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Energy Management and Sustainability on the Road to 10G

Mission Critical Microgrids: Securing a Better Energy Future through the Power of Choice

Dan Middleton

Senior Vice President, Americas
Bloom Energy

2021 Fall Technical Forum
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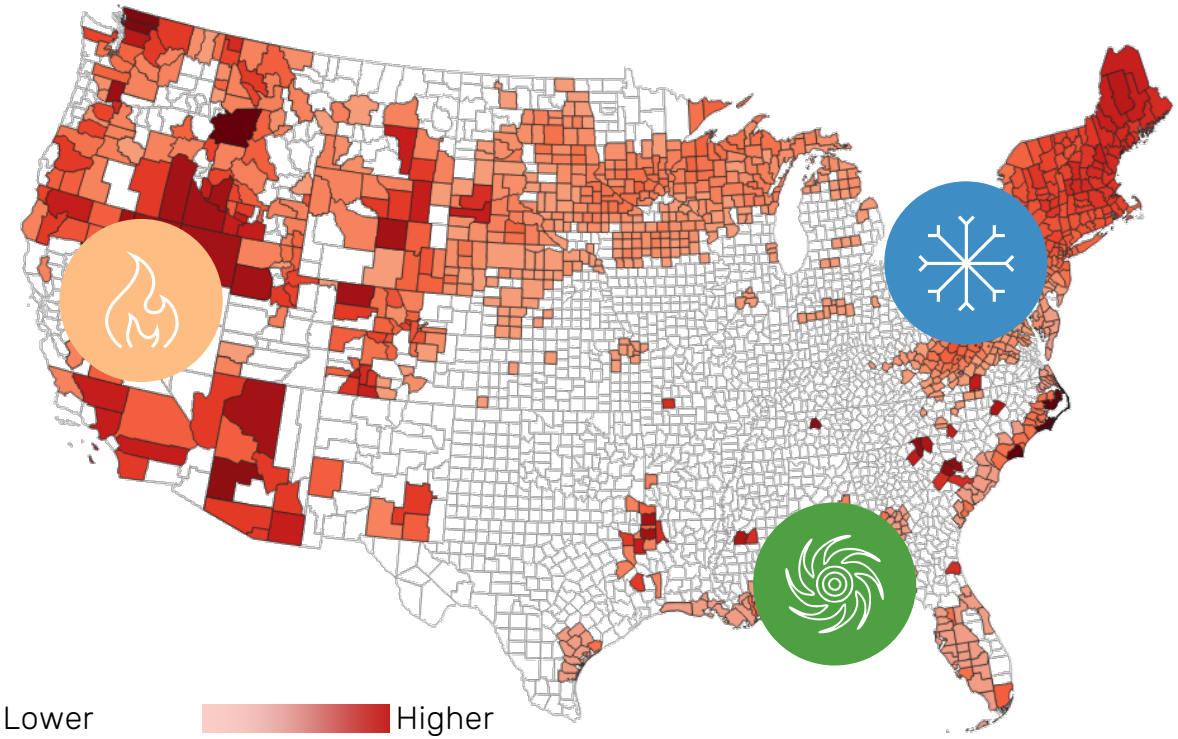
EXTREME WEATHER IS INCREASING GRID DISRUPTION

‘once in a lifetime’ events are becoming increasingly common.

CLIMATE RISK HAS CREATED A SET OF 'RESILIENCY ZONES'

US resiliency hazard map



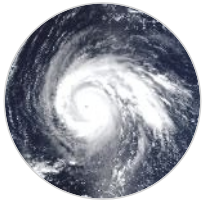
Drought and Fires

PSPS events in 2019 left 3 million Californians without power, many for multiple days

PSPS events expected to continue for next 10 years

Severe & Winter Storms

In 2021, severe winter storms crippled Texas' energy system and left ~ 4.5 million without power.



