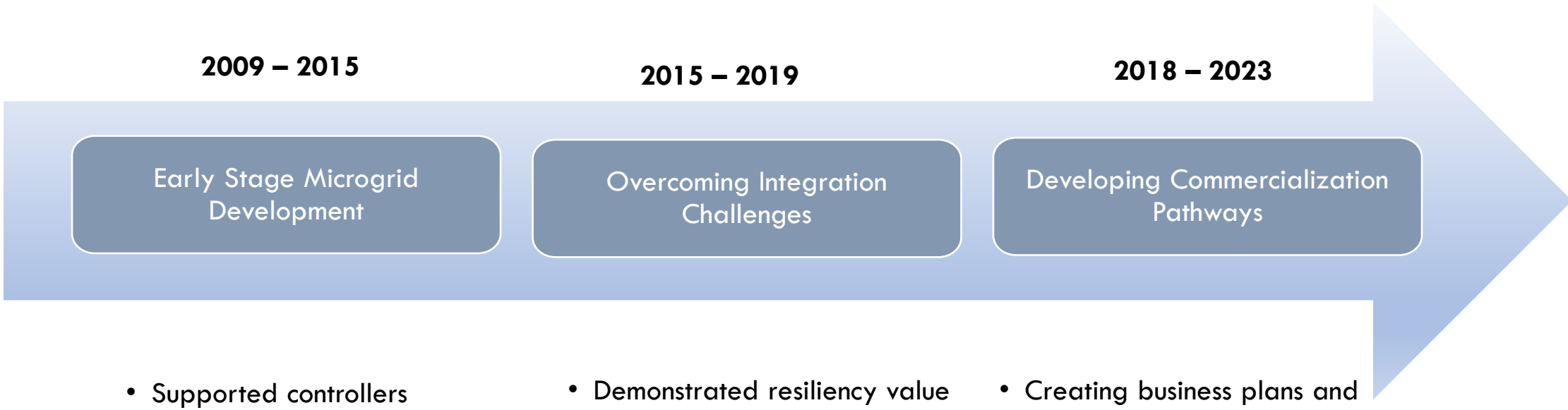
Microgrid Research Program

Qing Tian, Ph.D. P.E.

California Energy Commission

A Decade of Microgrid Research

Developing Commercially Viable Technology



- Supported controllers development
- Developed approaches to integrating multiple resources

- Demonstrated resiliency value of microgrids for critical facilities
- Integrated large number of resources and refined controller designs

- Creating business plans and commercialization pathways for microgrids in California

A Decade of Microgrid Research

Deploying the Largest Number of Installed Microgrids

~60 microgrids | ~$210 M invested | ~$160M 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

2015 GFO Dedicated to Complete Systems

CRITICAL FACILITIES

Demonstrate low carbon-based microgrids that:

1. Protect critical facilities from service interruptions
2. Have high potential for energy and cost savings

- Community Microgrid at Blue Lake Rancheria
- Laguna Wastewater Treatment Plant Microgrid
- Renewable Microgrid for a California Healthcare Facility
- Solar Emergency Microgrids for Fremont Fire Stations

HIGH DER PENETRATION

Demonstrate ability to manage high amounts (up to 100%) of renewable energy to meet the facility/community load

- Las Positas College Microgrid Automation
- Direct Current Building-Scale Microgrid Platform
- Borrego Springs Renewable Energy Based Microgrid

Customer-owned | Third party-owned | Utility-owned

Blue Lake Rancheria Microgrid

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

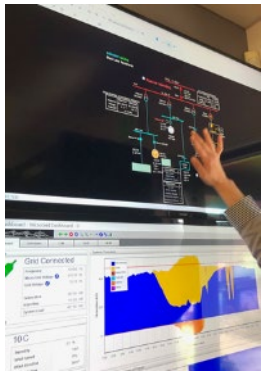
Technology Integration: The Schatz Energy Research Center at Humboldt State University

UNIQUE PROJECT ASPECTS

- Critical facility serving as an American Red Cross shelter.
- Islanded during multiple outages due to weather and nearby wildfires.
- Can deploy five levels of load shedding depending on the outage and system conditions.
- Plans to double the battery storage system, add solar PV, integrate more electric vehicle charging stations, and participate in demand response programs.

Source: Blue Lake Rancheria

Source: Schatz Energy Research Center



Source: Navigant

Kaiser Richmond Hospital Microgrid

Microgrid Design

Solar: 250 kW top-level parking garage solar PV array

Energy Storage: 250 kW / 1 megawatt-hour (MWh) li-ion battery storage

Software & Controls: Charge Bliss microgrid controller and Princeton Power Systems Energy Management Operating System

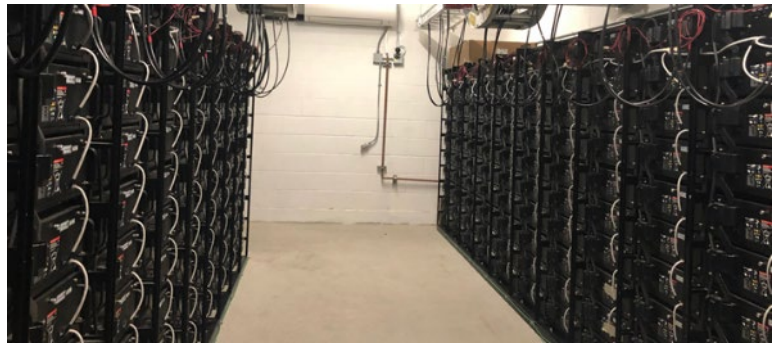
Other Infrastructure: LED lighting in solar canopies

Technology Integration: Charge Bliss and CONTECH-CA

Source: Charge Bliss

UNIQUE PROJECT ASPECTS

- Demonstrated first renewable-integrated microgrid supporting an acute, critical health facility in the state.
- The Office of Statewide Health Planning and Development, which regulates facility requirements, served as an active partner, approving connections to normal power and life & safety circuit
- Estimated 20% bill savings from mitigating high summer demand charges.



