Lessons Learned from Energy Commission Microgrid Research Activities

California Energy Commission

California Energy Commission Major Research Programs

- **Electric Program Investment Charge (EPIC)—Administered by the CPUC**
  - Ratepayer-funded program to benefit ratepayers
  - Administered by the Energy Commission and three Investor Owned Utilities (PG&E, SCE, and SDG&E)
  - Energy Commission Program ~ $130 M/year
- **Natural Gas RD&D—Administered by the CPUC**
  - Approximately $24 M/year
- **Special Funds** (e.g., climate vulnerability, transportation research)

Clean-Energy Microgrid Status in California

- **Trends…**
  - Limited deployment
    - Most are Energy Commission research projects
  - R&D projects demonstrating value
    - Successful facility support during major storms and fires
    - Offer 4 – 8 hours of power during grid outage
    - 20%-40% reduction in energy costs
    - Grid support with reduced congestion, voltage regulation

- **…Challenges Remain**
  - High costs
    - Up front costs can be difficult for many site owners
  - Individually designed
    - Not matured to plug and play capability
  - Long implementation schedule
    - 18 – 36 months to full implementation

Medical Center

Fire Station

Community

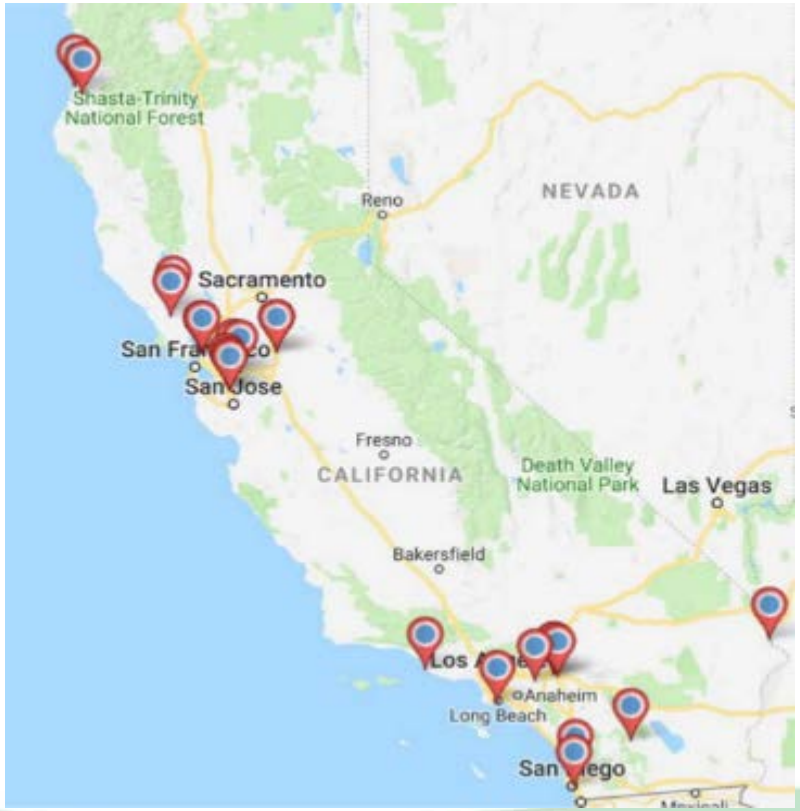
A Decade of Microgrid Research

Deploying the Largest Number of Installed Microgrids

39 microgrids | $90M invested | $71M match funding

- Increasing resiliency
- Maturing microgrid control technologies
- Learning best approaches to integrating multiple resources
- Sharing lessons learned and best practices
- Driving down costs and establishing deployment norms

Locations of EPIC funded Microgrid Projects



Diverse Combination of Microgrid End Users

Critical Facilities

Shelter

Medical Center

Fire Stations

City Hall, Police HQ, and Community Centers

Waste Water Treatment Plant

Airport

Ports

Military

Communities

Industrial

Digester

Distribution Center

Lessons Leaned from Microgrid Research

- Currently microgrids are individually designed, implemented and managed
  - Site design and grid interconnection approval major time factor
- Interest in microgrids has expanded dramatically over the last few years
  - Public Safety Power Shutoffs major factor in California's increased interest
- Business case for microgrids still under development
  - Up front cost a challenge for most end users
  - Full value and benefits provided by the microgrid still being defined
  - Three main ownership models (Utility, Customer, Third Party)