Hurricanes

In 2020, Hurricane Isaias and Zeta left 6.8 and 2.6 million respectively without power

Number and intensity of hurricanes expected to increase in the coming years

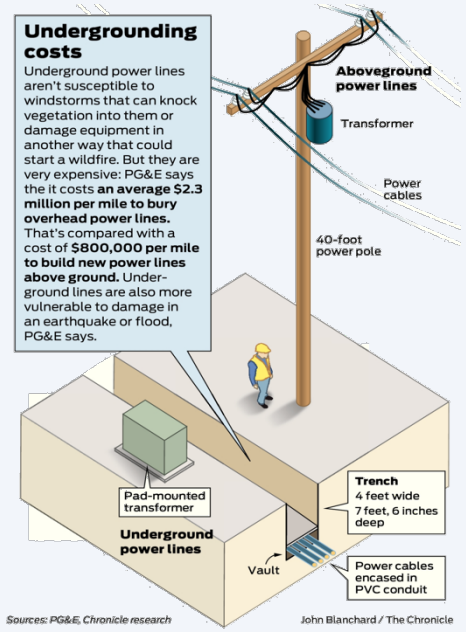
Key regions across the nation are susceptible to the impacts from ever growing natural disasters raising the need for resilient power solutions that can provide coverage through outages

HARDENING AT-RISK GRID INFRASTRUCTURE IS EXPENSIVE

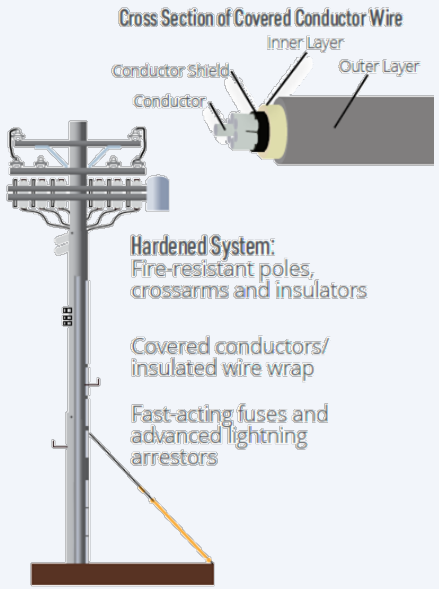
Sample Costs for Distribution Hardening Projects

Replacements
Up to $33,000 each

Undergrounding
$3-5 million / mile



Insulation
$1.2 million / mile



Major Utility Hardening & Risk Management Spending

$3 Billion
2021 Wildfire Mitigation Plan

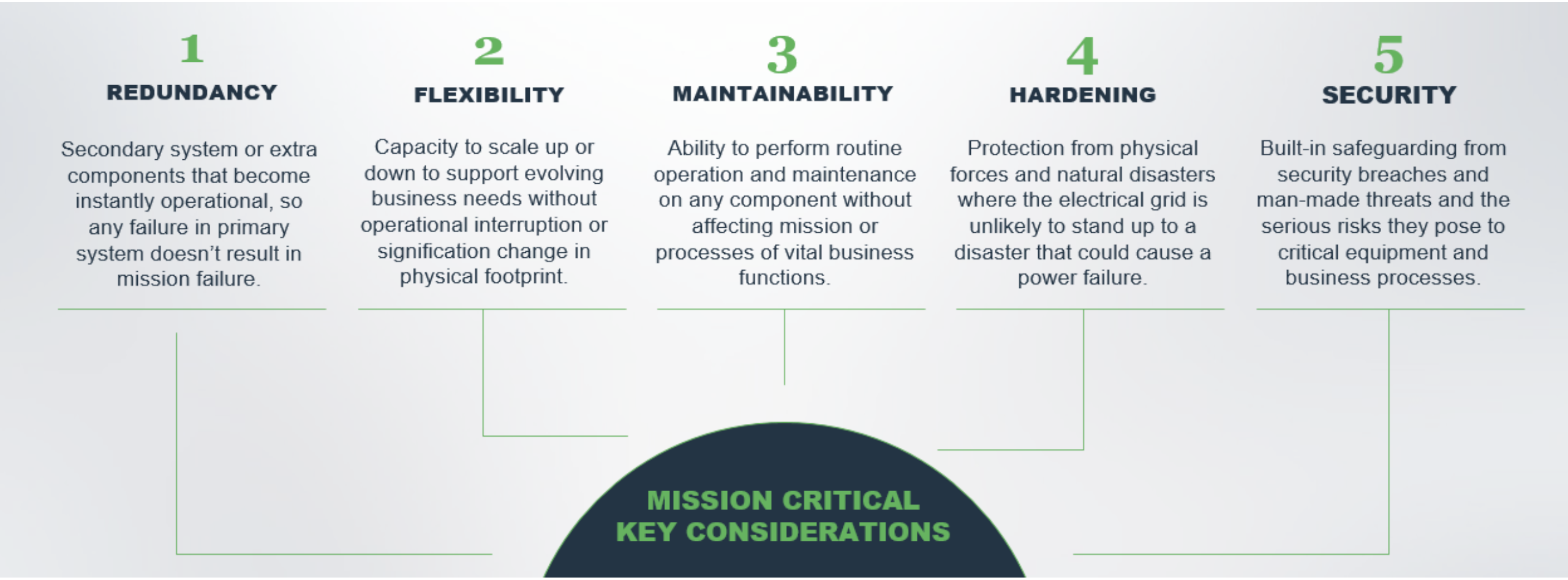
+$40 Billion
projected costs of new undergrounding proposal to bury 10,000 miles of power lines

