Community and Multi-User Microgrids for Resilience: Implementation Challenges and Perspectives from Puerto Rico and Washington

Microgrid Global Innovation Forum

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Ben Schwartz | Clean Coalition
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Carlos Alberto Velázquez | IREC

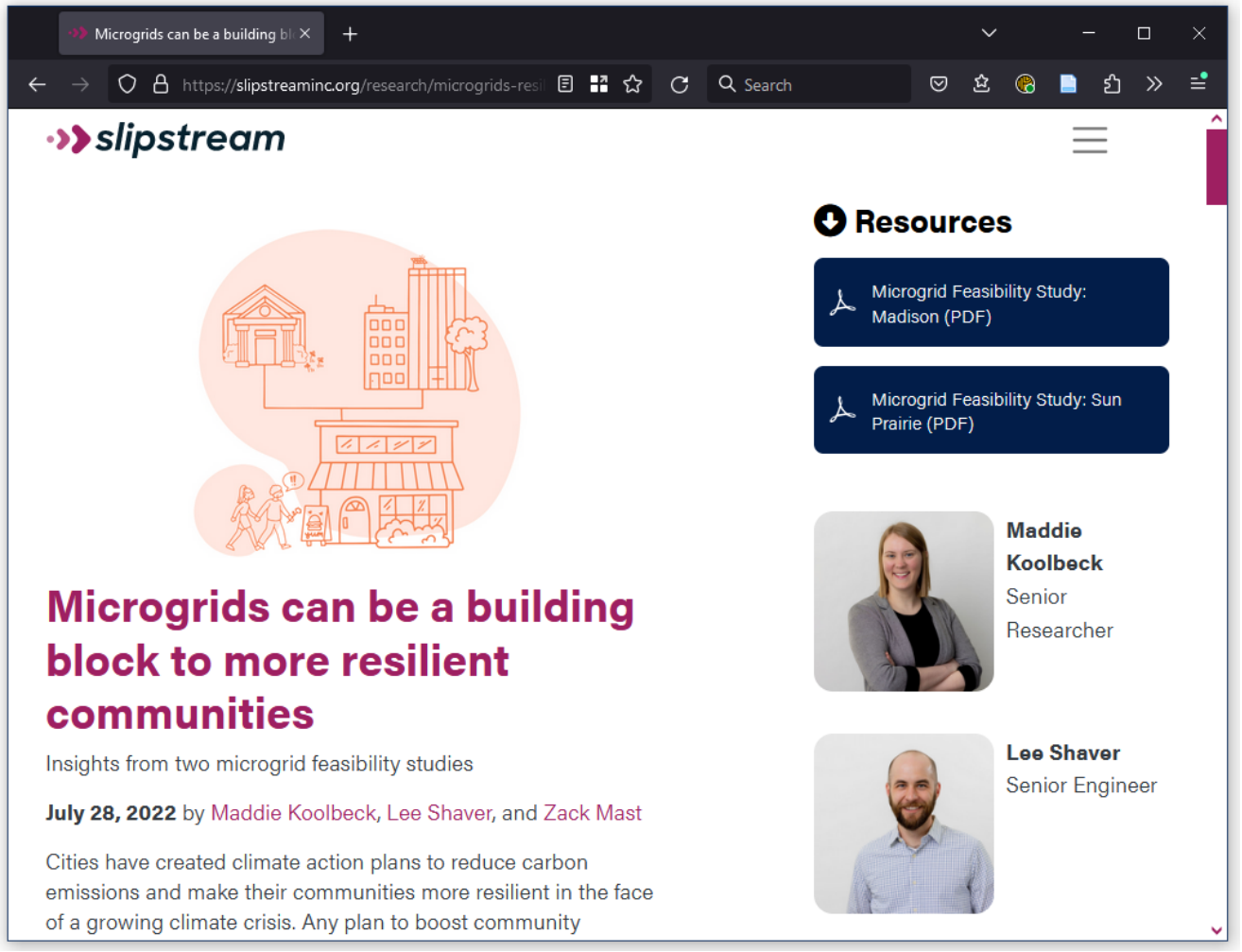
5 December 2023

slipstream

Climate + Clean Energy Solutions for everyone.

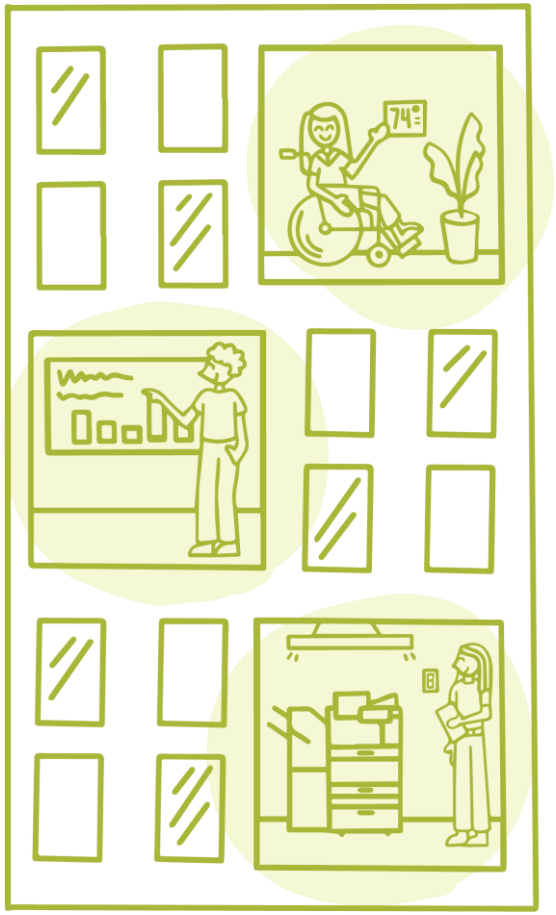
The knowledge, people, and resources to solve our biggest energy challenges.

Slipstream's microgrid work



- Microgrid feasibility studies
  - Community resilience centers
  - Critical municipal infrastructure
  - Multi-user microgrids
- Develop RFPs/OPRs for microgrid design and implementation
- Stakeholder engagement for community energy and resilience plans
- Field demonstration, program design and implementation, M&V

Agenda



Intro

Panelists

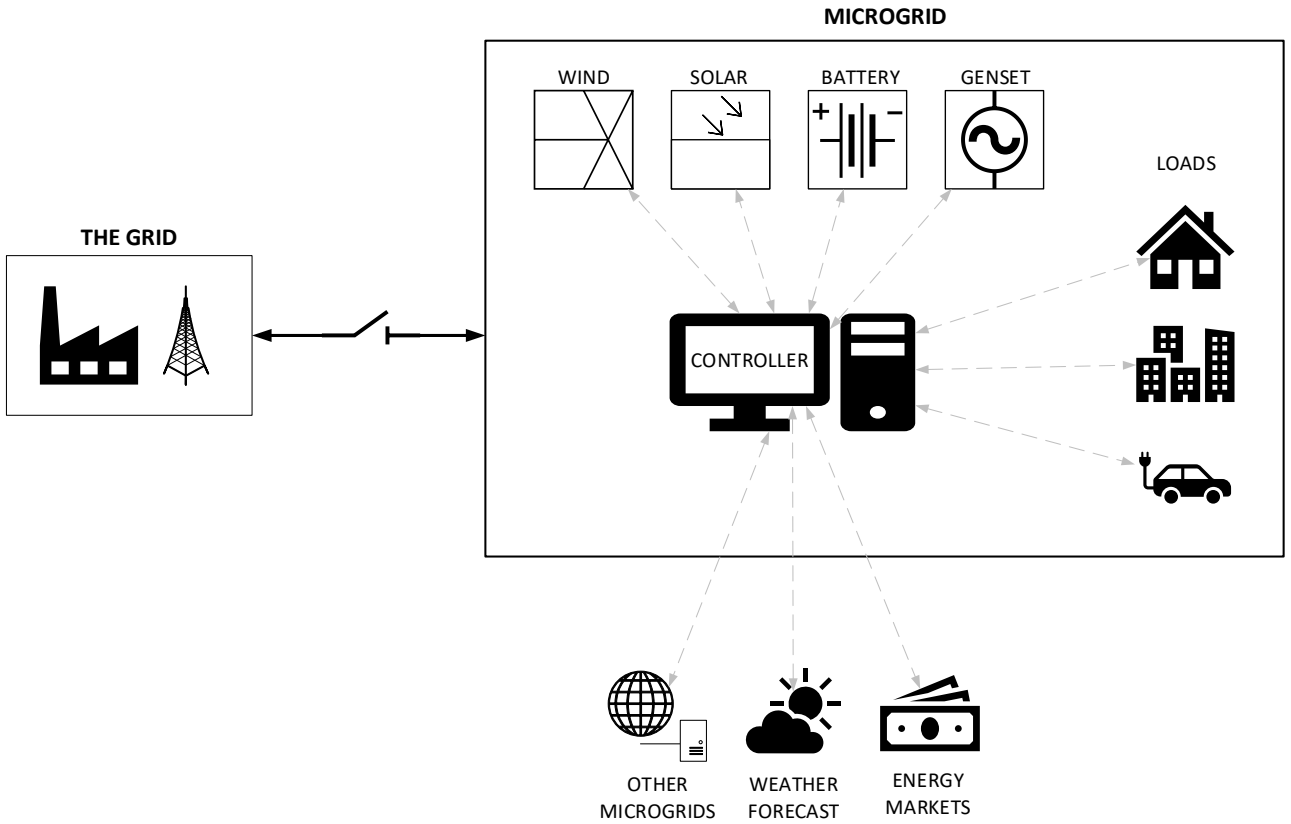
- Jared: Multi-user microgrid basics and strategic considerations
- Ben: Market pathways to establishing community microgrids in the highly-regulated West Coast market
- Carlos: Solar Energy Multi-Facility Microgrids in Puerto Rico for community resilience

Q&A

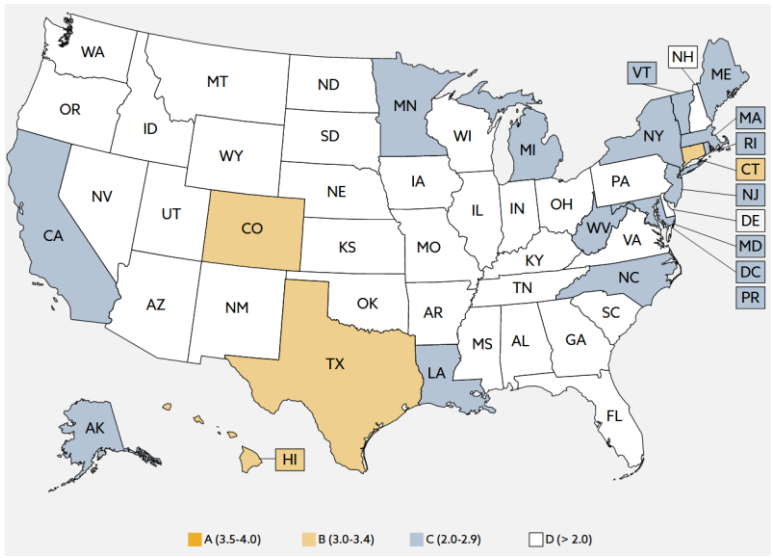
Multi-user, multi-facility, or community?

Basic concept

- A microgrid where assets are located in different facilities and/or owned and managed by different entities
- Resilience needs and cost/benefit analysis vary for each participant
- Typically does *not* include utility owned and operated microgrids that are transparent to their customers

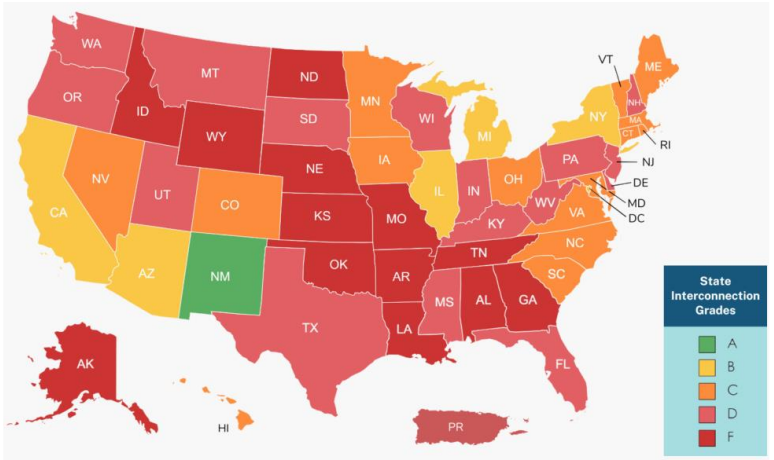


Setting the context: State and territory rankings



Think Microgrid: State Scorecard

Three of five metrics (Policy, Deployment, and Equity) address multi-user microgrids specifically



IREC and Vote Solar: Freeing the Grid

Focus on overall interconnection policy for DERs, considering equitable interconnection

Three contexts for developing multi-user microgrids

	DERs and microgrids well-supported	DERs well-supported, microgrid support developing	Microgrid and DER support developing
Overview	The state has adopted several DER interconnection best practices and has established market design components, policy reform, and program solutions that support microgrid development.	The state has adopted several DER interconnection best practices but exhibits only limited or passive program and policy-level activity supporting microgrids.	The state has adopted few to no interconnection best practices, and exhibits limited meaningful activity that accommodates microgrid development.
Biggest challenge for MUMs	Existing laws prohibit non-utility wires from crossing property lines. Market pathways developing.	Limited market pathways and/or infrastructure improvement and regulatory reform not keeping pace with policy and market design.	Costly, complicated, and/or slow processes for connecting energy sources for even basic microgrids.
Examples	CA, HI, WA, PR	AZ, IL, MN, PR	GA, ID, KS, TN

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Community and Multi-user Microgrids for Resilience

SEPA Research and Industry Strategy

Jared Leader, Senior Director, Resilience

December 2023

Smart Electric Power Alliance

Vision

A net-zero carbon energy system that is safe, affordable, reliable, resilient and equitable

Mission

To accelerate the transformation to a carbon-free electricity system through actionable solutions

Who Are We?

