Clean Coalition

Solar, Storage, and Microgrids for Schools

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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.

Solar & Storage can deliver a trifecta of benefits

1. Economic

   Savings

2. Environmental

   Sustainability

3. Resilience

   Safety

Various types Solar and/or Storage for Schools

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- Solar-only provides solar energy and delivers economic & environmental benefits. The solar will turn off during grid outages and there are no resilience benefits from solar-only.
- Storage-only allows energy to be time-shifted and provides economic and **limited resilience** benefits. Because storage-only simply time-shifts grid energy, solar-only deployments deliver no substantial environmental benefits. The resilience benefits will only last as long as the amount of energy that was stored at the time of a grid outage allows – then it's lights out.
- Solar+Storage combines solar & storage to deliver economic, environmental, and **limited resilience** benefits.
- Solar Microgrid combines to deliver economic, environmental, and **indefinite resilience** benefits. The solar provides an ongoing energy source, which is required for ongoing resilience.

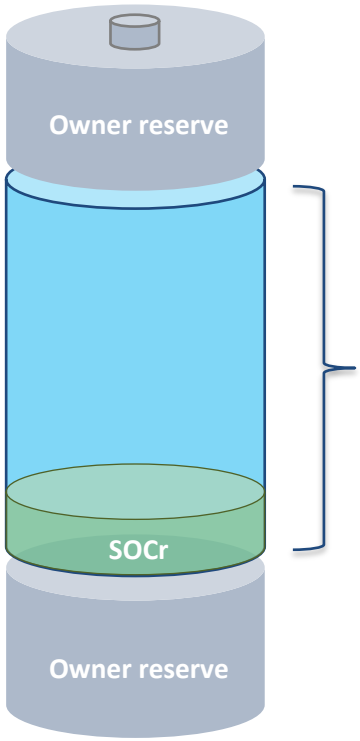
Various types of Microgrids

- A microgrid is a combination of energy resources, definitely including generation, that are coordinated to serve specified loads, including in an islanded fashion.
- A Solar Microgrid is a behind-the-meter (BTM) microgrid that solely relies on solar for energy generation when islanded.
- A Hybrid Solar Microgrid is a Solar Microgrid that includes additional sources of energy generation, beyond just solar.
- A Community Microgrid a microgrid that covers a target grid area and relies on existing distribution feeders (ie, power lines) to operate when islanded. Community Microgrids typically include both front-of-meter (FOM) and BTM resources, including Solar Microgrids, and require effective participation from utilities, which have mostly erected barriers to date.

Storage, Resilience, Value-of-Resilience (VOR), and Load Management

Storage is optimized 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.

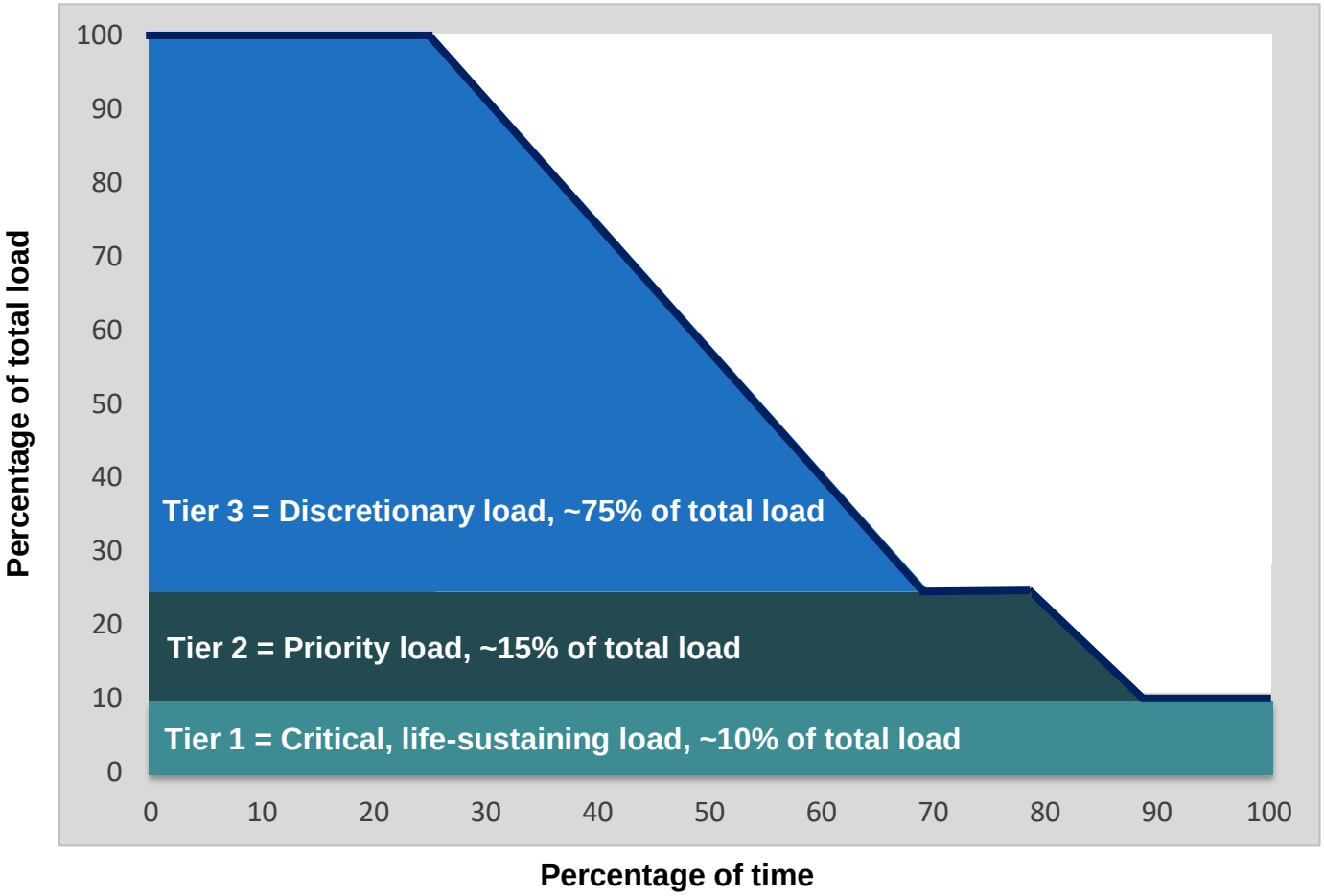


SOCr = the minimum state-of-charge (SOC) that is reserved for provisioning resilience. The SOCr can be dynamic and/or resized to between 0% and 100% of the contracted BESS energy capacity. A lower SOCr facilitates BESS operations that optimize daily economic performance, while a higher SOCr facilitates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