$1 Billion +
Climate Change Resiliency Plan

$680 Million +
Grid Modernization in CT and MA

Sources: http://www.pgecurrents.com/2017/09/05/infographic-pge-circuit-miles/, A. 18-12-009, Ex. PG&E-4 WP, Vol. 1, EIA, PG&E Plan, ConEd Plan, Eversource EEI Conference.

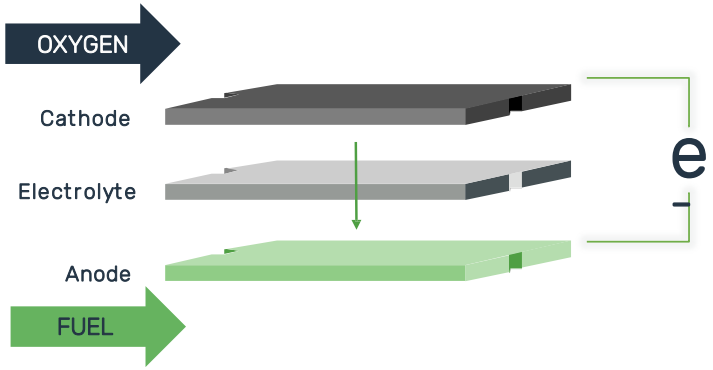
OPERATING A MISSION CRITICAL FACILITY



THE RESILIENCY CHALLENGE: ELIMINATING TRADEOFFS

FUEL CELLS: COMBUSTION FREE ELECTRICITY

COMBUSTION-FREE ELECTRICITY



OXYGEN IONS REACT WITH THE FUEL IN THE FUEL CELL TO PRODUCE ELECTRICITY.