Smart Electric Power Alliance

- A membership organization
- Staff of ~65
- No Advocacy – 501c3
- Founded in 1992
- Unbiased
- Research, Education, Collaboration and Standards
- Technology Agnostic
- Local, State and National Focus

5 x 2025 Initiative

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SEPA recognizes the attentive need for solutions and alignment in five specific focus areas that will drive our partnerships with utilities, industry, regulators, legislators, customers, and other energy stakeholders

By solving the challenges in these areas, we can drive industry progress.

Resilience

Transportation

Energy Storage

Emerging Technology

Policy

SEPA Working Groups

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Peer Collaboration Across 8 Diverse Communities

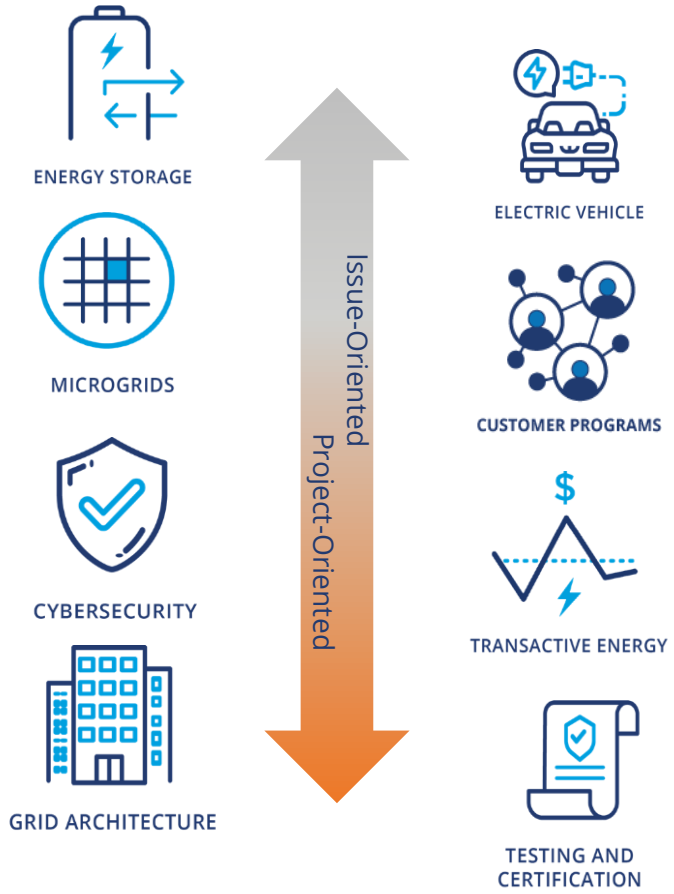
350+ Member Organizations, 1500+ Individual Members

Practical challenges and best practices

New business models and requirements

Challenges for data and connected-hardware

Risk mitigation with grid and IT architecture



Utility deployment and strategies

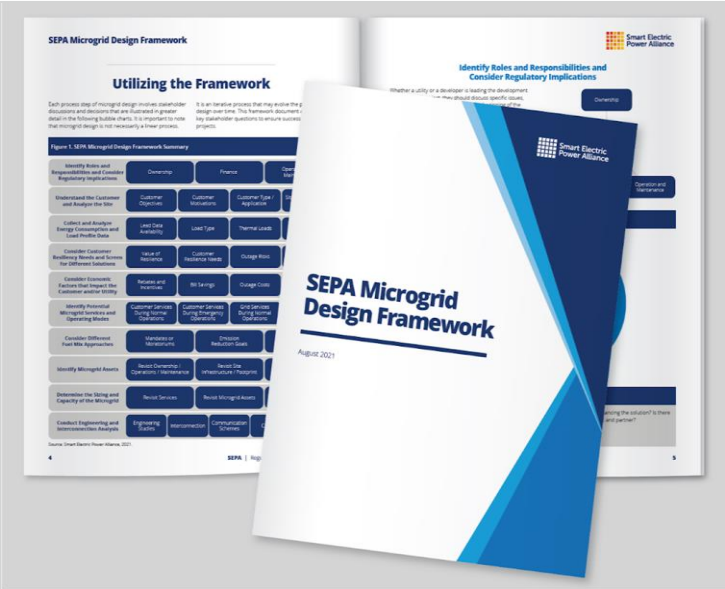
Expand customer choice innovatively

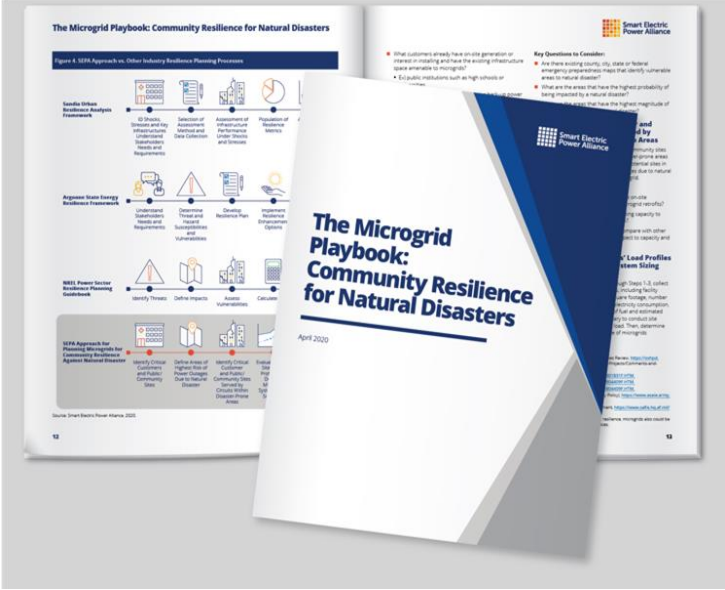
Utilization that enables high DER penetration

Smart grid standards and interoperability

How-to Questions? WorkingGroups@SEPApower.org

Perspectives for Today…





NORTH CAROLINA
Department of Environmental Quality

KENTUCKY ENERGY & ENVIRONMENT CABINET

WEST VIRGINIA
OFFICE OF
ENERGY

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Where Do Microgrids Fit in?

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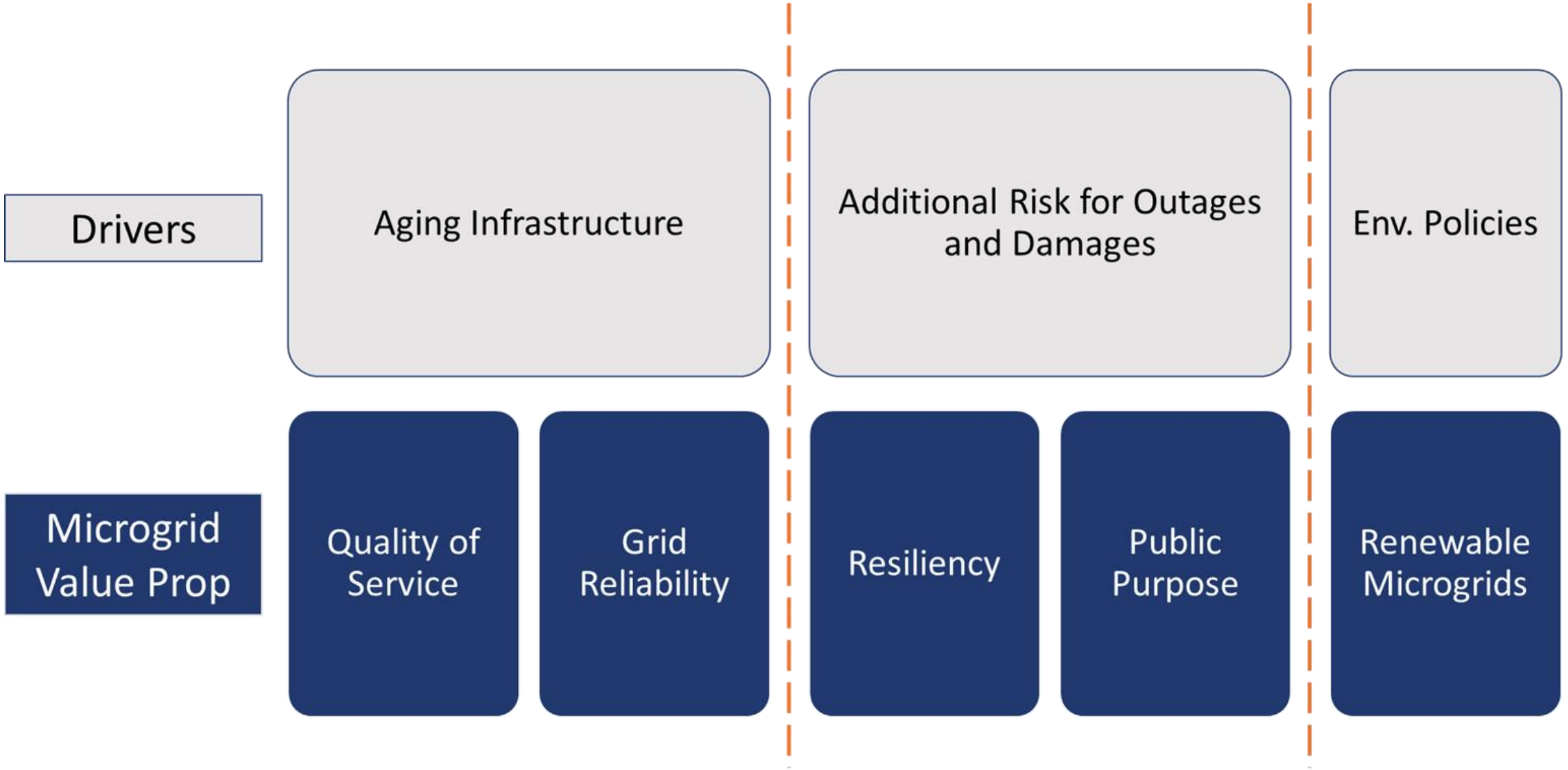

A Framework for Consideration…

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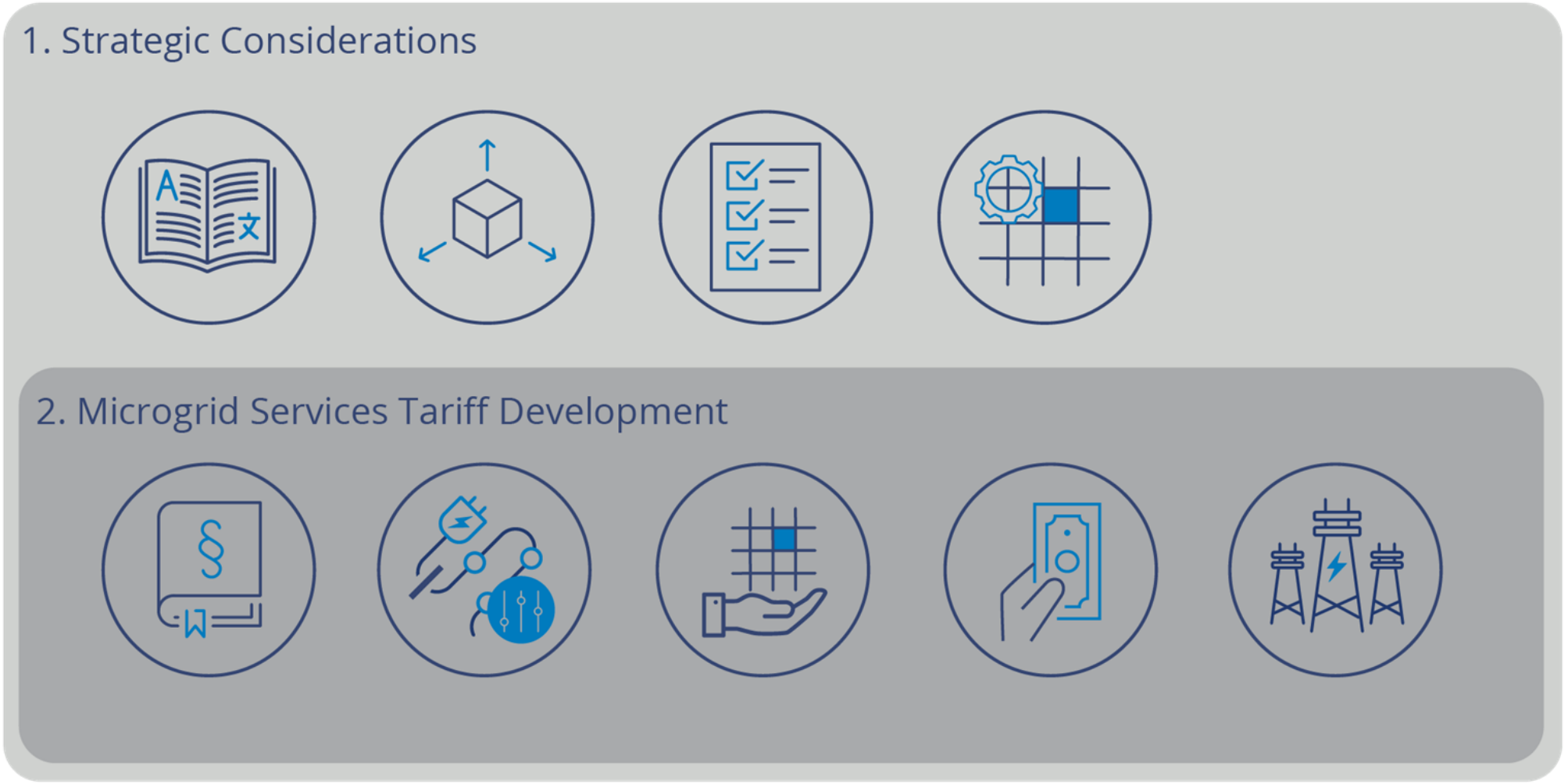

#1, Strategic Considerations

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Microgrid Terminology

- Agreggator
- Asset Owner
- Interconnections
- Microgrid Operator
- Multi-User Microgrid Participant

Microgrid Archetypes

- Customer Microgrid
- Multi-User/Community Microgrid
- Utility Microgrid
- Remote Microgrid
- Virtual Microgrid

Microgrid Reguirements

- Customer Interaction
- Grid Interaction
- Performance
- Clean Energy

Microgrid Island Operational Structures

- Utility Microgrid Operation
- 3rd Party Microgrid Operation
- Utility-3rd Party Joint Microgrid Operation

Other Considerations Necessary: RPS and Emissions Requirements, Distribution Upgrades, Purview of PUC, Community Interest, and Societal Benefits / Cross-Subsidization

Microgrid Terminology

Aggregator operates DER portfolio for others. Provides energy, ancillary and/or grid services in blue-sky normal conditions as well as during island operation.