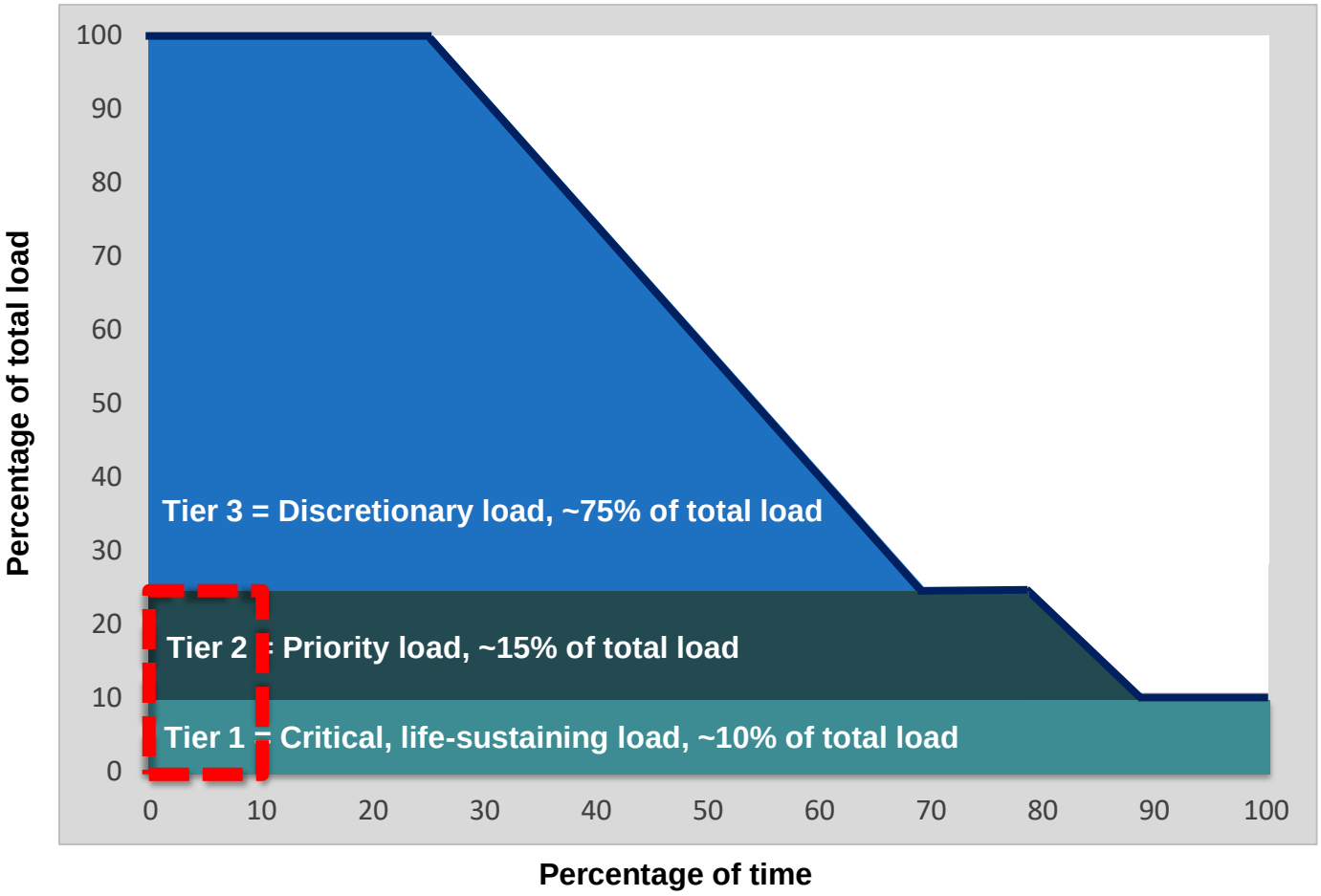
Bottom owner reserve is often required to meet BESS warranty requirements that are imposed by BESS vendors.

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



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.

Value-of-Resilience (VOR) depends on tier of load

- Everyone understands there is significant value to resilience provided by indefinite renewables-driven backup power, especially for the most critical loads
  - But, this value-of-resilience (VOR) has yet to be quantified in a straightforward methodology.
  - Hence, VOR is often given no value, leaving a dangerously short-sighted economic gap.
- The Clean Coalition aims to establish a standardized value-of-resilience (VOR) for critical, priority, and discretionary loads that will help everyone understand that premiums are appropriate for indefinite renewables-driven backup power to critical loads and almost constant backup power to priority loads, which yields a configuration that delivers backup power to all loads a lot of the time
- The Clean Coalition's VOR approach standardizes resilience values for three tiers of loads:
  - Tier 1 are mission-critical & life-sustaining loads and warrant 100% resilience. Tier 1 loads usually represent about 10% of the total load with a 3x energy value.
  - Tier 2 are priority loads that should be maintained as long as doing so does not threaten the ability to maintain Tier 1 loads. Tier 2 loads usually represent about 15% of the total load and get a 1.5x energy value.
  - Tier 3 are discretionary loads comprising the remaining loads, usually about 75%. Tier 3 loads possess no extra value and are only maintained when Tier 1 & 2 are secure.

Value-of-Resilience (VOR) details

VOR123

VOR123 is the value-of-resilience (VOR) from Solar Microgrids methodology that the Clean Coalition has developed to normalize VOR across all types of facilities & geographies. The VOR normalization is founded in tiering loads into three categories: Tier 1 (critical), Tier 2 (priority), and Tier 3 (discretionary). Since each Tier has its own resilience requirement and VOR, this methodology is called VOR123.

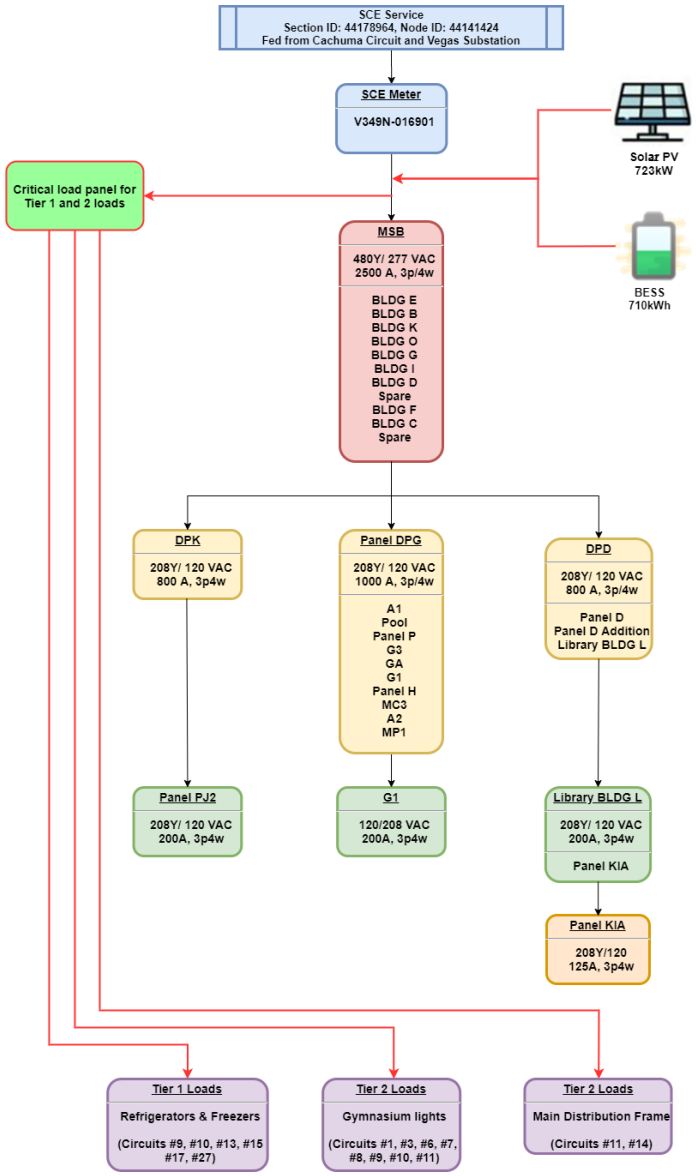
VOR123 webinar

https://clean-coalition.org/news/webinar-valuing-resilience-solar-microgrids-thursday-5-nov-2020/