SIMPLE PLATFORM ARCHITECTURE

BENEFITS OF FUEL CELL MICROGRIDS

RESILIENT

Uninterrupted power without compromise

PREDICTABLE

Lock in predictable costs

SUSTAINABLE

Decarbonized power for the digital world

TURNKEY

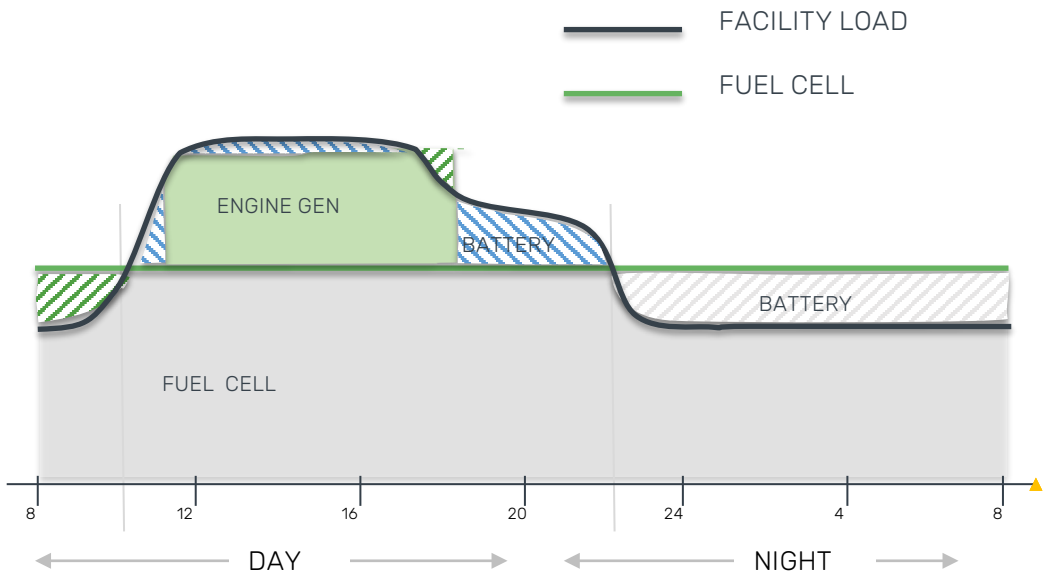
'Plug and play' power with comprehensive customer care