Asset Owner owns distributed generation, storage or demand management resources, or electric infrastructure used to form and operate a microgrid.

Interconnections: two key reference points for microgrid interconnection: Point of Connection and Point of Common Coupling defined in IEEE Standard 1547-2018 and related standards such as IEEE 2030.7/8.

Microgrid Operator is an independent entity or utility customer responsible for the safe operation of a multi-user or customer microgrid consistent. May also act as aggregator for wholesale markets and utility grid services in normal blue-sky mode.

Multi-User Microgrid Participant is an entity or person that contributes to and/or uses the services provided by the microgrid.

Microgrid Archetypes

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Customer Microgrid is an independently developed microgrid with distributed energy resources and loads wholly within a single customer's site

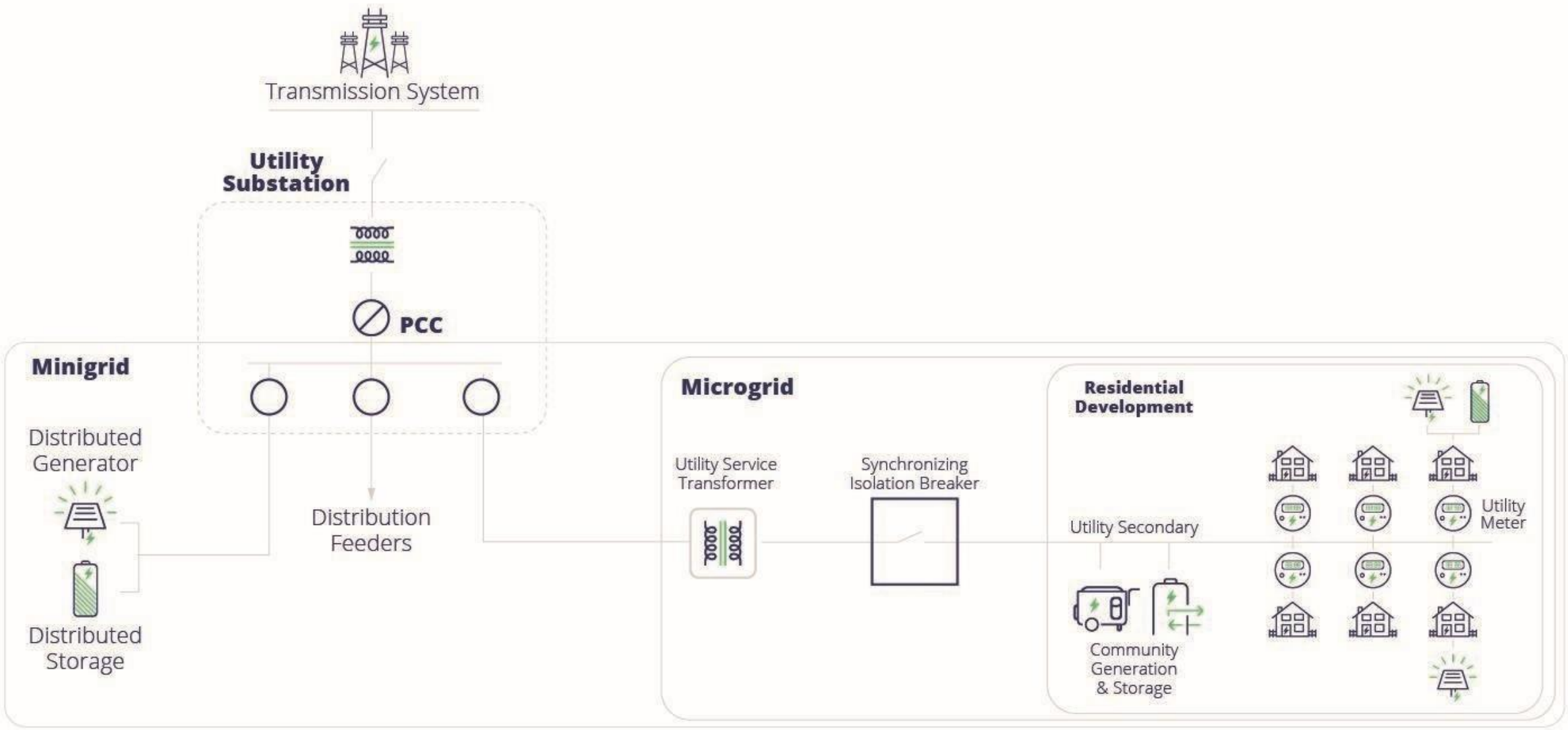
Multi-User / Community Microgrid is an independently developed microgrid using a utility distribution grid to link DER with multiple specific customer loads or a community.

Utility Microgrids are usually multi-user/community scale projects. Utility takes the lead in independent development or partners with a resource provider.

Remote Microgrid is a resilient power system for a facility/campus that is not grid connected. It is an effective solution for certain circumstances but not in scope of grid-connected microgrids sought by state policies for community resilience.

Virtual Microgrid (aka Virtual Power Plant) is not able to island and so is not within scope for microgrids based on jurisdictions to date. Virtual microgrids provide blue-sky services.

Microgrid Archetypes



Source: Smart Electric Power Alliance and Paul DeMartini, 2020

Microgrid Island Operational Structures

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	Utility Operation	3rd Party Operation	Joint Operation
Operational Responsibility & Controls	Full utility operational responsibility and controls of distribution system and microgrid controller	Microgrid operator ownership of distribution system segment and microgrid controller.	Utility operational ownership w/ grid-side controller
Energy & Load Operations	Utility issues signals to third parties, who control the energy producing and load modifying resources (resource operator)	Microgrid operator has control. Coordinates with utility distribution operator.	Customer or third party has control when in islanded mode
Separate Resilience Contracts?	Yes for resource operator	Yes for microgrid operator	N/A

#2, Tariff Development

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Tariff Structure and Eligibility

- Program-Based Tariff
- Resilience Service-Based Tariff
- Microgrid Enabling Tariff
- Type, Scope and Scale

Microgrid Interconnection and Islanding Capabilities

- Interconnection Study and Agreement
- Microgrid Engineering Design
- Special Facilities Agreement
- Microgrid Operating Agreement

Microgrid Services

- Blue Sky Services (Energy and Grid Services)
- Island Services (Resilience Services)

Compensation Mechanisms

- Wholesale Market Participation
- Bi-Lateral PPAs
- Existing Tariffs, Programs and Procurements
- Resilience Service Agreement

Utility Provided Services

- Distribution Services
- Distribution Lease Arrangements
- Retail Wheeling

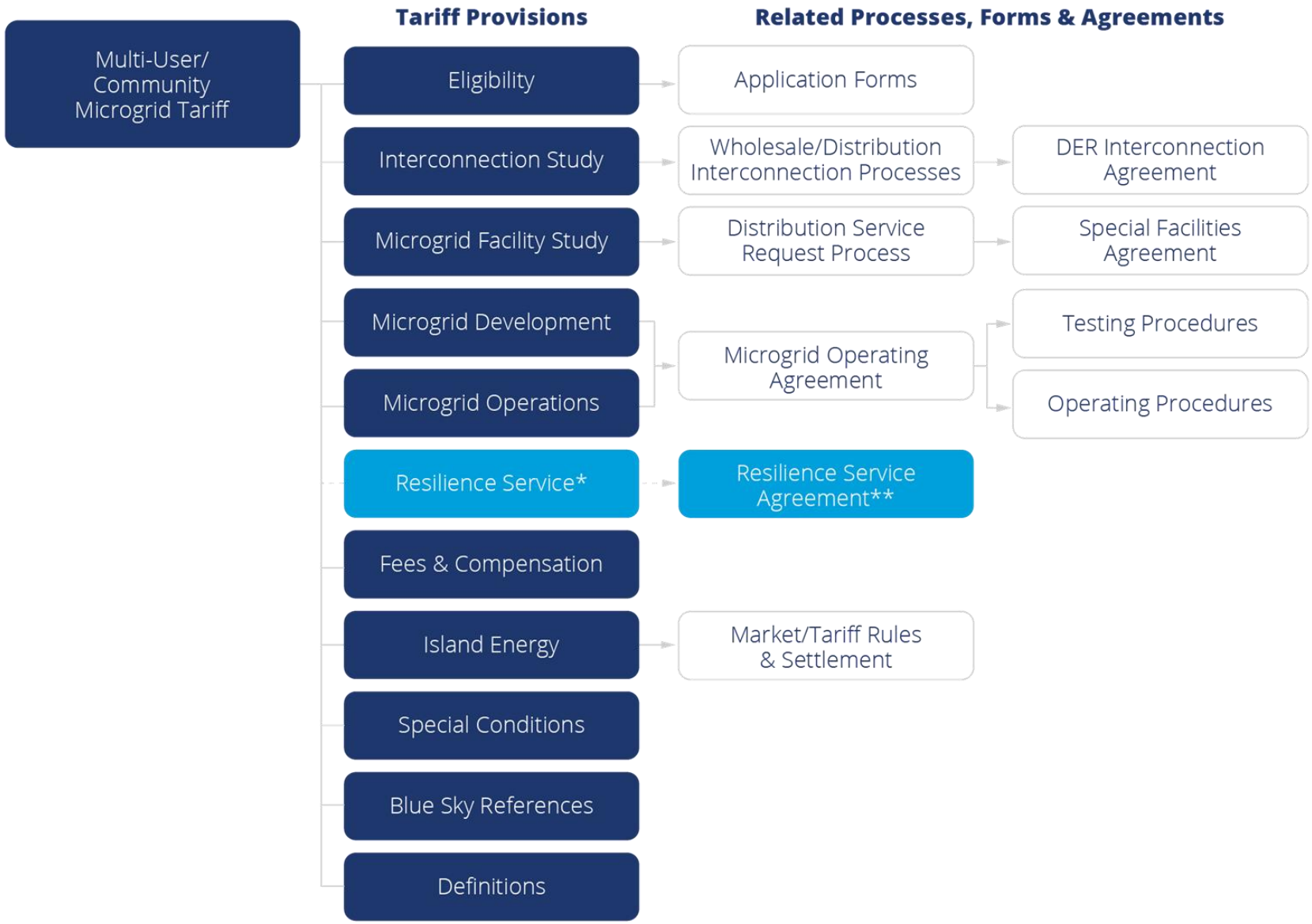
Tariff Structure

Program based-tariff designed to enable the specific elements of a microgrid enabling program that is intended to incentivize microgrid development.

Resilience service-based tariff designed to compensate a microgrid operator for providing microgrid forming service that provides frequency, voltage and other power quality services necessary to maintain electric service to customers.

Microgrid enabling tariff designed to enable the development and operation of a multi-user microgrid, but does not include any microgrid service provision or compensation.

Tariff Structure



Microgrid Services and Compensation Mechanisms

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	Customer Service	Grid Service
Blue-Sky Service	▪ Community Solar Programs ▪ Decarbonization	▪ Wholesale Energy Market Participation / PURPA PPA ▪ Wholesale Ancillary Services ▪ Distribution NWA
Island Service	▪ Resilience Services ▪ Islanded Energy Services	▪ System Resilience Services ▪ Microgrid Forming Services

Key Takeaways

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- Start with a common vocabulary for any stakeholder discussions
- Begin discussions around the structured process provided by the framework to effectively engage stakeholders
- Focus tariff on customer demand and commercial readiness of microgrids
- Develop tariff on lifecycle of a microgrid from eligibility through commercial operations and related enabling agreements (e.g. interconnection, special facilities and operating/service agreements)
- Focus tariff on island mode operations and interrelationship with existing tariffs, programs, procurements and wholesale opportunities under blue sky mode operations
- Services that microgrid operator provides microgrid participants are typically not covered under a tariff and can be handled through separate contracts
- Regulators will need to consider appropriate oversite of 3rd party – customer contracts
- Utilities need to work across functional areas to develop a tariff

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Download for Free

To get the full visit sepapower.org and search, *“microgrid tariff design.”*

Financing and Deploying Community Microgrids via the Resilient Energy Subscription (RES):

Lessons learned from policy in California and projects in Washington

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Mission

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

Renewable Energy End-Game

100% renewable energy; 25% local, interconnected within the distribution grid and ensuring resilience without dependence on the transmission grid; and 75% remote, fully dependent on the transmission grid for serving loads.

