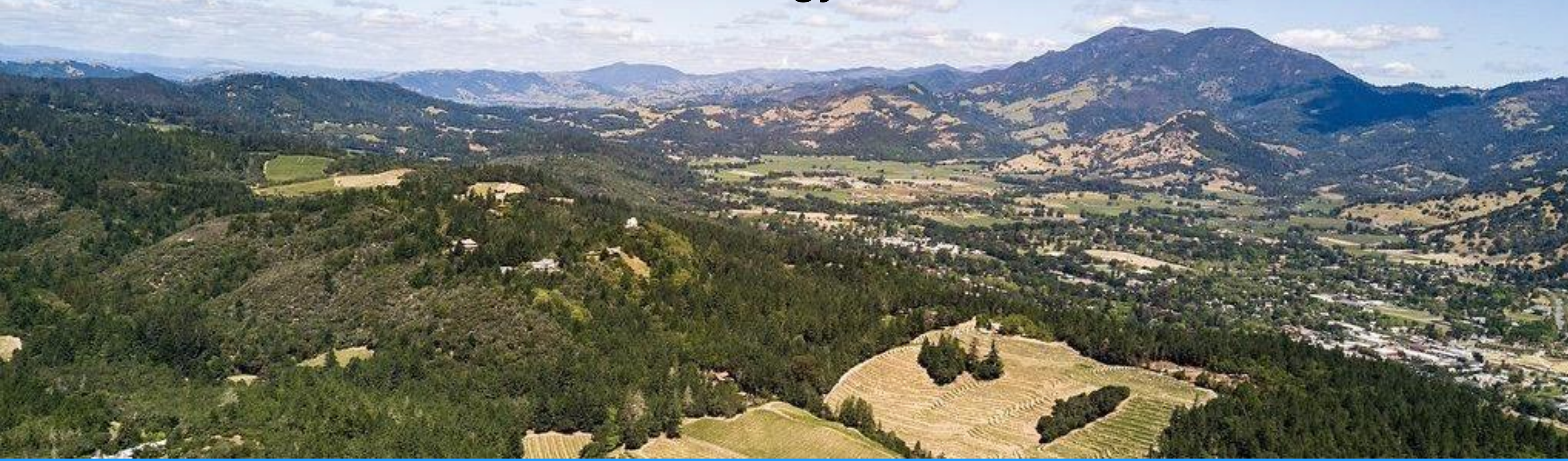
Clean Coalition

Making Clean Local Energy Accessible Now

Community Microgrids

A resilient clean energy solution for cities



Frank Wasko
Managing Director
949-501-0967 mobile
frank@clean-coalition.org

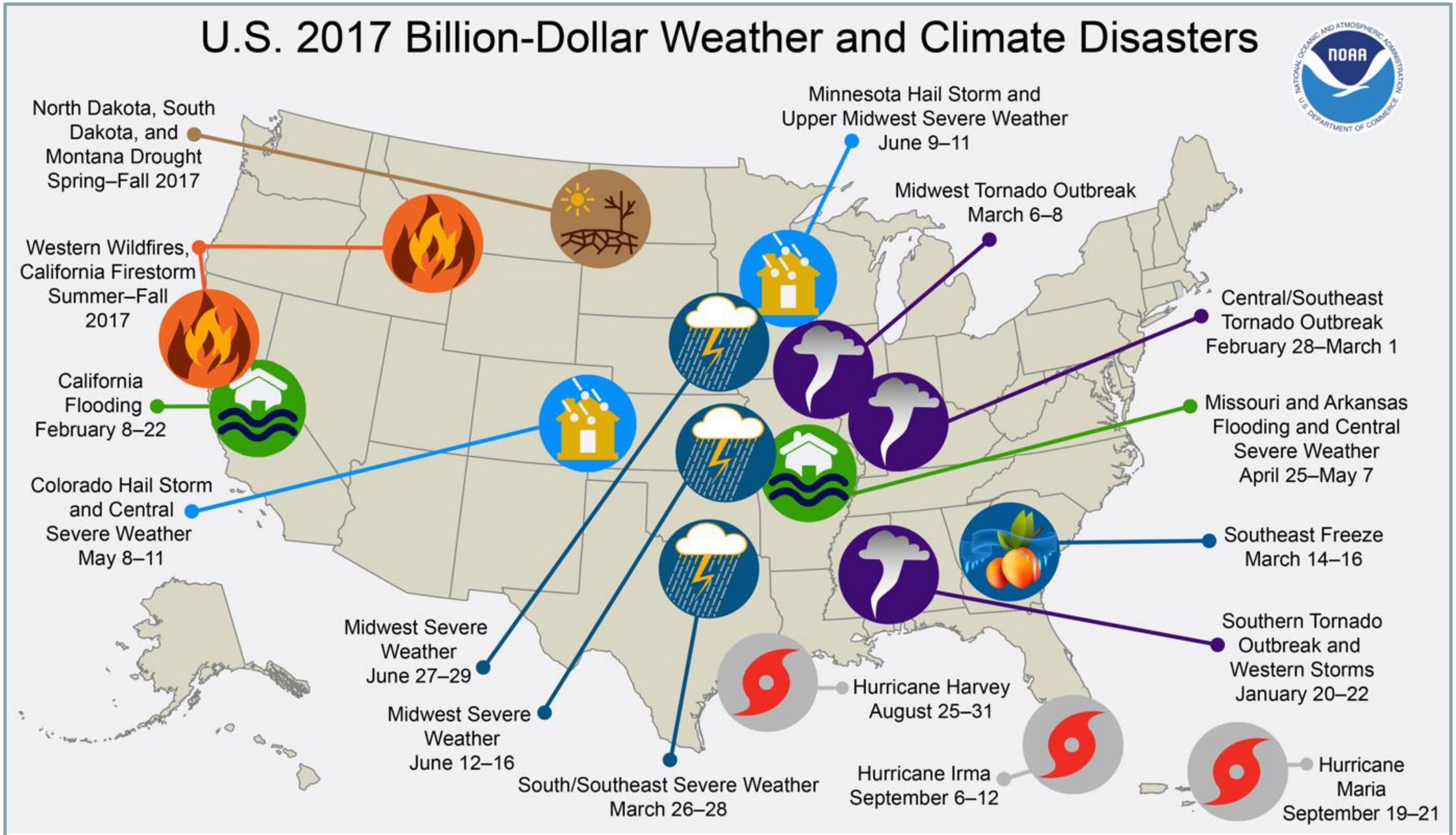
Malini Kannan
Program Engineer
650-533-8039 mobile
malini@clean-coalition.org

Presentation outline

- Current situation
  - Lack of resilience
- Traditional grid, microgrids and Community Microgrids
  - Benefits and components
- Value of Resilience (VOR)
- Use cases and case study
- System design: Distributed Energy Resources (DER) and microgrid-specific equipment
- Regulatory and economic challenges and solutions
- How cities can help make Community Microgrids a reality

Current situation:
$1B+ weather events in U.S. Jan – Sept 2017

Clean Coalition



Source: National Oceanic and Atmospheric Administration

Current situation:
Public Safety Power Shutoffs (PSPS) outages

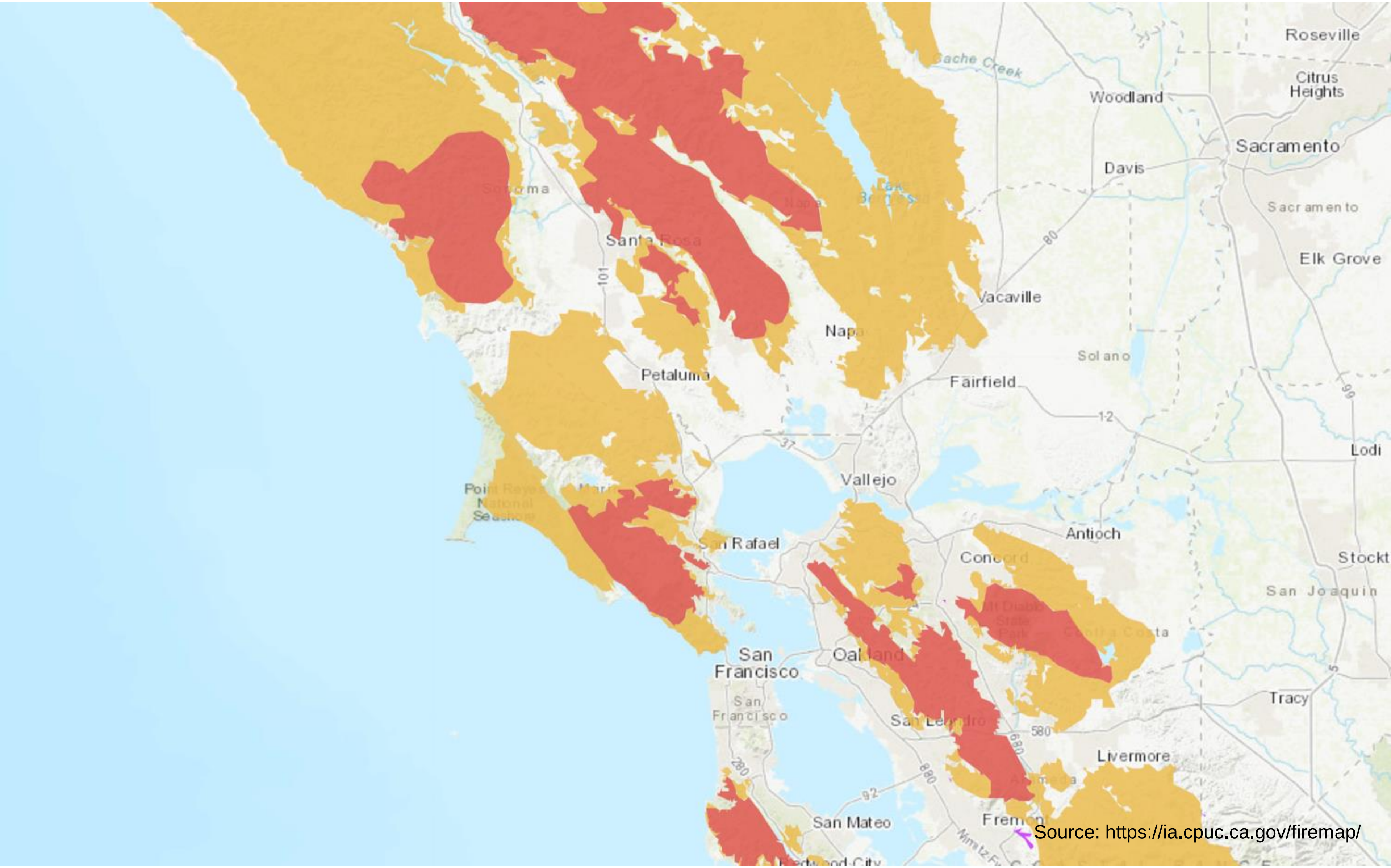
Clean Coalition

WHICH CUSTOMERS ARE MOST LIKELY TO HAVE THEIR POWER TURNED OFF?

