Clean Coalition

Solar Microgrids & Community Microgrids

Economic, environmental & resilience benefits

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<u>Mission</u>

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

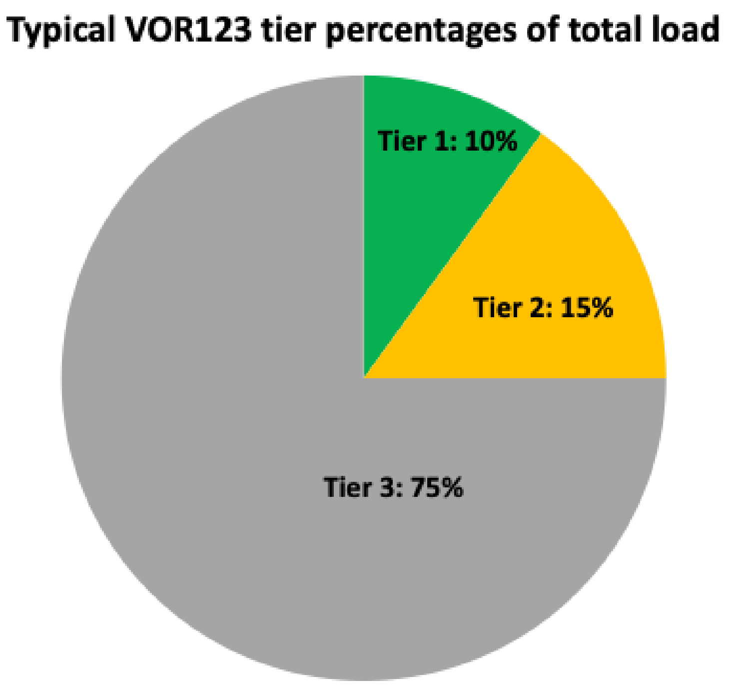
<u>100% renewable energy end-game</u>

- 25% local, interconnected within the distribution grid and facilitating resilience without dependence on the transmission grid.
- 75% remote, dependent on the transmission grid for serving loads.

Understanding value-of-resilience (VOR)

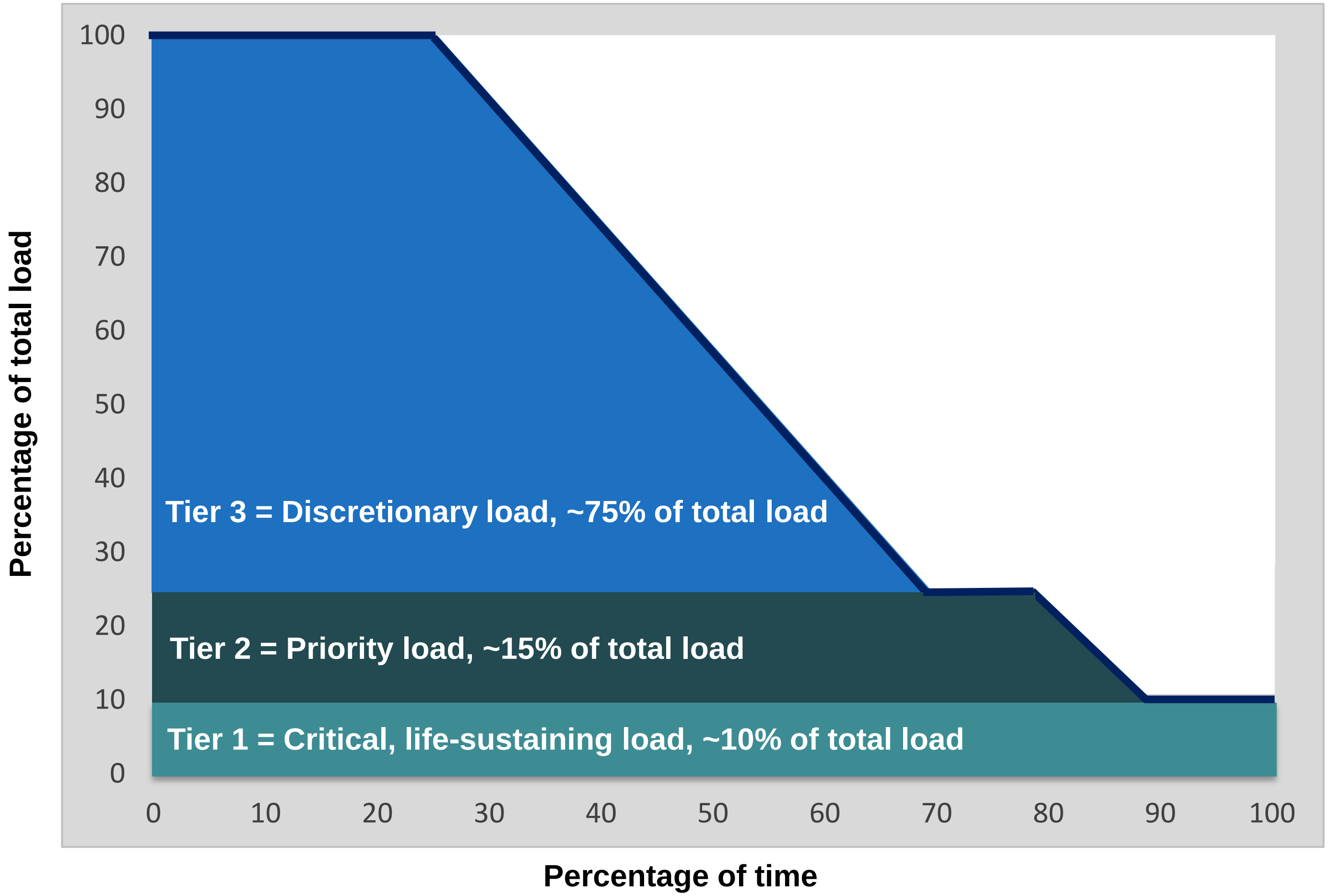
VOR requires tiering of electricity loads

- 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. The VOR for Tier 1 loads is 3x the usual price of electricity.
  - **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. The VOR for Tier 2 loads is 1.5x the usual price of electricity.
  - **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. There is no VOR premium for Tier 3 loads.



The overall VOR (or VOR123) of a typical Solar Microgrid is generally worth a 25% adder to the electricity bill.

Typical load tier resilience from Solar Microgrids



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 kW solar.

Diesel generators are designed for limited resilience

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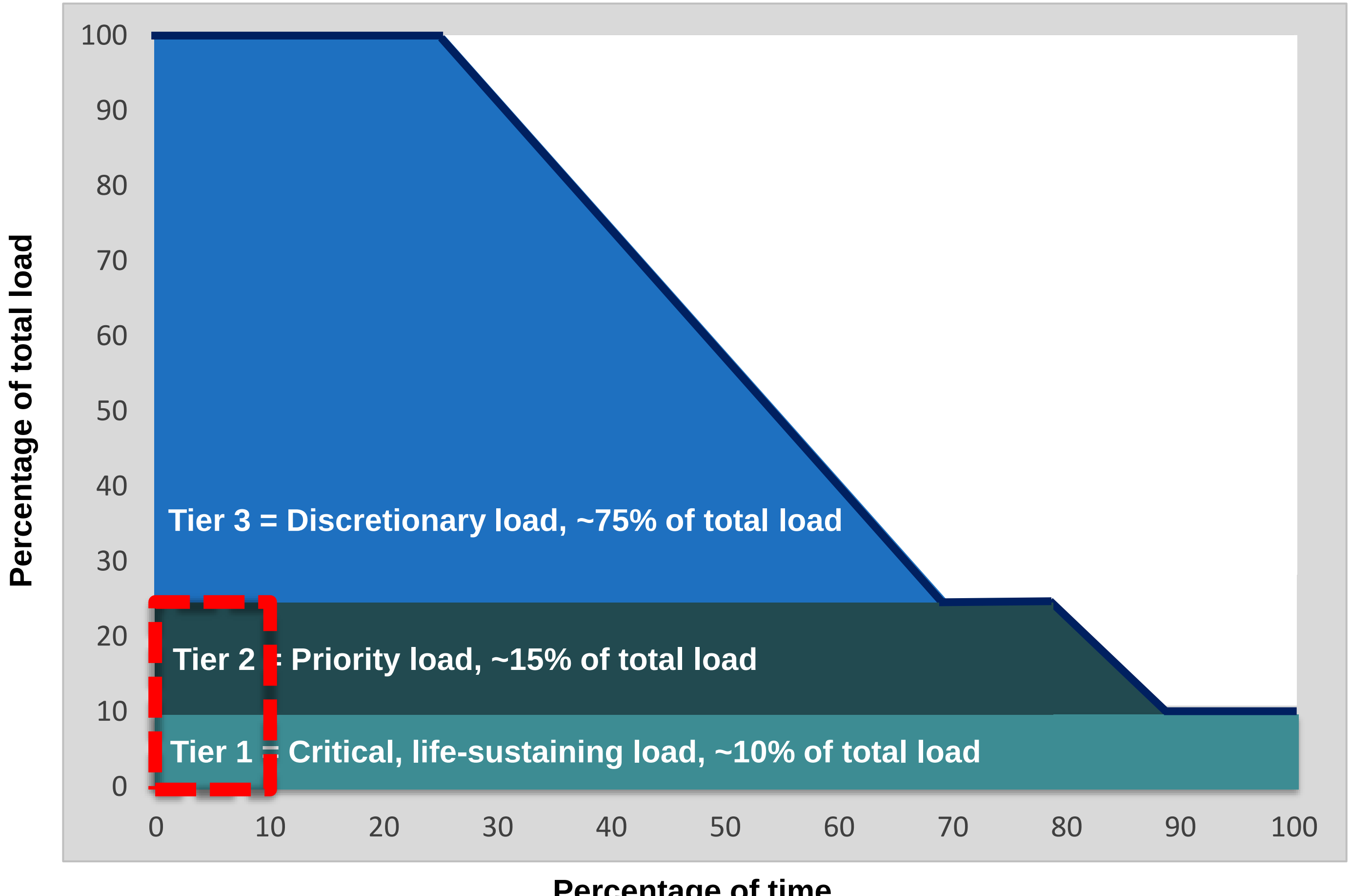