The Resilient Energy Subscription (RES) addresses three Community Microgrid financing challenges

The RES helps finance Community Microgrids while properly valuing their significant resilience benefits, addressing these three challenges:

1. **Establishing** initial Community Microgrids to provide resilience to Critical Community Facilities (CCFs).
2. **Enhancing** Community Microgrids to offer resilience opportunities within the initial Community Microgrid footprint.
3. **Expanding** Community Microgrids to larger footprints that can guarantee resilience to a wider list of facilities and include additional communities.

Critical Community Facilities (CCFs) in a Southern California community.

Resilient Energy Subscription (RES) defined

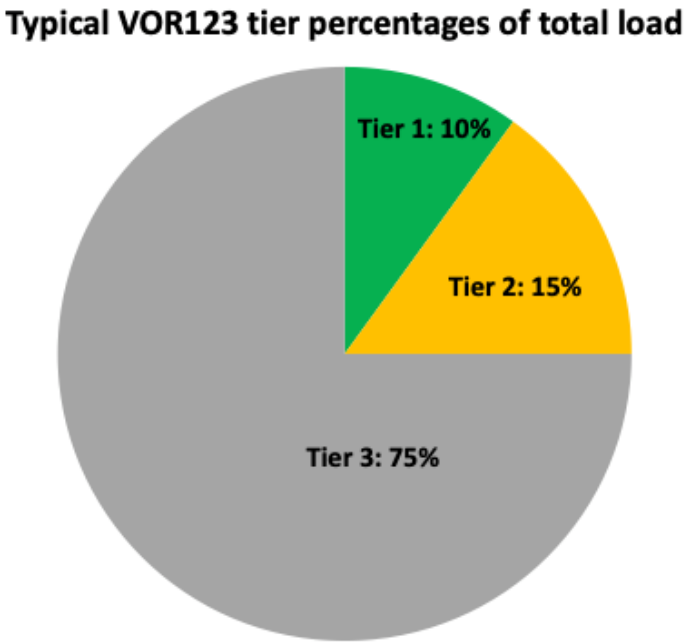
- A straightforward fee-based market mechanism that finances the enhancement and expansion of Community Microgrids
  - Community Microgrids provide guaranteed daily delivery of locally generated renewable energy during grid outages, ensuring unparalleled energy resilience.

- Allows any facility within the footprint of a Community Microgrid to procure this unparalleled energy resilience
  - A facility pays a simple monthly $/kWh fee — separate from any existing rate tariffs — on top of their normal electricity rates for guaranteed daily delivery of locally generated renewable energy during grid outages.
  - *Usually reserved for a facility's most critical loads.*

- Facilitates the deployment and expansion of Community Microgrids
  - Allows the Community Microgrid owner-operators to recover the cost-of-service (COS) required to meet contracted RES obligations.
  - COS is determined by the capital expenditures (capex) associated with Community Microgrid assets, operational expenditures (opex) associated with operations and maintenance (O&M), and an appropriate rate of return.

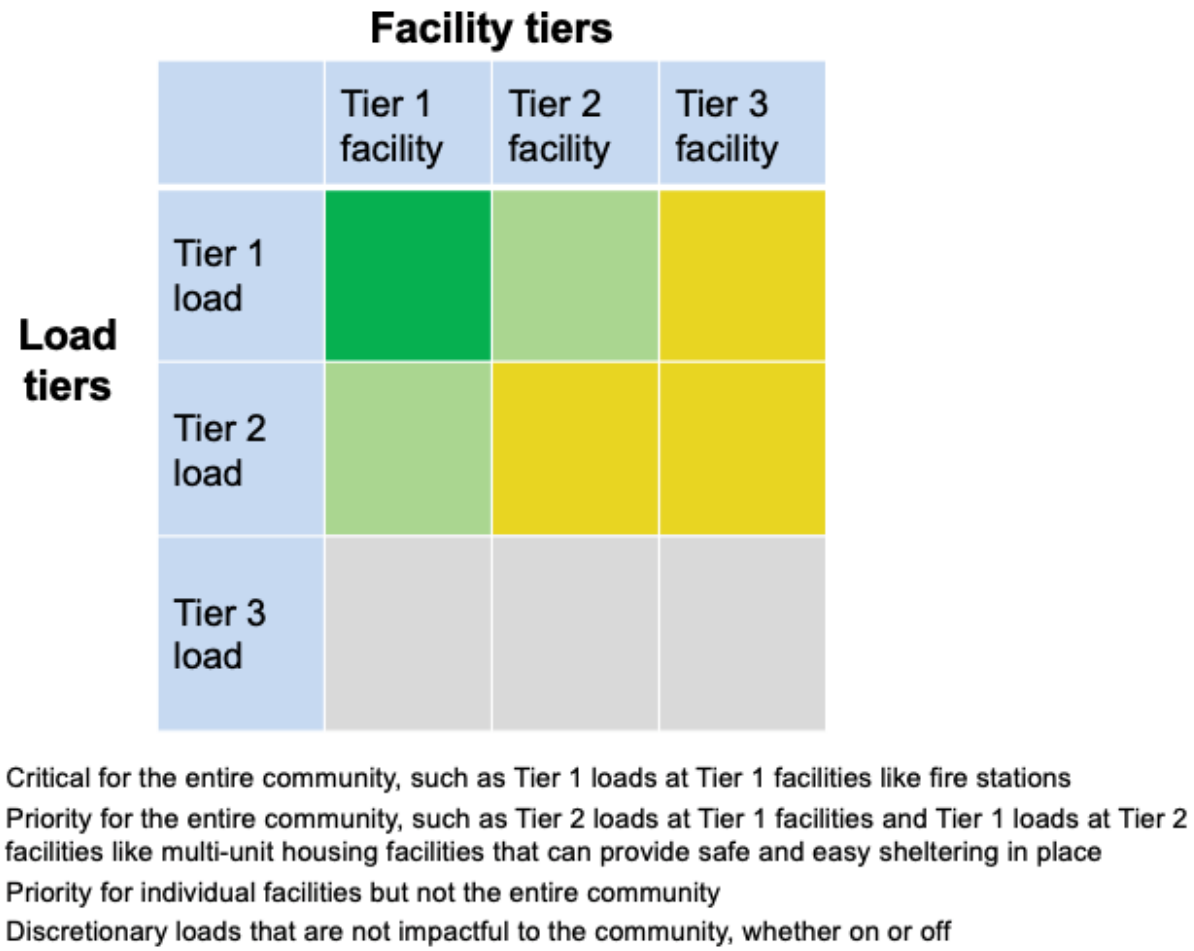
VOR123 depends on tiering electricity loads

- *The Clean Coalition's VOR123 approach standardizes resilience values for three tiers of loads,* regardless of facility type or location:
  - **Tier 1, usually about 10% of the total load, are mission-critical, life-sustaining loads** that warrant 100% resilience.
  - **Tier 2, or priority loads, usually about 15% of the total load**, should be maintained as long as doing so does not threaten the ability to maintain Tier 1 loads.
  - **Tier 3 are discretionary loads** that make up the remaining loads, usually about 75% of the total load. Maintained when doing so does not threaten Tier 1 & 2 resilience.



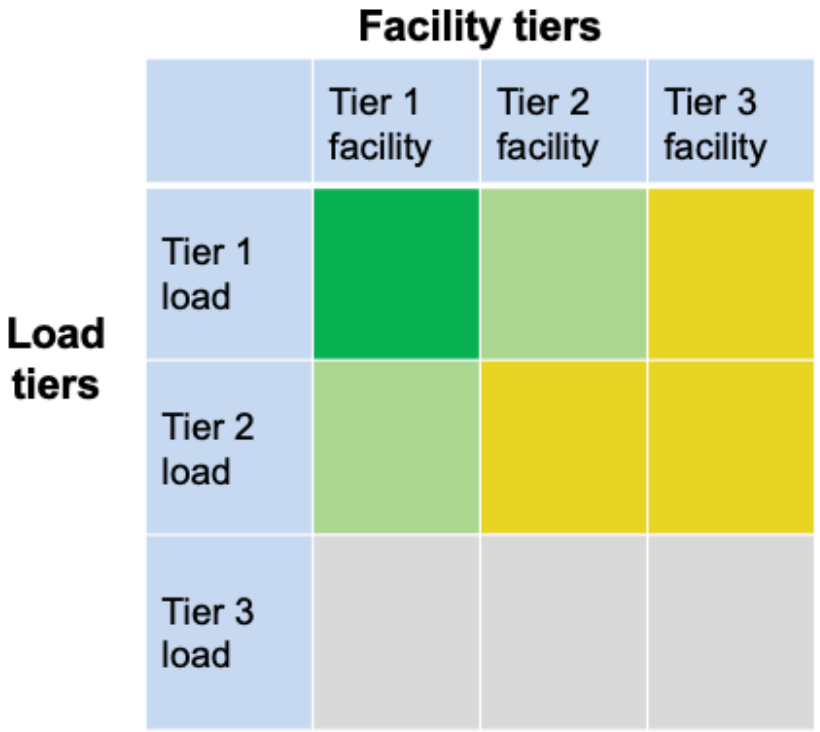
VOR123 for a Community Microgrid

- The VOR123 principles for an individual facility can also be applied to a larger grid area by tiering facilities, in addition to tiering loads:



VOR123 for a Community Microgrid

- The top emphasis is to provision 100% resilience for Tier 1 loads at Tier 1 facilities (the darker green square in the chart).
  - Tier 1 facilities include CCFs such as fire stations and emergency shelters — and can also include grocery stores, data centers, pharmacies, gas stations, EV charging stations, & apartment complexes that can provide sheltering-in-place during grid outages.
- The second emphasis is for Tier 1 loads at Tier 2 facilities and Tier 2 loads at Tier 1 facilities (the lighter green squares).



= Critical for the entire community, such as Tier 1 loads at Tier 1 facilities like fire stations

= Priority for the entire community, such as Tier 2 loads at Tier 1 facilities and Tier 1 loads at Tier 2 facilities like multi-unit housing facilities that can provide safe and easy sheltering in place

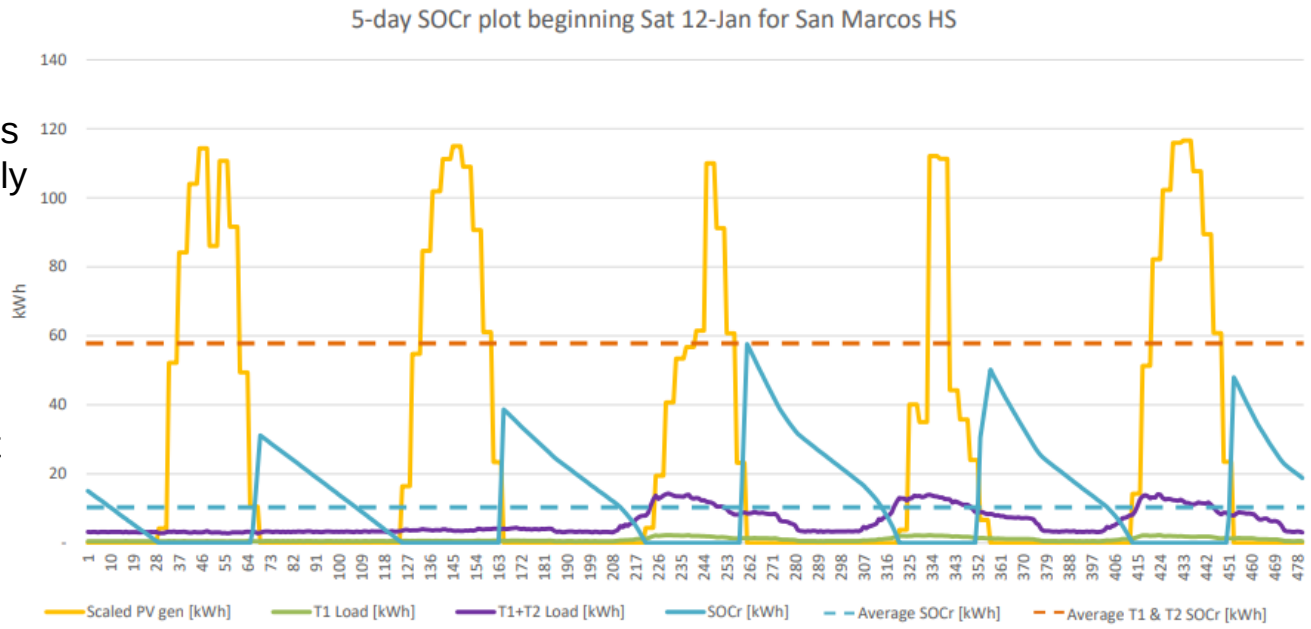
= Priority for individual facilities but not the entire community

= Discretionary loads that are not impactful to the community, whether on or off

RES feasibility: Community Microgrid owner-operator perspective

- ROE for the Community Microgrid owner depends on the following factors:
  - Microgrid financial inflows:
    - RES fees*
    - Energy sold to the utility on an everyday basis
    - Solar and battery energy storage system (BESS) financial incentives
  - Microgrid financial outflows:
    - Microgrid capital expenditures (capex)
    - Microgrid operational expenditures (opex)

* Income from RES fees depends on the maximum guaranteed daily energy from the Community Microgrid. The Clean Coalition calculates this quantity using its state-of-charge for resilience (SOCr) methodology, which analyzes BESS capacity against actual solar generation and site load profiles.