If we need to turn off power for safety, it will be limited to neighborhoods or communities served by electric lines that run through areas experiencing extreme fire danger conditions. We will turn the power back on as soon as it is safe to do so. The most likely electric lines to be considered for shutting off for safety will be those in areas that have been designated by the California Public Utilities Commission (CPUC) as at extreme risk for wildfire (Tier 3 areas).

- Multiple PSPS events were planned in 2018, one event executed.
- Negative impact: Critical facilities, businesses, and residents lose power during planned shutdowns and cannot provide services.
- Microgrids can provide a solution to keep power on, however local hazards (e.g. local fire threats) need to be considered to be considered in the design process.

Current situation: CPUC fire threat map



Source: https://ia.cpuc.ca.gov/firemap/

Diesel generators are not the answer

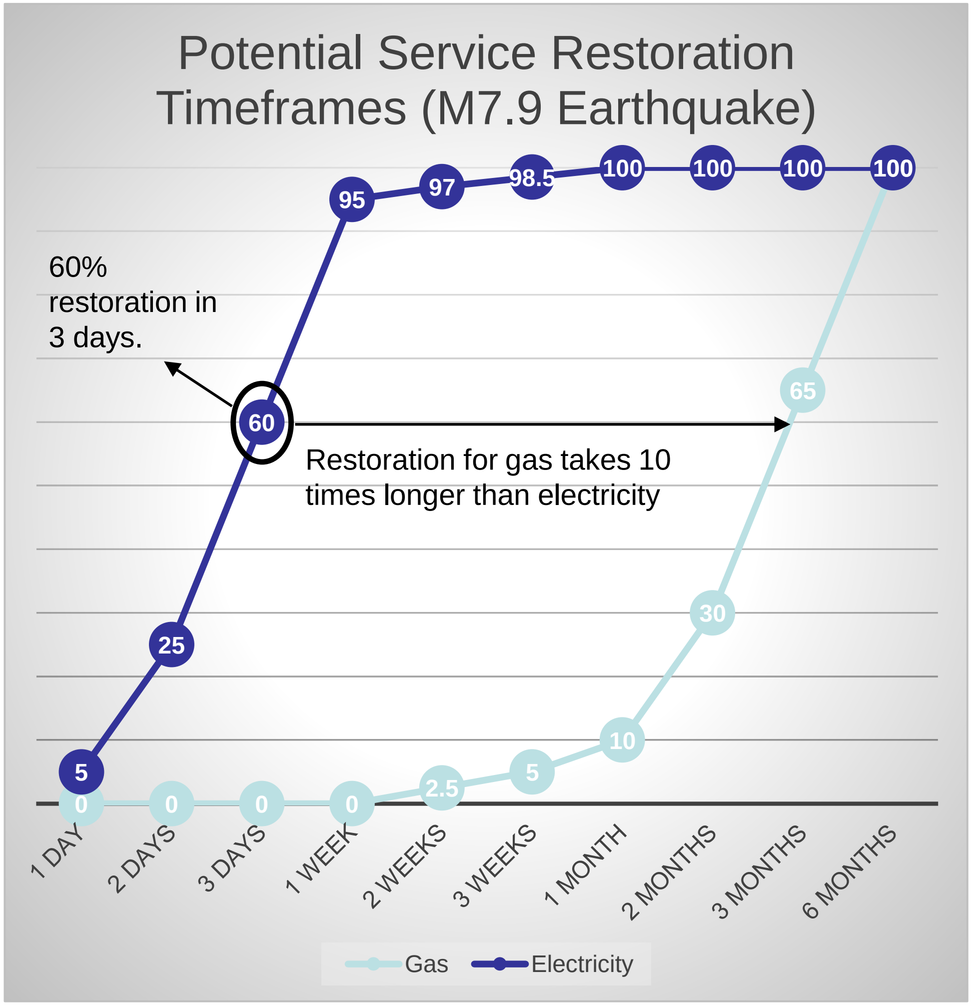
Clean Coalition

- **Heavy polluters**
  - Concentrated in densely populated areas, compounding health risks
  - Require monthly testing just for proper maintenance
    - Spew the worst pollution during this testing
- **Expensive to run**
  - Operations and maintenance is costly
  - Diesel fuel costs continue to rise: In CA, from \$3.07/gal in 2017 to \$3.94/gal in 2018
- **Fuel may be scarce during disasters**
  - There is generally only enough diesel fuel to maintain power backup for two days
  - Replenishing diesel in a major disaster is not always possible

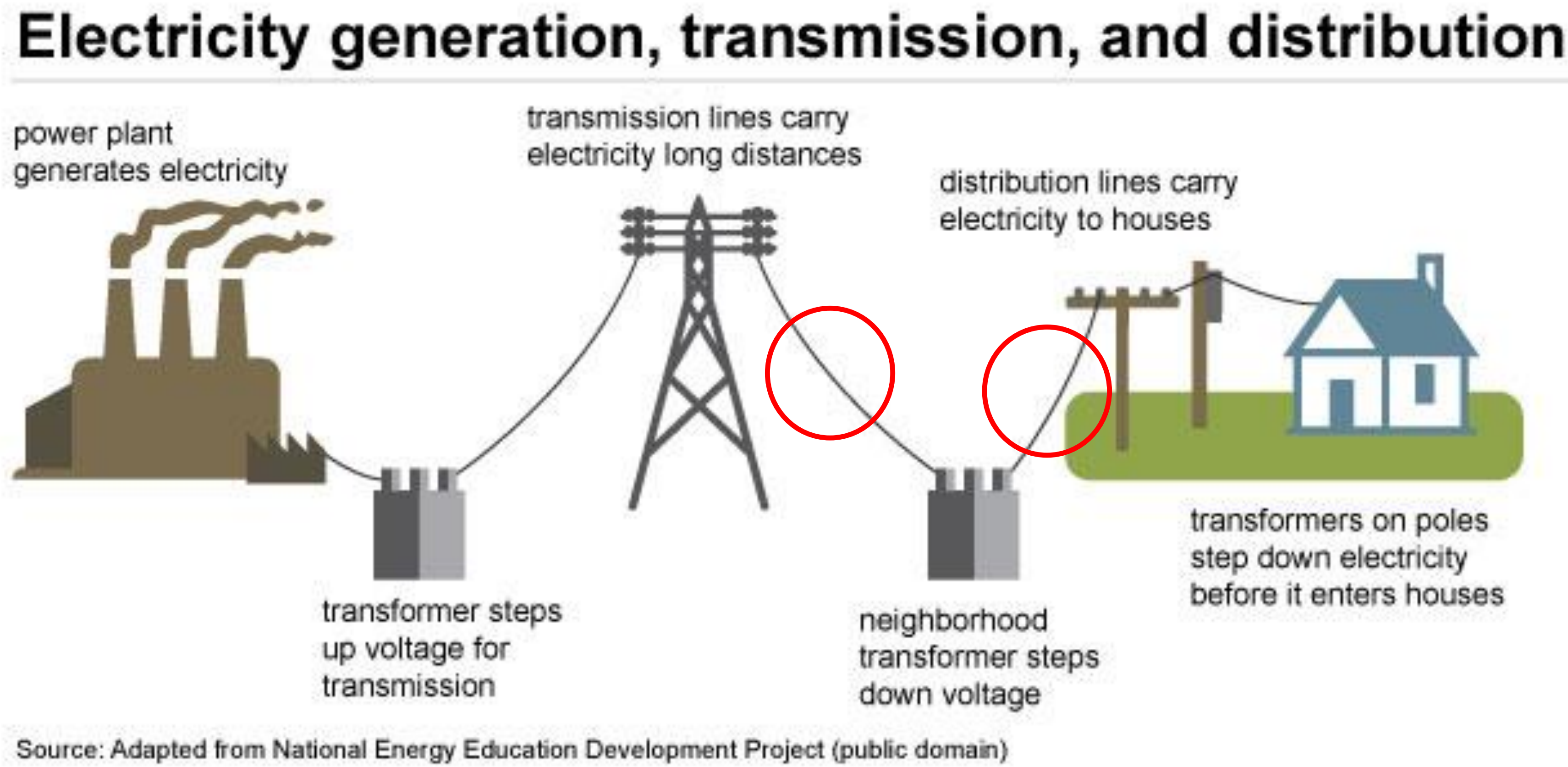
Gas is not the answer

Clean Coalition

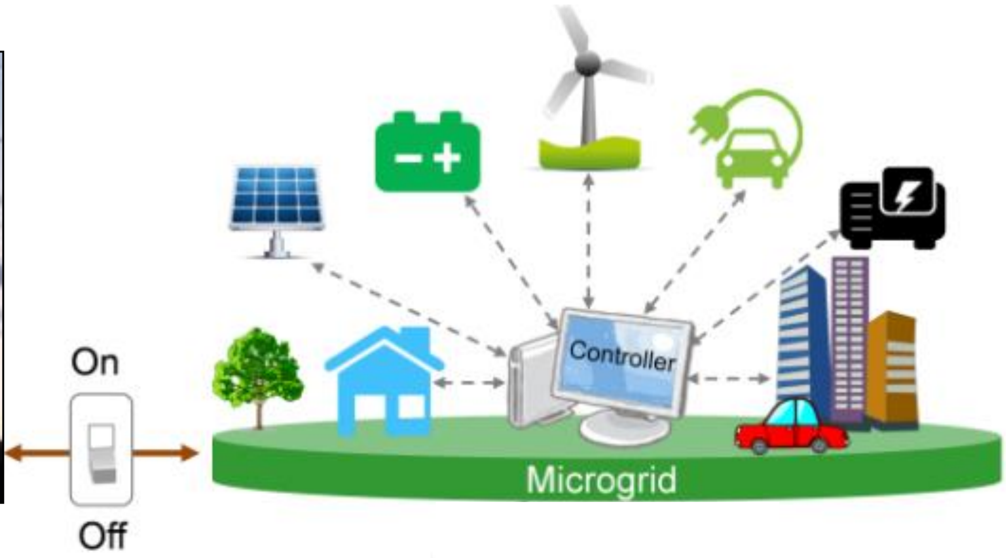
- Gas lines are just as susceptible as power lines to service disruptions from earthquakes and other disasters.
- Restoration of service for gas lines after earthquakes takes 10X longer than restoration for electricity.