Load Management is fundamental to VOR123

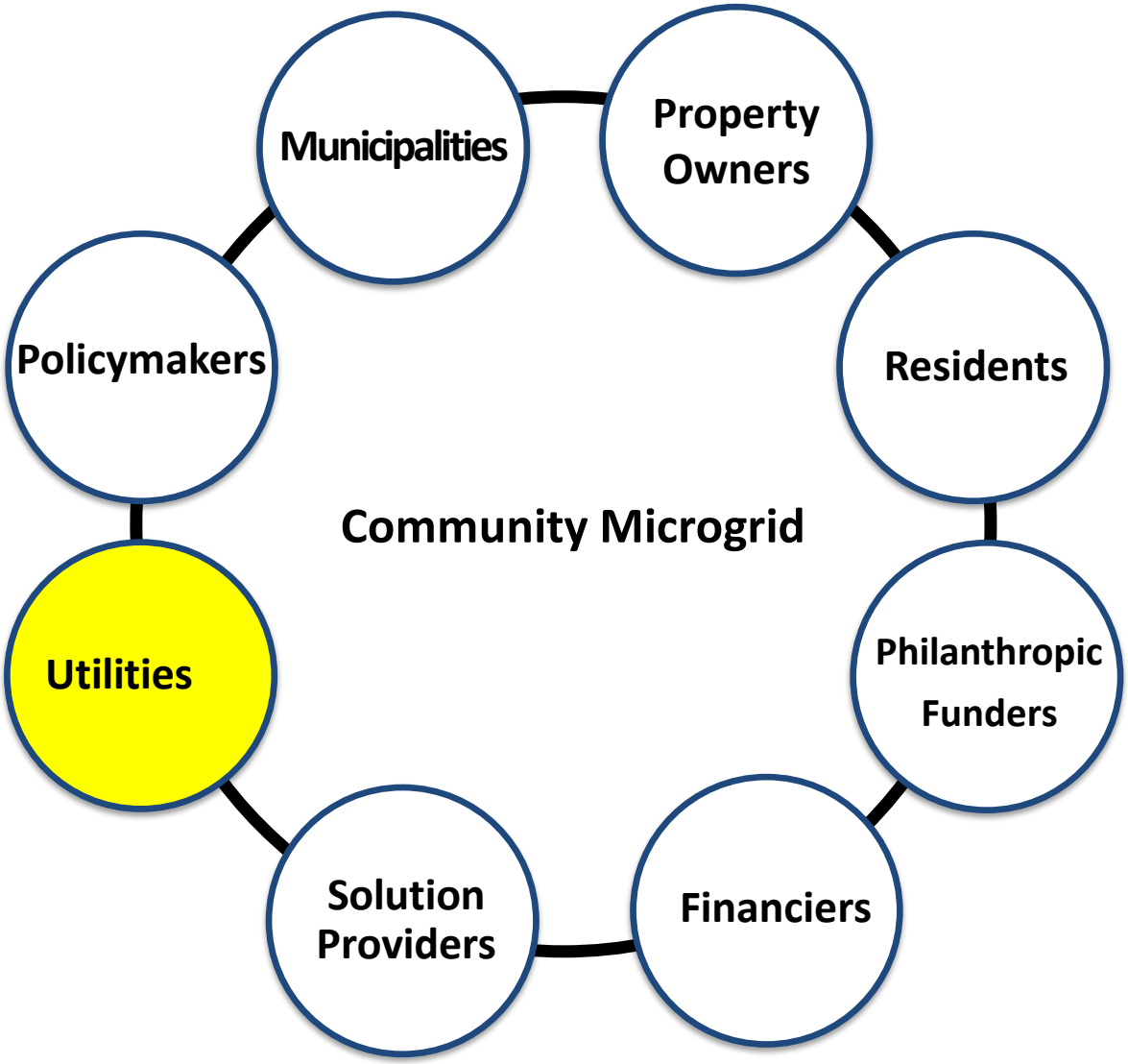
Although there are multiple potential Load Management configurations, the minimal functionality anticipated to be cost-effectively implemented is referred to as **the Critical Load Panel (CLP) approach**.

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.



Getting things done = aligning stakeholders

Community Microgrid stakeholders



Remember that all stakeholders are human

1. Humans like things to be simple
   - Make sure that objectives & analyses are effectively presented.
2. Most humans are capitalists
   - Economics are fundamental to all stakeholder decisions.
   - With utilities, follow the money.
   - With policymakers, hold them accountable.
3. Success requires multi-pronged action combined with courageous & relentless pursuit
   - Perform comprehensive analyses.
   - Tell the story effectively – which usually means colorfully.
   - Repeat the messaging courageously and ad nauseum.

Santa Barbara Unified School District (SBUSD) example

1. Approached anyone who would listen that Solar Microgrids were key solutions for the School District and the communities served
   - Board members, community leaders, Superintendent, facilities staff.
2. Overcame core resistance points harbored by Superintendent
   - Previous experience in prior school district with a Power Purchase Agreement (PPA) that escalated out of control.
     - Solution: Ensure that the Clean Coalition will secure a fixed-rate PPA, fixed for 25+ years.
   - Concern about being stuck with a sour supplier for decades.
     - Solution: Require predefined buyout prices at key years.
   - End of PPA disputes
     - Solution: Require that systems are removed at District's sole option – for no cost to the District.
3. Won a competitive solicitation process to facilitate projects
   - Feasibility study for all 21 campuses, request-for-proposal (RFP) process, and contracting support.

SBUSD outcomes as of mid-2022

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Site	Battery Power (kW)	Battery Energy (kWh)	PV Size (kWdc)	Status
Adams ES			98	Final electrical
Cleveland ES			45	Final electrical
District Office & La Cuesta Continuation HS	112	223	110	in construction
Central Food Warehouse & Maintence Facilities	112	223	76	in construction
Dos Pueblos HS	558	1,115	1,134	Scheduled for June
Franklin ES & Adelante Charter			181	Scheduled for February
Goleta Valley JHS			249	in construction
La Colina JHS			207	Final electrical
La Cumbre JHS & SB Community Academy	223	446	272	Scheduled for March
Monroe ES			106	in construction
Roosevelt ES			121	Scheduled for March
Santa Barbara HS	446	892	620	Scheduled for June
Santa Barbara JHS			219	Final electrical
San Marcos HS	446	892	713	Scheduled for June
	1,896	3,791	4,152	

Recent elementary school example from SoCal

Solar Microgrid Methodology for feasibility studies

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Step 1

Load Profiles

- Baseline: recent annual loads.
- Master: adds future expected loads, e.g. EV charging.
- Critical: loads required to be maintained during outages.

Industry Tools:
- Clean Coalition: load analysis calculators.
- UtilityAPI: 15-minute load intervals.

Step 2

Resource Scenarios

- Optimal solar, storage, and other potential onsite resources.
- Sizing and combinations to achieve the required critical load and economic outcomes.

Industry Tools:
- Helioscope: solar siting.
- Energy Toolbase: resource sizing.

Step 3

Site Layouts

- Specific locations & sizing for solar, storage, and any other viable resources.
- Location of key electrical assets e.g. panels, etc.
- Energy usage profiles including load profiles.

Industry Tools:
- Clean Coalition: site layout tool.

Step 4

Economic Analysis

- Costs and financing options covering each viable resource scenario.
- Added resilience value.

Industry Tools:
- Energy Toolbase: economic analysis.
- Clean Coalition: resilience calculator (e.g. avoided diesel).

