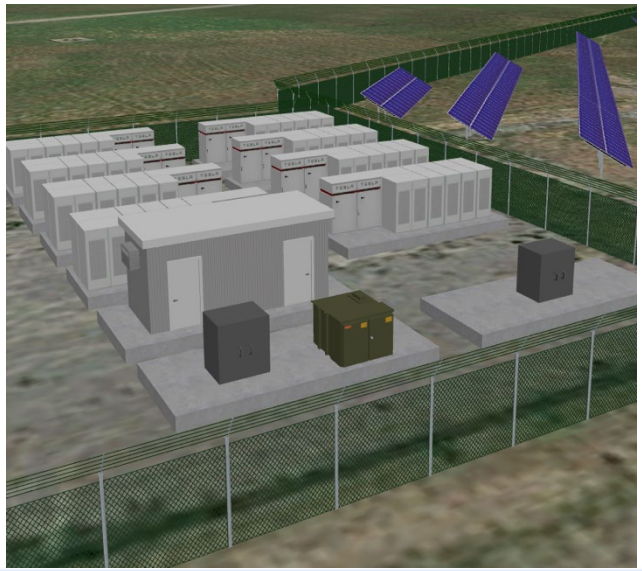
Redwood Coast Airport Renewable Energy Microgrid

Local government and an IOU advancing a resilient and clean energy future



What is a microgrid?

- The U.S. Department of Energy defines a microgrid as *"A group of interconnected loads and distributed energy resources (DER) within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. Additionally, a microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island-mode."*
- Microgrids vary in size and complexity
  - Behind-the-meter, single facility
  - Behind-the-meter, multi-facility campus
  - Front-of-the-meter, multi-customer system that utilizes the DSO's grid
- Benefits can include: resilience, cost reduction and/or revenue generation during "blue sky" conditions, services to the grid, allowing a greater penetration of variable renewables on the grid, part of the pathway to "the smart grid of the future."

Key Highlights of the RCAM project

- Local government leading the way
- DERs and microgrids in our local communities
- Supporting vulnerable populations
- Demonstrating the value of partnerships
- Cutting edge project with focus on replication

Source: TrinidadMike

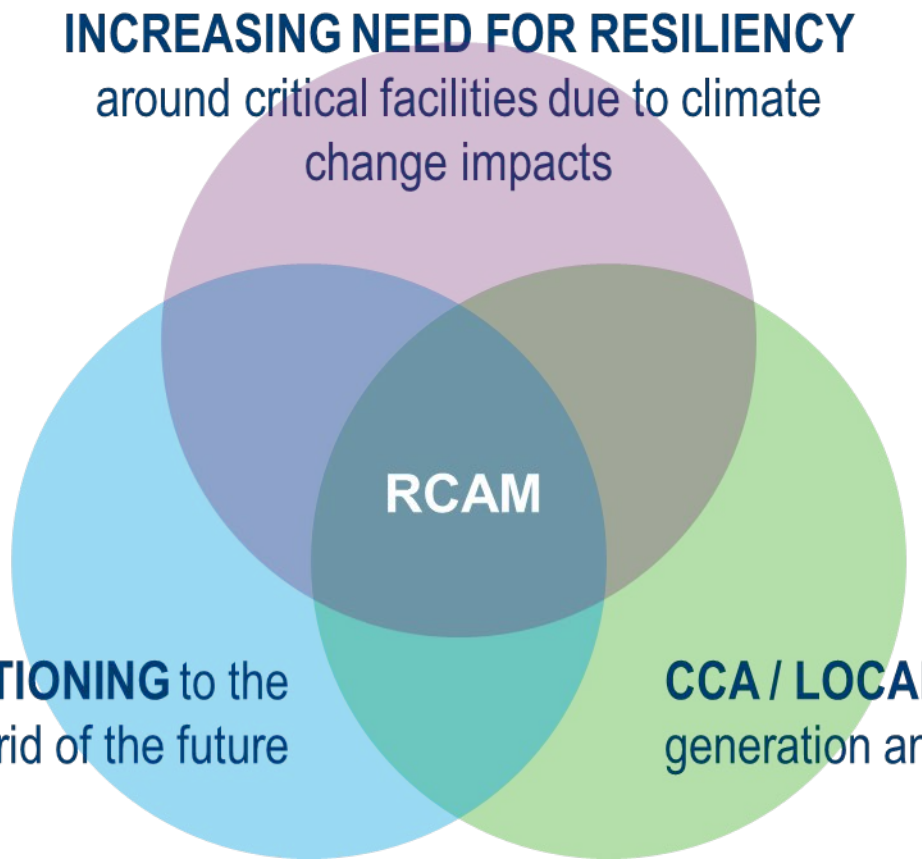
Motivation

Schatz Energy Research Center

Humboldt County is a rural, isolated community at the end of a transmission line.