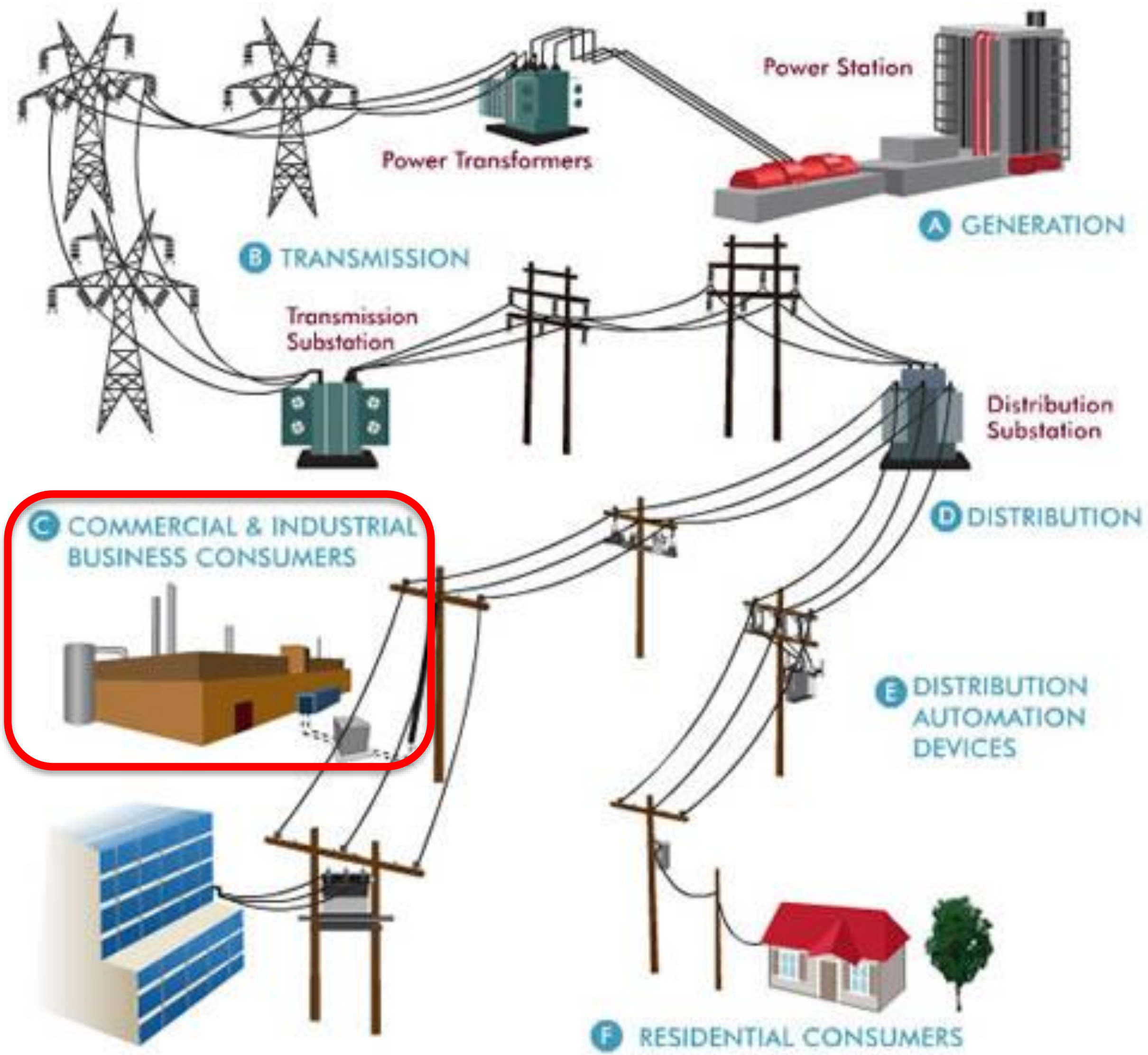
Traditional grid operations



- Long-term vision: Develop **Community Microgrids** to serve areas that currently lack reliable power, or that are at risk for frequent power shutoffs.



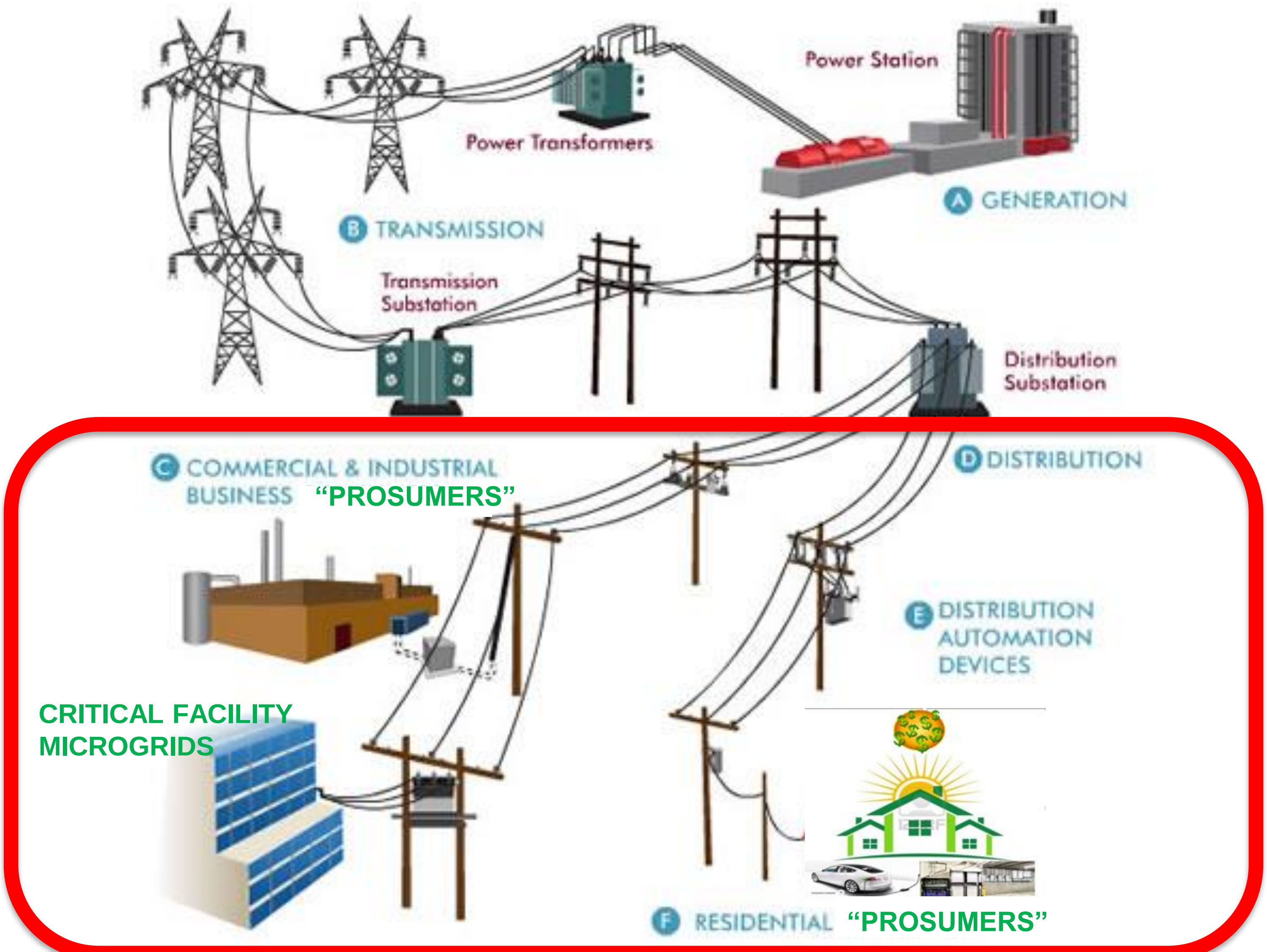
Facility microgrids focus on single customers



Source: Oncor Electric Delivery Company

Community Microgrids can serve up to thousands of customers

Clean Coalition



Source: Oncor Electric Delivery Company

Community Microgrid defined

Clean Coalition

A modern approach for designing and operating the electric grid, stacked with local renewables and staged for resilience.

- **Can "island" from the grid:** A coordinated local grid area that can separate from the main grid and operate independently.
- **Components:** Solar PV and other renewable energy, energy storage, demand response, and monitoring, communications, & control.
- **Clean local energy:** Community Microgrids facilitate optimal deployment of distributed energy resources (DER).
- **Resilient:** Ongoing, renewables-driven backup power for critical and prioritized loads, and eventually all community energy needs.
- **Replicable:** A solution that can be readily extended and replicated throughout any utility service territory.

