Fuel Cells for Resiliency and Decarbonization in California

April 1, 2019
California Policy Priorities

- GHG reduction & air quality improvement
- Increased penetration of renewables
- Resiliency and de-energization
- Zero emission transportation
- Community health risk mitigation
- Decarbonization

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

Behind-the-Meter Distributed Generation

Large-Scale Utility Generation Resources

Distribution System Resources

TIGER Stations (Transmission Integrated Grid Energy Resource)
Stationary Fuel Cells in Microgrids

- Increased resiliency with local backup power and load management
- Connect or island from central grid
- High efficiency
- Balance intermittent resources
- No pollutant emissions
- Power purchase agreements eliminate end user risk
- Reduce operating costs and avoid T&D investment

Utilities
Data centers
Research Facilities
Industrial
Hospitals
Public Safety
Town of 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
Fuel Cells for Military Microgrids

Naval Submarine Base, Groton, Connecticut Multi-Microgrid

- 7.4 MW 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
- Full commercial operation in May 2019
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 fuel cell power plant.
- 1.4MW baseload with steam generation for CHP – heat to campus
- Baseload, net metering
- Black-start capability
Fuel Cells for Municipal Microgrids

City of Hartford, Connecticut Fuel Cell-Only Microgrid

- Constellation Energy providing engineering, procurement, construction and operation services

During non-emergency and emergency operation, the microgrid provides **100%** of electricity needed.

Excess electricity generated by the system reduces electricity costs at four Hartford schools.

In the event of power outage, the system also provides emergency power to a local fuel station and grocery store.

**Utility Grid**

**Disconnect Switch**

**Utility Grid Feed**

**Gas Station**

**Supermarket**

**PARKVILLE ELEMENTARY SCHOOL**

**Dwight Branch Library**

**PARKVILLE SENIOR CENTER**

**CHARTER OAK HEALTH CENTER**

**Utility Grid Feed**

**800 Kilowatts**

**Fuel Cells**

**Normal Output**

**Emergency Output**

**Emergency Power Switch**

**Grid Disconnect Switch**
Fuel Cells for Municipal Microgrids

Video Source: https://www.youtube.com/watch?time_continue=5&v=2gMv-Diaxow
Fuel Cells for Seamless Load Transfer & Backup Power

**October 2012 Hurricane Sandy**
- All 23 fuel cells in the impacted areas remained operational during the storm

**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

**San Diego, CA September 2011 Blackout**
- Albertsons Supermarket remains open for business
- Perishable inventory protected
Fuel Cells for Critical Power

Albertson’s Supermarket (San Diego, CA)

- 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

September 2011 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

- 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
Proven Resiliency in the Field

Hurricane Sandy 10/29/12

CA Earthquake 8/24/14

Data Center Utility Outage 4/16/15

Napa Fire 10/9/17

Physical Damage 11/21/16

Japanese Super-Typhoon 10/23/17

Bloom Installation at Brookside, DE

Utility fault dropped 138,000V feed, fuel cells worked flawlessly. NO IMPACT. Thank you @Bloom_Energy! #ebayinnovation

March 19, 2019  Core Group Meeting  13/36
Large-Scale Fuel Cell Systems For Resiliency, Grid Services and Clean Air

Utilities

Bridgeport, CT – 14.9 MW – Dominion Energy
• Resiliency and power for 15,000 homes
Newark, DE – 30 MW – 2 Delmarva substations
• Power for 22,000 homes
• Resilient combined cooling, heat and power and small footprint
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 – Hanhwa Energy, Korea East West Power
• Direct hydrogen for combined heat and power to local utility
Incheon, South Korea – 20 MW CHP – KOSPO
• Announced September 5
Busan, South Korea - 30.8 MW CHP – Korea South-East Power
• District heating and power for 71,500 homes
Renewable Fuel Cells in Microgrids

University of California, San Diego

- 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 serves baseload and treats turbines as grid
Fuel Cells for Campus Decarbonization

UC Irvine Medical Center’s 1.4 MW fuel cell 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 (NOx)
  - 64 tons of sulfur dioxide (SOx)
  - 3,000 pounds of particulate matter (PM10)
  - 7,000 tons of CO₂
Fuel Cell Systems For Decarbonized Critical Power

Challenges

- eBay’s Data Center in Utah loses $6,000 per second of downtime
- The company’s sustainability mission was in conflict with UT’s electric grid which sources 80% of its electricity from coal

Solution

- 6 MW of fuel cell systems provide primary, onsite, reliable power matched to the operational requirements of the data center
- System provides 100% of electricity demand while drastically reducing carbon footprint

How it works

- Redundant, modular architecture provides highly reliable power
- System architecture replaces large and expensive backup generators and UPS components
Fuel Cells for Decarbonization

UC Irvine full grid simulations

SGIP FC fleet data

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Stationary Fuel Cells Reduce Pollutants

UC Irvine full grid simulations

SGIP fuel cell fleet data
Poor Battery Dispatch & RTE Increases Emissions

SGIP Battery fleet data (Non-PBI)

SGIP Battery fleet data (PBI)

March 19, 2019
Fuel Cells Achieve California’s Energy & Climate Goals

Fuel cells interconnect to the grid to provide:

- Decarbonization
- Air Quality Improvement
- Islanding for De-energization
- Resiliency
- Grid Support and Ancillary Services
Fuel Cells for Resiliency and Decarbonization in California

April 1, 2019

THANK YOU!