We are vulnerable to tsunamis, earthquakes, landslides, floods, wildfires and now PSPS events.

A Microgrid for Today's Environment



Project Objectives

Community Benefits

- Provide resilience to critical community services in the face of climate change
- Provide local benefits via renewable energy development (create jobs, keep energy $$$ local, increase energy security, reduce price volatility, increase local control & ownership)
- Reduce greenhouse gas emissions

Ratepayer Benefits

- Demonstrate a viable, replicable business model for a 100% renewable community scale microgrid
- Develop agreements, standards and processes for replicability
- Advance technology and policy through cutting edge public research

Source: US Coast Guard

Key Project Partners

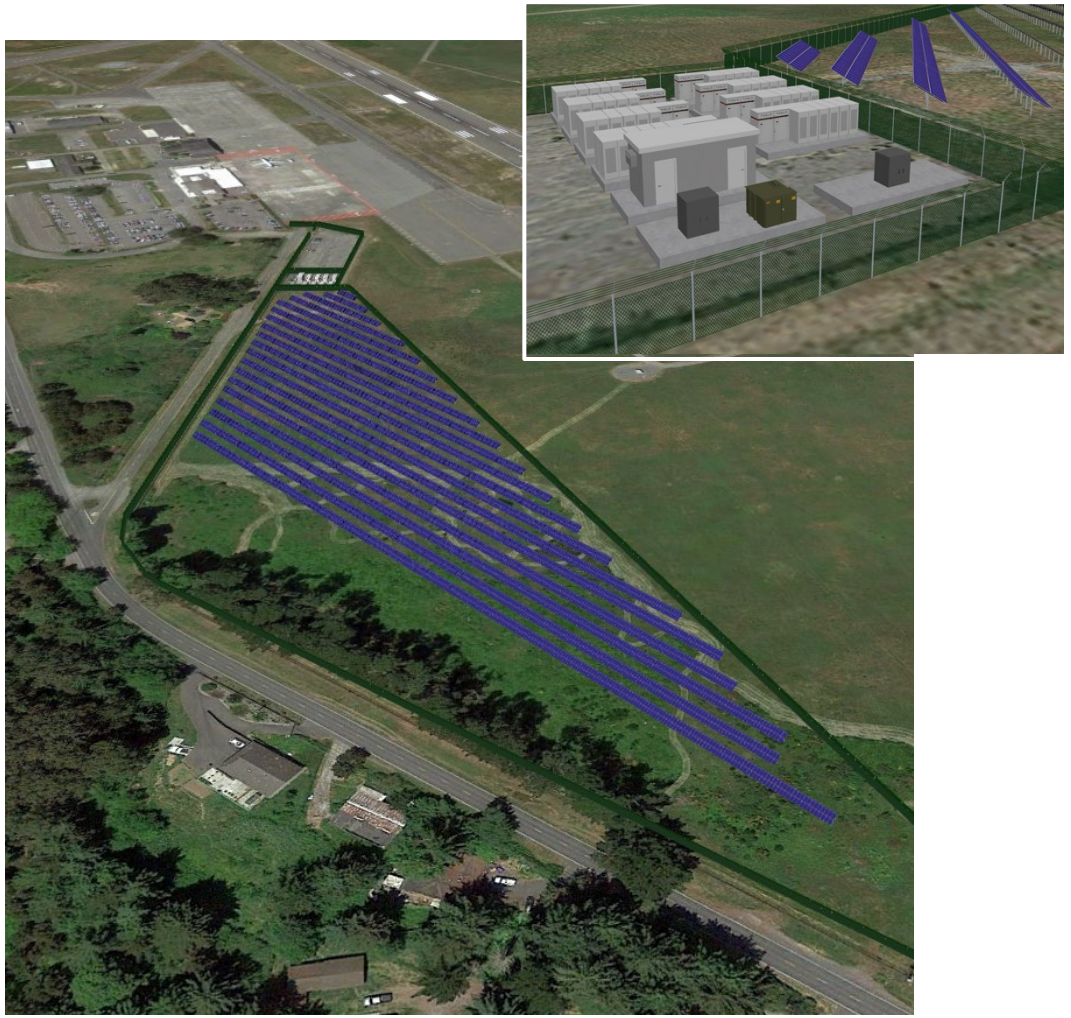
- **Schatz Energy Research Center**: prime contractor & technology integrator
- **Redwood Coast Energy Authority**: local CCA, distributed generation owner & co-funder
- **Pacific Gas & Electric**: distribution system operator
- **CEC and PG&E Electric Program Investment Charge (EPIC)**: grant funders
- **County of Humboldt**: airport owner/operator
- **TRC Companies** → business case evaluation, cybersecurity
- Key vendors: **Tesla** → PV/battery, **Schweitzer Engr. Labs** (SEL) → controls