Source: Navigant

Fremont Fire Station Microgrids

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

Source: Ecology Way

Source: Navigant

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.
- Island capabilities of up to 10 hours.

Borrego Springs Microgrid

Microgrid Design

Solar: Integrated existing 26 MW ground-mounted solar PV array and 3 MW distributed customer rooftop solar PV

Energy Storage: 1.0 MW / 3 MWh li-ion battery storage, adding to a 500 kW / 1,500 kWh li-ion battery and 3x 25 kW li-ion batteries (previous project phase)

Software & Controls: SDG&E and Spirae DERMS / Advanced Microgrid Controller

Other Infrastructure: Incorporates all three 12 kV circuits in Borrego Springs, and currently integrating a 250 kW ultracapacitor

Technology Integration: SDG&E

UNIQUE PROJECT ASPECTS

- Multi-phase project; most recent EPIC-funded phase focused on increasing solar + storage and microgrid automation and controls. The utility-operated DERMS/microgrid controller now connects to the 26 MW Borrego Solar Project owned by Clearway.
- All of Borrego Springs (2,800 customers) can island for several hours during the day (4.5 hours in May 2018) and designated critical loads can island at night.
- SDG&E is working to resolve challenges with such a high penetration of solar PV, which can cause frequency issues while islanding. This will be important experience for the state as it moves to 100% carbon-free energy.

Source: SDG&E

Source: Navigant

2018 Microgrids for Commercialization

Title	Objectives
Port of Long Beach Microgrid	• Support the Joint Command and Control Center with PV and a stationary battery • Include mobile battery energy storage that can be deployed to power pumping stations or refrigerated container yards
Port of San Diego Microgrid	• Integrate solar PV generation, battery energy storage, energy efficiency improvements, and a centralized microgrid controller • Allow key elements of the terminal to remain operational when islanded from the grid for a minimum of 12 hours to support the DOD strategic port and a jet fuel storage facility for the San Diego International Airport
Miramar Microgrid	• Builds on an existing microgrid • Maintain critical flight line facilities during grid outages • Make better use of local landfill gas
Camp Parks Army Microgrid	• Produce a nested microgrid design • Create a blueprint for incorporating multiple DER, a control system, and a resilient nodal building block approach
Port Hueneme Microgrid	• Develop new approaches to ensure stable power to sensitive components, such as in data centers • Partner with the Navy's development of a microgrid test facility

2018 Microgrids for Commercialization

Title	Objectives
Redwood Coast Airport Microgrid	• Demonstrate a multi-customer, front-of-the-meter microgrid managed by a CCA (Redwood Coast Energy Authority) and an IOU (PG&E) • Allow CCA to participate in the CAISO wholesale market and provide low carbon resilience to a commercial airport and USCG Air Station
Rialto Microgrid	• Generate power from food waste and sewage sludge and support 3 days of islanding with feedstock interruption, or indefinite islanding with continued feedstock supply • Capable of shaving 100% of grid draw during peak power demand in normal operations
Virtual Wide Area Microgrids	• Develop microgrids at DACs in multiple IOU territories and control them via cloud-based controls and optimization platform • Support fire stations, police stations, 911 call centers, school refrigeration facilities
Santa Rosa Junior College Microgrid	• Demonstrate a microgrid serving 27 campus buildings • Meet 40% of the campus electricity requirement, to reduce the campus' peak load, to provide support services to the surrounding grid, and to create a highly resilient power system benefitting the campus and the community.

Clean-Energy Microgrid Status in California

- **Trends…**
  - Limited deployment
    - Most available information is on Energy Commission research projects
  - R&D projects demonstrating value
    - Successful facility support during major storms and fires
    - Offer 4 – 10 hours of power during grid outage
    - 20%-40% reduction in annual energy costs
    - Grid support with reduced congestion, voltage regulation
- **…Challenges Remain**
  - High costs
    - Up front costs can be difficult for many site owners: PPAs a growing market
  - Individually designed
    - Not matured to plug and play capability
  - Interconnection costs and time delays make it challenging to implement
    - Microgrids supporting multiple customers even more challenging but valuable for resilient

California Tribal Energy Resiliency Alliance (C-TERA)

- **Develop and deploy a portfolio of grid-serving clean energy projects:**
  - Serve the specific needs of tribal communities and their critical facilities and provide resilience for the tribes and adjacent communities.
  - 17 proposed projects totaling approx. $500M ($250M federal funds/$250M non-federal funds).

- **Support formation of Energy Technical Assistance Hubs:**
  - Deliver technical support for C-TERA projects from concept to sustainable operations.
  - Provide services to accelerate the adoption of clean energy solutions, enhance community resilience, support economic and workforce development, and ensure that all tribes statewide are well positioned to access and benefit from future funding opportunities.

Questions

Qing Tian, Ph.D. P.E.

qing.tian@energy.ca.gov

(916) 776-0820