A typical diesel generator is configured to maintain 25% of the normal load for two days. If diesel fuel cannot be resupplied within two days, goodbye. This is hardly a solution for increasingly necessary long-term resilience. In California, Solar Microgrids provide a vastly superior trifecta of economic,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

Natural gas infrastructure is not resilient

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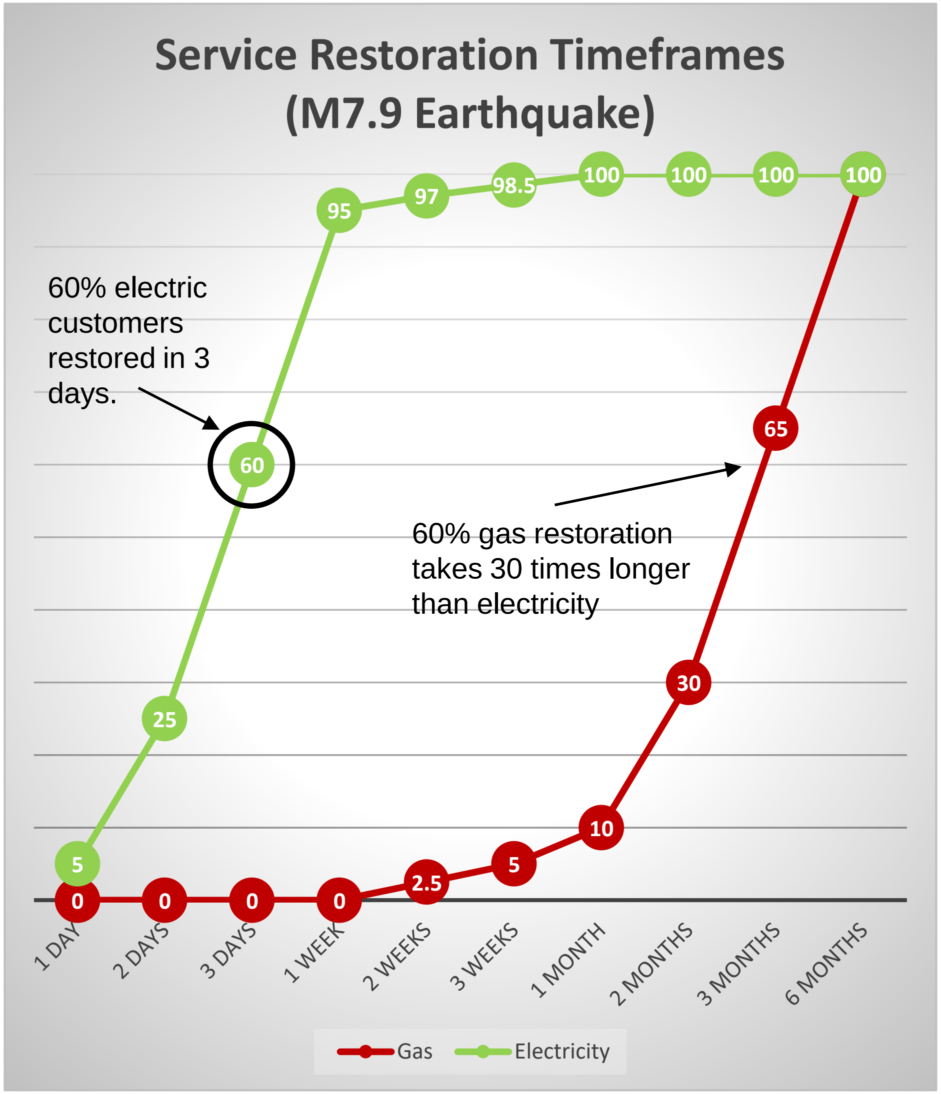
- **Assertion:** Gas-driven generation is often claimed to be resilient.
- **Reality:** Gas infrastructure is not resilient and takes much longer to restore than electricity infrastructure.
- **Threats:** Gas infrastructure can be flat-out dangerous and is highly vulnerable to earthquakes, fires, landslides, and terrorism.

2010 San Bruno Pipeline Explosion



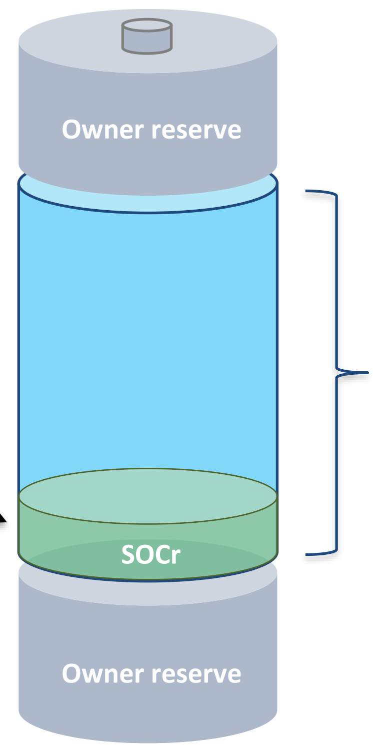
Source: The City and County of San Francisco Lifelines Study

Understanding the role of energy storage

Optimize batteries for economics & resilience

Top owner reserve is often in place to absorb battery energy storage system (BESS) degradation over time, while still delivering the contracted daily cycling energy capacity.

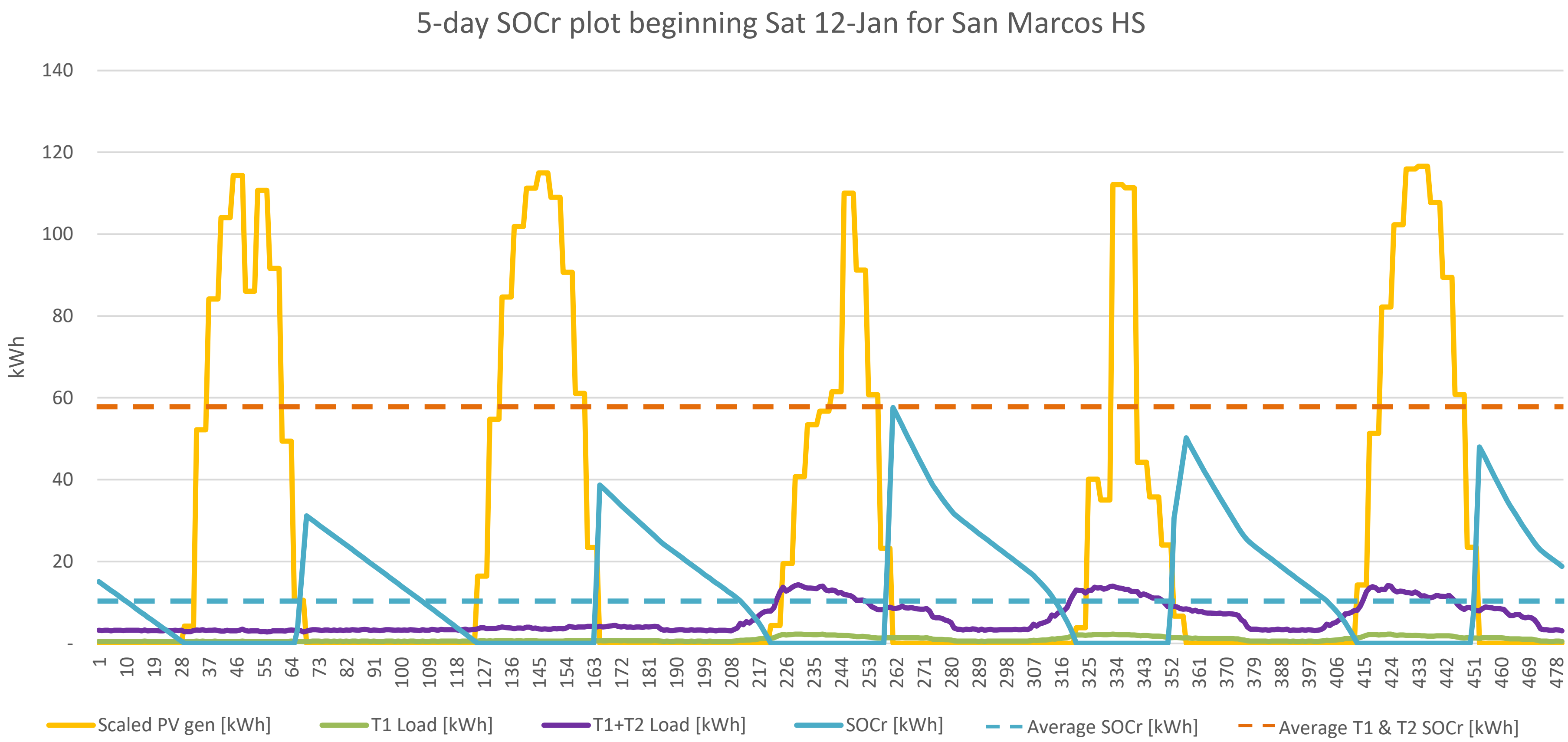
SOCr = the minimum state-of-charge (SOC) that is reserved for provisioning resilience. The SOCr can be dynamic and/or resized to between 0% and 100% of the contracted BESS energy capacity. A lower SOCr facilitates BESS operations that optimize daily economic performance, while a higher SOCr facilitates the provisioning of greater resilience.



Contracted BESS energy capacity (kWh) that must be available for daily cycling over the contract duration for achieving specified economic & resilience performance.

Bottom owner reserve is often required to meet BESS warranty requirements that are imposed by BESS vendors.

