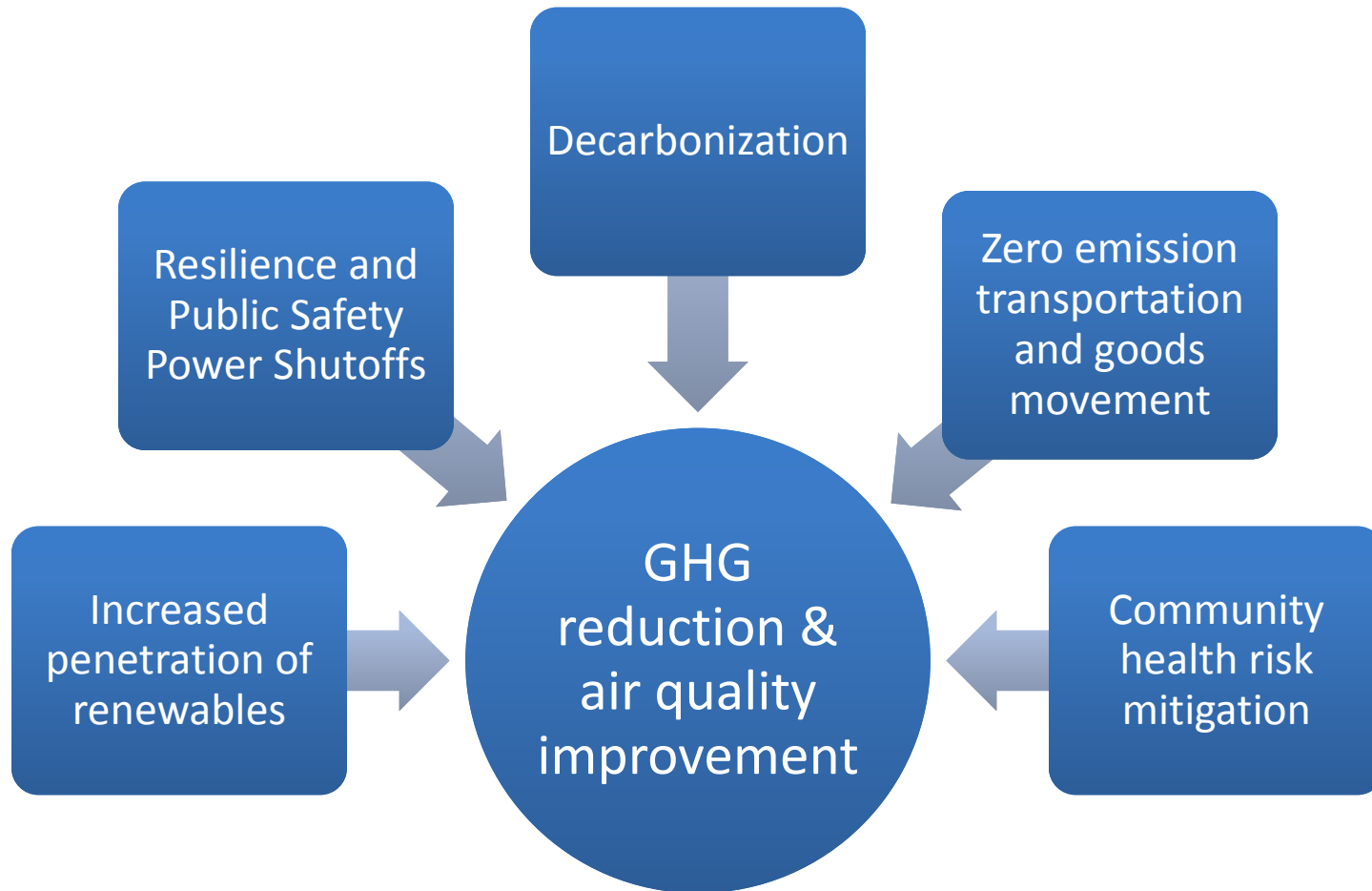
May 1, 2020



**California Stationary  
Fuel Cell Collaborative**



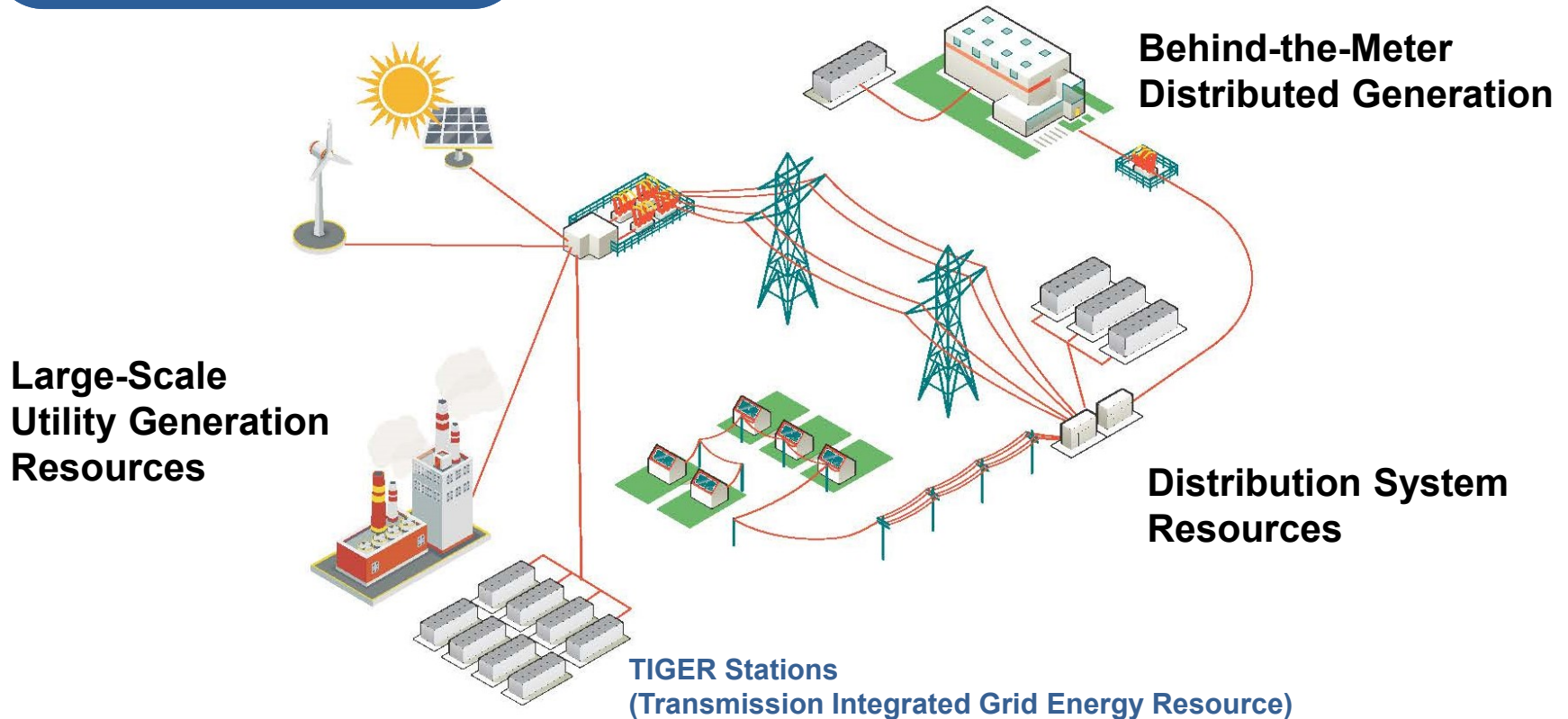