Innovative Partnerships

- Features a unique partnership between an IOU and a CCA
- Builds on long-term relationships and trust
- Includes the expertise and partnership of a renowned renewable energy research center
- Project team is working with CEC, CPUC and CAISO to share lessons learned that can foster replication of microgrids and DERs in communities throughout CA

Project Description

- First front-of-meter, multi-customer microgrid on PG&E's system
- 2.2 MW PV array DC-coupled to 2.2 MW/8.8 MWh battery storage → CAISO wholesale market participation
- 300 kW_{AC} net-metered PV array → reduce airport electric bills
- Microgrid controllers → will allow the system to island and provide uninterruptible power for long periods



Technical Design

Grid-connected Mode

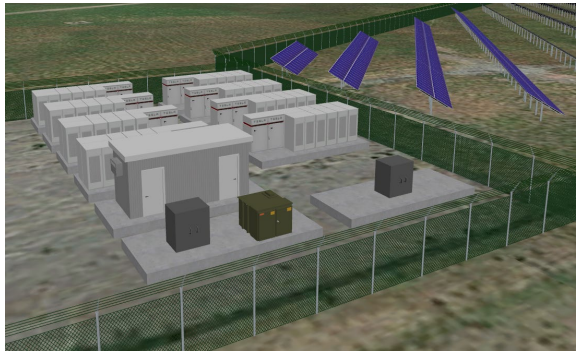
- RCEA (3rd party) will control generation asset, participate in wholesale market → energy arbitrage
- Wholesale interconnection constrained to 1,480 kW max import and 1,778 kW max export to mitigate otherwise required distribution system upgrades

Islanded Mode

- PG&E as distribution system operator (DSO) will control generation asset

Technical Innovation

- DC-coupled PV + battery system
- Control and monitoring of the DERs from the Distribution Control Center
- Protection settings
  - Multiple sets of protection settings
  - Distinct settings for grid-connected and island modes
  - Inverter-based generation poses challenges for meeting required fault current
  - Protection relays and controls limit export and import capacities to mitigate distribution system upgrade requirements