SOCr dynamically minimized to maximize economics



Understanding the need for Load Management

Load Management is fundamental to VOR123

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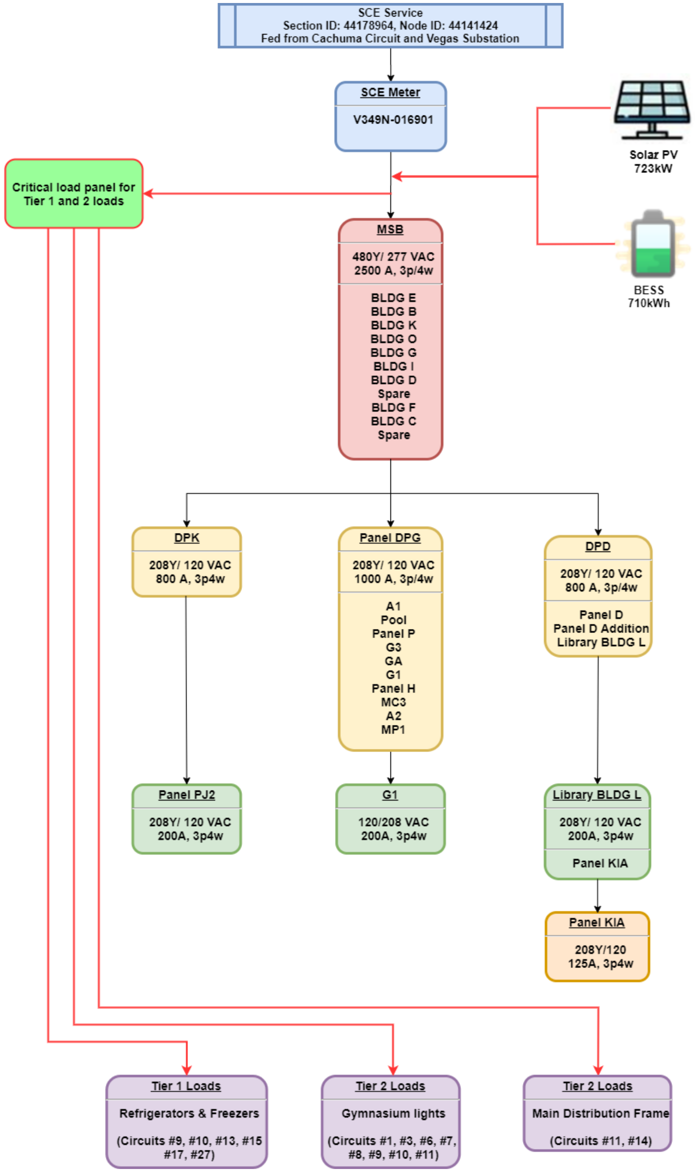
Although there are multiple potential Load Management configurations, the minimal functionality anticipated to be cost-effectively implemented is referred to as **the Critical Load Panel (CLP) approach**.

The CLP name reflects the requirement for a smart critical load panel that maintains Tier 1 loads indefinitely and toggles Tier 2 loads. In the CLP approach, Tier 3 loads will be toggled as a group by toggling power to the Main Service Board (MSB). Figure 9 illustrates the CLP approach for SMHS, with Tier 1 and Tier 2 loads being served by new dedicated wire runs that connect to a new smart critical load panel.



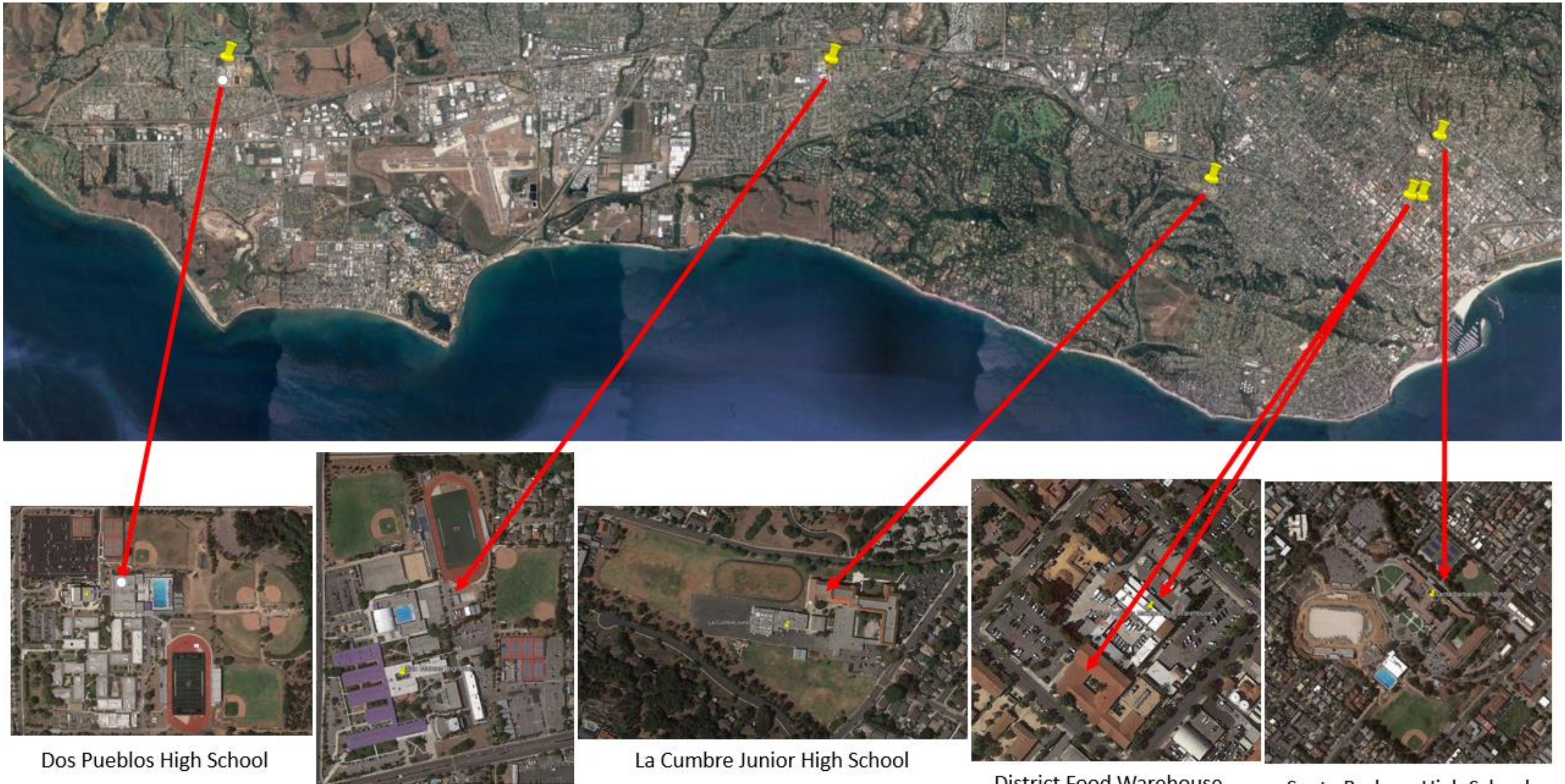
Santa Barbara Unified School District (SBUSD)

case study

Santa Barbara Unified School District (SBUSD)

- The entire Santa Barbara region is surrounded by extreme fire risk (earthquake & landslide risk too) and is extremely vulnerable to electricity grid outages.
- The SBUSD is a major school district that increasingly recognizes the value-of-resilience (VOR) and has embraced the Clean Coalition's vision to implement Solar Microgrids at a number of its key schools and other critical facilities.
- SMHS is in the middle of the extensive SBUSD service area.

Six SBUSD Solar Microgrid sites



Dos Pueblos High School

San Marcos High School

La Cumbre Junior High School

District Food Warehouse
& District Office

Santa Barbara High School

Guaranteed SBUSD bill savings and free VOR

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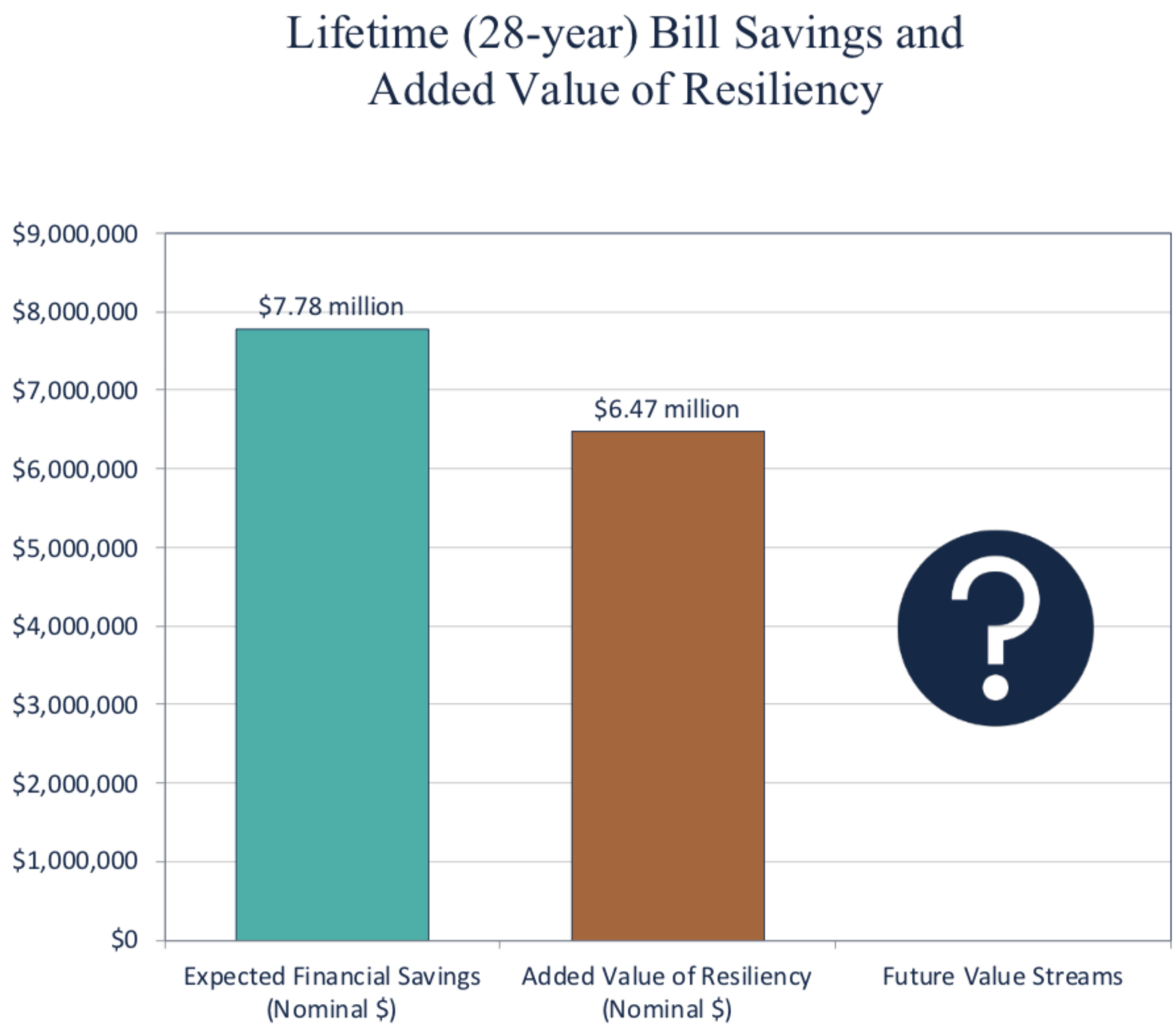