# California Policy Priorities



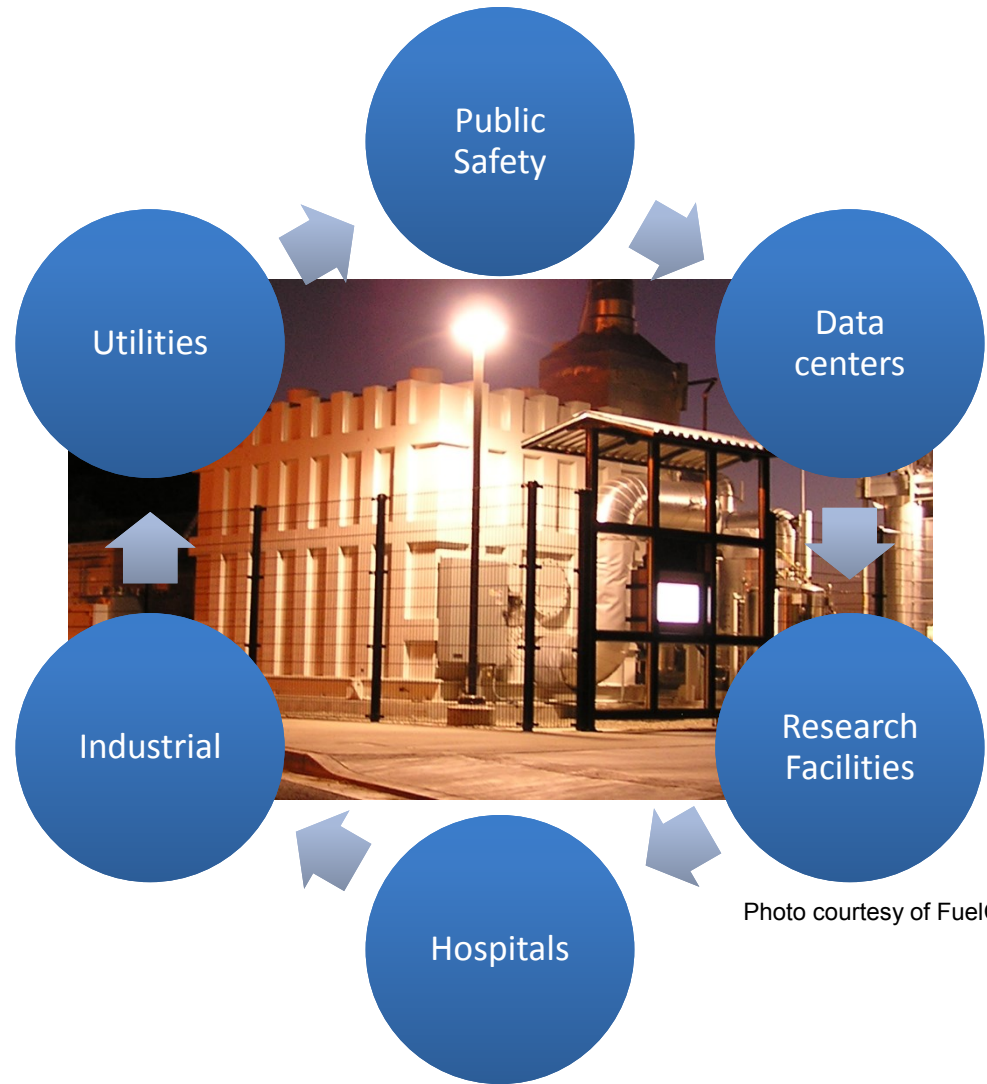
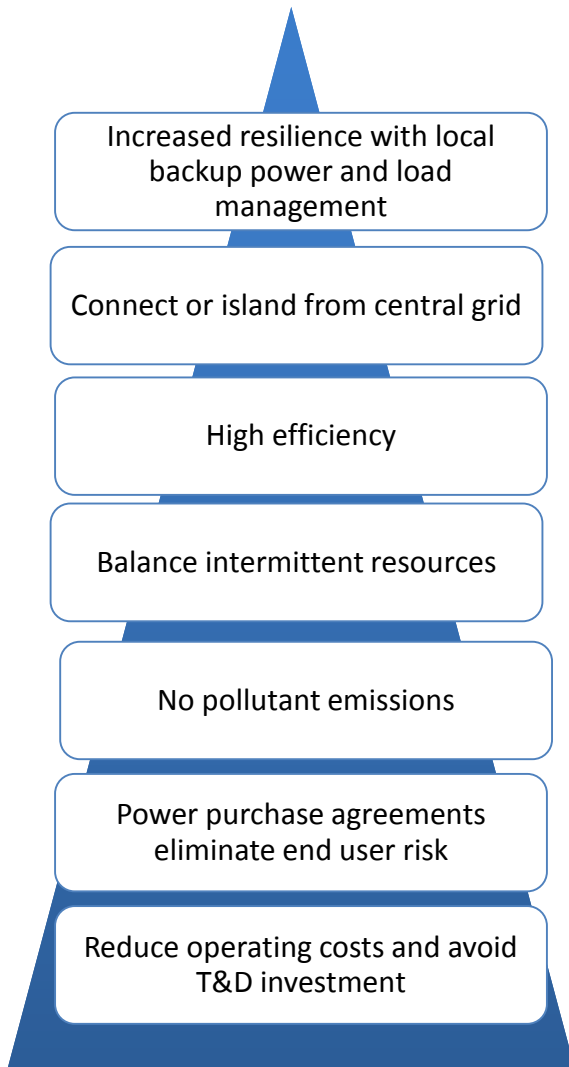
# Fuel Cells Provide Clean, Resilient Power