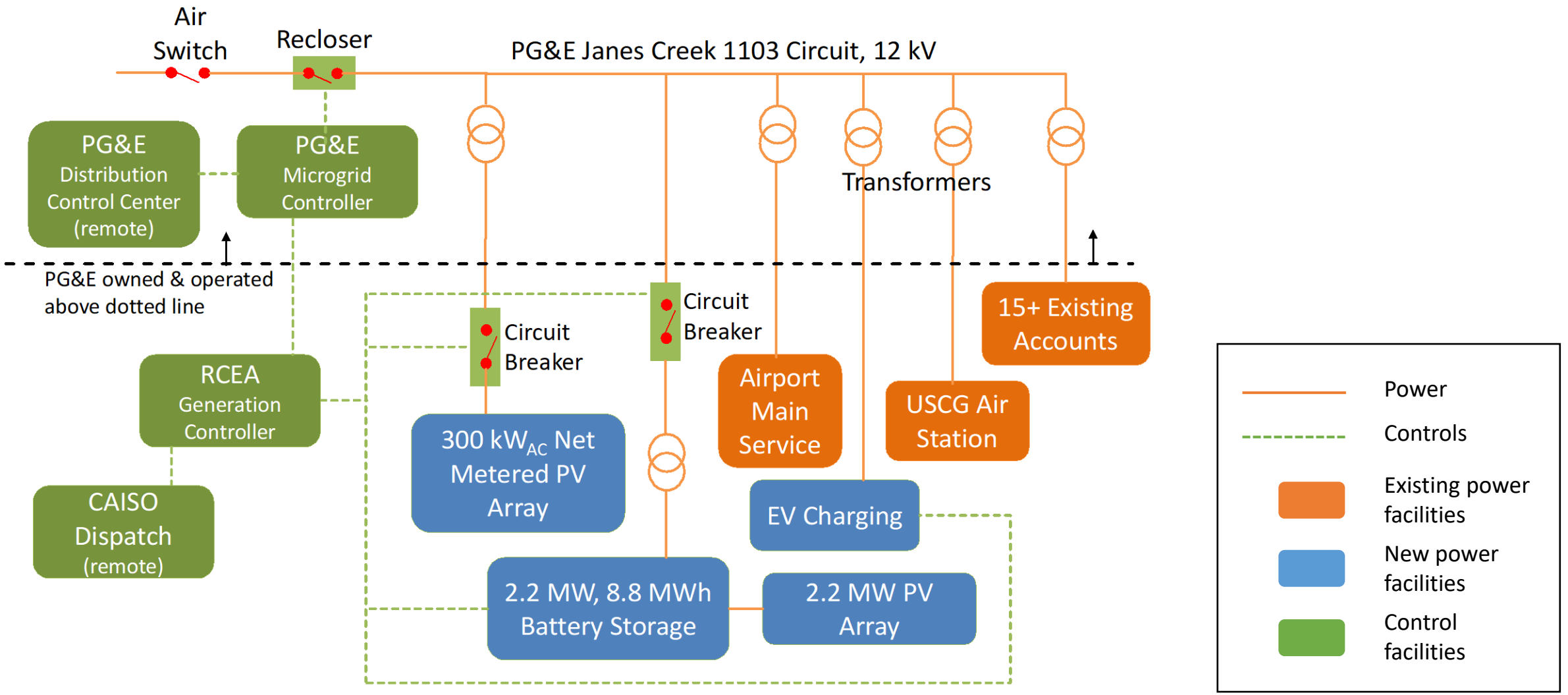
Innovation: Unique Ownership Structure

- First front-of-the-meter, multi-customer microgrid in PG&E's territory
- Unique roles and responsibilities for Distribution System Operator (DSO) and CCA
- 3rd party will sell power in the CAISO market during "blue sky" operation, will form islanded section of DSO's grid during bulk grid shutdown
- DSO will have visibility and control from Distribution Control Center, will control grid in island mode
- Defining responsibilities, standards, requirements → protection synchronization, power quality, black start capability, metering
- Defined a "bright clean line" delineating who owns, operates and is responsible for hardware, software and operational tasks
- Lessons learned will inform the CPUC microgrid proceeding

Operating Agreements & Replication

- Unique partnership between an IOU and a CCA
- CCA will own and operate DERs that will form the islanded microgrid on IOU's distribution circuit, this requires special attention
- Areas of collaboration include:
  - Design → must be safe, reliable and functional and must seamlessly mesh with the existing distribution system
  - Development of contractual agreements
    - RCAM Microgrid Operating Agreement
- Focus is to develop necessary agreements for RCAM project within existing regulatory framework with eye toward future replication potential