San Marcos High School (SMHS) case study

SMHS is vulnerable to distribution outages too

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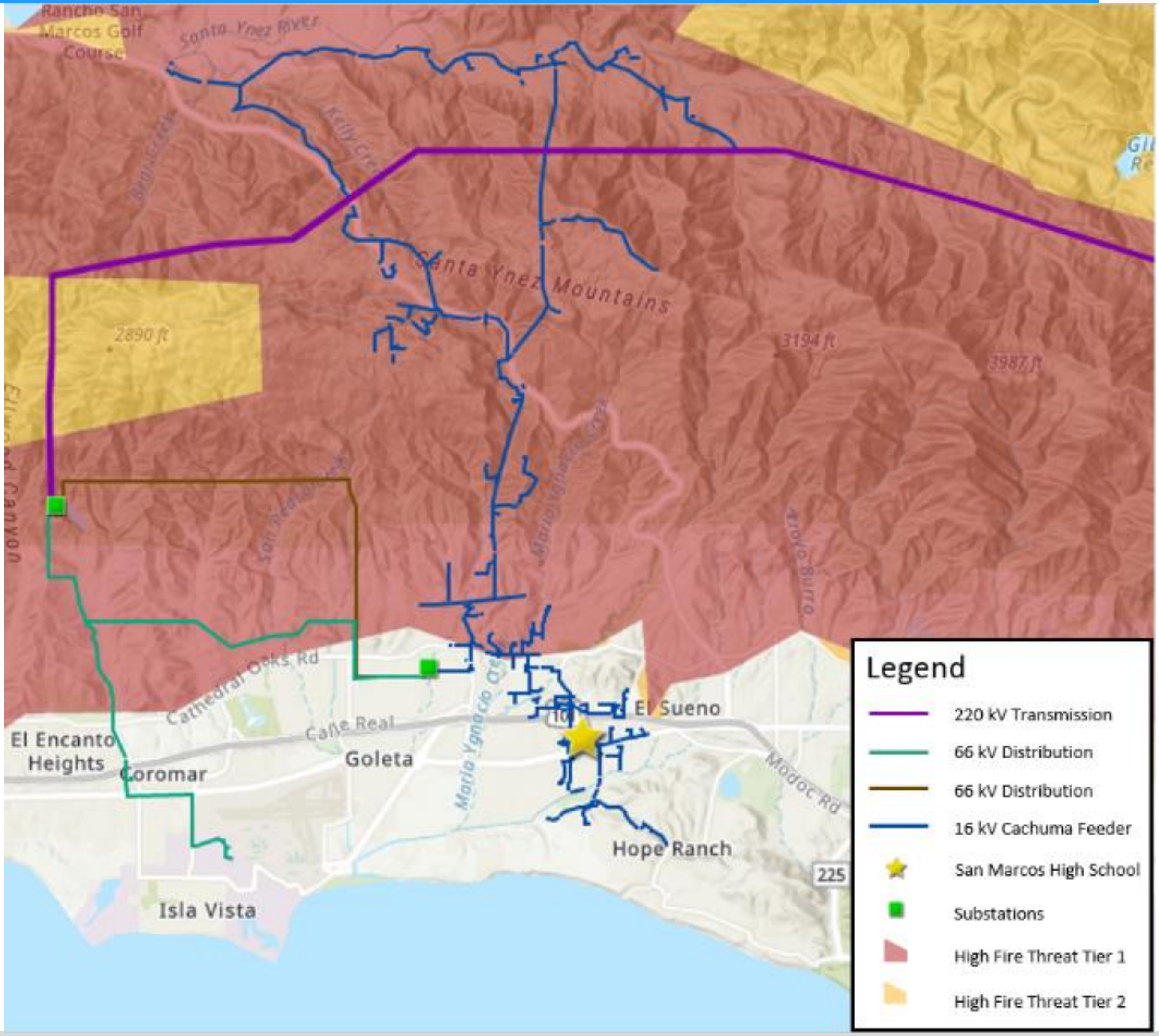

San Marcos High School (SMHS)

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- SMHS is a large public high school serving 2,000+ students in grades 9 through 12.
- Red Cross designated facility.
- School features include:
  - Array of classroom buildings
  - Large pool
  - Gymnasium
  - Football stadium
  - Multiple baseball fields
  - Cafeteria
  - Outdoor Greek theater
  - Auditorium
  - Numerous tennis & basketball courts
- Craig Lewis in the Class of 1981.

SMHS Solar Microgrid overview

The SMHS Solar Microgrid is intended to enable the school to operate independently during grid outages of any duration with **indefinite resilience for the most critical loads** and **resilience for all loads for significant percentages of time**.

- **Solar**
  - 725 kWp
  - Solar is entirely in the form of solar parking canopies
  - Net Zero Energy (NZE) is exceeded at 101%
- **Battery Energy Storage System (BESS)**
  - 700 kWh energy capacity
  - 350 kW power capacity
- **Critical (Tier 1) loads**
  - Food service refrigerators & freezers, maintained indefinitely
  - 4.36 kW of average load
  - 3.44% of total average load
- **Priority (Tier 2) loads**
  - Gym lights and Main Distribution Frame, maintained at least 80% of the time
  - 4.32 kW of average load
  - 3.41% of total average load

San Marcos High School – site drawing example

San Marcos HS

4750 Hollister Ave, Santa Barbara CA 93110

Solar PV

Annual PV Production Target: 1,164,000 kWh

Battery Energy Storage Resiliency

Average State of Charge Reserve (SOCr): 28.50 kWh

Tier 1 Average Load: 4.36 kW

Tier 2 Average Load: 4.32 kW

EV Charging Infrastructure

Stalls	ADA Stalls	Non-ADA Stalls	Existing EVSEs	5-Year Install
514	22	492	0	37

Notes

1. This site is a designated community resilience center and Red Cross emergency shelter.
2. No lighting in main lot (some perimeter).
3. Main parking lot to be redesigned and existing portables relocated prior to solar construction. Will need to add ADA stalls under solar canopy and POT as part of main parking lot reconfiguration.
4. Will need to cover existing ADA stalls in NW Lot with the south ends of canopies C-5 and C-6 and two existing light poles will need to be removed.
5. Long homerun through campus from canopies C-5 and C-6, approximately 1,450'. Short homerun of approximately 150' crossing drainage swale from main parking lot to POI.
6. Small parking area under C-4 may be challenging to cover/upgrade ADA compliance.
7. Good BESS location adjacent to main service enclosure.
8. Suggest participation in future SCE EV Charge program. Due to location of EV charging areas, SCE likely to drop a new dedicated service feed.

Santa Barbara Unified School District

District-Wide Solar PV Energy and Resiliency RFP

PV, BESS, and EV Charge Site Plan

5/18/2020

Solar Microgrids deliver unparalleled resilience

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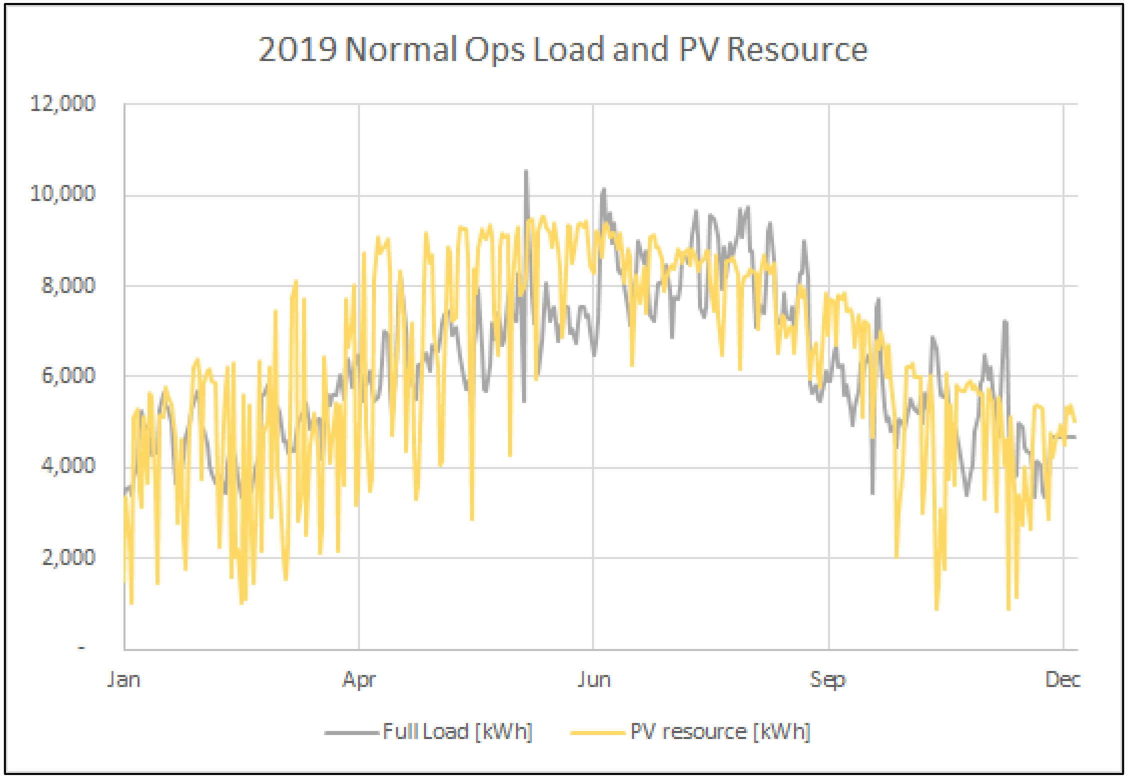
Solar Microgrids deliver unparalleled resilience