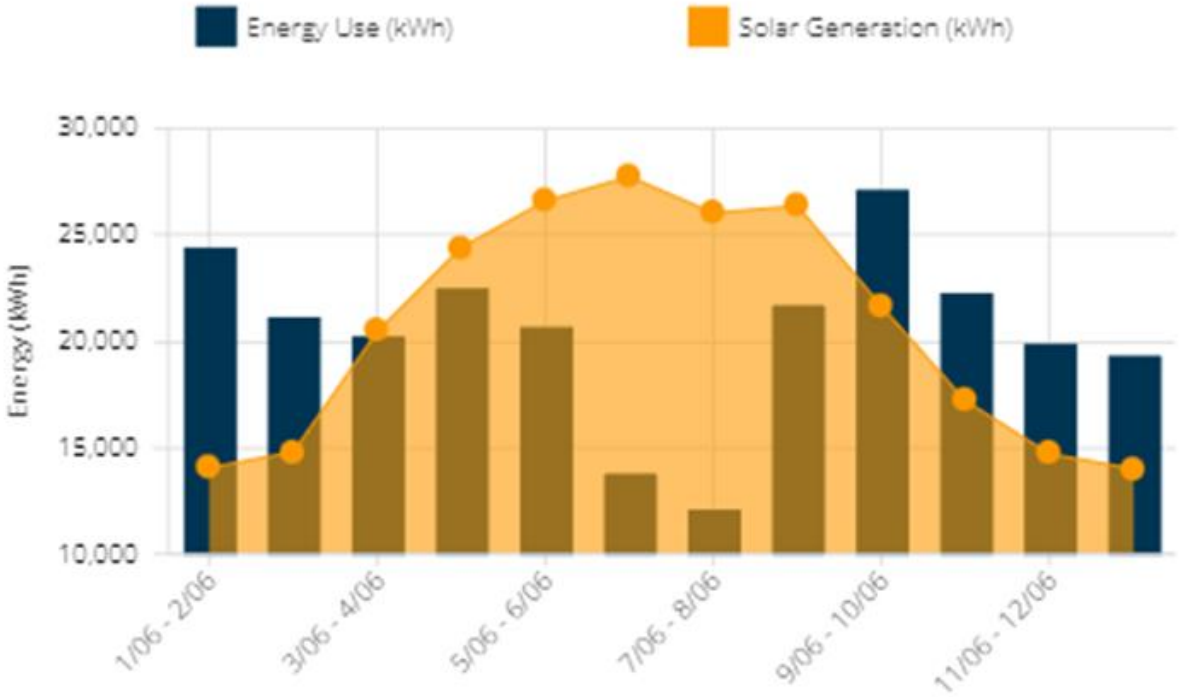
Step 5

Reporting & Recommendations

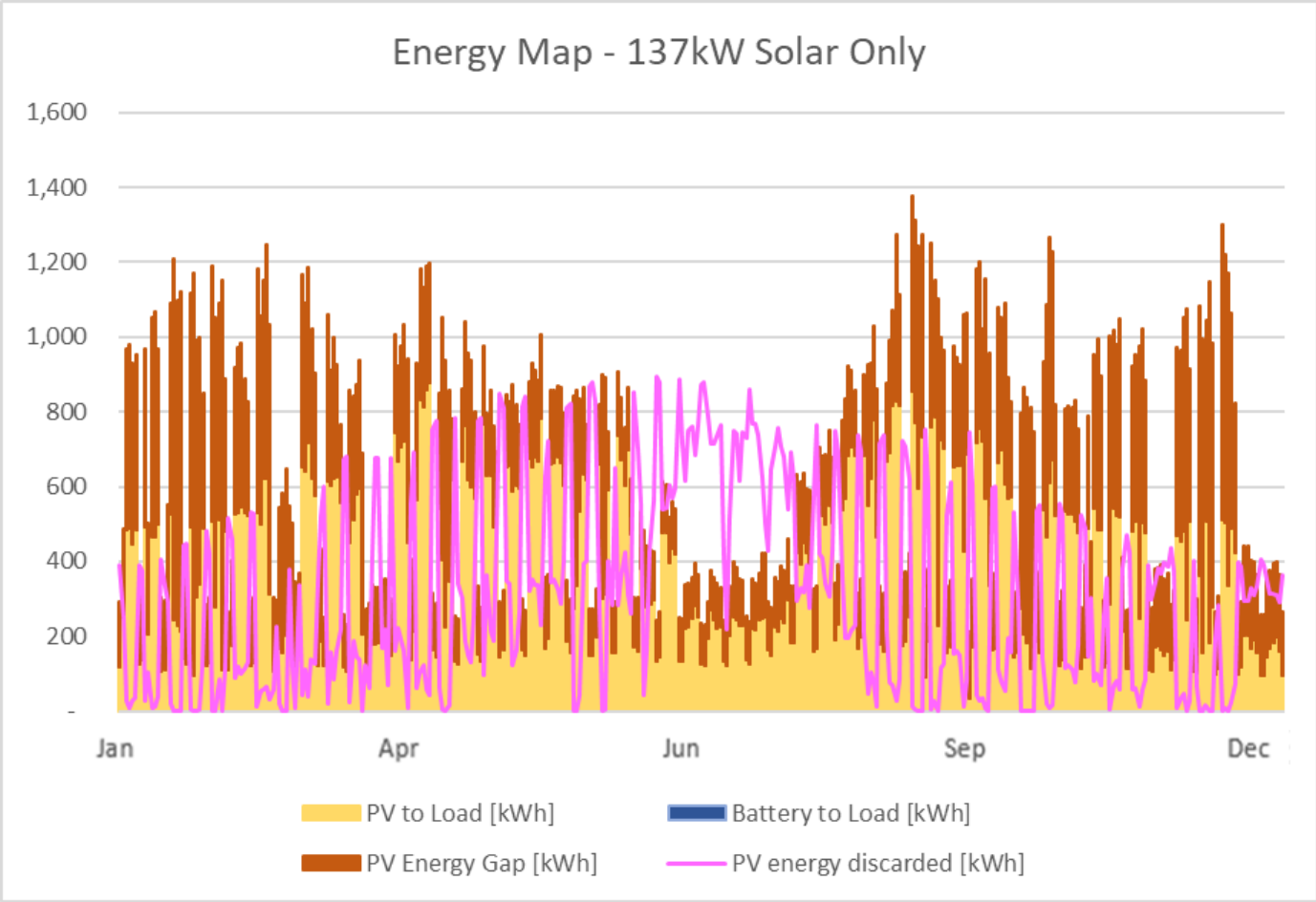
- Project Review Meetings.
- Reports and Presentations.
- Recommended options & next steps.

137 kW solar only billing analysis

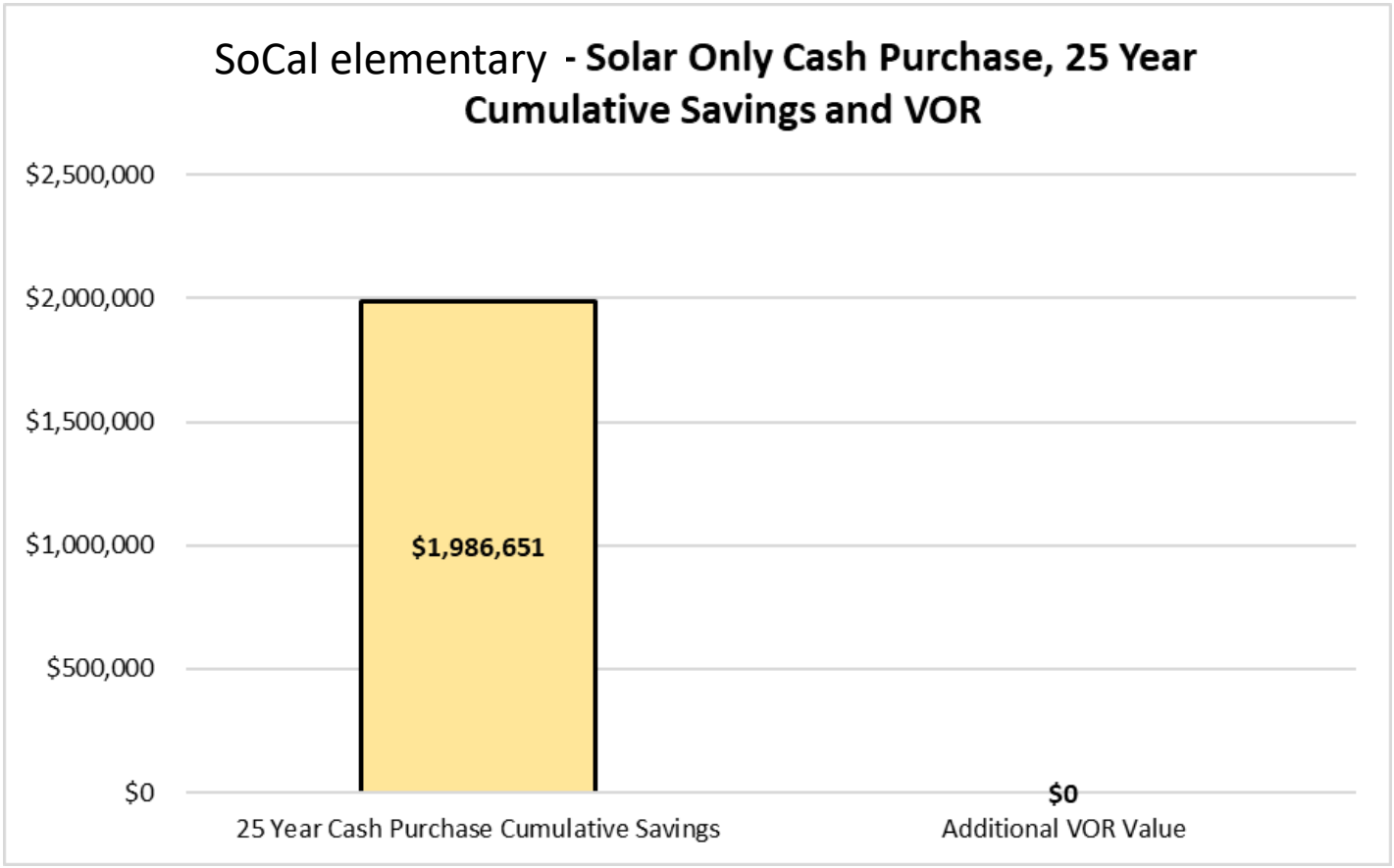
- 200,000 kWh annual load.
- 50,000 kWh from new anticipated EV chargers.
- 250,000 kWh modeled load.
- 175 kW modeled peak load with EV chargers.
- $21,000 modeled annual bill (more than 50% demand charges)