## Significant System Benefits

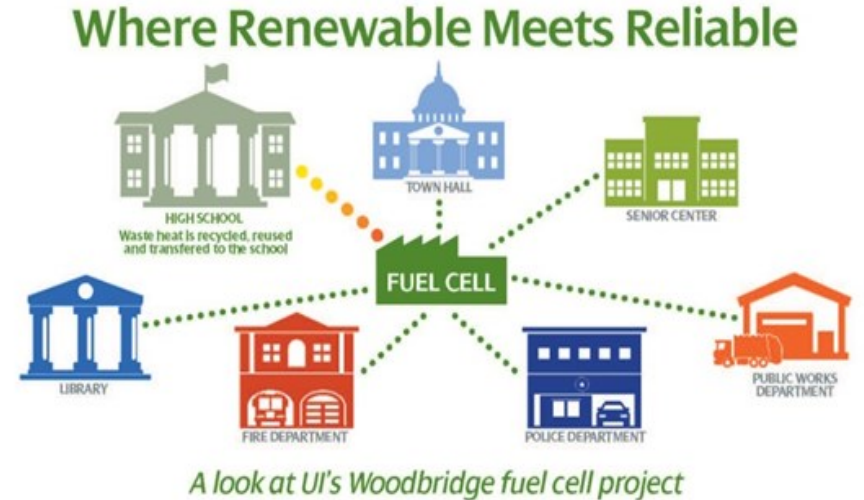
- Load-following and islanding capabilities
- Firm, reliable source of 24/7 clean power
- Scalability to meet local system needs
- Improved power quality
- Very high system efficiencies



# Stationary Fuel Cells in Microgrids



# Fuel Cells in Utility Microgrids



## Town of Woodbridge, Connecticut

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

# Fuel Cells for Military Microgrids



## Naval Submarine Base, Groton, Connecticut Multi-Microgrid

- 7.4 MW FuelCell Energy system in grid parallel operation to support critical operations during outage
- Inverter follows microgrid load and load-leveler maintains constant fuel cell power
- Power purchase agreement to submarine base
- Operational in Q3 2020

# Fuel Cells for Campus Microgrids



## University of Bridgeport (UB) Connecticut Fuel Cell-Only Microgrid

- Serves a 5,600 student campus
- PPA to UB creates \$300,000 annual savings. NRG owns FuelCell Energy power plant.
- 1.4MW baseload with steam generation for CHP – heat to campus
- Baseload, net metering
- Black-start capability

# Fuel Cells for Corporate Microgrids

## Stone Edge Farm, Sonoma, CA Microgrid

- Developed by Wooster Engineering Specialties, a general engineering contractor specializing in alternative energy.
- Combines a number of off-grid energy solutions with peak shaving and load shifting services for energy self-sufficiency and carbon footprint reduction. Includes 26 kW Plug Power fuel cells and solar powered electrolysis for hydrogen production. Designed to scale as needed.
- Grid-tied microgrid can island and operate continuously and autonomously, and generates extra energy for Stone Edge Farm to sell a substantial amount back to PG&E.





# Fuel Cells for Seamless Load Transfer & Backup Power



## October 2012 Hurricane Sandy

- All 23 fuel cell in the impacted areas remain operational during the storm



## CT October 2011 Winter Storm Alfred

- 400 kW Doosan fuel cell systems
- South Windsor, CT High School serves as community shelter
- Whole Foods Market avoids costly food spoilage
- CT Juvenile Training Facility operated continuously

# Fuel Cells for Critical Power

## Albertson's Supermarket (San Diego, CA)



- 400 kW Doosan 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

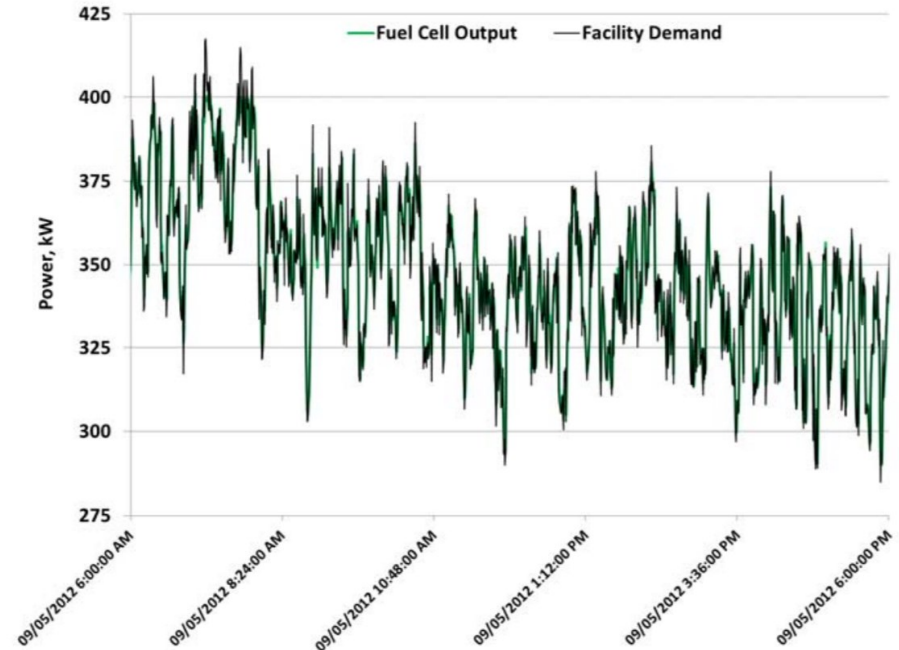
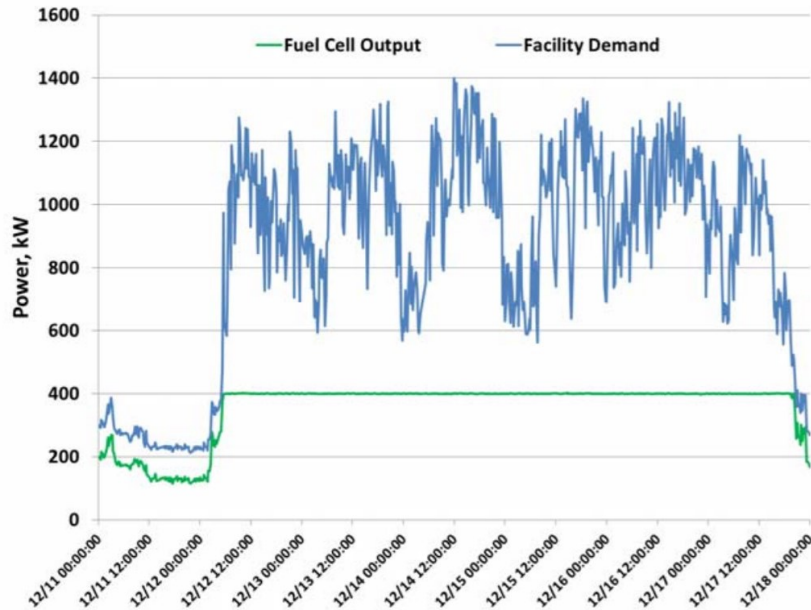
## September 2011 San Diego Blackout