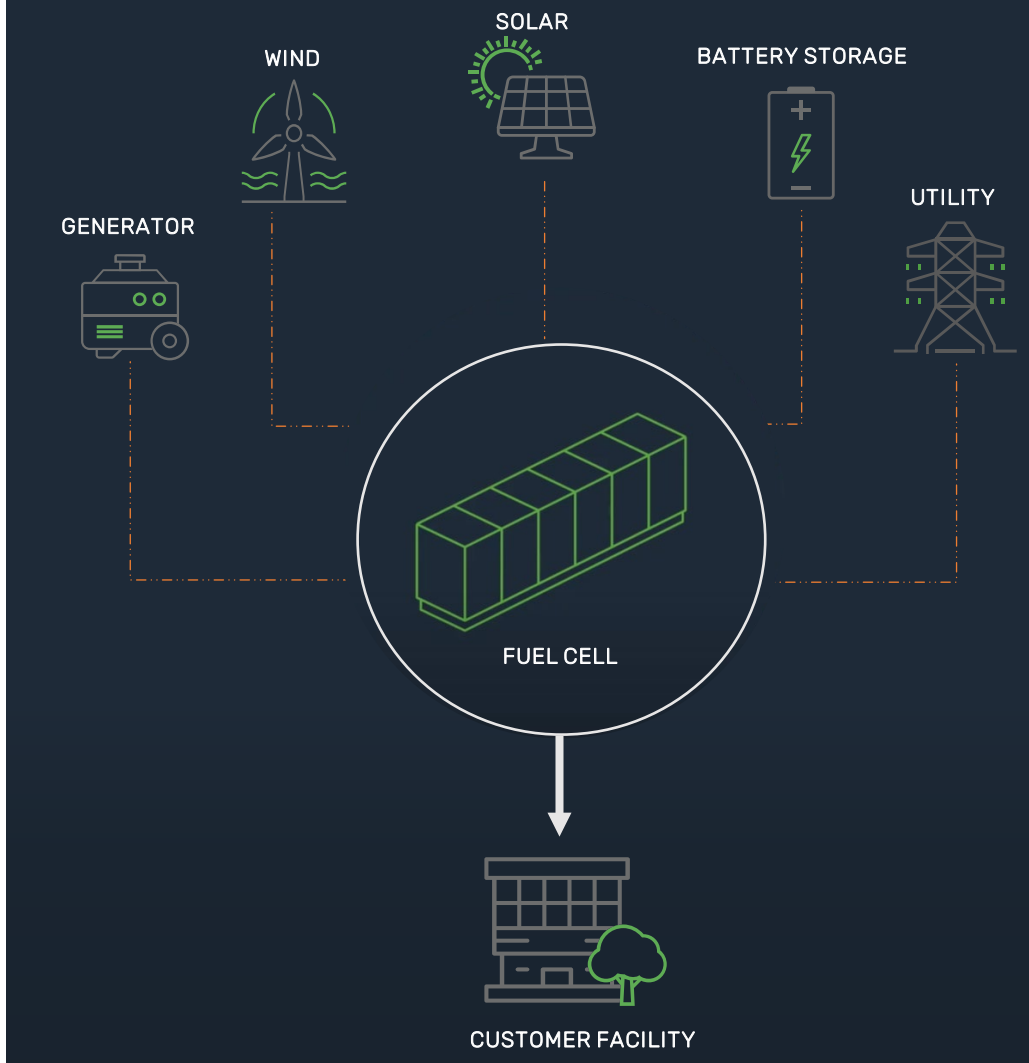
MICROGRID SYSTEM ARCHITECTURE

FUEL CELLS PROVIDE A CRITICAL FOUNDATION FOR MICROGRIDS OF VARYING COMPLEXITY

- Fuel cell system serves baseload primarily with ability to modulate output
- Solar and wind used as much as possible
- Battery covers short peaks and enables load shifting
- Utility can be used for peak shaving when available
- Optional generator is used sparingly for extended peaks

24 HOUR LOAD PROFILE WHEN ISLANDED





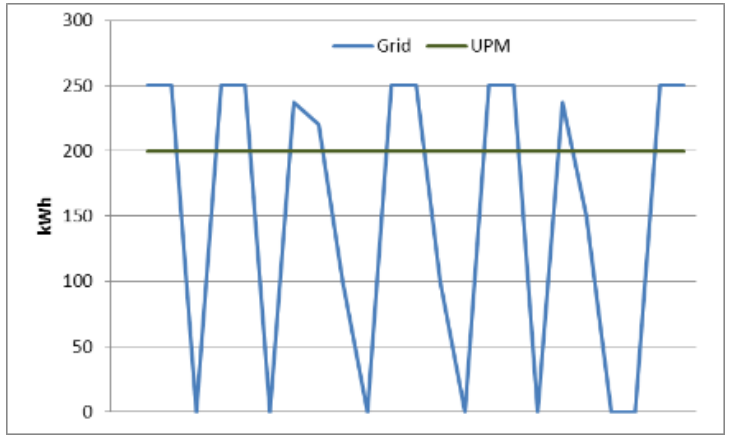
MISSION CRITICAL RELIABILITY

Highly Available Generation

KEY DESIGN ELEMENTS

- Multiple levels of redundancy
- No single point of failure
- Concurrent maintainability
- Simple air-cooled design
- 24/7 monitoring & proactive maintenance

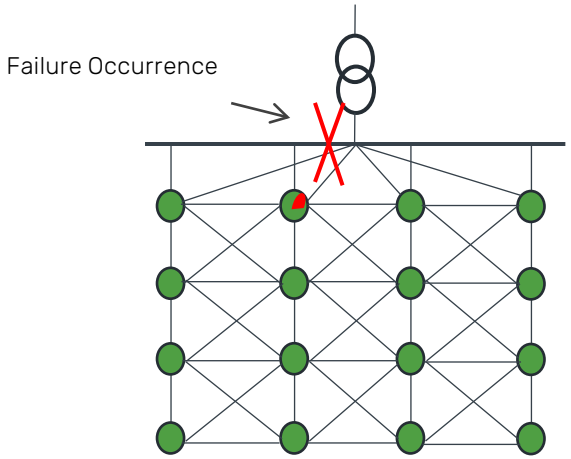
Mission Critical Grade Power



KEY DESIGN ELEMENTS

- Grid independent inverters
- Load following
- Energy storage
- Digital power quality