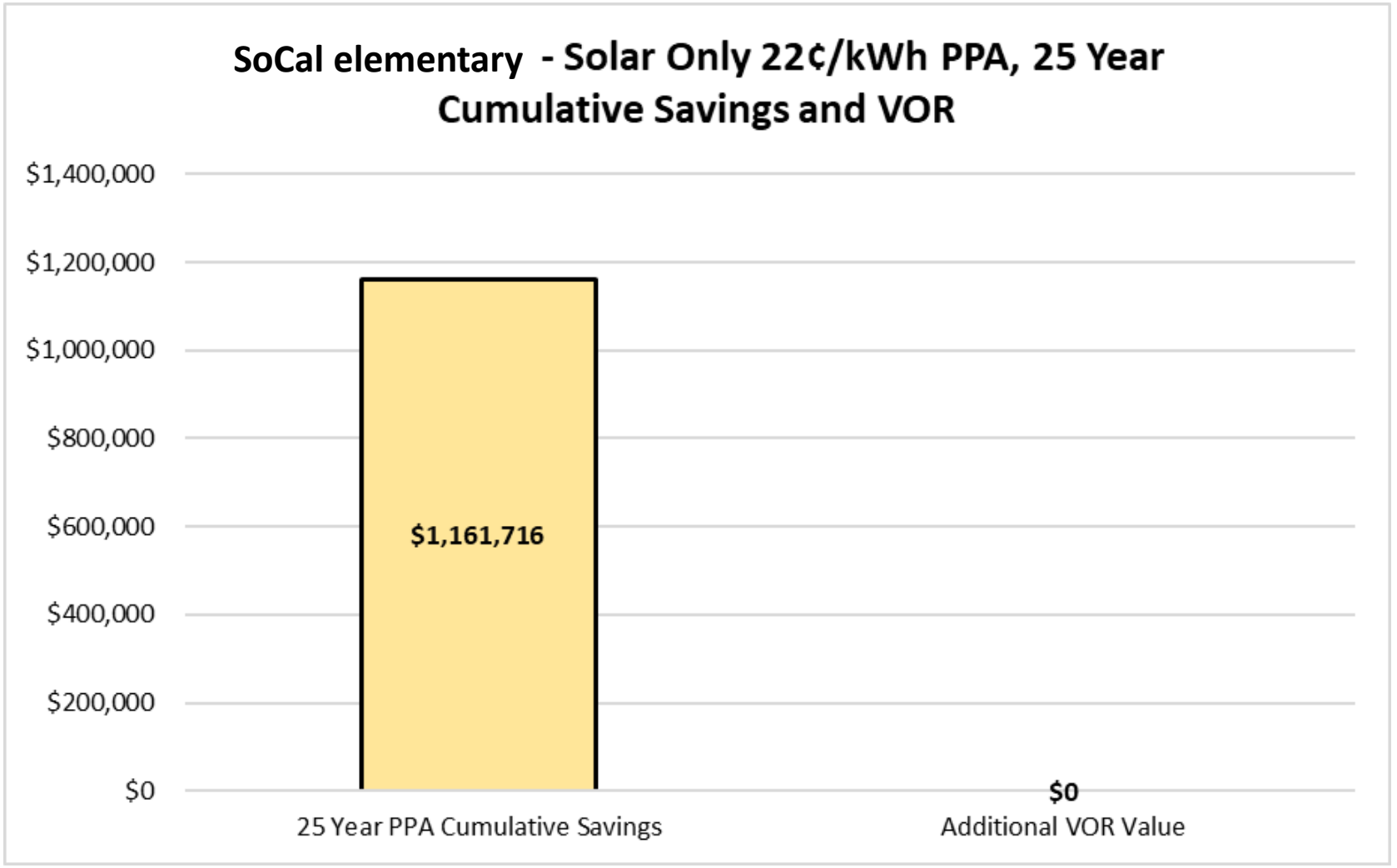
Energy Flow for 137 kW solar



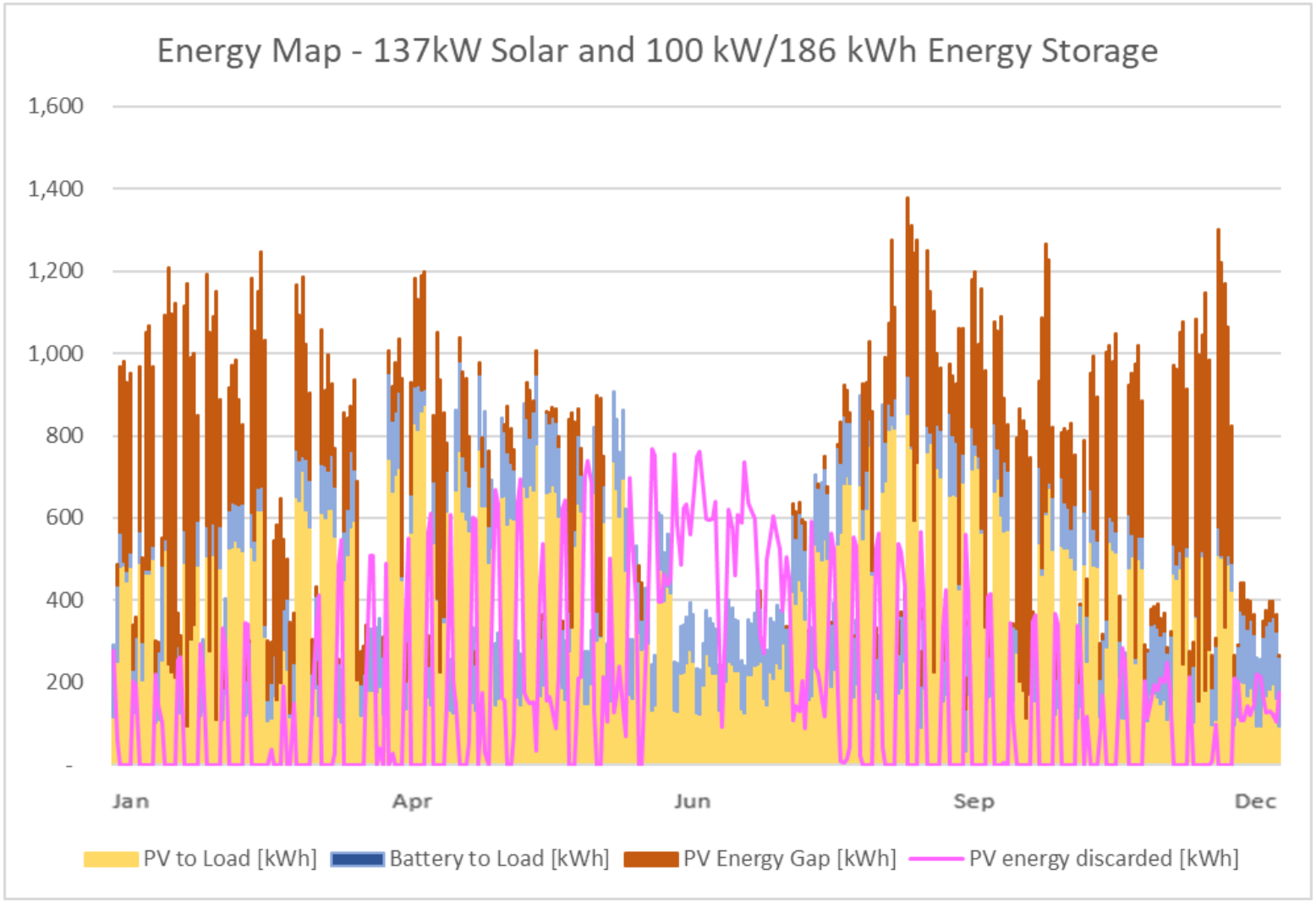
137 kW solar, 25-year cash purchase economics