- One of the few retail stores operating in the valley
- Provided essential services and goods to the community



# Fuel Cells for Dispatchable Load Following

Data courtesy of Doosan Fuel Cell America



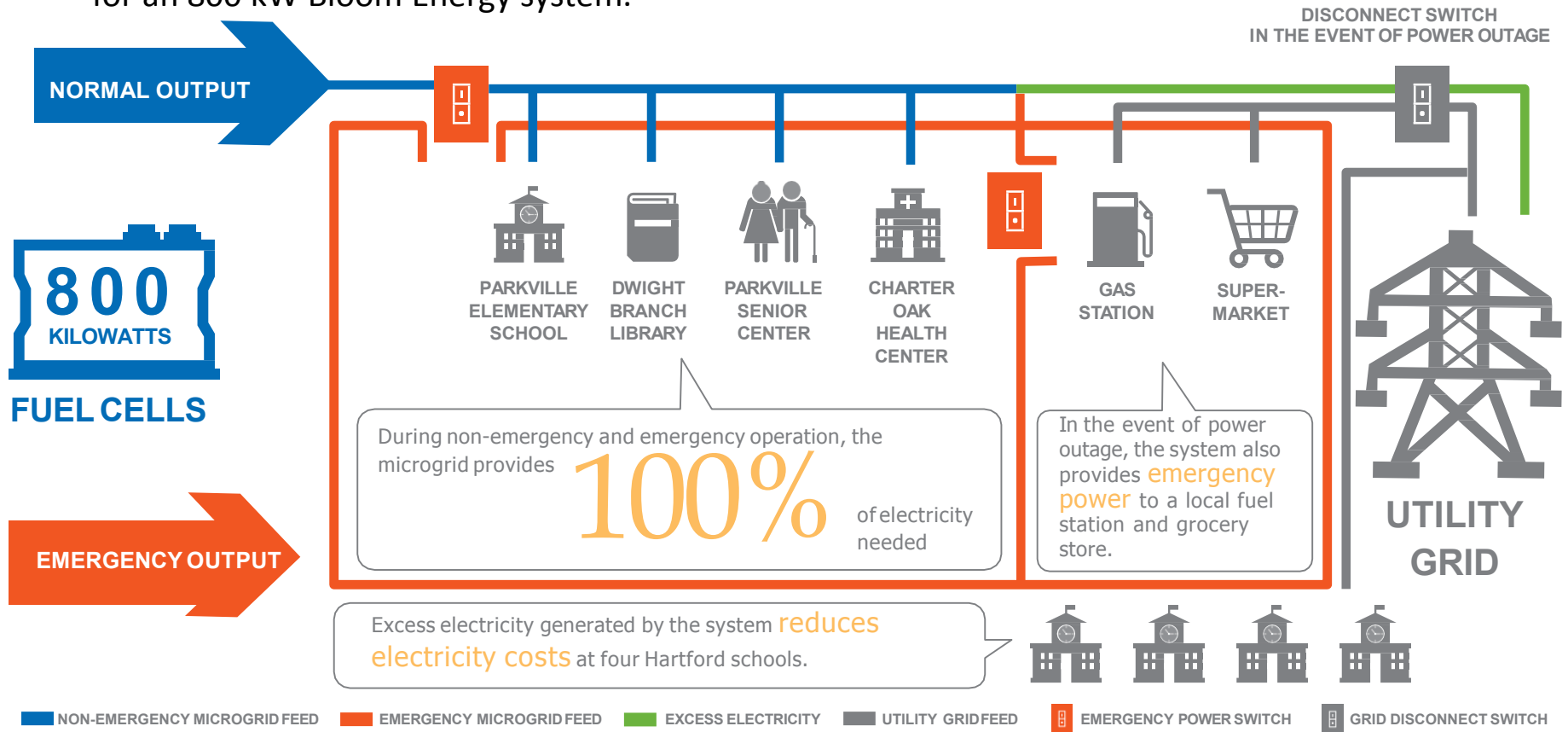
- Coca-Cola bottling facility
- 5 day/week production facility
- 400 kW baseload weekdays
- Load-following with 100 kW minimum utility import on weekends

- Whole Foods Market
- Supermarket
- Continuous load-following
- Net-metering with zero utility power import