Grand Orcas Community Microgrid plan for the entire OPALCO territory

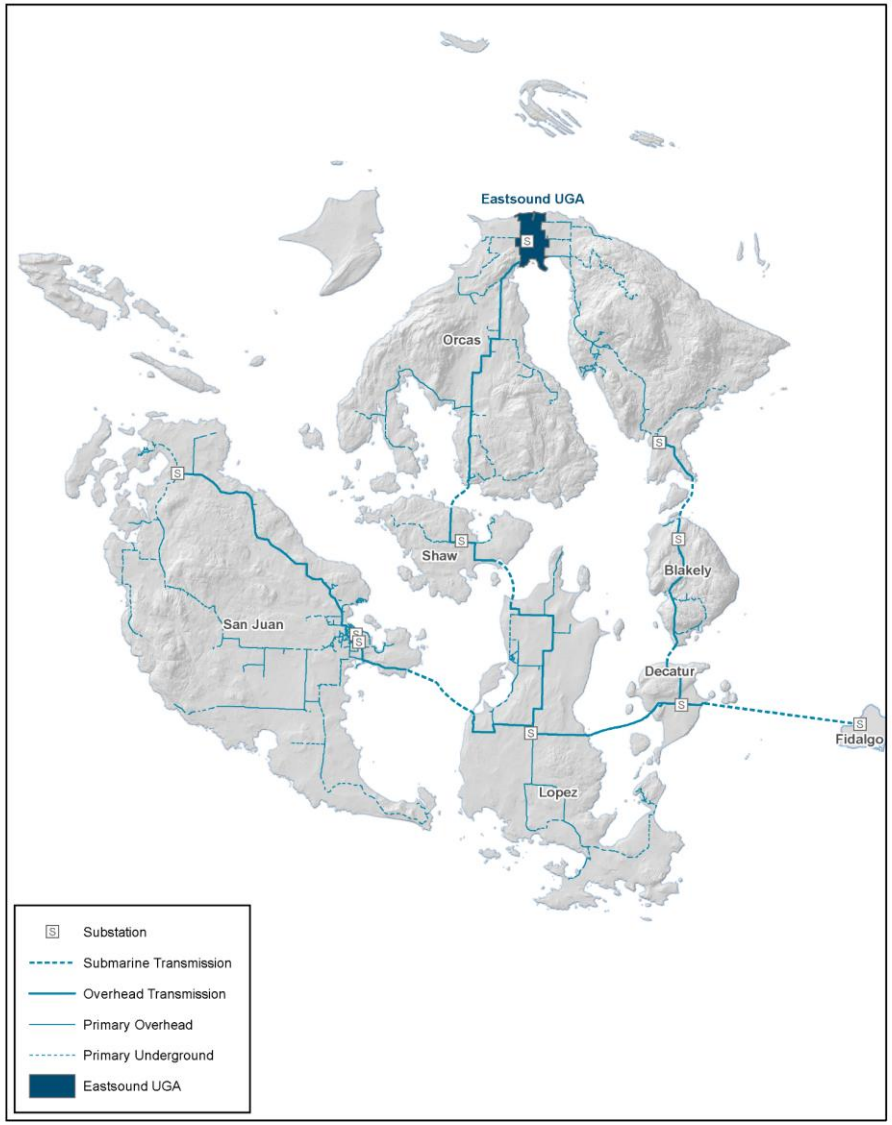


Figure 1: OPALCO's service territory covers San Juan County and includes 20 islands. Eastsound is shaded towards the top of Orcas Island and represents the initial Orcas Community Microgrid location. Over time, the Community Microgrid will expand to cover all of Orcas and then eventually the entire OPALCO service territory.

Eastsound Tier 1 & 2 facilities map

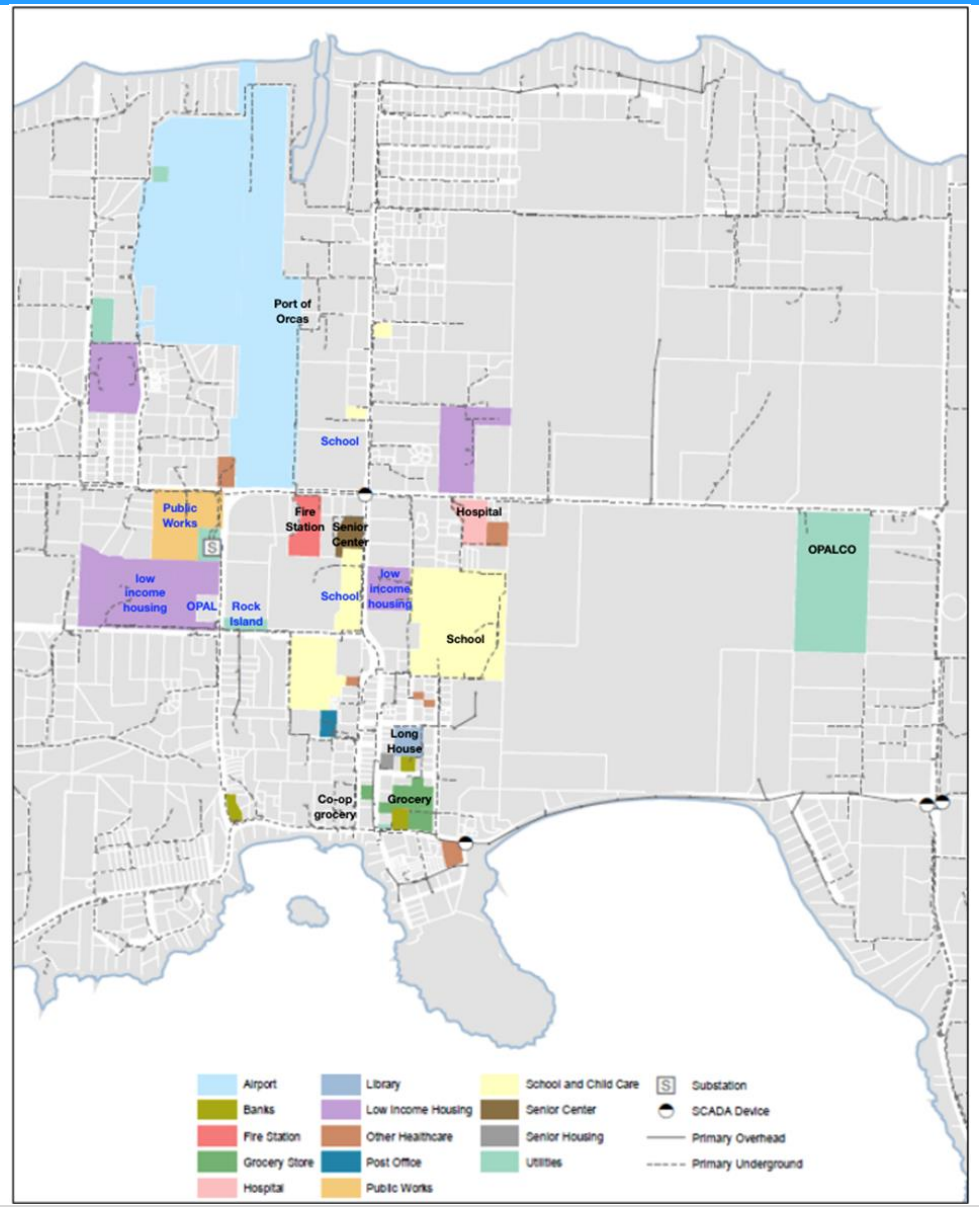


Figure 2: Eastsound facilities that are being provisioned with priority Community Microgrid resilience in the initial Orcas Community Microgrid design are shaded. Tier 1 Critical Community Facilities (CCFs) are shaded and labeled with black text, while Tier 2 CCFs are shaded in blue text. Figures 3 and 4 further depict the initial Orcas Community Microgrid in block diagram form.

Eastsound Tier 1 & 2 facilities block diagram

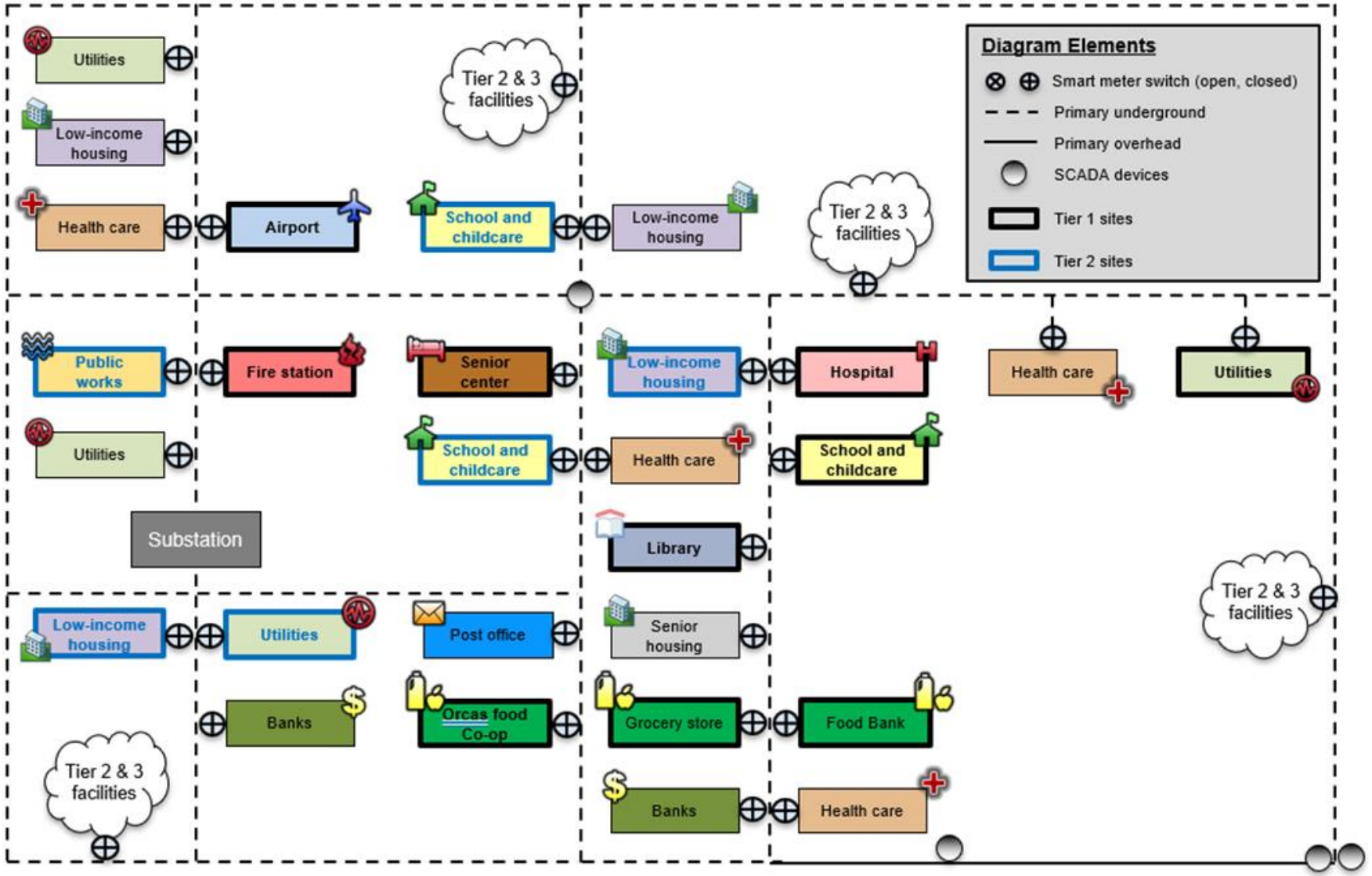
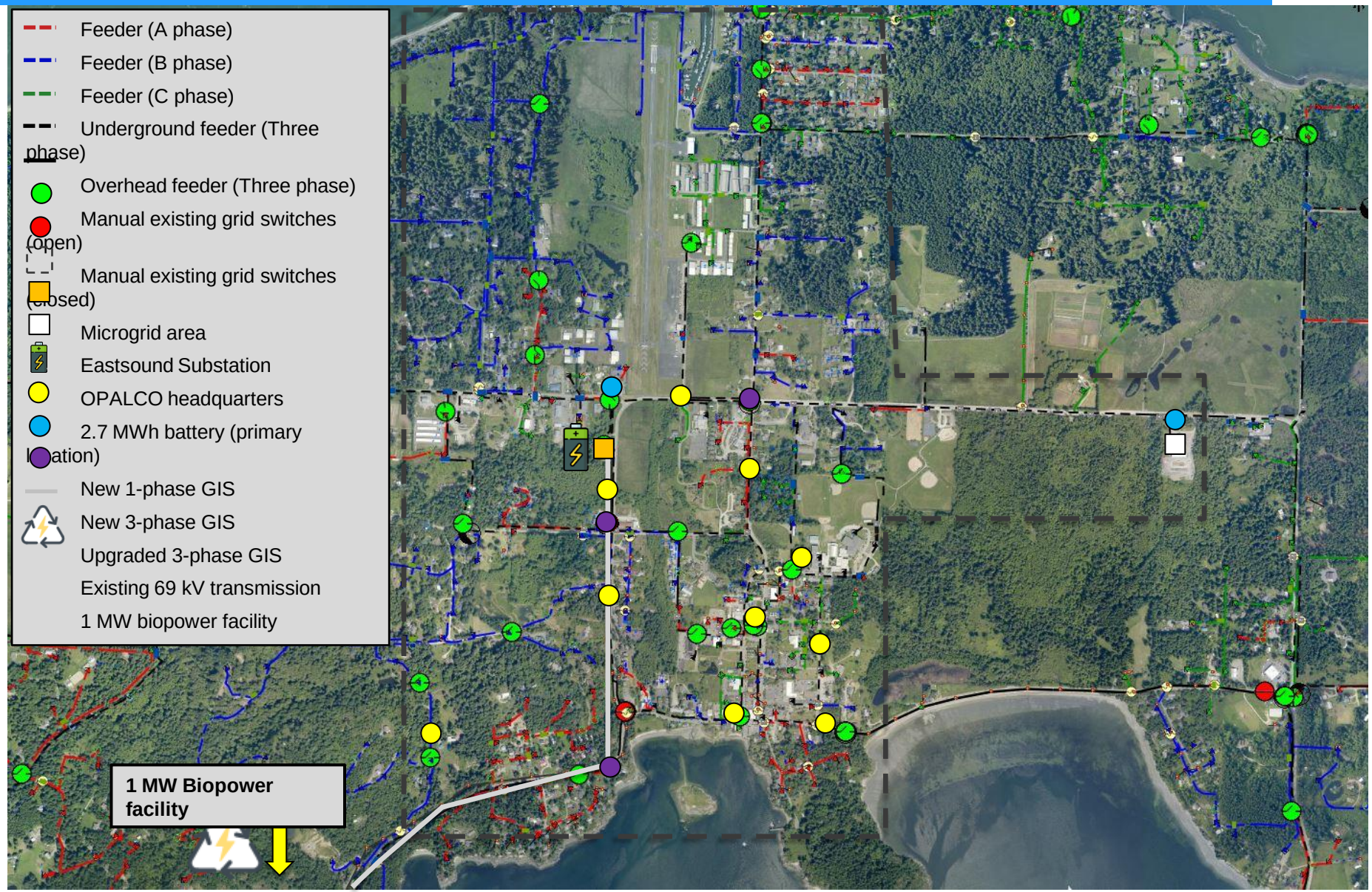


Figure 3: Noteworthy facilities in Eastsound and within the target grid area of the initial Orcas Community Microgrid. This figure reflects the block diagram version of the grid area shown in Figure 2.