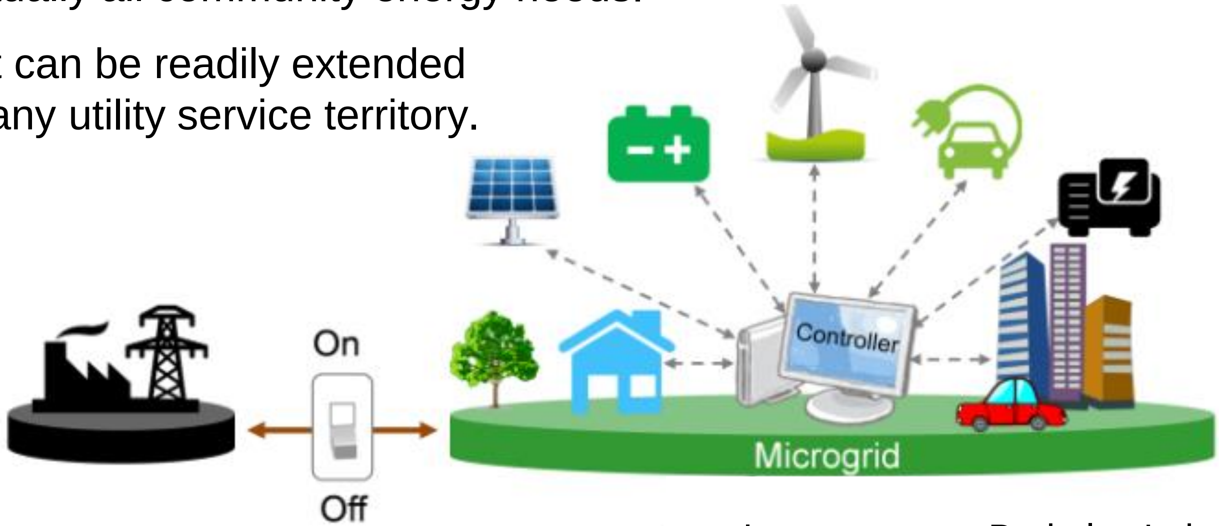
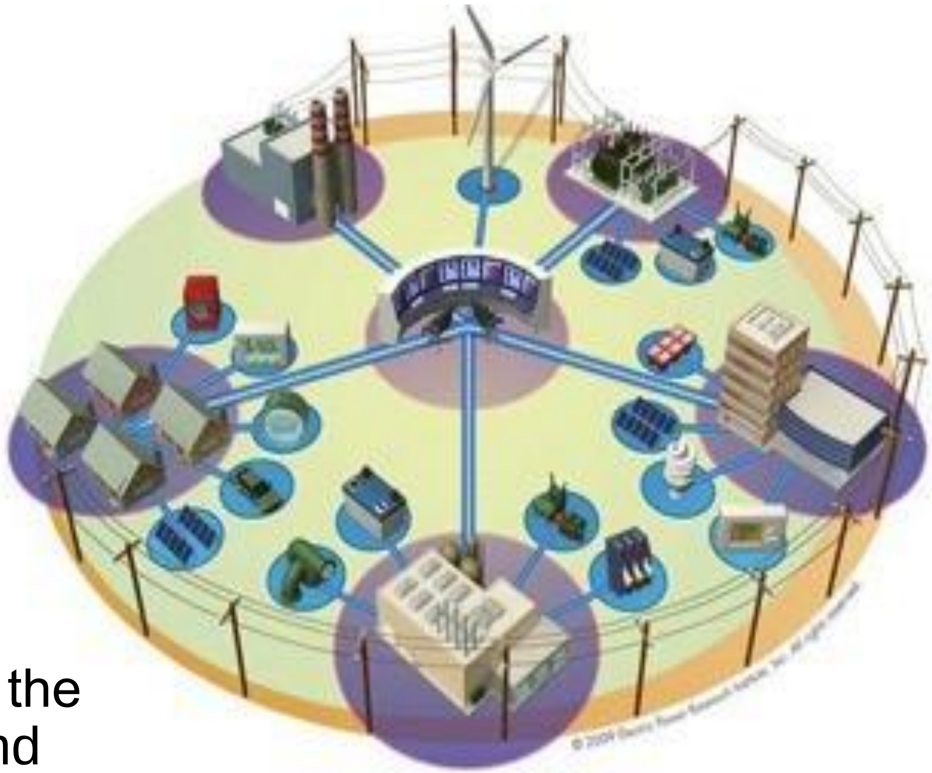


Image source: Berkeley Labs

Community Microgrid benefits

- **Reliability and power continuity**
- **Resilience and safety**
- Local, renewable energy
  - Greenhouse gas reductions
  - Local control of energy
  - For electric vehicles and charging infrastructure
  - Reduced transmission losses
- Local jobs in engineering, construction, and maintenance
- More participation enables by a network of “prosumers” who share the use, generation, and revenue of and from energy
- Energy security and national security



What is power system resilience?

- **Power quality:** Issues with harmonics, power factor, etc. related to voltage, frequency, and waveform of electricity on the grid.
  - Timescale: micro-seconds to seconds
- **Reliability:** Measured after 5 minutes of grid outage
  - Timescale: minutes to hours
- **Resilience: The ability to keep critical loads online indefinitely** in the face of extreme or damaging conditions
  - This is Clean Coalition's definition of resilience
  - Focused on reducing outage duration, cost, and impact on critical services.
  - Timescale: hours or days

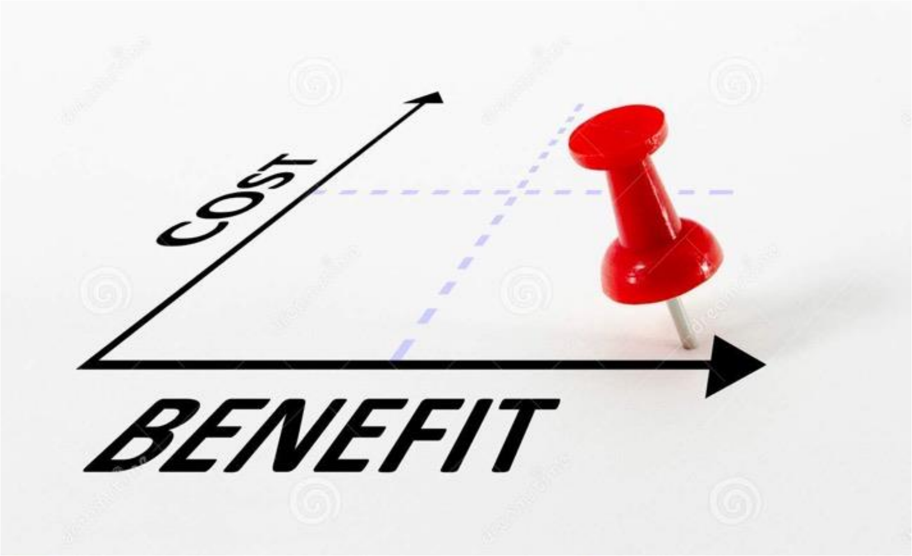
Resilience provided by Community Microgrids has tremendous value

- **Powers critical loads until utility services are restored**
  - Eliminates expensive startup costs and the need to relocate vulnerable populations
- **Ensures continued critical services**
  - Water supply, medical and elder-care facilities, grocery stores, gas stations, shelters, communications centers
  - Avoids the cost of emergency shipments
- **Provides power for essential recovery operations**
  - Lighting for buildings, flood control, emergency shelters, food refrigeration
  - Minimizes emergency response expenses
- **Reduces dependence on diesel generators**
  - Diesel is expensive and can be difficult to deliver in emergencies
- **Keeps businesses open**
  - Serves the community and maintains revenue streams

But how do we determine the monetary value of resilience?

Clean Coalition

- Qualitatively, everyone understands the significant value of indefinite renewables-driven backup power for critical loads
- However, we do not yet have a standard for valuing this resilience
  - The lack of a standard is hampering the market for Community Microgrids with solar+storage
  - Prospective site hosts focus on economics as a key consideration



Determining the monetary value of resilience

Clean Coalition

Factors to consider

- **Cost of outages:** Varies by location, population density, customer type. Can include lost output and wages, spoiled inventory, delayed production, damage to the electric grid
- **Cost of storage:** Varies by size of electric load and size of critical load
- **Cost of islanding:** 3% - 21% of non-islandable solar+storage cost

Consequence of disaster	Resilience assessment metric
Unavailable electrical service	- Cumulative customer-hours of outages - Cumulative customer energy demand not served - Average percentage of customers experiencing an outage in a specified time period
Grid restoration	- Time to recovery - Cost of recovery
Monetary impact	- Loss of utility revenue - Cost of grid repair and replacement - Cost of recovery - Avoided outage cost - Lost business revenue
Community impact	- Critical services without power

Source: Grid Modernization Laboratory Consortium, 2017

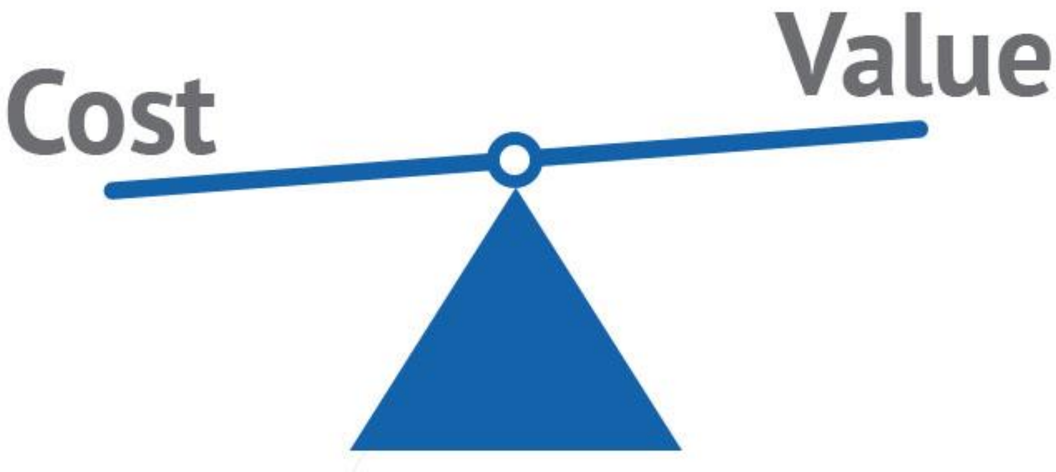
Valuing resilience at any facility: The Clean Coalition Value of Resilience (VOR) Model