Example NZE total solar generation vs total load



Islanding full load for an entire year with Hybrid Solar Microgrid

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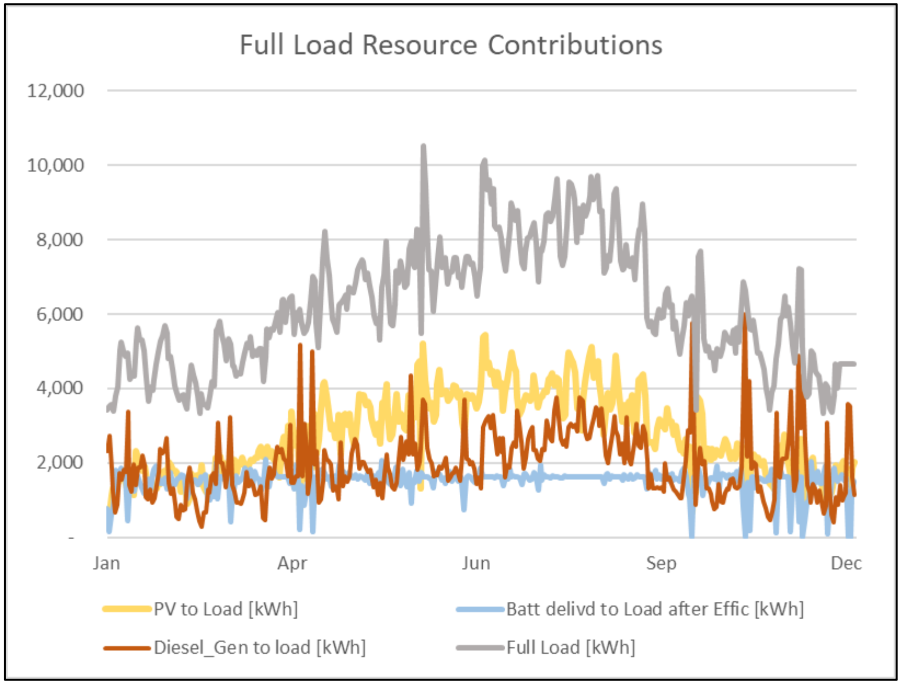
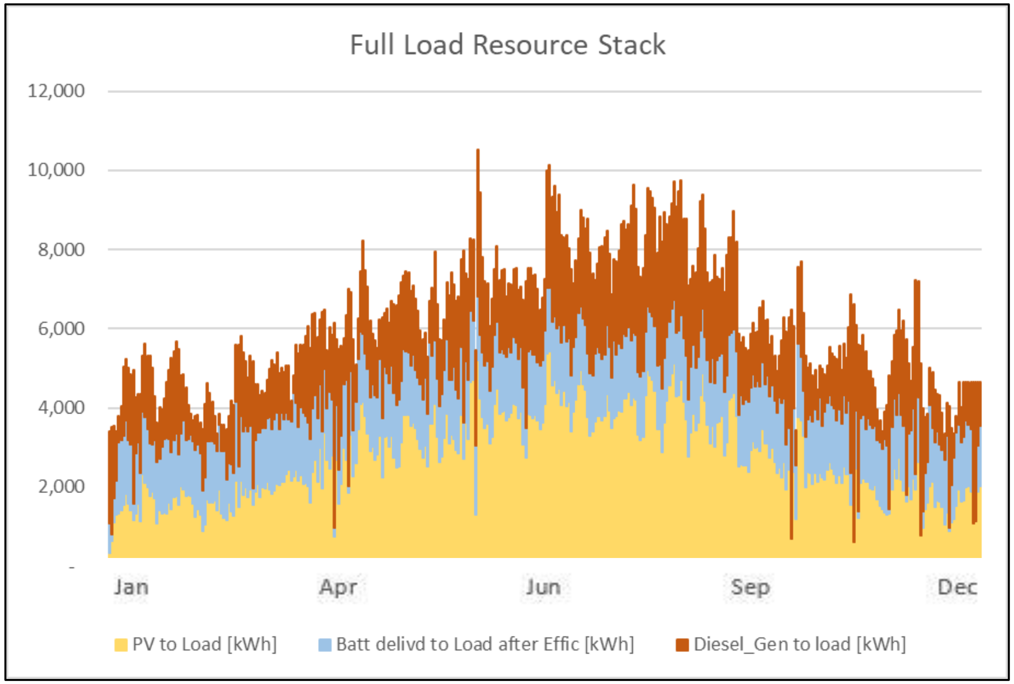
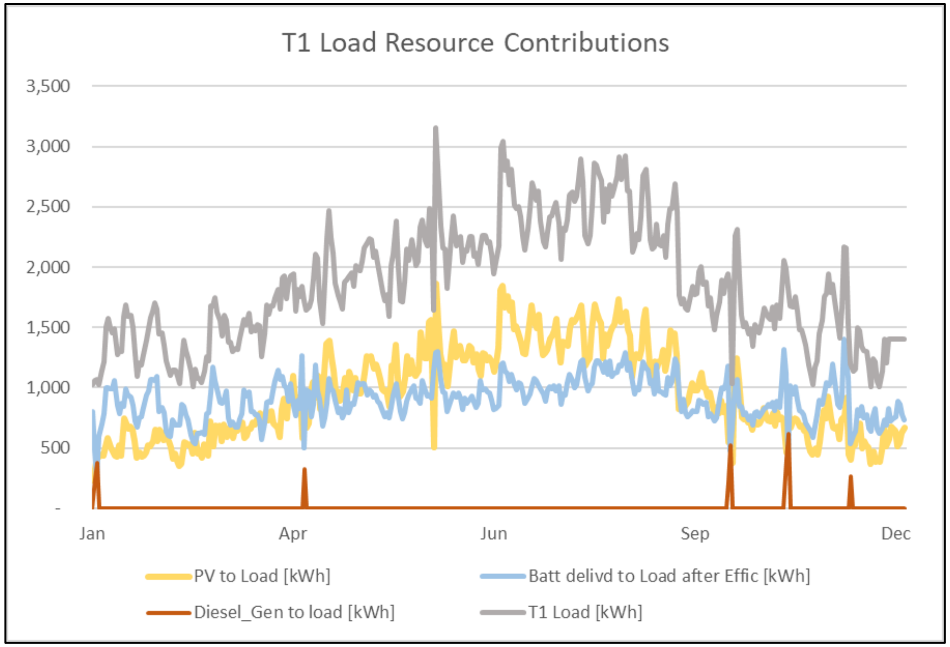


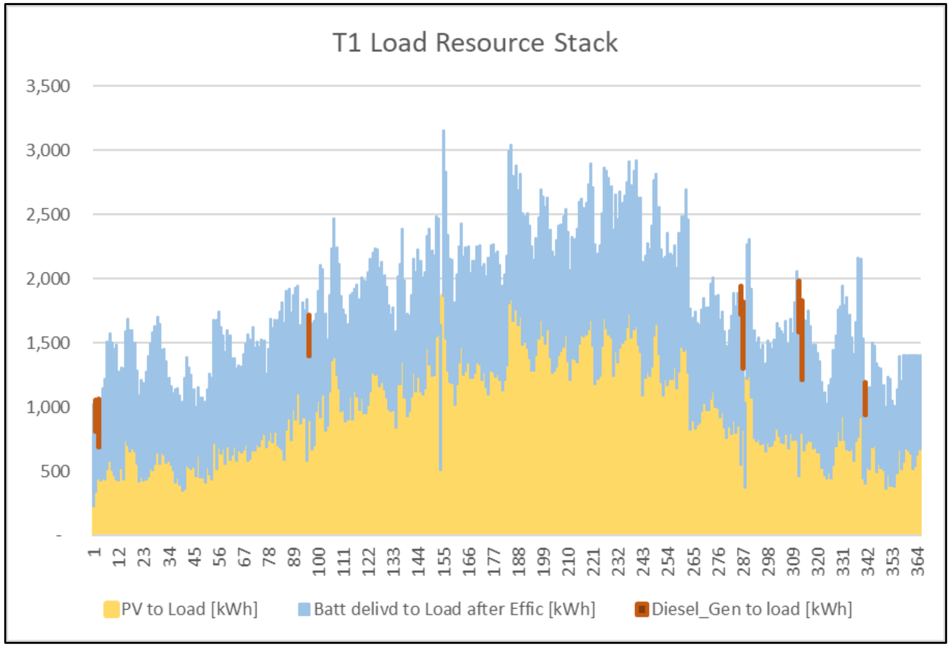


- **31.6%** (716,015kWh requiring 57,076 gallons) of the full load needs to be served by the diesel generator in order to keep the full load online for an entire year.
  - 6,013kWh (481 gallons) served by the diesel generator on the max day (8 Nov 2019)
  - Some level of diesel generation is required every day of the year.