OCM map for Orcas Island



RES feasibility: Community Microgrid owner-operator perspective

Analysis factors from a 2021 design for a Community Microgrid in Southern California:

Microgrid financial outflows:

	Year:	Capex	Opex
PV		$3,000,000	$7,000
BESS		$1,400,000	$5,000
Microgrid hardware + MC2		$500,000	$15,000
PV+BESS incentives		-$1,800,000	
Total annual expense:	1	$3,100,000	$27,000
	2	$-	$27,000
30-year analysis	3	$-	$27,000
	4	$-	$27,000

Microgrid financial Inflows:

	RES fees
RES fee ($/kWh)	$0.20
Guaranteed daily load (kWh)	2,300
Total annual income:	$165,000
	$165,000
	$165,000
	$165,000

	Sales to utility
Tariff to utility	$0.10
Annual PV sold (kWh)	2,400,000
	$236,000
	$236,000
	$236,000
	$236,000

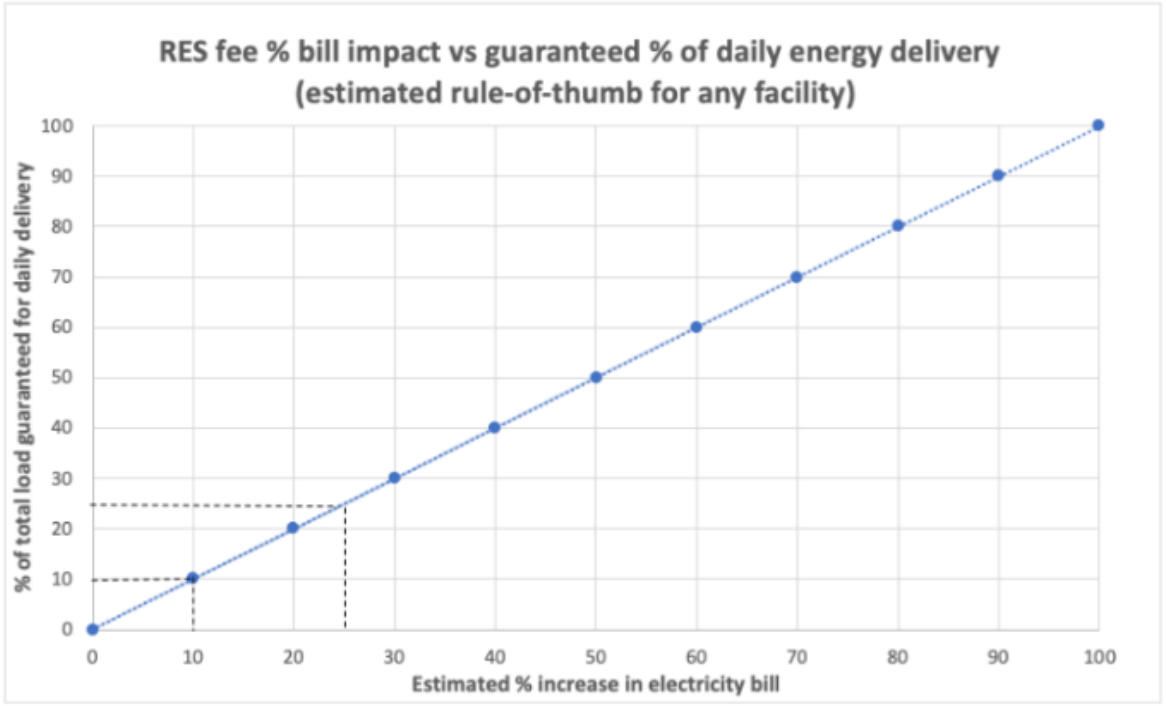
With these expenses and income, the Community Microgrid owner will see an internal rate of return (IRR) of at least **9%.**

RES feasibility analysis results

- *The Clean Coalition's analysis shows:*
  - A **value-appropriate** RES subscription ratio of 1.0 (1% bill increase per 1% guaranteed load coverage) for the subscriber is feasible.
  - A **positive IRR** of 9% for the Community Microgrid owner is feasible.
- *Therefore, the RES is financially feasible for all stakeholders.*

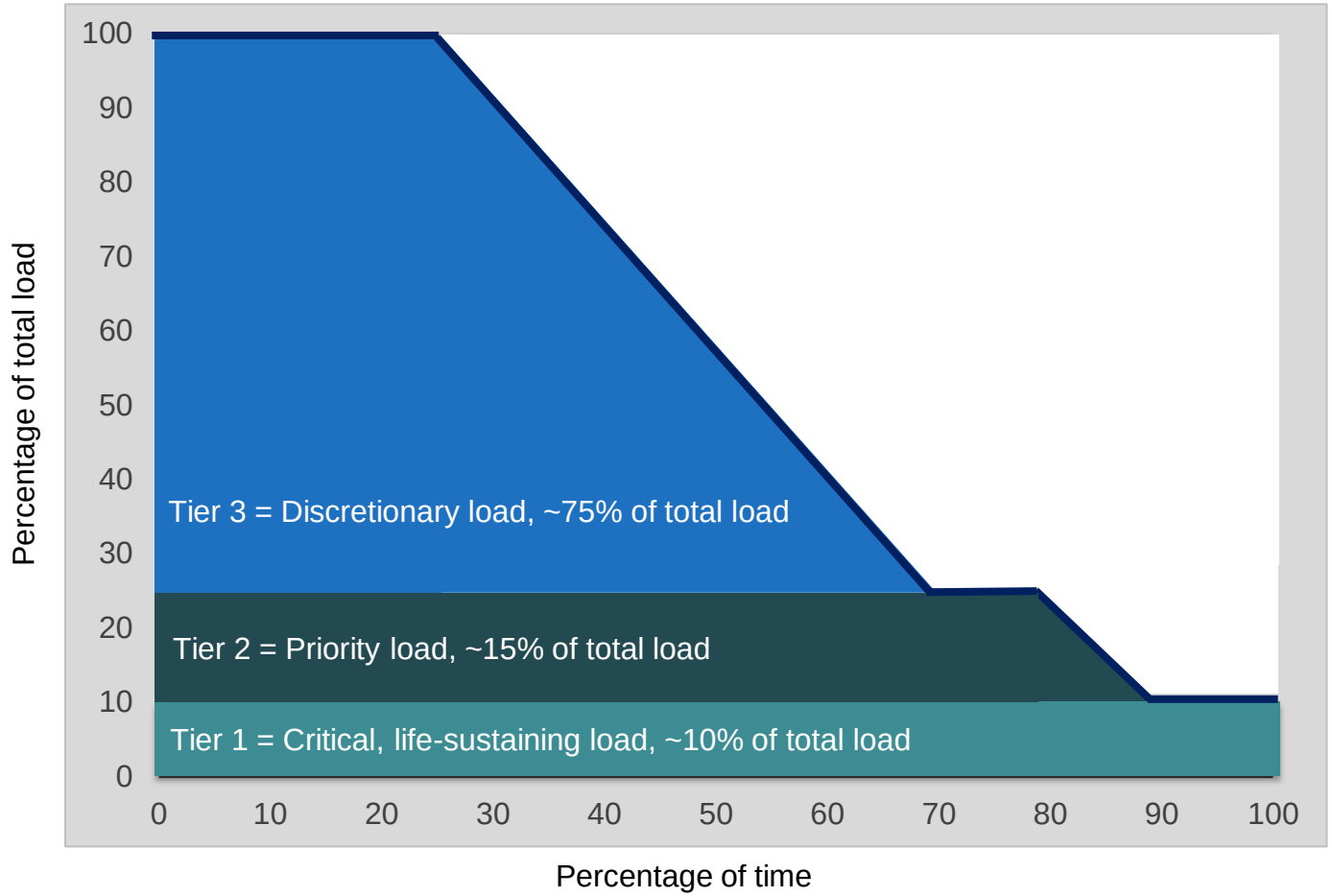
Key Takeaways:

- RES allows Community Microgrids to be deployed at scale and expanded, as more facilities desire resilient energy guarantees.
- RES provides a revolutionary and straightforward approach for financing Community Microgrids and delivering unparalleled resilience to communities.
- RES enables a greater harmonization between local energy needs and societal planning in a way that helps put the people first.



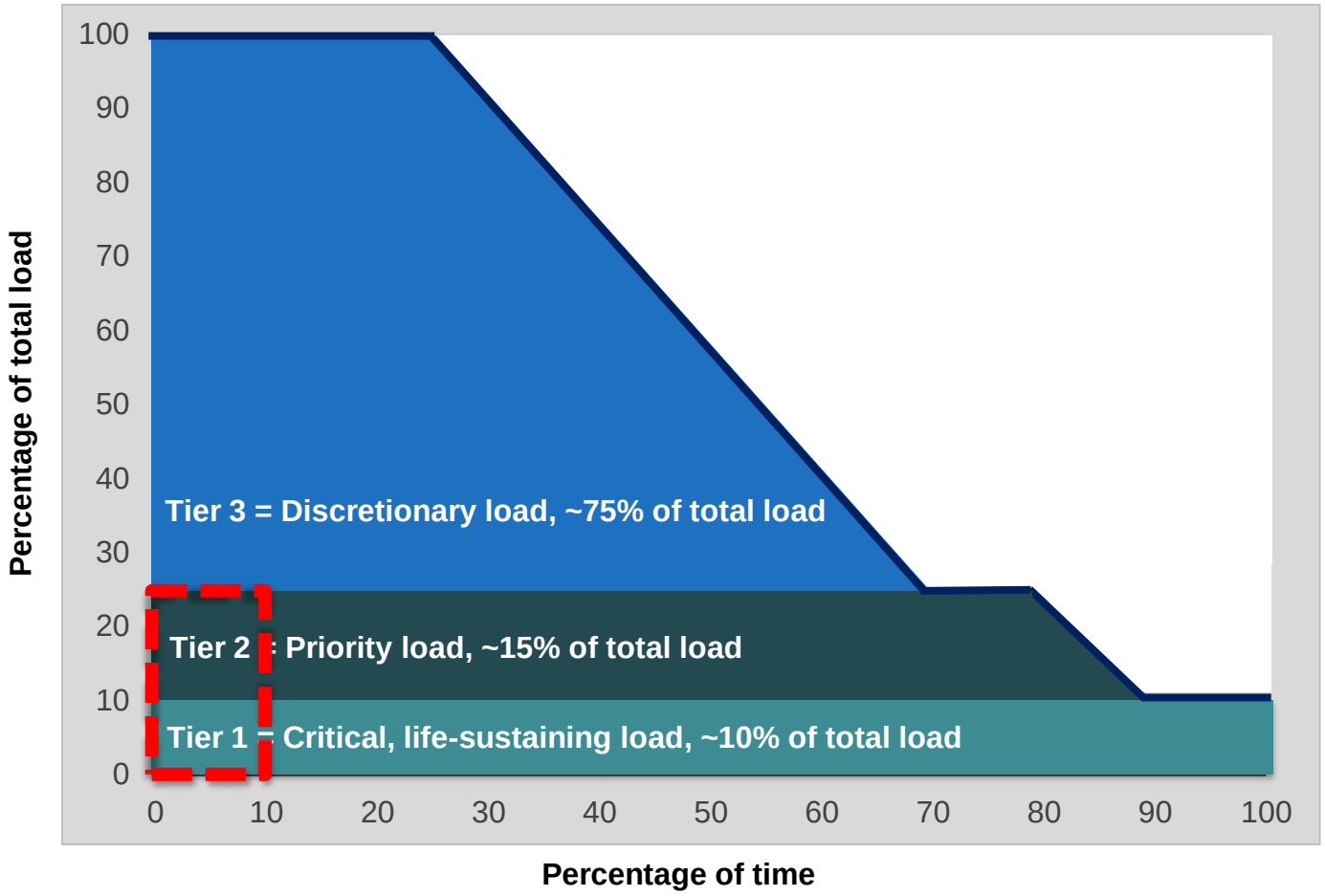
Backup Slides

Typical load tier resilience from a Solar Microgrid



Percentage of time online for Tier 1, 2, and 3 loads for a Solar Microgrid designed for the University of California Santa Barbara (UCSB) with enough solar to achieve net zero and 200 kWh of energy storage per 100 of kW solar.