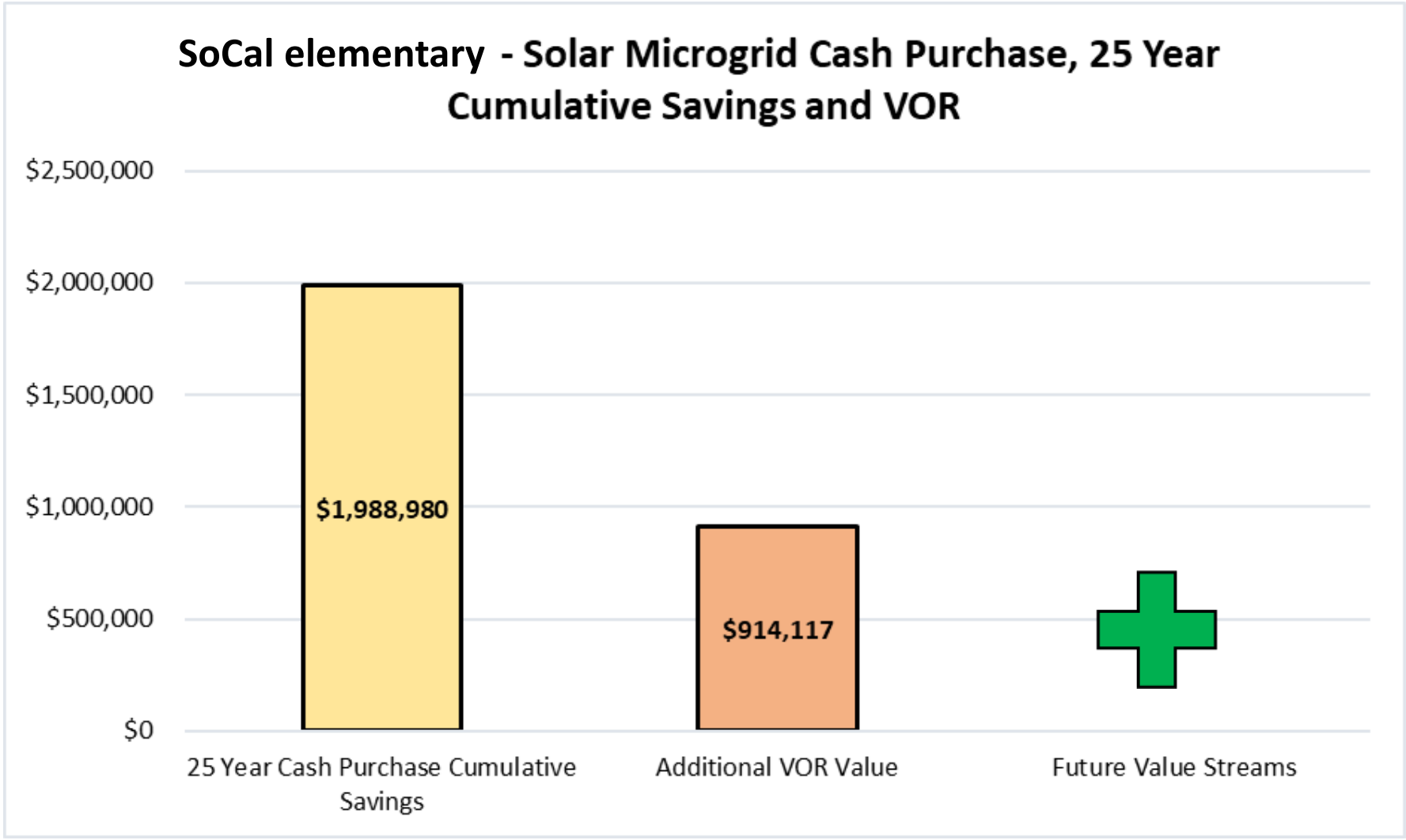
137 kW solar, 25-year PPA economics



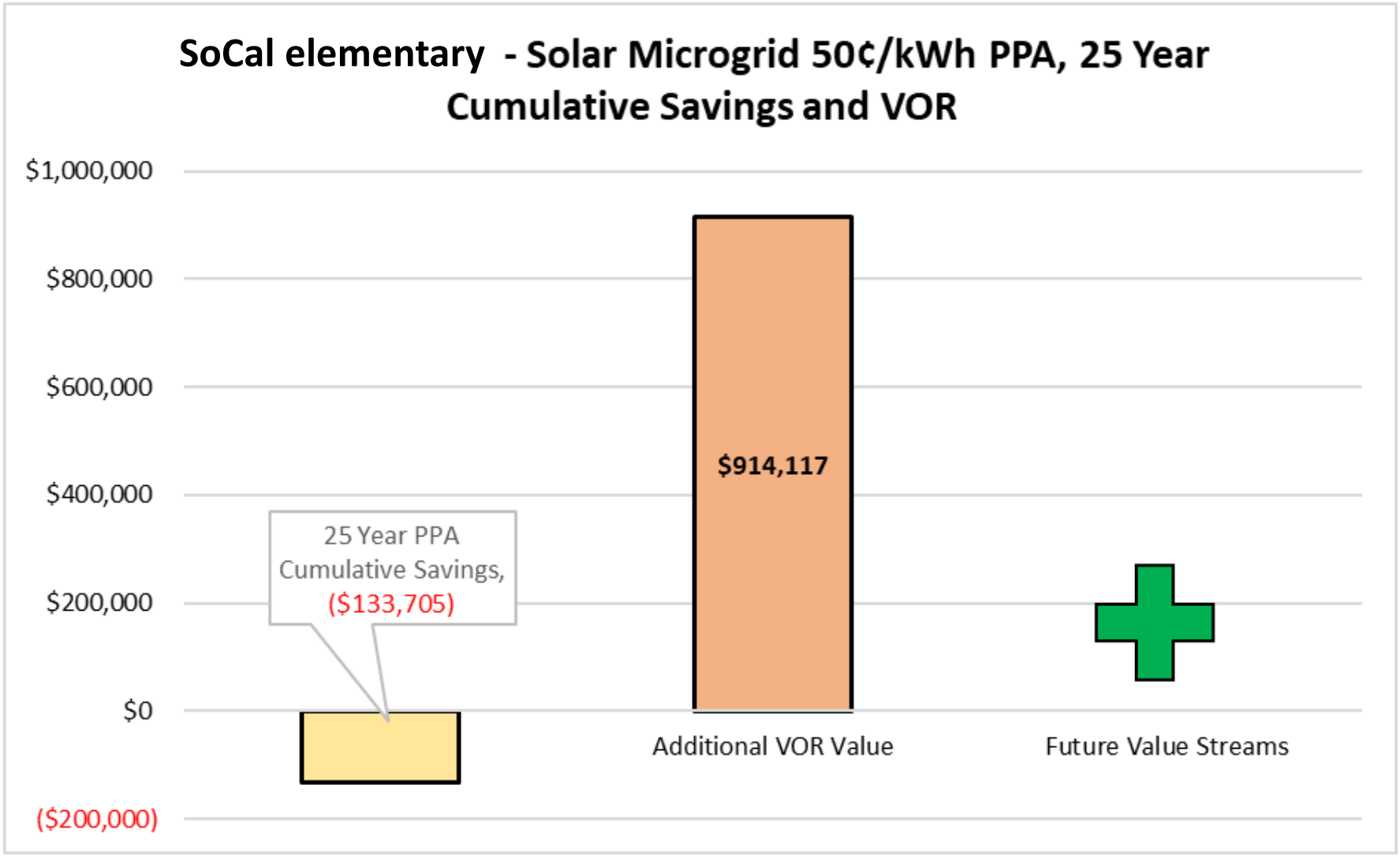
Energy Flow for 137 kW solar and 100 kW / 186 kWh storage Solar Microgrid