57,281 gallons (~95 fuel tank refills) of diesel needed throughout the entire year

Islanding T1 load (30% of normal load) for an entire year with Hybrid Solar Microgrid





- **0.4%** (2,976kWh requiring 212 gallons) of the T1 load needs to be served by the diesel generator in order to keep the T1 load online for an entire year.
  - 615kWh (49 gallons) served by the diesel generator on the max day (9 Nov 2019)
  - Diesel generation is required for 8 days of the year
    - January 2, January 3, April 6, October 13, October 14, November 8, November 9, December 7

212 gallons (35% of existing fuel tank) needed throughout the entire year

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Goleta Load Pocket (GLP) Community Microgrid case study

Goleta Load Pocket (GLP) and attaining resilience

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The GLP is the perfect opportunity for a comprehensive Community Microgrid

- GLP spans 70 miles of California coastline, from Point Conception to Lake Casitas, encompassing the cities of Goleta, Santa Barbara (including Montecito), and Carpinteria.
- GLP is highly transmission-vulnerable and disaster-prone (fire, landslide, earthquake).
- **200 megawatts (MW) of solar and 400 megawatt-hours (MWh) of energy storage** will provide 100% protection to GLP against a complete transmission outage (“N-2 event”).
  - 200 MW of solar is equivalent to about 5 times the amount of solar currently deployed in the GLP and represents about 25% of the energy mix.
  - Multi-GWs of solar siting opportunity exists on commercial-scale built environments like parking lots, parking structures, and rooftops; and 200 MW represents about 7% of the technical siting potential.
  - Other resources like energy efficiency, demand response, and offshore wind can significantly reduce solar+storage requirements.

Target 66kV feeder at the core of the GLP

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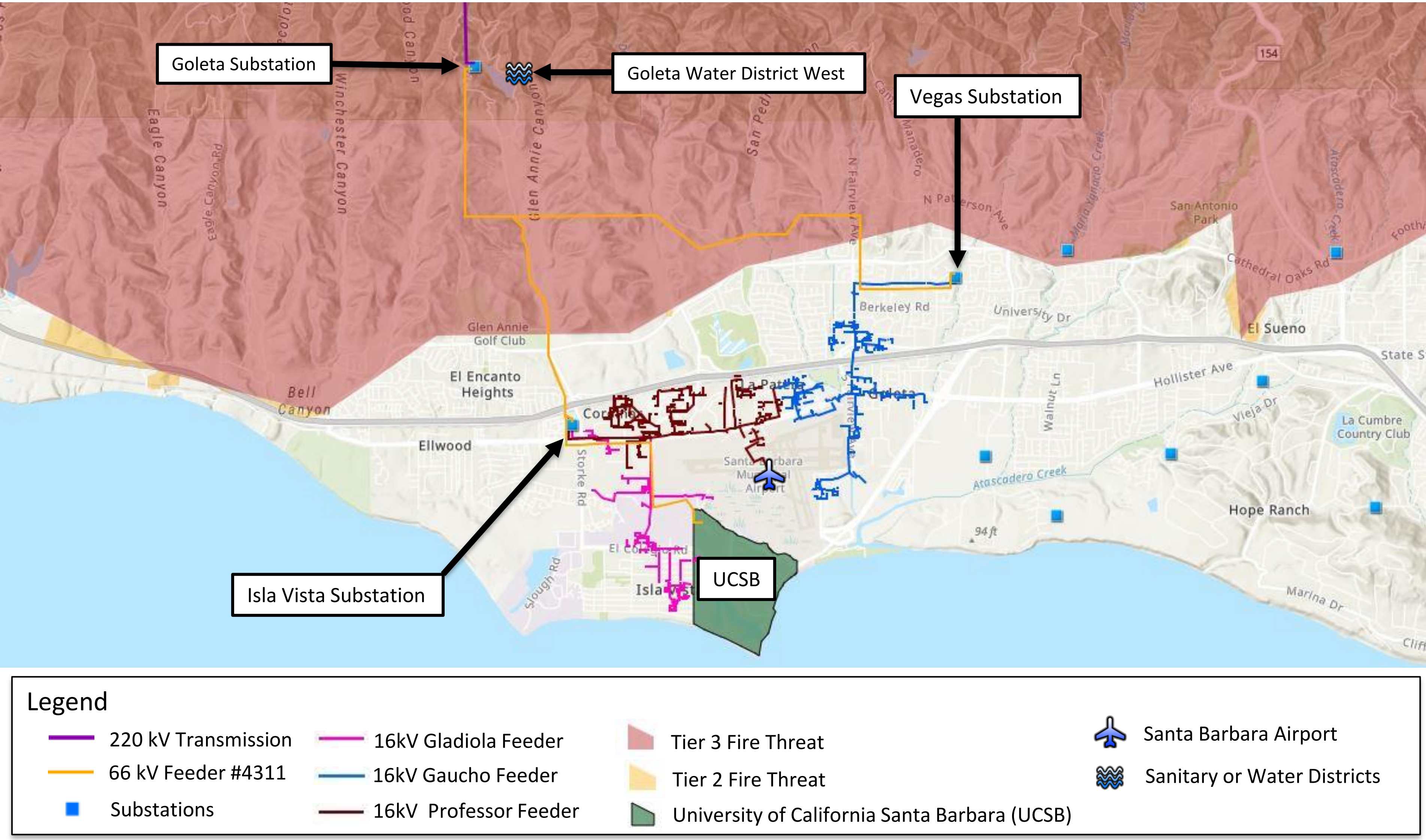

Target 66kV feeder serves critical GLP loads

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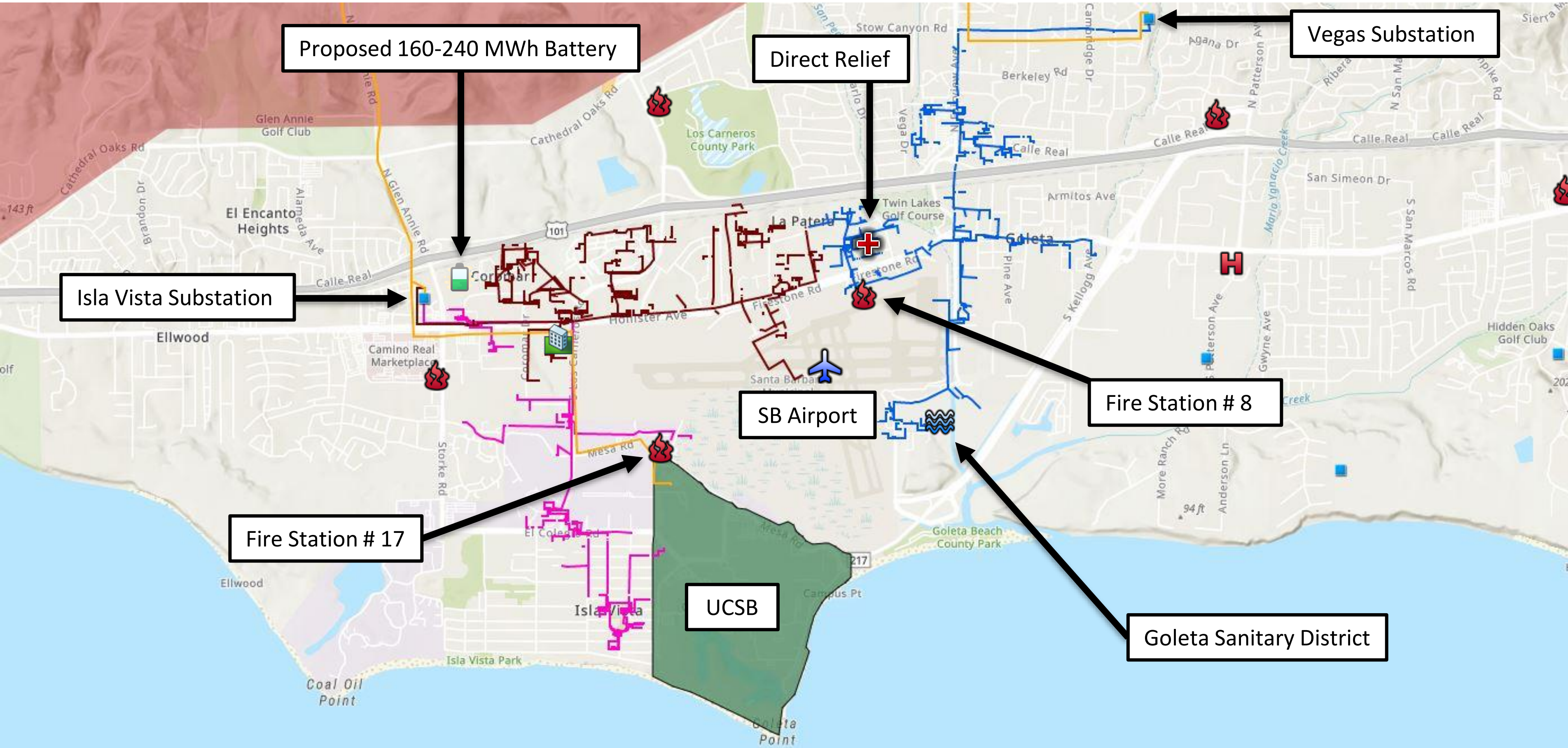
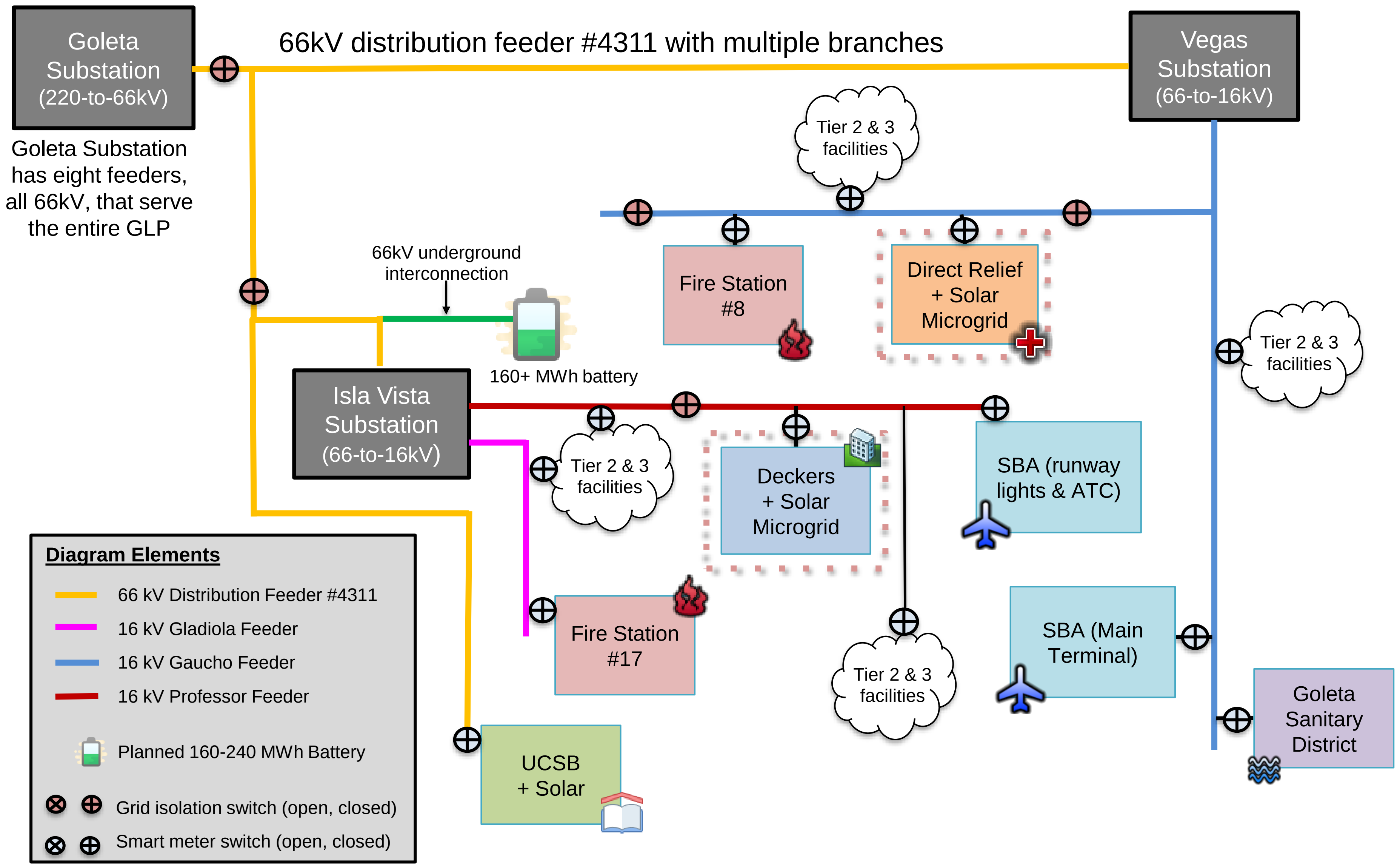