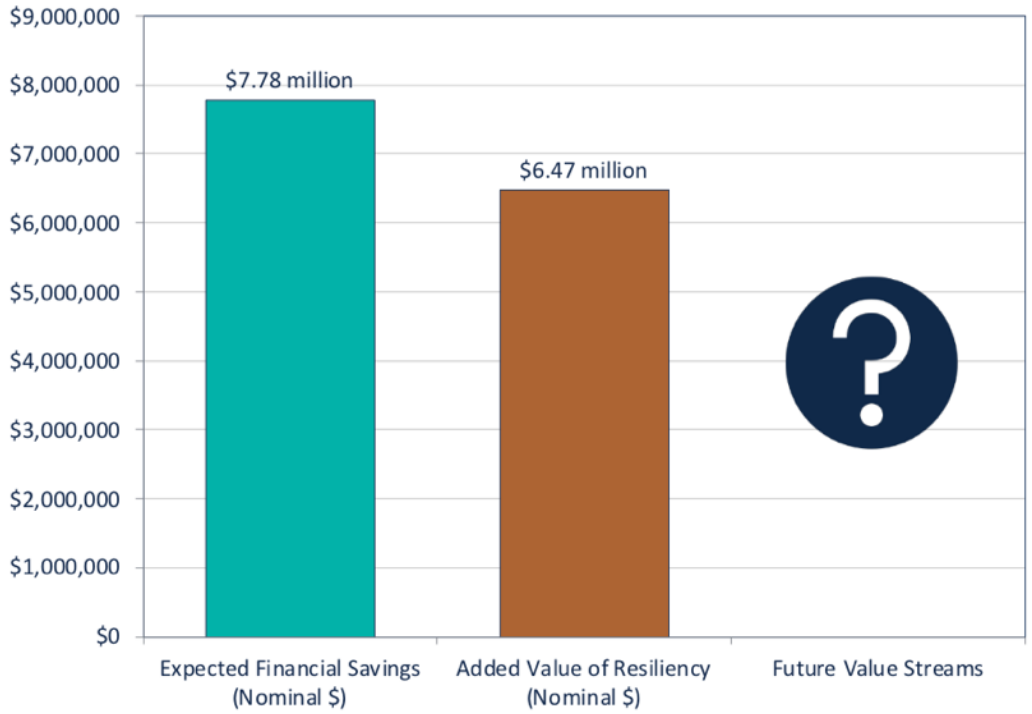
Diesel generators are designed for limited resilience



A typical diesel generator is configured to maintain 25% of the normal load for two days. If diesel fuel cannot be resupplied within two days, goodbye. This is hardly a solution for increasingly necessary long-term resilience. In California, Solar Microgrids provide a vastly superior trifecta of economic, environmental, and resilience benefits.

VOR123 yields a 25% typical adder

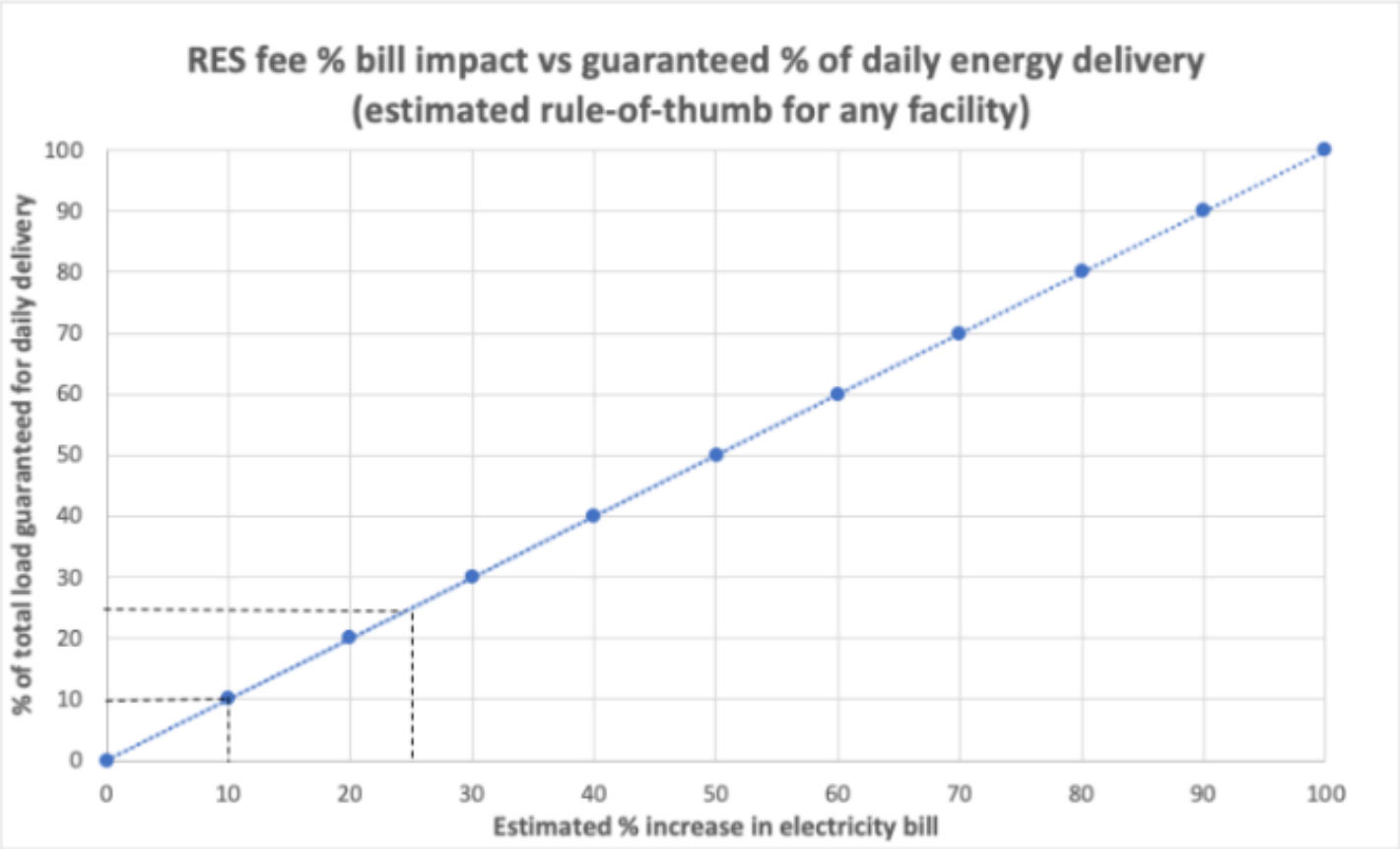
- Based on this tiering system, the Clean Coalition arrived at **25% as the typical VOR123 adder** that a site should be willing to pay for resilience.
- The Clean Coalition has validated the 25% adder using four approaches: Cost-of-service, Department of Energy multiplier, market-based, and avoided diesel generator cost (see https://clean-coalition.org/disaster-resilience/#adder).
- We also applied VOR123 to the Solar Microgrids for the Santa Barbara Unified School District (SBUSD), which is getting significant resilience benefits for free:



Bill savings and resilience value accruing to the SBUSD from six Solar Microgrid sites plus eight additional solar-only sites.

COS for expanding a Community Microgrid via RES

- Once an initial Community Microgrid is established for serving the CCFs, incremental COS will be low for expanding the Community Microgrid via the market-based RES.
- Each 1% of load that a facility secures via a RES will result in an approximately 1% electricity bill increase:



RES feasibility:
Community Microgrid owner perspective

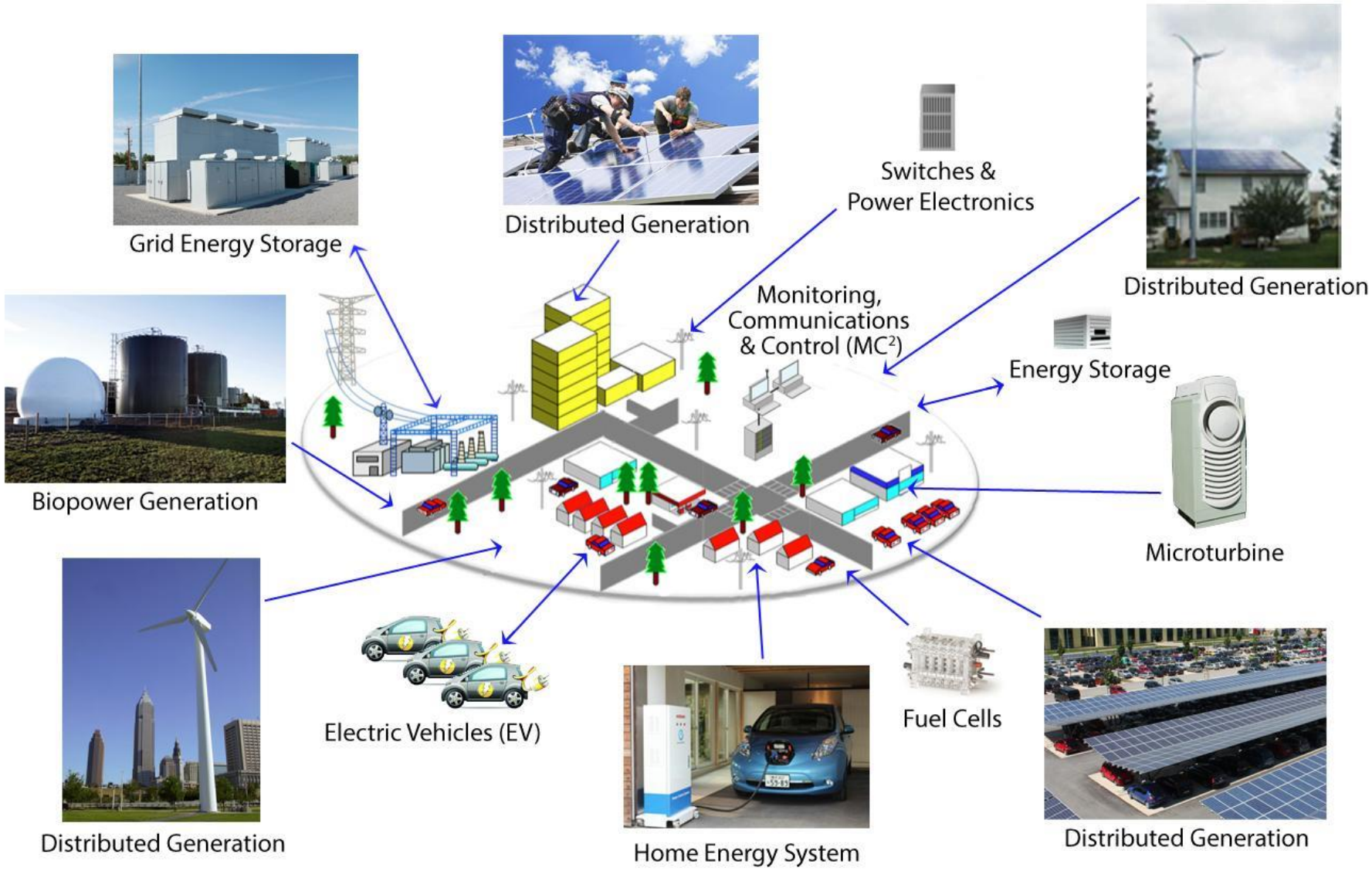
Clean Coalition

Analysis factors from a real-world design for a Community Microgrid in Southern California:

Factor	Amount	Units
RES fee	0.20	$/kWh
Tariff for energy sold to utility	0.10	$/kWh
Daily site load guaranteed by RES	2,300	kWh
PV+BESS financial incentives	1,800,000	$
PV size	1,500	kW
PV capex	3,000,000	$
BESS size	2,000	kWh
BESS capex	1,400,000	$
Microgrid hardware + MC2*	500,000	$
PV annual opex	7,000	$/year
BESS annual opex	5,000	$/year
Microgrid MC2 annual opex	15,000	$/year

* MC2 = Monitoring, Communications, and Controls for a microgrid.