Simplified 1-Line Diagram



Innovation: CAISO Market Participation

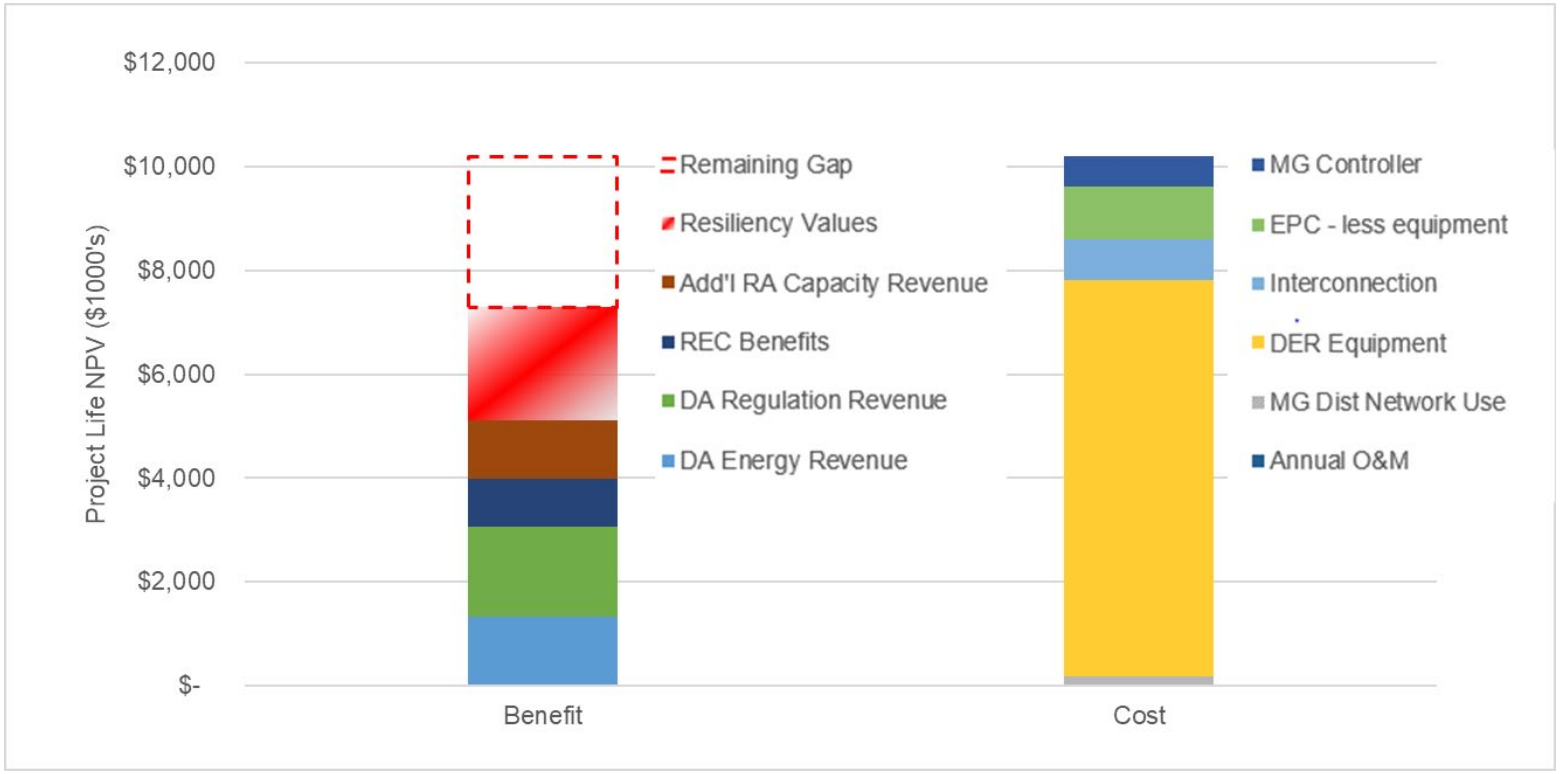
- Wholesale market revenue can be key benefit for FTM microgrids.
- We are working with CAISO on a number of key innovations.
- We will eventually be one of the first “Hybrid Resource” market participants.
- Microgrids must be able to hold energy storage capacity in reserve for resilience purposes and this is a new concept.
- What happens when in island mode regarding CAISO settlement processes?

RCAM Base Case + Resiliency

$2.2M
RESILIENCY VALUE

0.71
BENEFIT / COST (25 YEARS)

$2.9M
REMAINING GAP



Costs and Benefits

- Costs (actual and estimated)
- Wholesale market revenue (TEA, NREL)
- Resiliency value (TRC modeling)
  - Loss of service & revenue
  - Loss productive time (worker GDP)
  - Customer interruption cost
  - Determined using accepted models (FEMA Benefit-Cost Analysis Re-engineering methodology, Interruption Cost Estimate Calculator)
- Remaining gap made up by many additional benefits (added resilience, job creation, local energy control)

Statewide Impacts of RCAM

- CPUC Microgrid proceeding
  - PG&E CMEP Program approved, CPUC requiring statewide adoption
  - RCAM is the model for the PG&E program
- CAISO hybrid resource initiative
- WREGIS RECs accounting for hybrid resource
- CPUC interest in terms of diesel alternatives for substation microgrids for PSPS mitigation

We are on the cutting edge of microgrid development and deployment!


Questions?