- We need to move from the qualitative understanding of the value of resilience to standard metrics for VOR
- The Clean Coalition is working to quantify VOR in the form of a simple, standardized value
  - Standard metrics for VOR will enable municipalities, utilities, businesses, and others to effectively consider VOR when analyzing Community Microgrid economics
  - Will result in more Community Microgrids being deployed
- The VOR model will be used to:
  - Simulate realistic solar+storage and Community Microgrid scenarios, to help define standard metrics for the value of resilience for critical loads
  - Analyze the cost and value of sizing a solar+storage system for resilience at any given facility

Value of Resilience Model outputs

The tool calculates:

- The minimum battery capacity you need for resilience
- The cost to monetize demand charge reduction at your site
- Your total system cost, based on the calculated battery capacity
- **Resilience cost:** The total system cost for the resilience portion of your system
- **Resilience value:** The annual value of resilience provided by your system



Value of Resilience: $2,808/kW of critical load per year

Clean Coalition

Annually, **resilience is worth $2,808 per kilowatt of critical load (preliminary estimate)**

- Based on real-world scenarios run through the Clean Coalition VOR model
- Based on keeping the critical (Tier 1) load online for one day on the worst-case solar day
  - If outage spans days with greater solar resource, may be able to keep Tier 2 or even Tier 3 loads online
- **Tier 1** = Critical load, usually 10% of total load
  * Life-sustaining or crucial to keep operational during a grid outage
- **Tier 2** = Priority load (15%):
  * Important but not necessary to keep operational during an outage
- **Tier 3** = Discretionary load (75%):
  * Remainder of the total load

Community Microgrid Use Cases

Clean Coalition

- **Communities with unreliable or non-resilient power**
  - Characterized by frequent power outages, usually at the end of a feeder
  - Communities that have high risk for natural disasters such as winter storms, hurricanes, wildfires, earthquakes, and others
- **Facilities that need highly reliable and resilient power**
  - Critical facilities: hospitals, fire stations, water treatment facilities, gas stations, etc.
  - Facilities with a business case: data centers, manufacturing plants, hospitality services, etc.
  - Housing that supplies at-home medical services requiring electricity: e.g. oxygen, refrigeration for medication, etc. or other critical services

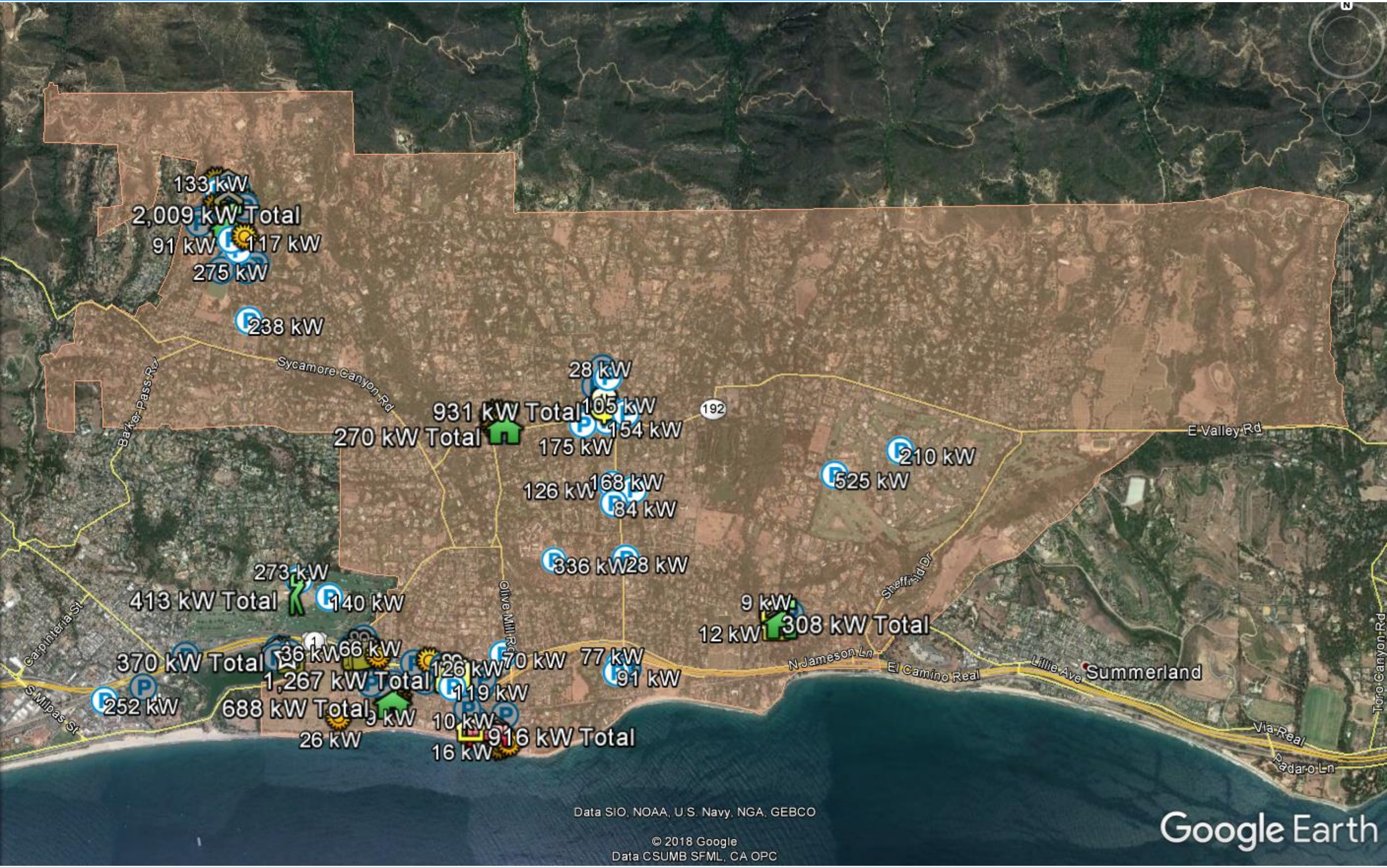
Community Microgrid
System design methodology

Clean Coalition

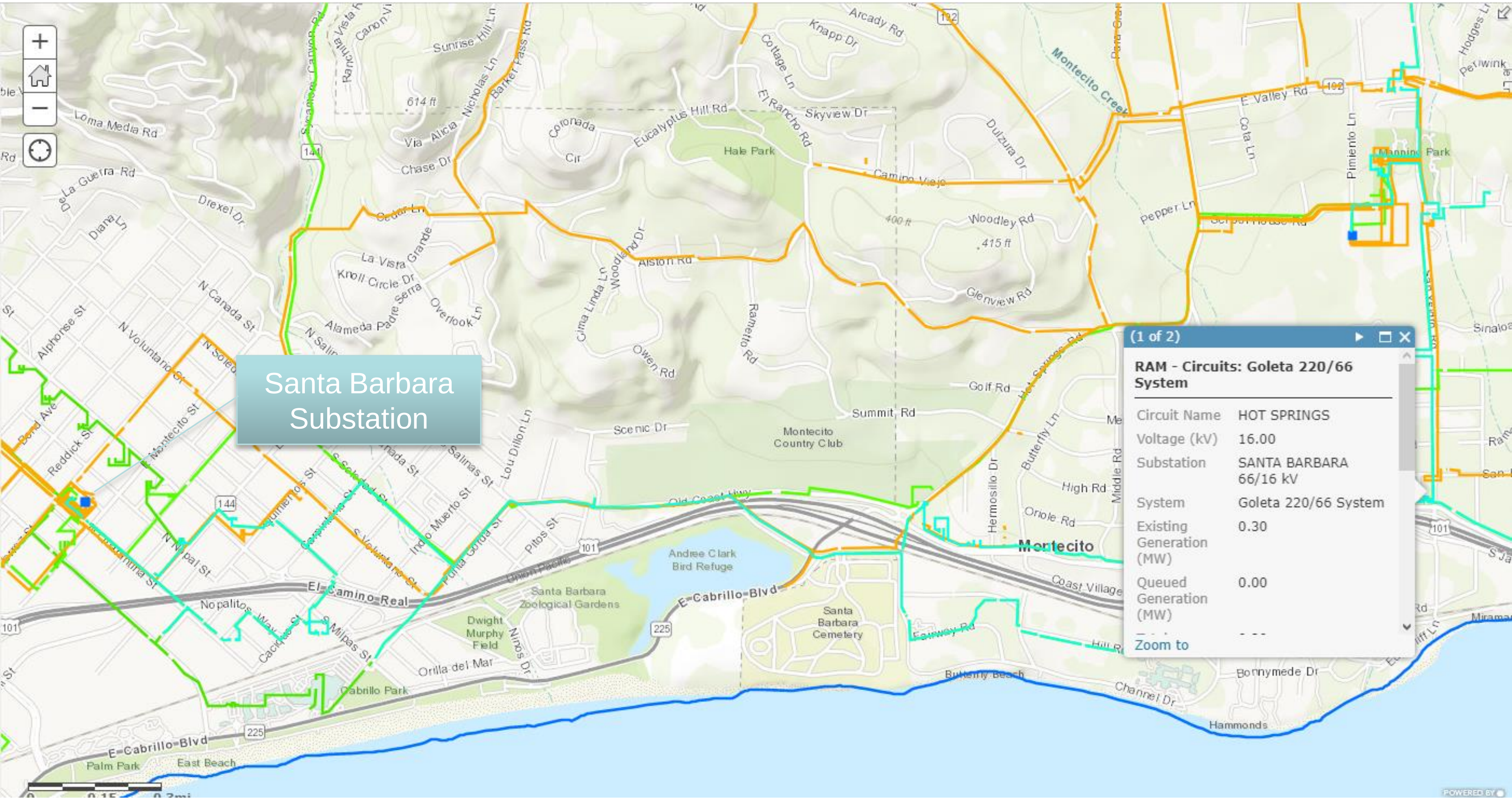
- **Phase 1: Feasibility assessment**
  - Stakeholder alignment and goal setting
    - Design requirements and constraints
  - Perform Solar Siting Survey (SSS)
  - Shortlist sites for preliminary technical and economic analysis
  - Gather preliminary site details including load data, and perform a technical and economic analysis
    - Aim for 70% accurate cost estimates
- **Phase 2: Planning and engineering**
  - Detailed technical and economic analysis
    - Aim for 90% accurate cost estimates
  - Develop conceptual and functional design
  - Develop key engineering documents needed for utility buy-in (single-line diagram)
- **Phase 3: Develop request for proposals (RFP)**

