Microgrid Overview
SMUD Board Presentation

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Definition of Microgrid

EPRI’s Definition of “Microgrid”

1. A group of inter-connected loads and DER equipment and devices, within defined electrical boundaries.
2. Acting as a single controllable entity with respect to the grid.
3. Able to connect and disconnect from the grid, operating in both grid-connected or island-modes.
Types of Microgrids/Range of Objective

- **Commercial/Industrial Microgrids**: generally built with the goal of reducing demand and costs during normal operation, although the operation of critical functions during outages is also important, especially for data centers.

- **Community/Utility Microgrids**: designed to improve reliability and to promote community participation.

- **Campus/Institutional Microgrids**: many campuses already have DG resources, with microgrid technology linking them together. They are usually large and may be involved with selling excess power to the grid.

- **Military Microgrids**: critical loads, cyber and physical security, both for fixed bases and forward operating bases.

Most microgrids will be grid-connected >99% of the time.
Microgrid Technology, Components and Costs

Components

- DER (Generation and Storage)
  - Diesel, natural gas, combined heat and power (CHP), biofuel, solar photovoltaic (PV), wind, and fuel cell and energy storage

- Microgrid Controller
  - Primary, Secondary, Tertiary

- Additional Infrastructure
  - Distribution system infrastructure (switchgear, protection equipment), information technology communications upgrades, metering

- Soft costs
  - Engineering, construction, commissioning, regulatory

Costs

- Leverage existing DER
- Lowest average cost in Community and Utility microgrid markets

<table>
<thead>
<tr>
<th>Type</th>
<th>Typical Cost Range ($M/MW)</th>
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<tbody>
<tr>
<td>Campus/Institutional</td>
<td>$2.5 – $4.9</td>
</tr>
<tr>
<td>Commercial/Industrial</td>
<td>$3.4 – $5.4</td>
</tr>
<tr>
<td>Community</td>
<td>$1.4 – $3.3</td>
</tr>
<tr>
<td>Utility</td>
<td>$2.3 – $3.2</td>
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Source: NREL “Phase I Microgrid Cost Study” 2018
## Why Build a Microgrid?

### Understanding Microgrid Objectives

<table>
<thead>
<tr>
<th>Objective</th>
<th>Solutions…</th>
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<tbody>
<tr>
<td>Integrating more renewables (hosting capacity)</td>
<td>Infrastructure upgrade, smart inverters, energy storage</td>
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<tr>
<td>Reducing local emissions</td>
<td>Grid-tied renewables, CHP, building and transportation electrification</td>
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<tr>
<td>Defer / Avoid Utility Upgrade (non-wires alternative)</td>
<td>Smart inverters, energy storage, flexible load – coordinated by DERMS/ADMS/etc.</td>
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<tr>
<td>Enable building and transportation electrification</td>
<td>Aggregation of local controllers, flexible load management</td>
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<tr>
<td>Improve Local Resilience / Reliability</td>
<td>Infrastructure upgrade, backup generators, energy storage, microgrid</td>
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Microgrids as part of Resilience Strategies - Key Drivers

- Expanding T&D expensive and difficult
- Hardening of grid can be expensive
- Local resilience sources can be strategic

**Hardening Measures**
- Higher Design & construction standards

**Recovery Measures**
- Faster restoration management and damage assessment

**Survivability Measures**
- Resilient technologies namely microgrids utilizing DER technologies for outage mitigation
Rising Expectations

- The vision of grid interactive community resilient solutions is to leverage existing DER and create “community microgrids” to begin a more decentralized restoration from outages, and then connect these to the full electric grid
  - Reduces the likelihood and impact of power outages from major events;
  - Improves the restoration of grid power along with the capability of customers to receive that power; and
  - Strengthens the customer’s and community’s ability to address prolonged outages.
The Utility Challenge: Integration of Microgrids

Regulatory Challenges:
- Ownership of generation
- Administrative burden of regulation

Technical Challenges:
- Bi-directional power flows
- Fault current contribution
- Unit Level Volt/VAR support
- Islanded Operation

Economic Challenges:
- DER technologies still costly and with uncertain lifetimes
- Business model still undeveloped
- Utility rate structures in early implementation
Microgrids & Resilience Technology & Demonstration Landscape

Customer-Owned Community

Utility Managed Community

Solar+ES+EV Charging Microgrid

EV as Dispatchable Assets

Utility-Operated in Front of the Meter DERs

Utility Operated DERs during PSPS
Together...Shaping the Future of Energy
Additional Material
Enable Resiliency through Community Design

Integrate with and repurpose existing Infrastructure and DERs

Enable independent communication systems for critical infrastructure

Improve restoration through community control, grid-forming inverters, & interconnection practices

Demonstrations validate decarbonization and resilience co-benefits!

Balancing decarbonization goals, energy affordability, equity considerations, and sustainability commitments
Achieving Resilience and Carbon Reduction Goals

Can Community Microgrids Enable Both These Goals?

Reliability and Resilience

Achieve 100% Renewable and Decarbonization Goals

Clean, Affordable, Resilient, Equitable and Safe
EPRI Integrated Grid Demonstrations

Blue Lake Rancheria & Humboldt County Airport Microgrids

Duke Energy Mount Holly Microgrid Test Facility

Bronzeville Community Microgrid (SHINES)

Multiple Customer

Single Customer

Utility Operated

37 demo projects

https://techportal.epri.com/demonstrations/ig
Example Utility Reliability/Resilience Applications

Xcel Energy

Community Resiliency Initiative

Solar plus Storage based microgrids to support community resiliency
- Community partner defines “critical” infrastructure
- Xcel Energy brings battery storage and islanding capability
- Solar and other generation provided by the site

Benefits:
- Improves resiliency
- Supports Xcel Energy’s clean energy transition
- Provides grid benefits

Enabling Legislation:
- HB18-1270 (http://leg.colorado.gov/bills/hb18-1279)

PG&E Arcata Microgrid

Categories of Microgrid

1. Single-customer facility
   - Description: Customer-side of the meter
   - Key Drivers: Customer reliability & resilience
   - Example: Angel Island (planning)

2. Remote
   - Description: Utility-sponsored projects, typically hybrid ownership (e.g., utility-owned distribution assets, customer-owned DG)
   - Key Driver: Potential T&D alternative in remote locations

3. Multi-customer on-grid
   - Description: Typically cities seeking to enable critical facilities to island in the event of broader grid outage and enhance local resiliency
   - Key Driver: Community resilience
Objective:

Design and build a first of a kind high performance community and residential microgrid to learn how to better serve changing customer needs.