# Fuel Cells for Municipal Microgrids

## City of Hartford, Connecticut Fuel Cell-Only Microgrid

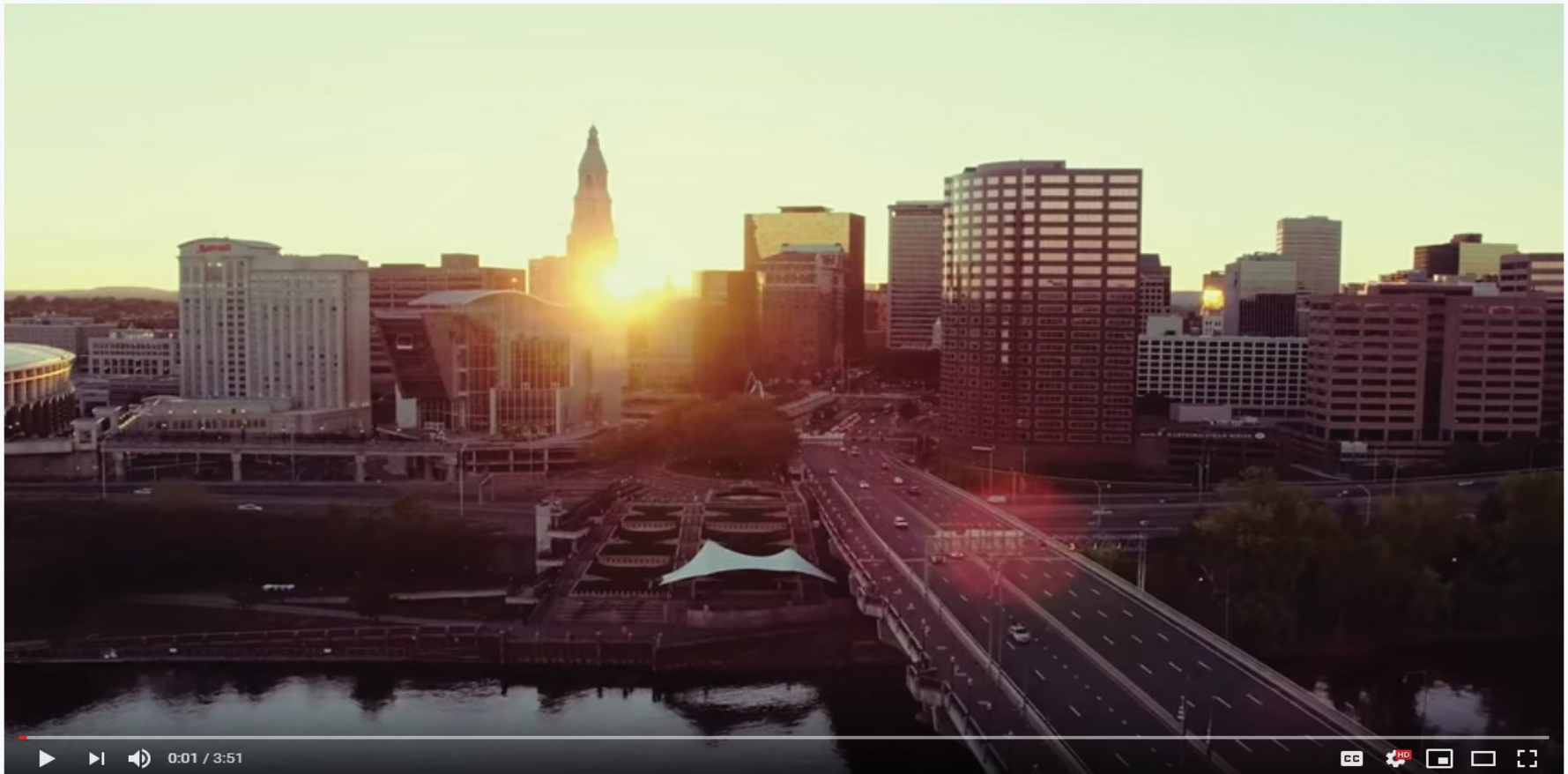
- Constellation Energy providing engineering, procurement, construction and operation services for an 800 kW Bloom Energy system.



# Fuel Cells for Municipal Microgrids

YouTube

Search



Discovery Education: Hartford Microgrid

Video Source: [https://www.youtube.com/watch?time\\_continue=5&v=2gMv-Diaxow](https://www.youtube.com/watch?time_continue=5&v=2gMv-Diaxow)

# Marcus Garvey Village Microgrid for Air Quality

Solar + Storage + Fuel Cell Microgrid Reduces Emissions and Increases Resiliency at Low-Income Housing Development in Brooklyn



## Project Overview

- 480 kW solar, Bloom Energy 400 kW fuel cell and 300 kW/1.2 MWh lithium battery
- Fuel cell serves as "anchor" generator for microgrid

## Benefits

- Energy cost savings, resilient microgrid for Marcus Garvey residents
- Grid Benefits: Targeted load reduction, grid reliability, reduced emissions with ratepayer savings

## EMISSIONS REDUCTIONS

	Annual CO <sub>2</sub> Emissions Reductions	Annual NO <sub>x</sub> Emissions Reductions
400 kW Fuel Cell	1,077,854 lbs/year	1,643 lbs/year
400 kW Solar	522,496 lbs/year	233 lbs/year



## Overall ConEd Initiative

- Saved Ratepayers Nearly \$1 Billion while Reducing Emissions and Alleviating Grid Congestion
- 6.2MW of fuel cells deployed across six locations within targeted load relief area
- Brooklyn Queens Demand Management Portfolio of Fuel Cell Projects Eliminates 25,053 lbs of NO<sub>x</sub> from New York City annually

# Renewable Fuel Cells in Microgrids

University of California, San Diego

- System operates with 3 MW roof top solar PV intermittent contribution
- Load-following by 30 MW gas turbine generators
- 2.8 MW directed biogas Fuel Cell Energy fuel cell serves baseload and treats turbines as grid



Photo courtesy of FuelCell Energy

# Fuel Cells for Campus Decarbonization



## UC Irvine Medical Center's 1.4 MW FuelCell Energy system and absorption chiller microgrid system

- 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 (NO<sub>x</sub>)
  - 64 tons of sulfur dioxide (SO<sub>x</sub>)
  - 3,000 pounds of particulate matter (PM<sub>10</sub>)
  - 7,000 tons of CO<sub>2</sub>