Feasibility Assessment
Solar Siting Survey (SSS) for Montecito

Clean Coalition

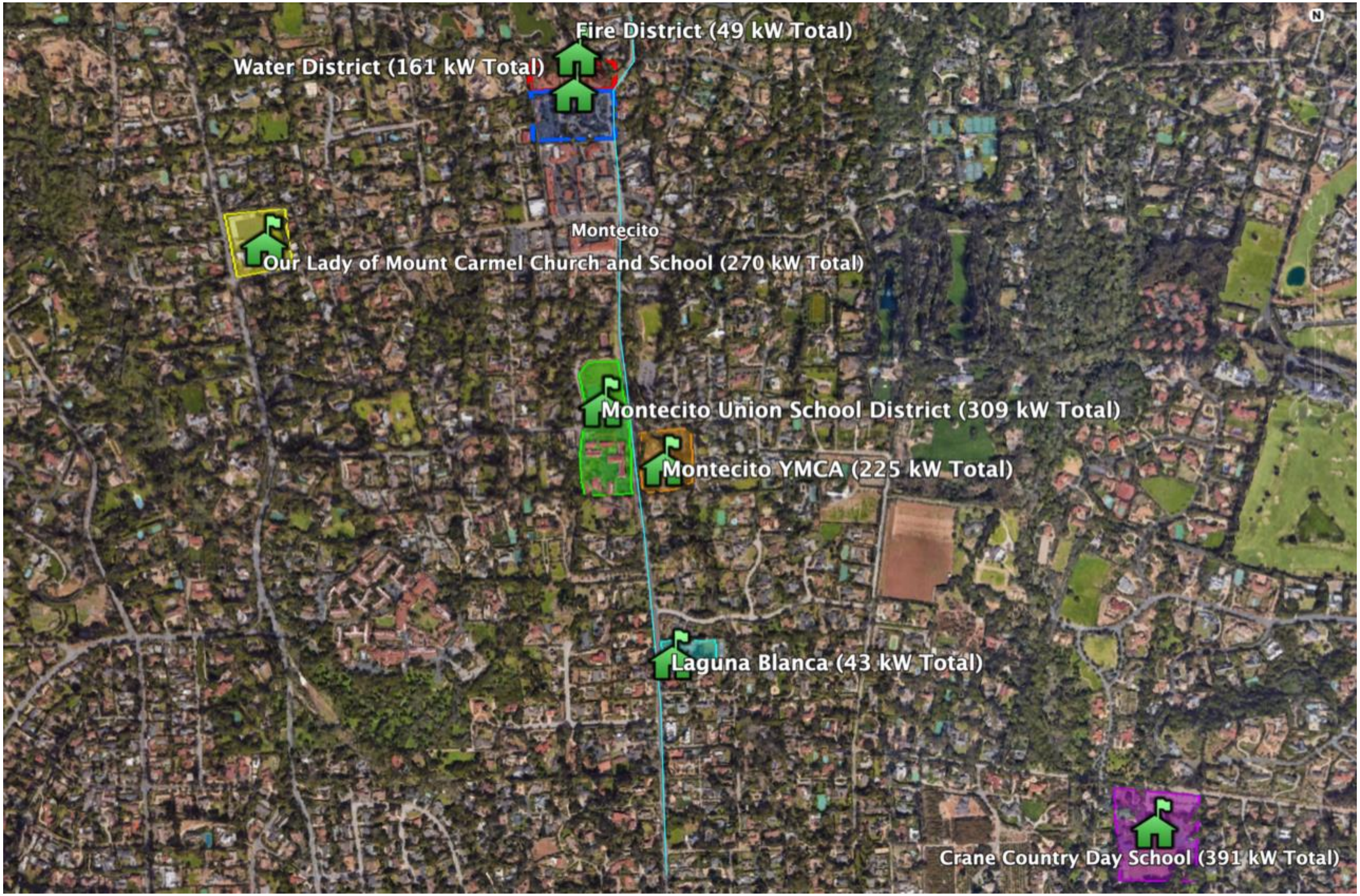


Feasibility Assessment
Hot Springs Feeder via Santa Barbara Substation

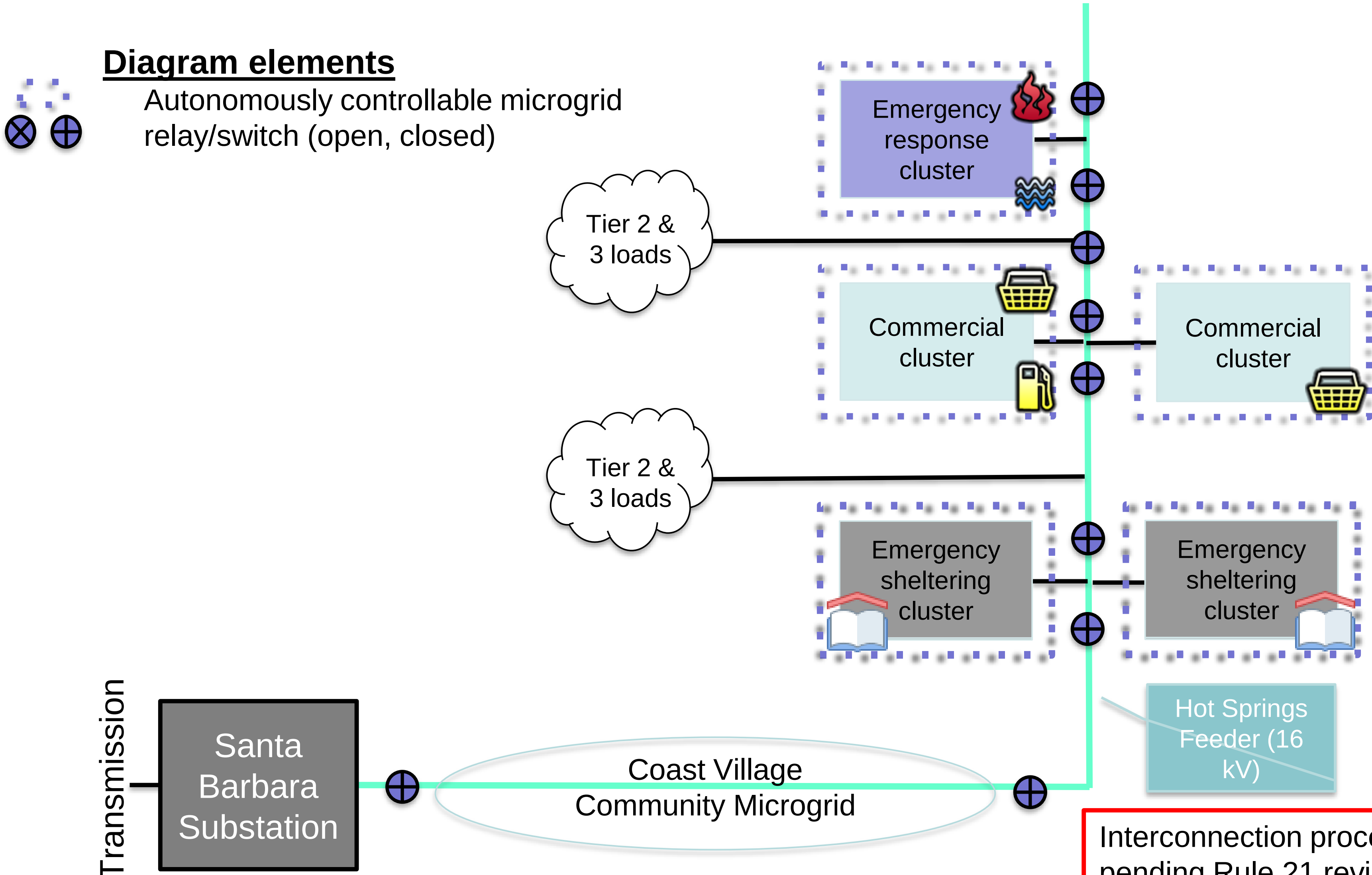


Feasibility Assessment
Critical facilities along Hot Springs Feeder

Clean Coalition



Feasibility Assessment
Montecito Upper Village block diagram



Interconnection process is pending Rule 21 review. Diagrams may change.

Feasibility Assessment
Montecito emergency response facilities

Clean Coalition

Site	Annual Historic Use	Proposed Solar PV Capacity (DC)	Solar PV Annual Production
Fire District	103,623 kWh	70 kW	102,533 kWh
Pump House	21,415 kWh	14.5 kW	21,379 kWh
WD Office	28,716 kWh	19.5 kW	28,765 kWh
WD Mech Yard	14,933 kWh	10.2 kW	15,141 kWh
Sand Lot	NA	75.9 kW	112,069 kWh
Phase 1 Total	168,687 kWh	190.1 kW	279,887 kWh

Note that the 75.9 kW Solar PV system proposed for the Sand Lot would be used to offset electricity from other municipal electric accounts, such as the Water District accounts not located in this site, via the Renewable Energy Self-Generation Bill Credit Transfer (RES-BCT) program.