Solar Microgrid 25-year cash purchase economics



Solar Microgrid 25-year PPA economics



Backup slides

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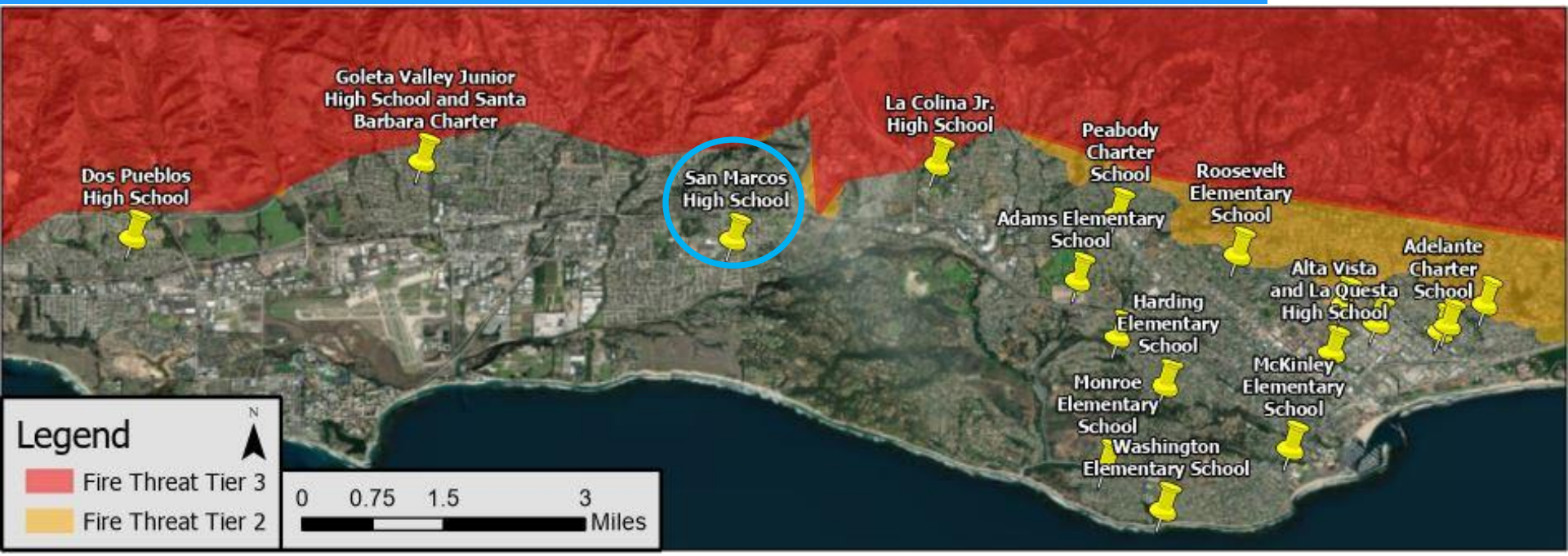
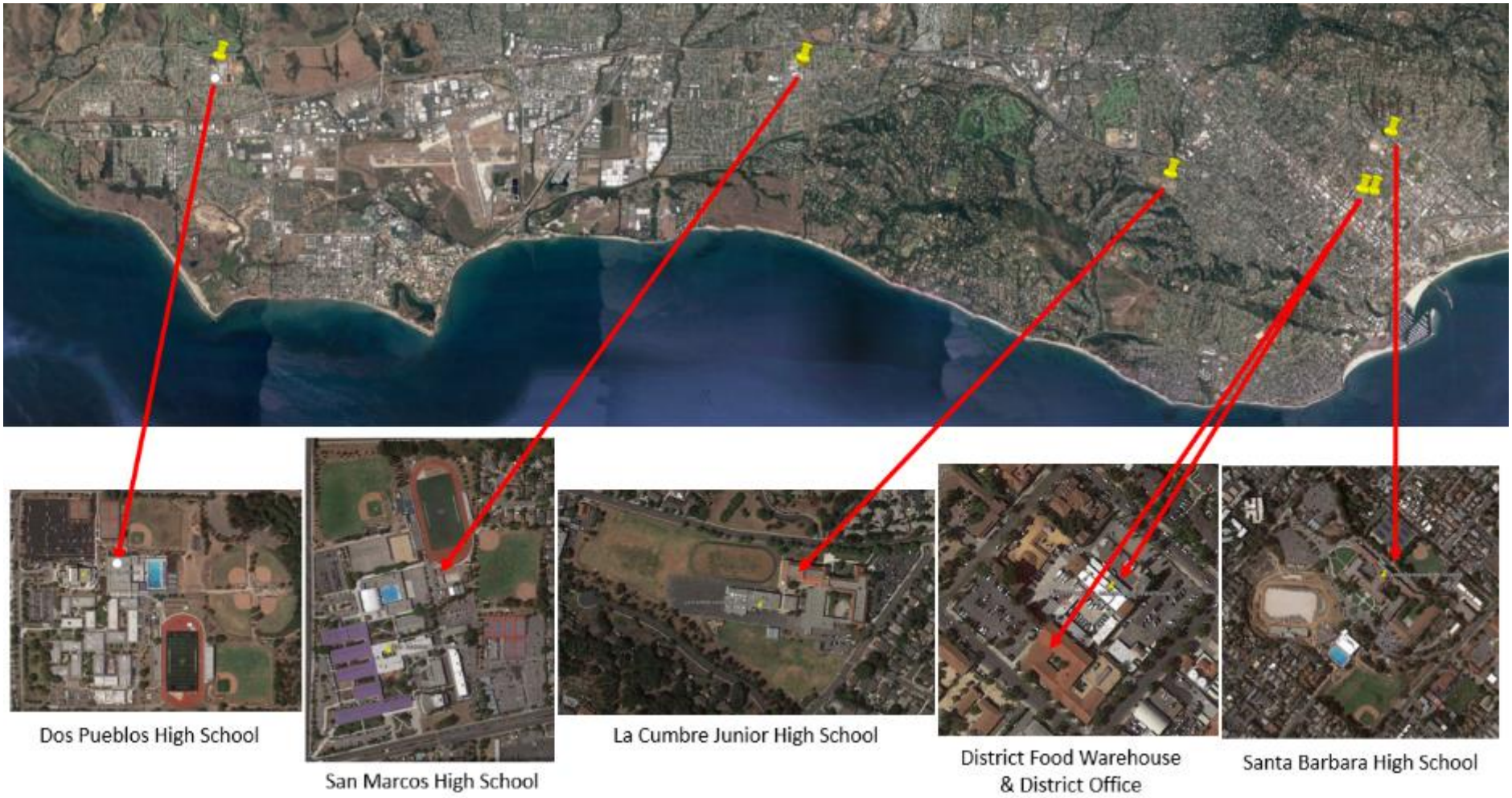
Santa Barbara Unified School District (SBUSD) case study

Santa Barbara Unified School District (SBUSD)