# Demonstrated Resilience

San Diego Blackout  
9/28/11

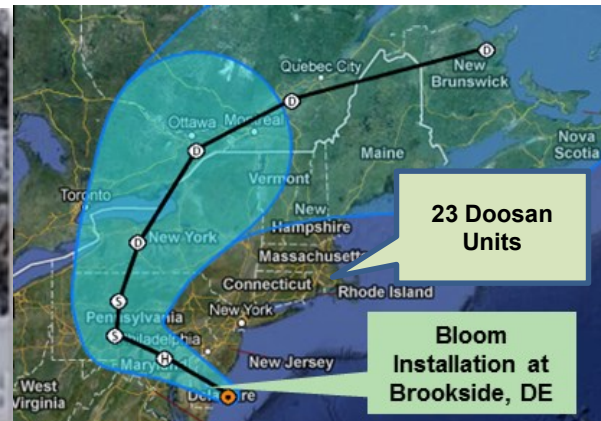


Winter Storm Alfred  
10/29/11

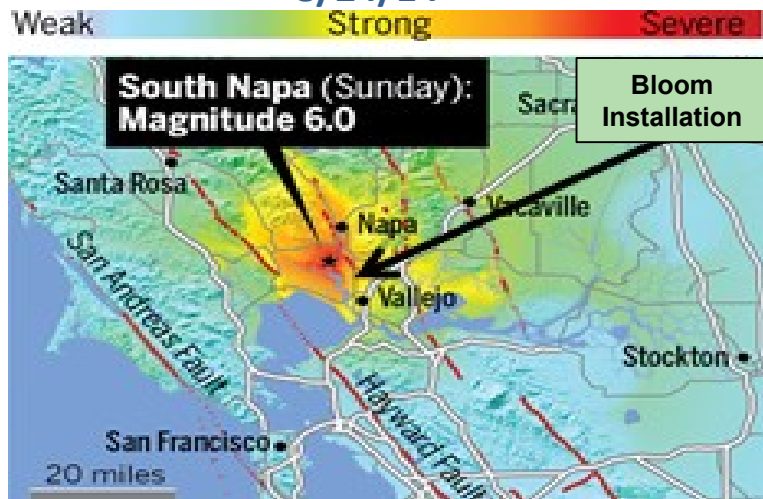


Fuel Cells for Food, Shelter and Comms

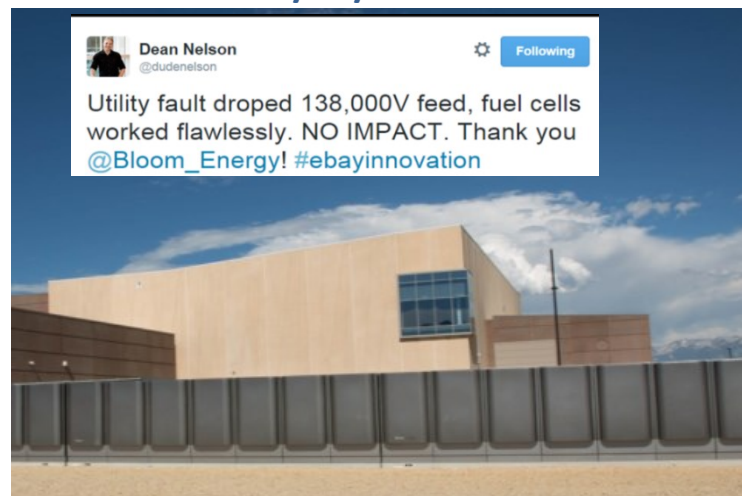
Hurricane Sandy  
10/29/12



CA Earthquake  
8/24/14



Data Center Utility Outage  
4/16/15



# Demonstrated Resilience

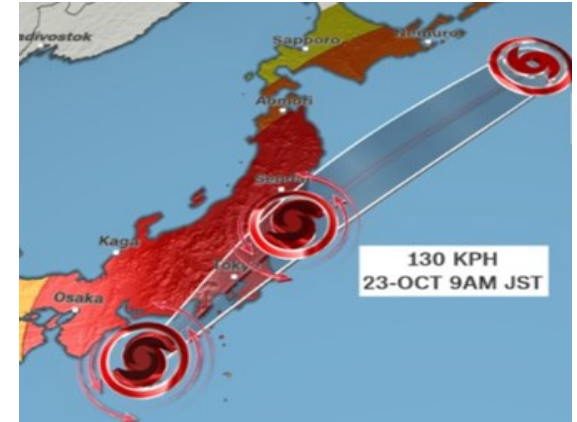
Physical Damage  
11/21/16



Napa Fire  
10/9/17



Japanese Super-Typhoon  
10/23/17



Ridgecrest Earthquakes  
7/4-5/19



Manhattan Blackout  
7/13/19



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

## Utilities - US

- New Britain CT – 20 MW Energy Improvement Park
  - Reliability for new state of art data center
- South Windsor, CT – 5 MW
  - Resiliency and power for 15,000 homes
- Bridgeport, CT – 14.9 MW – Dominion Energy
  - Resiliency and power for 15,000 homes
- Newark, DE – 30 MW – Constellation Energy
  - 2 Delmarva substations
  - Power for 22,000 homes
- Brookhaven, NY – 39.8 MW – PSEG/Long Island Power Auth.
  - Resilient combined cooling, heat and power and small footprint



Busan Green Energy Project: 30.8MW, photo courtesy of Doosan

## Utilities – South Korea

- Hwasung City, South Korea – 59 MW – Gyeonggi Green Energy
  - On 5.2 acres and supplies grid power and district heating
- Daesan, South Korea – 50 MW direct hydrogen – Hanhwa Energy, Korea East West Power
- Incheon, South Korea – 20 MW CHP – KOSPO
- Busan, South Korea - 30.8 MW CHP – Korea South-East Power
  - District heating and power for 71,500 homes

# Demonstrated Resilience



Small backup power fuel cell systems (5 kW-100 kW) reduce risk by ensuring that communications, data transfer, traffic signals and railroad crossings are operating during extended outages

## Hurricanes Sandy, Joaquin and Irma

Alteryg backup power fuel cell systems ran continuously through the category 4 Hurricane Sandy with sustained 130 mph wind and storm surges until local power was restored

Alteryg systems ran through Hurricane Irma in the Bahamas

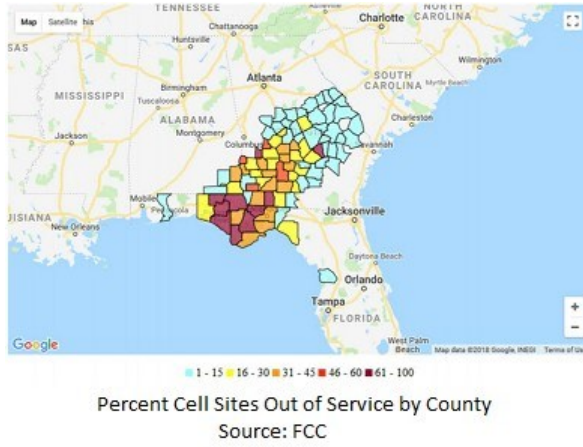
- Operational sites remained powered until re-fueled or fuel supply ran out
- Methanol reformer fuel with standard tank provides days of runtime critical for natural disaster recovery communications

## Napa Earthquake

Alteryg's backup power systems powered through the earthquake and suffered no damage or interruptions to service after the earthquake.

# Demonstrated Resilience

## Hurricane Michael: October 2018



- **Fourteen-foot storm surges. Buildings collapsing in Panama City. Mexico Beach obliterated. RVs tossed through the air; roofs peeled off motels and houses. Hurricane Michael came ashore on October 10, 2018 as the strongest hurricane to hit the Florida panhandle and across the southeast since record keeping began in 1851, leaving millions without power. The storm's peak winds upon landfall were the fourth-highest on record for the continental United States and reached 155 MPH.**
- **Plug Power fuel cells supported telecommunications networks in the southeast U.S. during and after Hurricane Michael**
- **2,393 hours of fuel cell operation**

# Demonstrated Resilience

## Utility Telecommunications

Customer: Large California utility provider of electricity and natural gas serving approximately 15 million customers

Applications:

- SCADA (Supervisory Control and Data Acquisition)
- Radios
- Monitoring Equipment

Status:

- Plug Power fuel cell customer since ~2010
- Approximately 30 sites installed
- Plans for annual replacements of decommissioned diesel generators