Interconnection process is pending Rule 21 review. Diagrams may change.

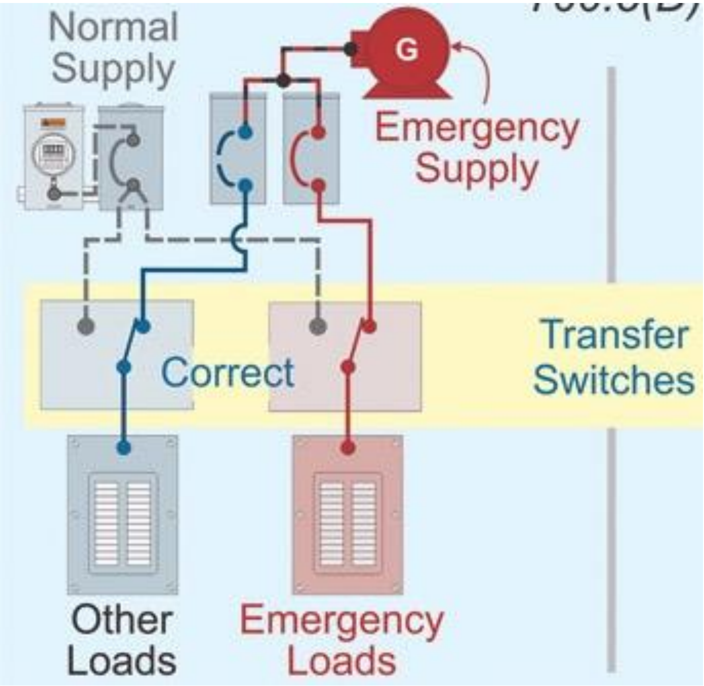
System design: DER

Clean Coalition

- **PV system sizing**
  - Size and model PV systems using PVWatts from NREL for different load profiles:
    - Previous annual load
    - Projected annual load based on load decrease and increases (e.g. energy efficiency, new equipment or higher occupancy.)
- **Energy storage system sizing**
  - Use Geli's ESyst tool to determine the optimal energy storage size for a grid-parallel system that takes advantage of peak shaving and demand charge management.
  - Use HomerPRO to determine optimal energy storage size for an emergency grid-island mode system.
    - Utilize the critical load profile and operational requirements (e.g. 100% uptime)

System-design: Microgrid-specific equipment

- Load-shedding functionality
  - Critical load/ emergency electrical sub-panel
- Islanding capability
  - Automatic transfer switch



Steps to establish a microgrid

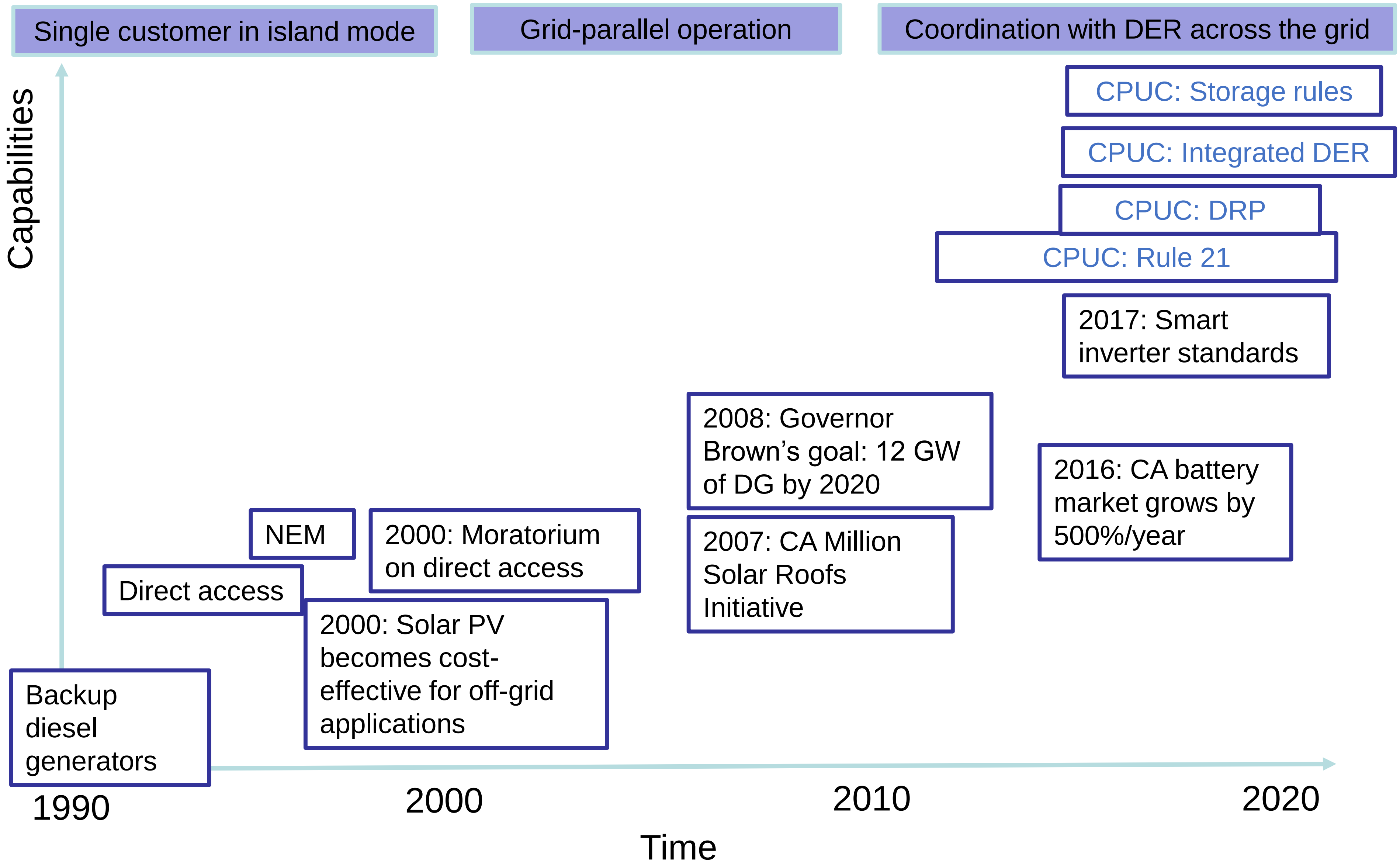
- Hold and RFP process
- Identify project team: EPC, financier, vendors, utility engineers, etc.
- Develop finance-ready collateral.
- Secure financing with a letter of intent (LOI), a signed power purchase agreement (PPA), or an energy services agreement (ESA).
- Submit interconnection application.
- Develop permit-ready drawings and secure permits.
- Procure equipment (solar, batteries, etc.).
- Construction and commissioning.
- Measurement and verification of system operation and cost savings.

Microgrids: Policy overview

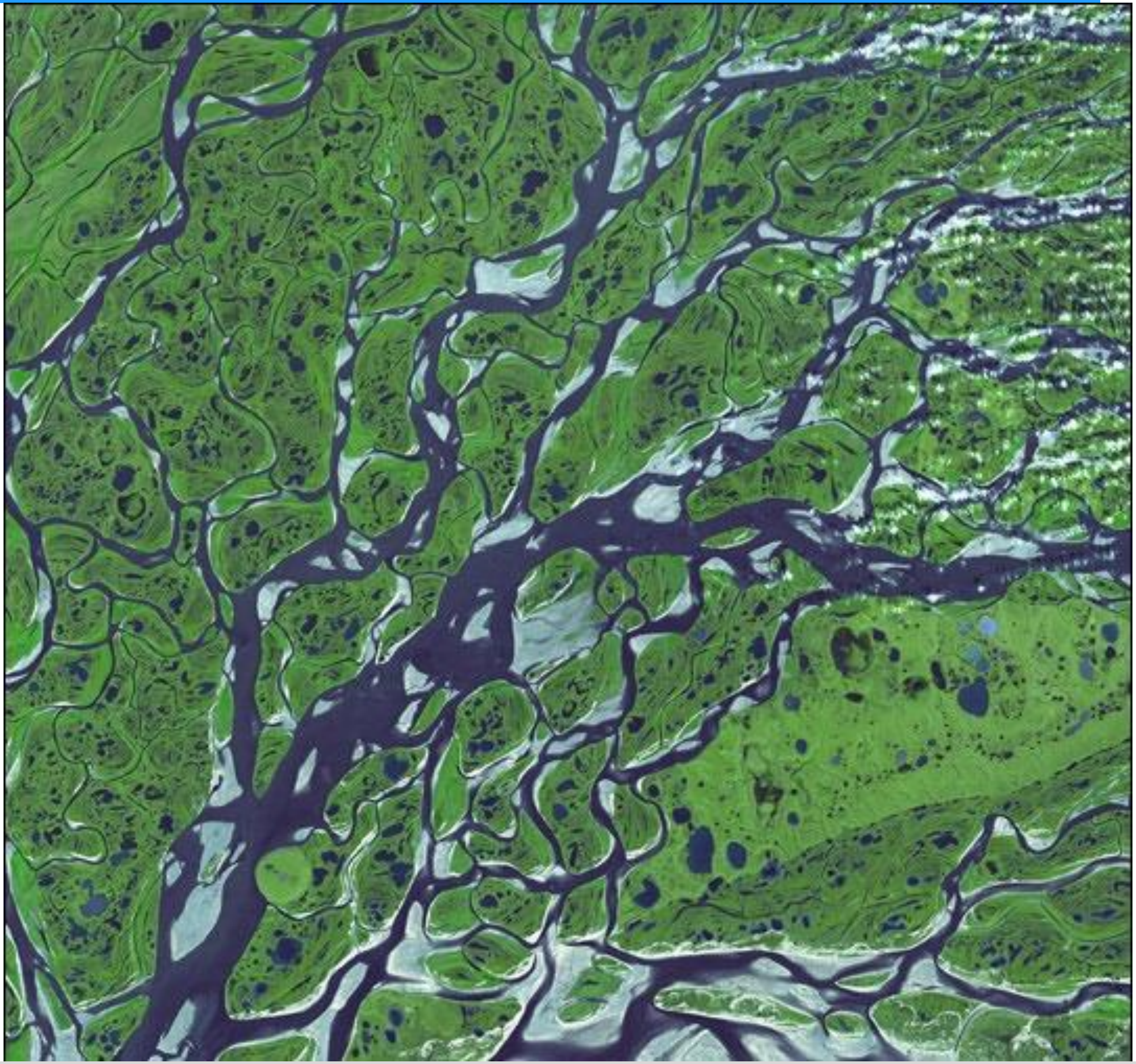
- Behind-the-meter (BTM) microgrids: **Policies to enable islanding and operation behind the meter exist. These systems are being deployed now.**
  - Applies to buildings and campuses with a single utility meter.
  - DER interconnection: Net energy metering (NEM) or non-exporting backup power
  - Key requirement: Automatic transfer switch (ATS)
  - Major constraint: Policies allow microgrids, but utility rate tariffs do not necessarily incent developing microgrids for all customers.