Utility Owned Microgrid—Borrego Springs

- First large scale utility-owned microgrid
- Actually islands real customers
- Alternative service delivery model
- Proved advanced technologies for future applications
- Established a model to be used by other utilities both nationally and internationally
- Operation in a 100% renewable environment

Customer Managed Microgrid—Microgrid at Blue Lake Rancheria

Microgrid Design

Solar: 420 kW AC photovoltaic (PV) ground-mounted array

Energy Storage: 500 kW / 950 kWh lithium-ion (li-ion) battery storage

Software & Controls: Siemens Spectrum Power 7 Microgrid Management System and Schweitzer Engineering Laboratories Protection Relays

Other Infrastructure: Purchased distribution system infrastructure to create a new point of common coupling with the grid, integrating six buildings into the microgrid behind one electric meter

Technology Integration: The Schatz Energy Research Center at Humboldt State University

Source: Blue Lake Rancheria

Source: Schatz Energy Research Center

Source: Navigant

UNIQUE PROJECT ASPECTS

- Critical facility serving as an American Red Cross designated shelter.
- Successfully islanded during several unplanned utility outages due to weather and nearby wildfires. The microgrid can deploy five levels of load shedding depending on the outage and system conditions.
- Achieving energy cost savings of 58% and demand charge savings of 42%.
- Plans to double the battery storage system, add solar PV, integrate more electric vehicle charging stations, and participate in demand response programs.

SCHATZ ENERGY RESEARCH CENTER

Third Party Supported Microgrid--Fremont Fire Stations

Microgrid Design

Solar: 115 kW total carport solar PV (38 kW at Fire Station 11, 43 kW each at Fire Stations 6 and 7)

Energy Storage: 110 kWh li-ion battery storage at each fire station (totaling 333 kWh)

Software & Controls: Gridscape Solutions' cloud-based predictive distributed energy resource management software (DERMS) and energy management system – EnergyScope

Other Infrastructure: None

Technology Integration: Gridscape Solutions

UNIQUE PROJECT ASPECTS

- The solar + storage microgrid displaces diesel generation and extends fuel reserves in the event of a catastrophic emergency, keeping the fire station online longer as a viable first responder.
- The first fire station deployment was characterized by extensive prototype development and testing, refined over the next two deployments. Grant recipient Gridscape Solutions developed the EnergyScope product through this project.
- The systems have successfully executed 3-hour and 6-hour islanding tests, with plans for a 12-hour test.

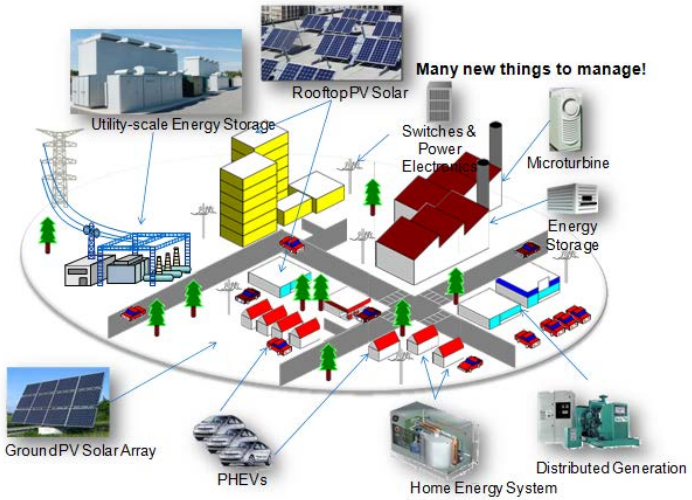
Source: Ecology Way

Source: Navigant

Lessons Leaned from Microgrid Research

LESSONS LEARNED FOR POLICYMAKERS

- Costs have continued to decrease, but must come down further for an attractive ROI in the absence of grants
- Analyzing data from operating microgrids will be increasingly important as the market grows and matures
- The EPIC-funded projects significantly improved the understanding of microgrid best practices in CA
- Modular or simple building block microgrid designs need to be defined if a rapid deployment of microgrids is desired
- Microgrid controllers and communication protocols need standardization
- Utility interconnection requirements need further standardization
- Longer duration islanding capabilities (days vs hours) may be required in the future



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