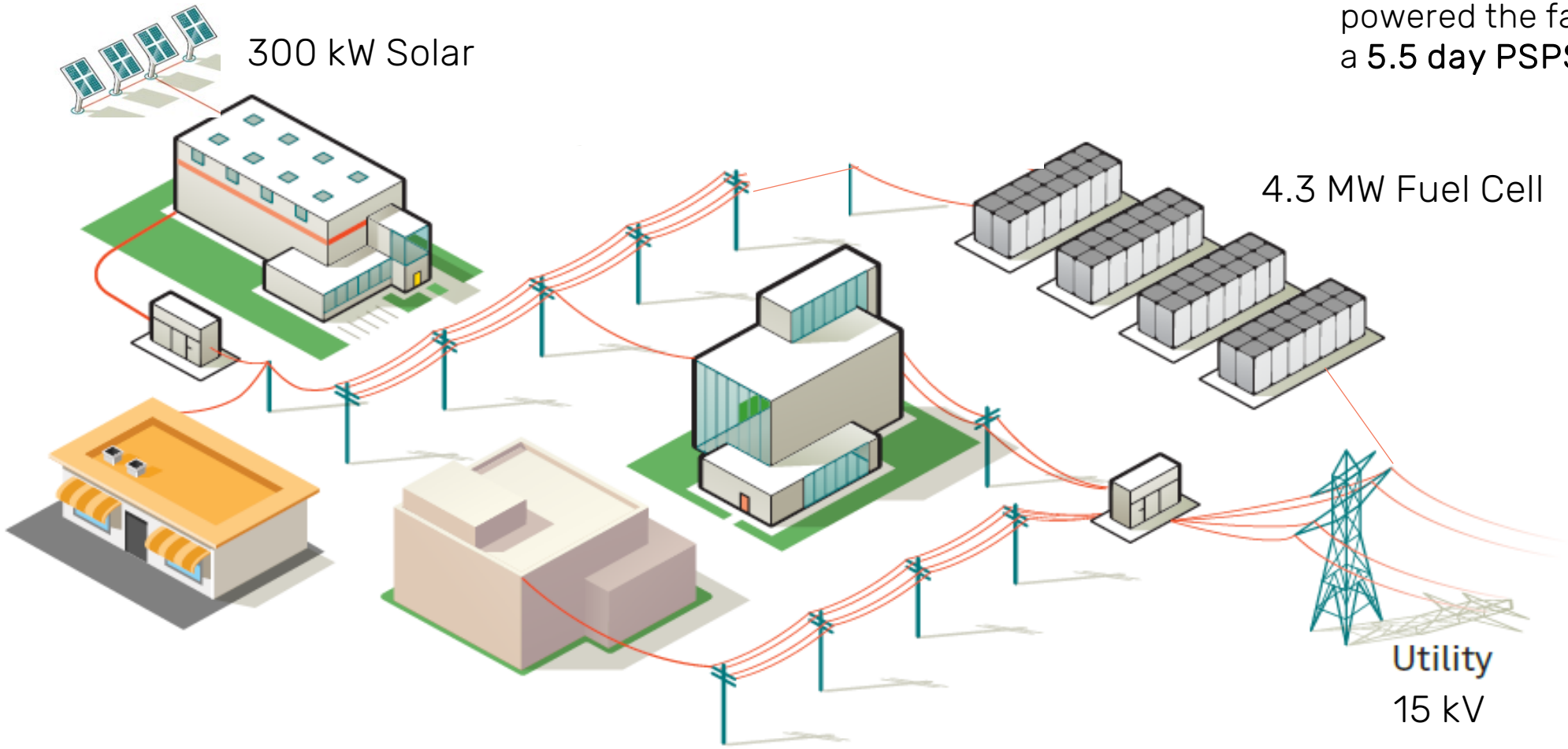
Reliable Fuel Delivery



KEY DESIGN ELEMENTS

- Network design without single points of failure
- Minimal physical exposure, leverages underground infrastructure

During CA wildfire season last year, the microgrid powered the facility through a **5.5 day PSPS event**



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Thank You!

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