- Microgrids using the public grid (e.g., Community Microgrids) face the same policy barriers as DER:
  - How do DER get compensated for grid services?
  - How can energy be sold within a microgrid?
  - How do we manage open access to utility wires, while the utility continues to operate power lines that it owns.
  - How can this be done in an equitable way?

Microgrid milestones and policy map



Policy tributaries and interaction



Pathway to Community Microgrids

	Community Microgrid	Pre-installed interconnection hub (PIH) microgrid	Behind-the-meter microgrids at critical facilities
Timeline for deployment	Long-term 5-10 years	Mid-term 3-5 years	Near-term 1-3 years
Scope and scale	• Entire substation grid area • Municipal buildings, businesses, and residences	• Neighborhood • Priority sections of the distribution grid • Determined by stakeholders and PG&E	• Single building • Critical facilities are key target sites • Businesses and residences can also choose to deploy
Loads to be served	• All loads • Critical and priority loads	• All loads within the priority sections of the distribution grid	• Design can accommodate critical, priority, and noncritical loads
Renewable energy demand*	• All loads • Critical and priority loads	• TBD based on the loads of the PIH area	• TBD based on desired loads

*Renewable energy supply can be augmented with existing diesel generators

Solutions to policy challenges
A phased approach with future-compatible tech

Clean Coalition

- Near-term: **Implement behind-the-meter microgrids at critical facilities**, and stage them for the capability to participate in a future Community Microgrid.
  - Automated or manual load shedding can reduce system size and cost.
  - Systems can be designed to power critical loads within facilities indefinitely with renewable energy and energy storage.
- Mid-term: **Work with CPUC and PG&E to incorporate renewable DER into PIH resilience zones**.
  - All customers within the PIH resilience zone will continue to have power.
  - Load shedding can be a part of this strategy to reduce demand.
  - PG&E will continue to operate lines they own.

Microgrids: Policy Future

- **Transmission TAC credit**
  - (recognizes and adds 3¢/kWh to value),
- **Dispatchable Energy Capacity Service (DECS)**
  - (FIT compensation for energy exports made dispatchable)
- **Value of Resilience (VOR)**
- **Interconnection Pilot**
  - (which aims to give WDG the same advantageous streamlined treatment as NEM, making it equally fast and predictable)
- **Using the public grid for Community Microgrids**
  - utilizing DER to meet prioritized loads, including DER behind a different customer's meter, islanding sections of the public grid for operation during grid outages, and the DERMS and MC2 required to make this work (which requires policy decisions to authorize and allocate costs)

Community Microgrid synergies

- Bundling DER deployments can **improve bankability**.
- Focusing on critical facilities and critical loads only **minimizes the cost of resilience**.
- Designing Community Microgrids for sites that have already implemented energy efficiency measures can **reduce capital costs**.
- Integrating a battery into a site with EV charging can reduce demand charges and **reduce the impact of high-power charging on the grid**.

The role of cities in enabling Community Microgrids

Clean Coalition

- Adopt permitting processes and fees that support DER.
- consider adopting reach-codes that require more energy-efficient buildings, all-electric-buildings, renewable energy-ready buildings, and microgrid-ready buildings.
- Pass a city or county resolution for community resilience to support future resilience activities.
- Subscribe to the Clean Coalition newsletter.
- Suggest City or Municipal staff to connect with.

About the Clean Coalition

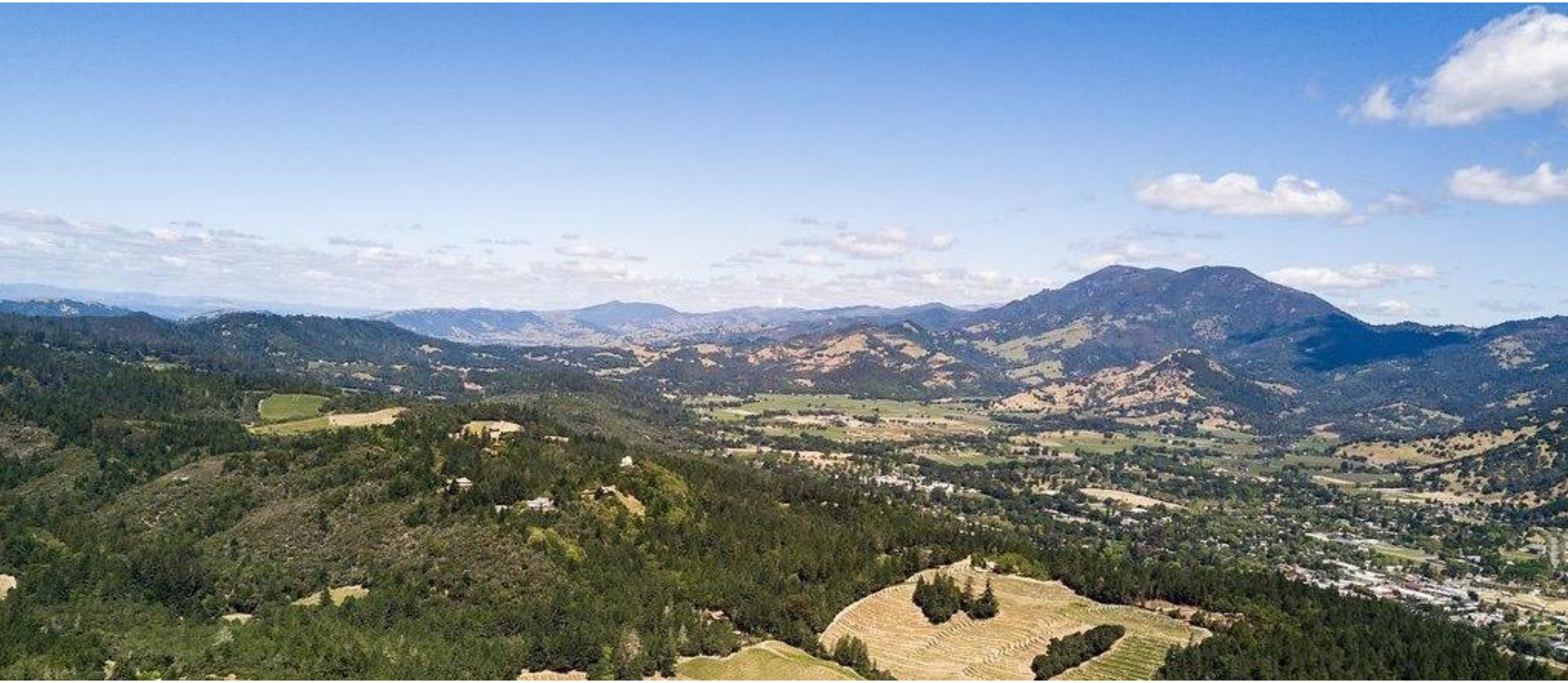
Clean Coalition

- A wealth of experience in microgrid planning and engineering
  - Developing projects that provide unparalleled economic, environmental, and resilience benefits
- Renewable energy modeling and design
  - 15+ Community Microgrid feasibility assessments completed to date with clients including Stanford University, various Fortune 500 companies, and multinational independent power producers (IPPs)
  - 2 California Energy Commission (CEC) grants
  - 1 Department of Energy (DoE) grant
  - 1 National Renewable Energy Lab (NREL) contract
- Experience working with utilities
  - Investor-owned utilities (IOUs): PG&E, SCE, SDG&E, PSEG Long Island
  - Municipal utilities: CPAU, LADWP, SMUD
  - Current active projects with PG&E, SDG&E, SCE, CPAU

Clean Coalition (nonprofit) mission

To accelerate the transition to renewable energy and a modern grid through technical, policy, and project development expertise

Thank you! Any questions?



Frank Wasko
Managing Director
949-501-0967 mobile
frank@clean-coalition.org

Malini Kannan
Programs Engineer
650-533-8039 mobile
malini@clean-coalition.org

System design cost assumptions and incentives

Clean Coalition

- **PV CapEx: $1,750/kW**
  - 30% Investment Tax Credit (ITC) is applied to EPC ground-mount price of $2.50/W
  - O&M costs: $10/kW/year
  - Replacement- $2,000/kWh (reflects end of ITC program and 20% reduction in module price)
- **Battery CapEx: $136.80/kWh**
  - 30% ITC is applied and SGIP Phase II applied
  - O&M costs: $5/kWh/year
  - Replacement- $205/kWh (replacement occurs when battery has degraded by 30%)
- **Converter CapEx: $569.30/kW**
  - DC-coupled system- PV and battery share a converter
  - 30% Federal ITC is applied
  - O&M costs: included in PV & battery O&M costs
  - Replacement- $850/kW (every 15-years)

How does energy storage provide value?

- Batteries for energy storage can help considerably in demand charge management for individual buildings or electric accounts, especial those with high peak usage compared to average usage, such as sites with daytime EV charging peaks.
- Energy storage also enables renewables-driven resilience.