Legend

- 220 kV Transmission
- 66 kV Feeder #4311
- Substations
- 16kV Gladiola Feeder
- 16kV Gaucho Feeder
- 16kV Professor Feeder
- Santa Barbara Airport
- Tier 3 Fire Threat
- University of California Santa Barbara
- Fire Stations
- Sanitary or Water Districts
- Goleta Valley Cottage Hospital
- Direct Relief
- Deckers
- Proposed 160-240 MWh Battery

Target 66kV feeder grid area block diagram



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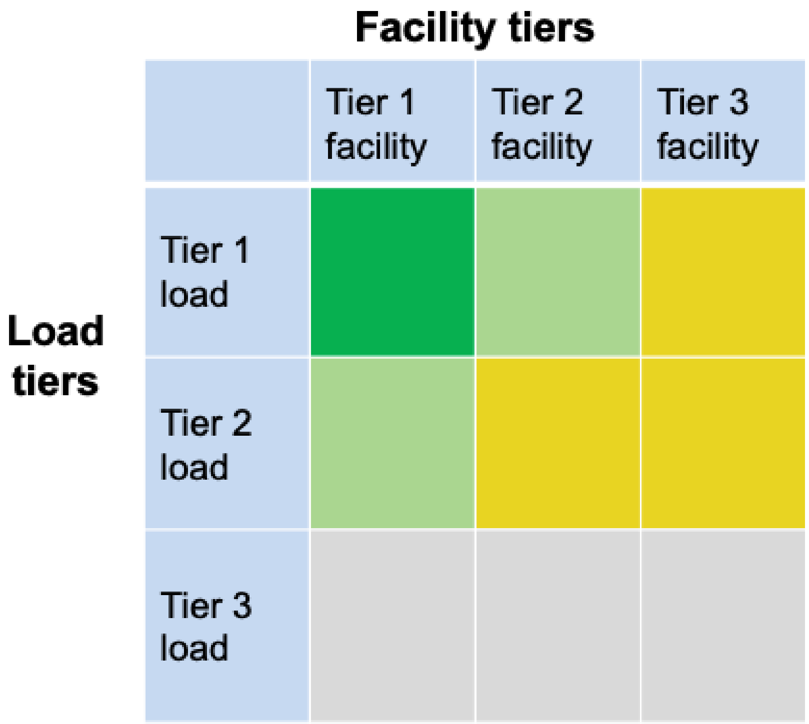
Understanding the Resilient Energy Subscription for financing Community Microgrids

VOR123 for a Community Microgrid

- The VOR123 principles for an individual facility can also be applied to a larger grid area.
- Top emphasis is to provision 100% resilience for Tier 1 loads at Tier 1 facilities, followed by Tier 1 loads at other facilities and Tier 2 loads at Critical Community Facilities (CCFs).



= 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

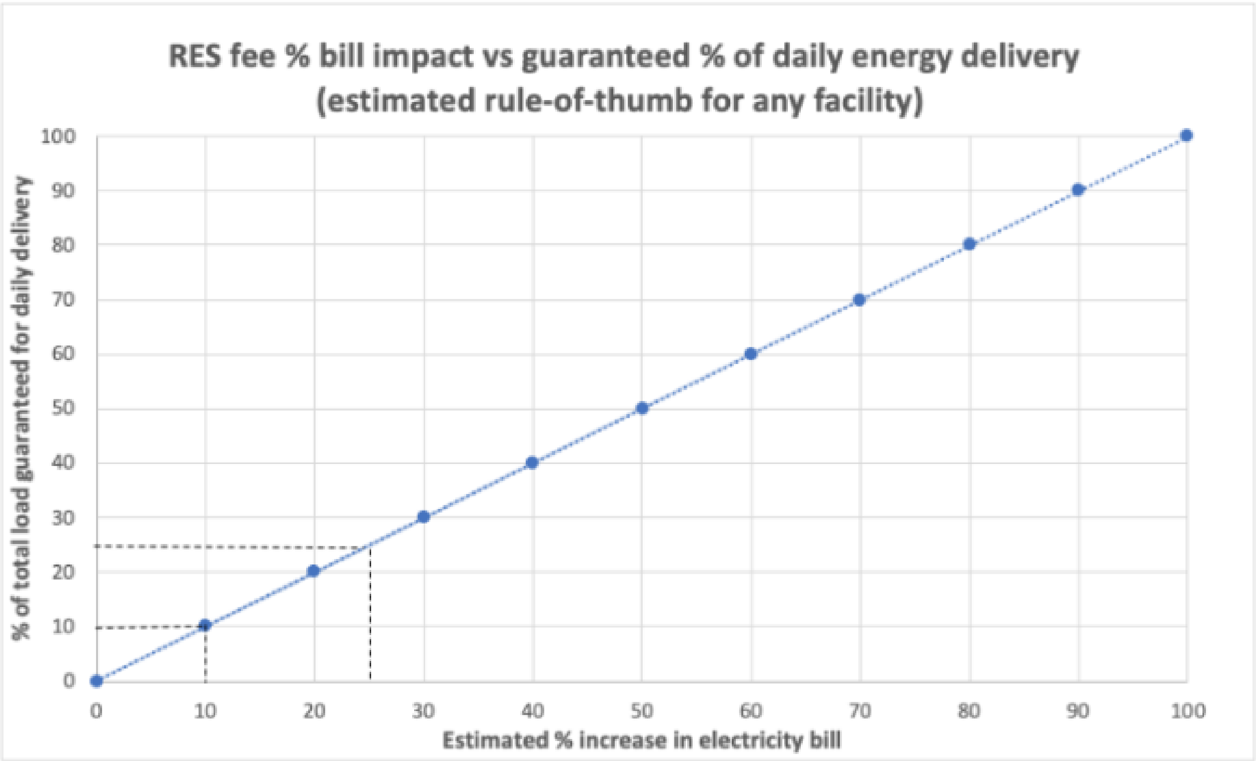
Resilient Energy Subscription (RES)

- Community Microgrid cost-of-service (COS) should be rate-based for Tier 1 loads, and potentially Tier 2 loads, at Critical Community Facilities and other facilities deemed to be Tier 1 facilities.
  - Potentially also at Tier 2 facilities that provide important community benefits.
- All other facilities can subscribe for resilience from the Community Microgrids via the Resilient Energy Subscription (RES) market mechanism in return for guaranteed allocations of daily energy during islanded operations.
- The RES fee is a $/kWh fee separate from any existing rate tariffs, paid for by a facility to reserve a guaranteed allotment of daily energy during grid outages.
  - In California, RES fees are expected to add ~1% to a facility's electricity bill for every 1% of normal load that is reserved for guaranteed daily energy delivery.
  - Example: If a bank determines that it wants to reserve 10% of its normal load, about the average Tier 1 load, then the bank will pay RES fees equating to about a 10% increase to its electricity bill.
  - The bank's RES fees will cover the COS, including CapEx, OpEx, and return-on-investment (ROI), for the Community Microgrid owner-operator to increase the capacity of the Community Microgrid to cover the commitment to the bank's RES allocation.
- For more on applying VOR123 to a Community Microgrid, see this RES article:

https://clean-coalition.org/news/a-revolutionary-way-to-easily-value-resilience-for-any-facility/

1% RES guarantee only costs 1% bill increase

Example bank wants to procure guaranteed resilience for Tier 1 and maybe Tier 2 loads



- Assuming the financial institution has the typical load tiering percentages of 10% for Tier 1 and 15% for Tier 2 loads (hashed black lines):
  - A RES contract for Tier 1 loads only will result in the bank's electricity cost increasing only 10%.
  - A RES contract for both Tier 1 and Tier 2 loads will result in a 25% increase.