Heading


Grid Energy Storage
Distributed Generation
Switches &
Power Electronics
Distributed Generation
Monitoring,
Communications
& Control (MC²)
Energy Storage
Biopower Generation
Microturbine
Distributed Generation
Electric Vehicles (EV)
Fuel Cells
Home Energy System
Distributed Generation

Solar Energy Multi-Facility Microgrids: Puerto Rico experience

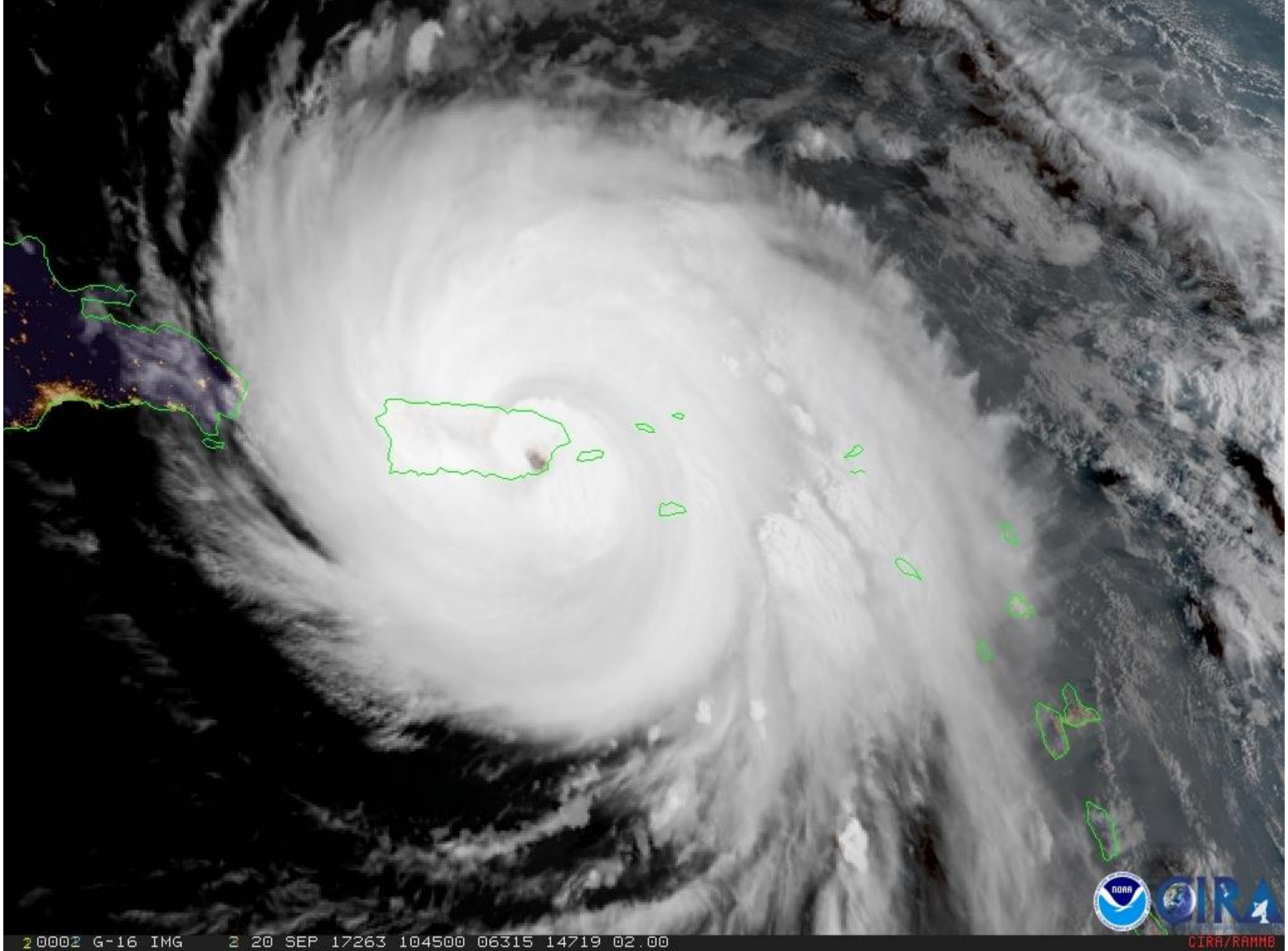
Dec 5, 2023

IREC

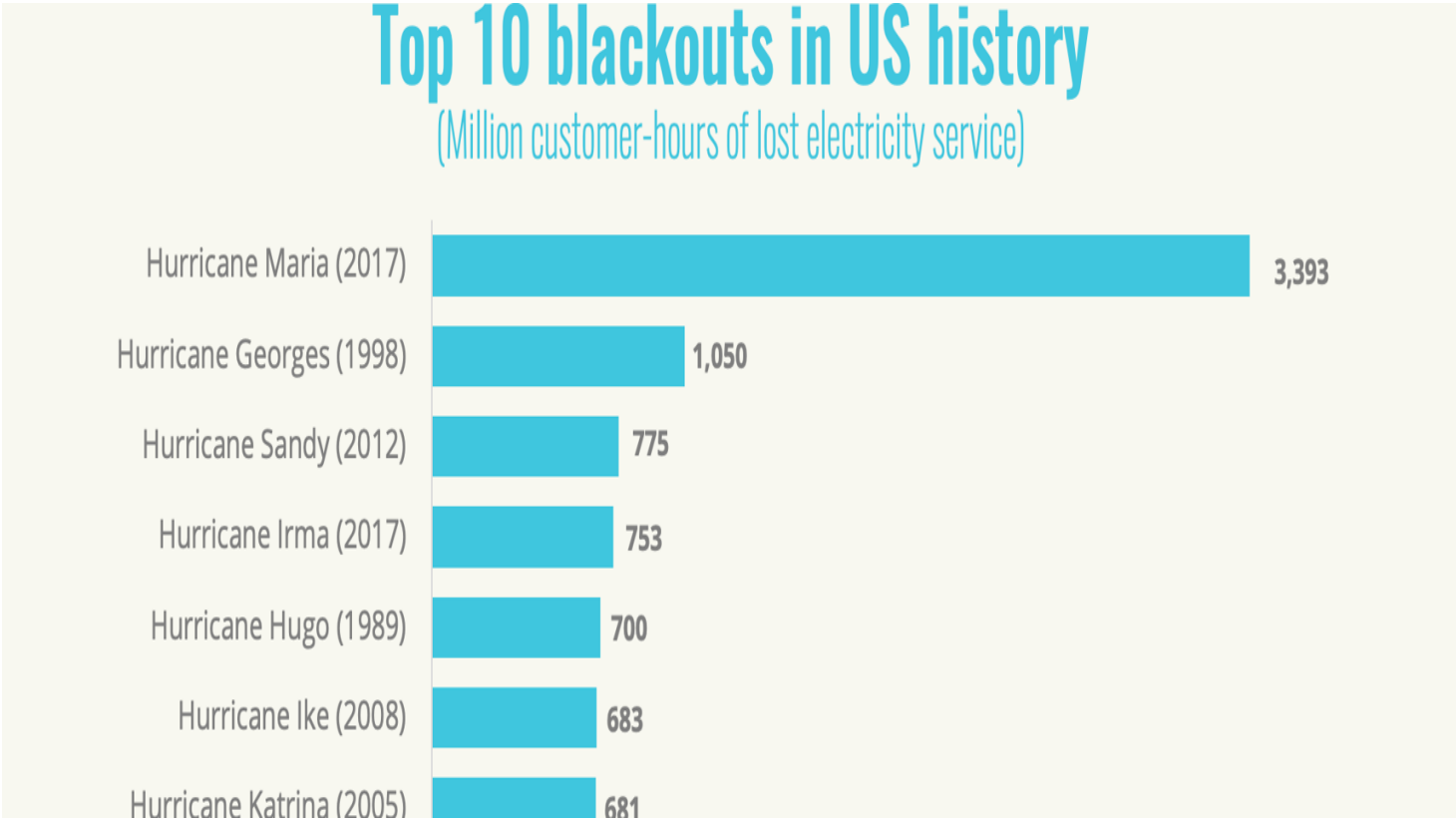
IREC builds the foundation for rapid adoption of clean energy and energy efficiency to benefit people, the economy, and our planet.

IREC in Puerto Rico

IREC


20002 G-16 IMG 2 20 SEP 17263 104500 06315 14719 02.00
CIRA/RAMMB

IREC



Longest electrical outage in U.S. history

IREC

Timeline restoration	% Customers E Restored
2 weeks	9%
1 month	19%
3 months	60%
4 months	70%
5 months	84%
11 months	100%

% households without power

IREC


MACHETE EN MANO
APOYA
Lo Local


El Sartén
DE FARY
José A. Farinacci
Propietario Rest. El Sartén de Fary


HIELO

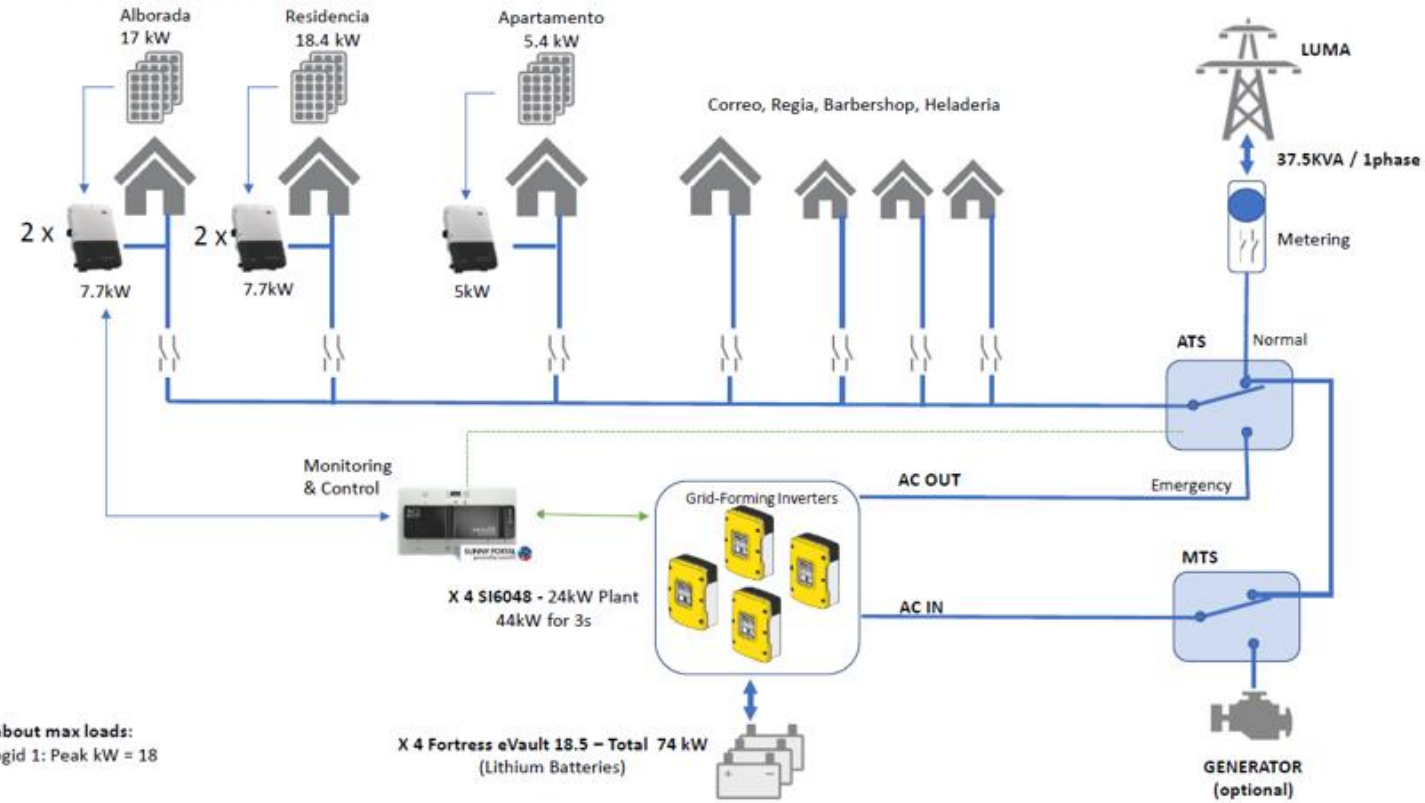

E Y PANADERIA
ALBORADA
AVISO
MANTENER DISTANCIA

Castañer Project Details

	Phase 1	Total Project
Customers	6	10
Number of interconnections	2	3
PV Capacity	56 kW	120 kW
Storage Capacity	127 kWh	259 kWh

IREC

MICROGRID 1: 41 kW DC and 35 kW AC



Interconnection of Castañer MG

- At the time the MG was commissioned LUMA did not have a procedure in place to interconnect a multiple facility microgrids
- Provisional approval was granted via email
- Electronic portal for project submittal did not have corresponding screens to input the project 7 physical structures, so a parallel process was created by LUMA to input by email.
- Interconnection dept formed a team to handle this project specifically
- As of 6 Dec 2022, LUMA has all the necessary documents and the project is under review for final approval and/or determination of some distribution system upgrade before granting Net Metering

IREC

Multi-Facility Interconnection: The Need for Island-Wide Regulation

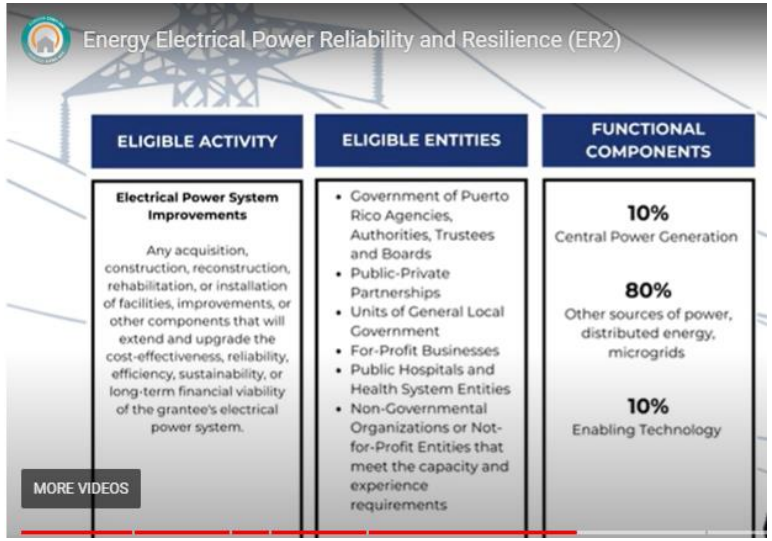
- Final Microgrid Regulation approved by the Puerto Rico Energy Commission in 2018
- PREPA was ordered to develop a regulation to govern the interconnection of multi-facility microgrid systems. Neither PREPA nor its successor, LUMA, has done so.
- PREB has taken up again MG regulation, via Resolution, and is currently in the process comment period to revise the MG regulation

Blue Sky day, without Net Metering a substantial loss of kwh

IREC

Microgrids: From community bootstrap to institutional - A key part of Puerto Rico's Energy Future

- The PR-100 report established that distributed generation and storage microgrids are important and beneficial components of the electrical grid.



Analysis of Microgrid Locations Benefitting Community Resilience for Puerto Rico

Robert F. Jeffers, Michael J. Baca, Amanda M. Wachtel, Sean DeRosa, Andrea Staid, William Fogleman, Alexander Outkin, Frank Currie

Prepared by
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