Quotes from the customer:

- “Maintaining generators is expensive. We spend a lot of time and money sending people to remote generators to check the oil, change the plugs and repair the breakdowns, which happen frequently because little-used engines deteriorate over time.”
- Of fuel cells: “The combination of high reliability, lower maintenance and no emissions has given fuel cells a place at our critical locations. What the neighbors think is cool is the peace and quiet now that they don’t have generators roaring to life in the middle of the night.”
- From “Fuel Cells and Utility Telecommunications: Focus on Reliability,” Utility Products, Nov/Dec 2013



# Demonstrated Resilience

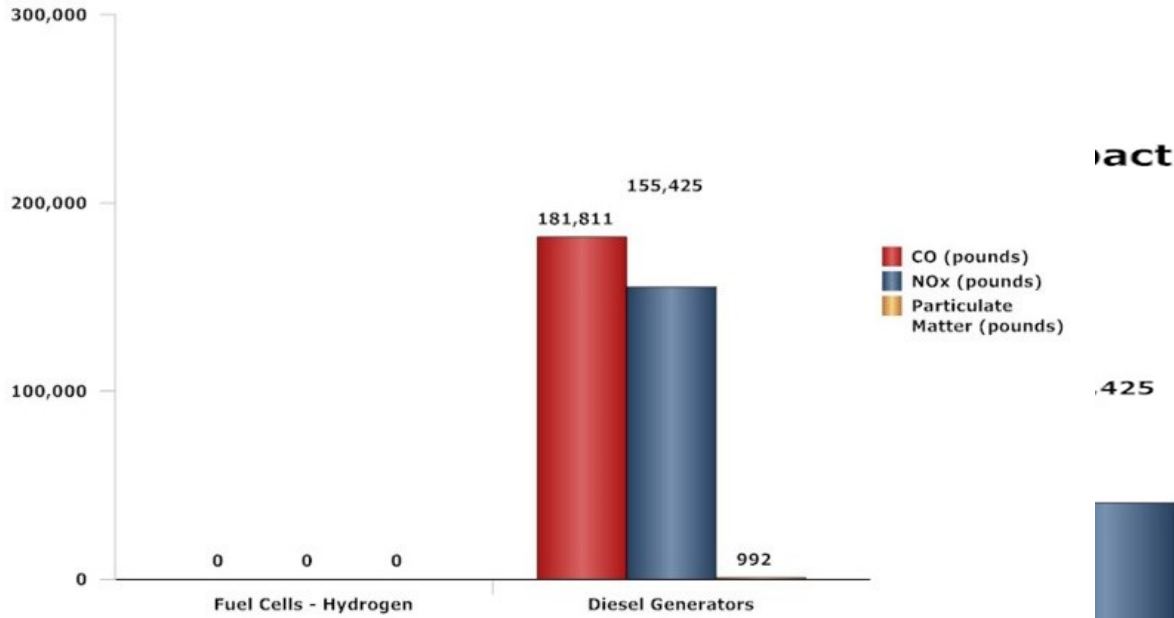
## Mobile Temporary Power

- Sonoma County Film Festival
- Collaboration between Alteryx Systems and IGX Group
- IGX Group is system integrator for mobile solution
- 5 kW roll door cube trailer
- Roll door cubes on trailer w/multiple days (5.5) of hydrogen fuel
- 35 kW and below for mobile generation

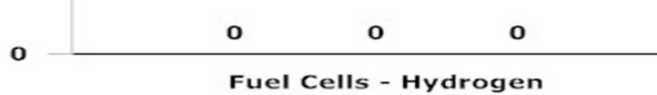


# Fuel Cells Win over Combustion Generators for Small Scale Power

## Environmental Impact



Assumptions:  
 1,000 sites  
 20kW diesel generator / 5kW fuel cell  
 150 hours runtime per year  
 5 years  
 Tier 4 Emissions Allowances



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 1,000 sites  
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## FOUR REASONS COMMUNICATIONS PROFESSIONALS SHOULD CONSIDER FUEL CELLS FOR THEIR NETWORKS:

### REASON 1: Fuel cells are cost-effective

**FACT:** Fuel cells in communications environments can offer savings of up to 30% on capital cost over diesel generators

### REASON 2: Fuel cells can be easily refueled

**FACT:** Multiple hydrogen storage and refueling methods make fuel cells easy to refuel for normal or disaster recovery operations

### REASON 3: Fuel cell reliability outstrips that of diesel generators

**FACT:** Fuel cell reliability is rated at 99.6% compared to diesel generator reliability of up to 88.4%. Which solution do you want to trust your network to?

### REASON 4: Fuel cells win on environmental issues

**FACT:** No hazardous emissions, low noise, vibration and heat signatures make hydrogen fuel cells a winning solution for many locations, including neighborhoods and national parks.





# Ballard 1 MW ClearGen Stationary System

Production of electricity from hydrogen  
co-produced at the SARA refinery in Martinique

First 1 MW fuel cell in a refinery



**Commissioned  
Q4-2019**

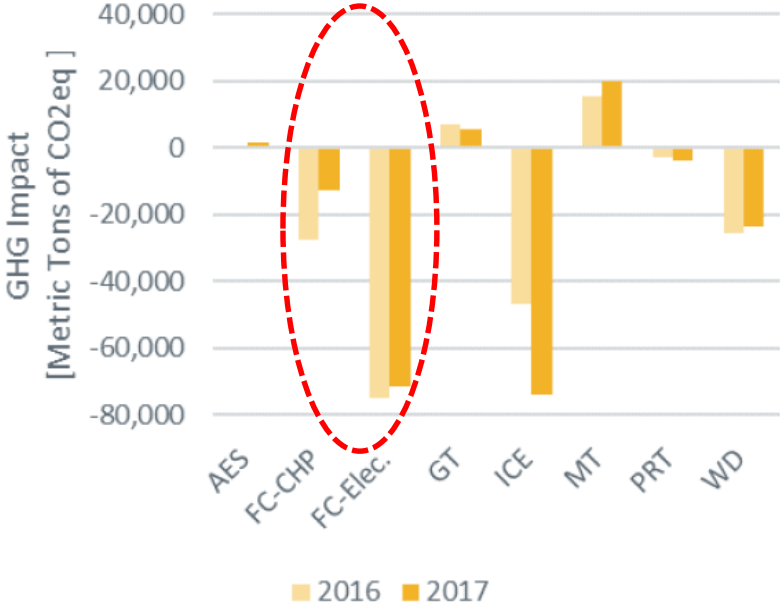


Ballard's ClearGen FC system in 40-foot Container  
PPA with local grid operator (15-years operation)  
Follow European and French regulation  
Adapt to hurricane, earthquake and high standard of  
oil & gas sector