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EV charging can be critical – and economically viable

EV charger resilience requires BTM configuration

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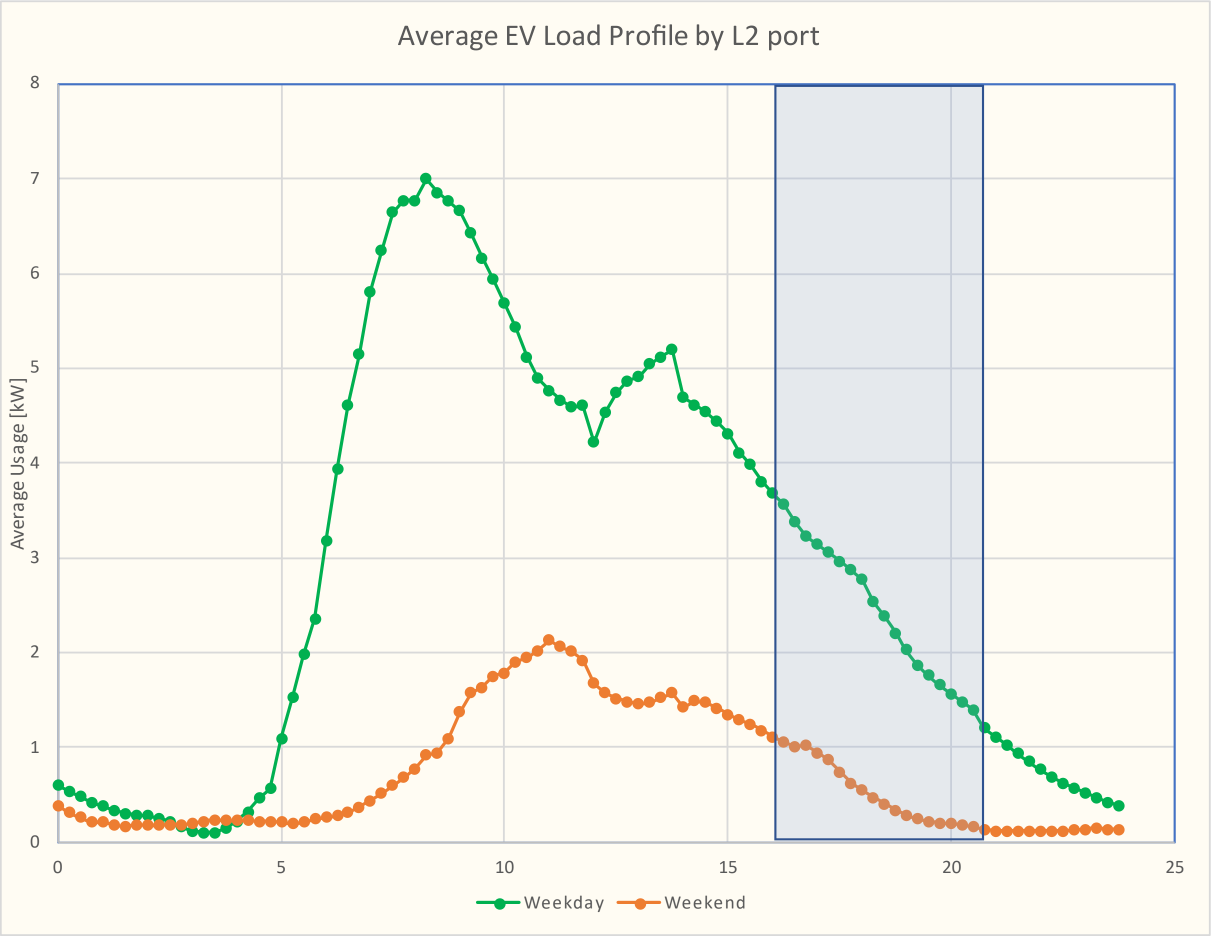
- If EV charging is on a dedicated meter, it cannot benefit from the resilience provided by a Solar Microgrid serving the main facility.
- Hence, some or all of the EV Charging Infrastructure (EVCI) should be configured behind-the-meter (BTM).
- EV charging load profiles can be easily developed and added to historical load profiles to perform net zero and economic analyses.

BTM EV charging is also required to optimize economic benefits from coming Policies & Market Mechanisms (P&MM) like those that can be reaped from vehicle-to-building capabilities.

Typical office charging profile

- Weekday and weekend profiles for an office environment.
- Values show actual data gathered & averaged from a large bank of Level-2 (L2) charging ports capped at 7 kW.
- Note the weekday lunchtime curve as EVs are moved.
- The weekend (orange) curve does not reach the same peak as weekday because the lower utilization reduces the average value.



Economics could warrant EV charging constraints

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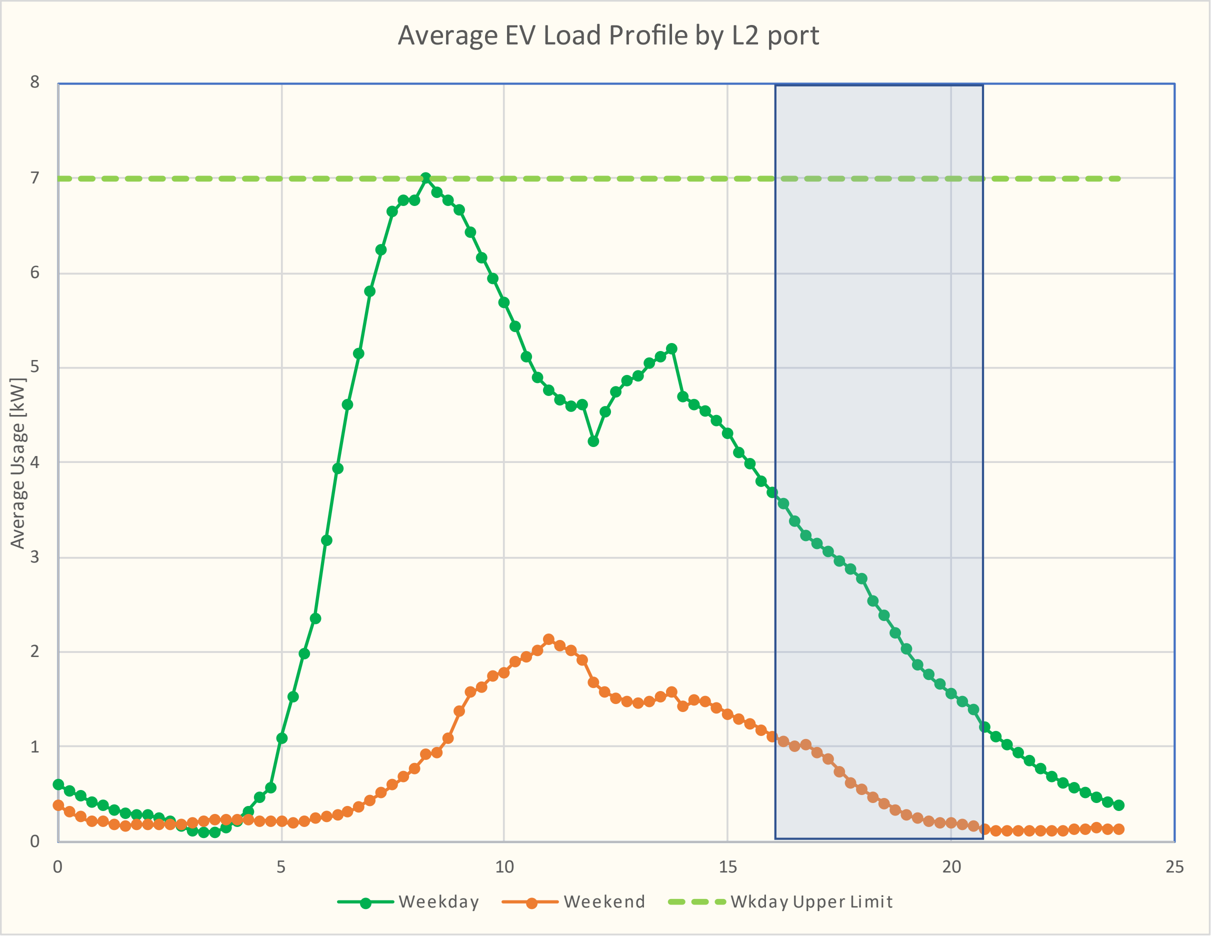
- The only natural charging constraint is the power capacity of the L2 EV chargers, which is 7 kW for each port in this example.
- Economic considerations could warrant charging constraints that avoid excessive demand charges and/or minimize energy usage at peak energy rates.
- Additional economic considerations could result from monetizing demand response (DR) and other grid services.



Example profile for optimizing EV charging economics

- The purple line shows a maximum EV charging profile that could be set to avoid excessive demand charges and prohibit EV charging via peak energy rates.
- Such limits will be increasingly important as more EV charging proliferates.
- The constrained profile limits charging to 2 kW per port and completely prohibits charging during 4-9pm peak energy rates.