# Fuel Cell Emissions Reduction Quantified

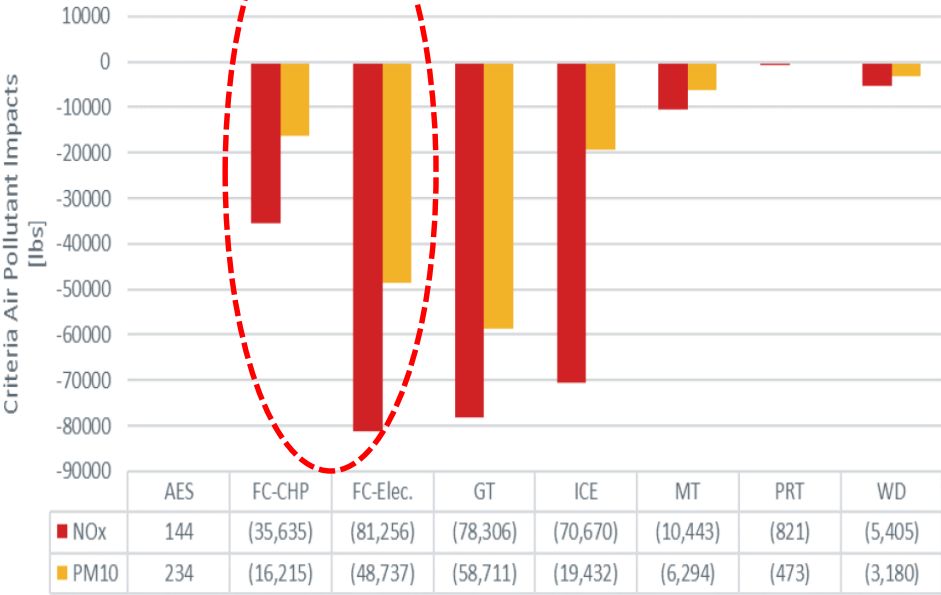
## GHG Reductions

By Technology Type and Year (A)



## Criteria Air Pollution Reductions

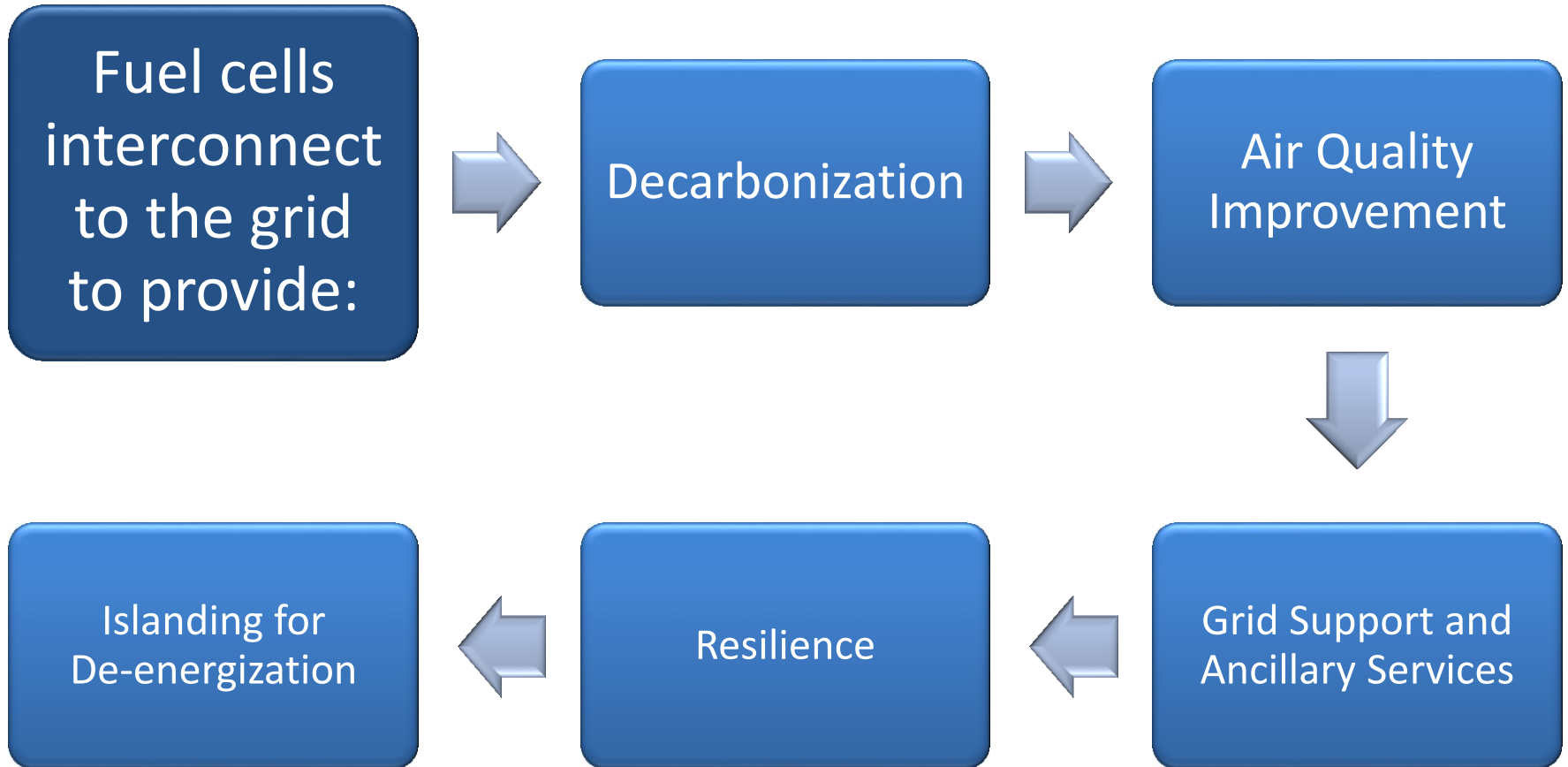
FIGURE ES-4: CRITERIA AIR POLLUTANT IMPACTS BY TECHNOLOGY TYPE (2017)



Source: SGIP 2016-2017 Impact Report, Table ES-6: GHG Impacts by Technology Type and Year and Figure ES-4 Criteria Air Pollutant Impacts By Technology Type (2017)



# Fuel Cells Achieve California's Energy & Climate Goals



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May 1, 2020

[www.casfcc.org](http://www.casfcc.org)



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