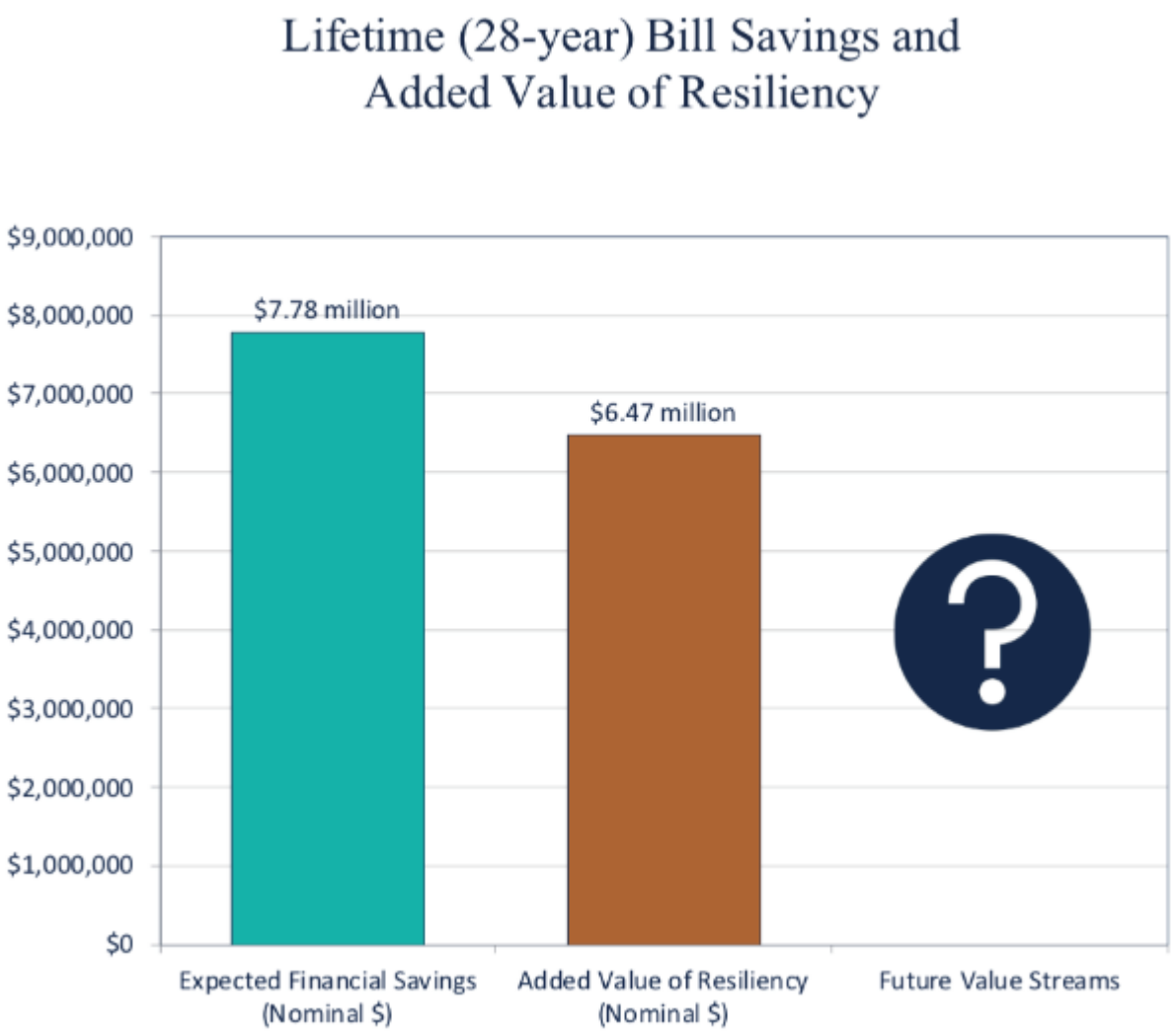


- The entire Santa Barbara region is surrounded by extreme fire risk (earthquake & landslide risk too) and is extremely vulnerable to electricity grid outages.
- The SBUSD is a major school district that increasingly recognizes the value-of-resilience (VOR) and has embraced the Clean Coalition's vision 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

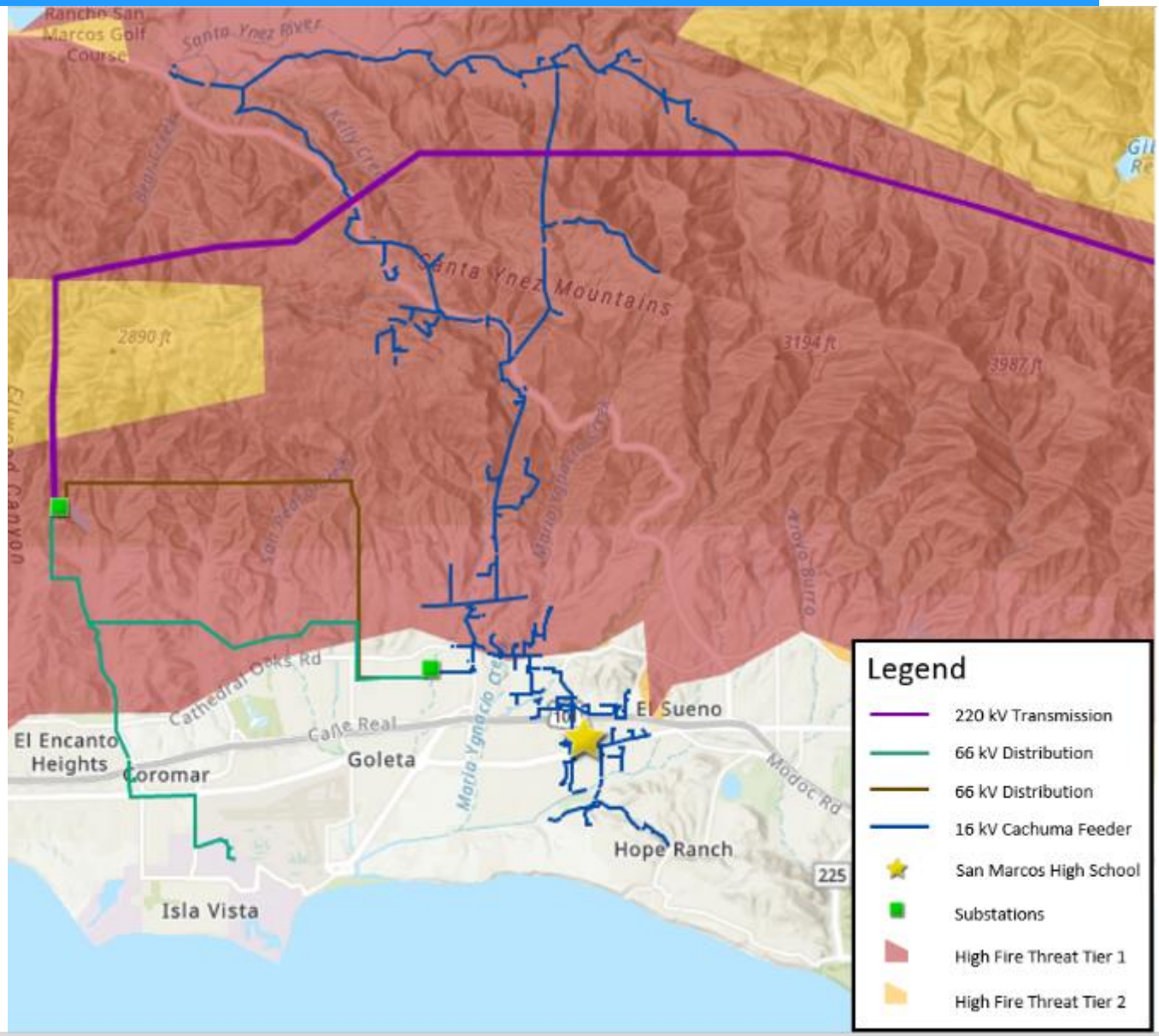


Guaranteed SBUSD bill savings and free VOR



San Marcos High School (SMHS) Solar Microgrid case study

SMHS is vulnerable to distribution outages too



San Marcos High School (SMHS) campus view

- 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

SMHS Solar Microgrid site layout

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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.

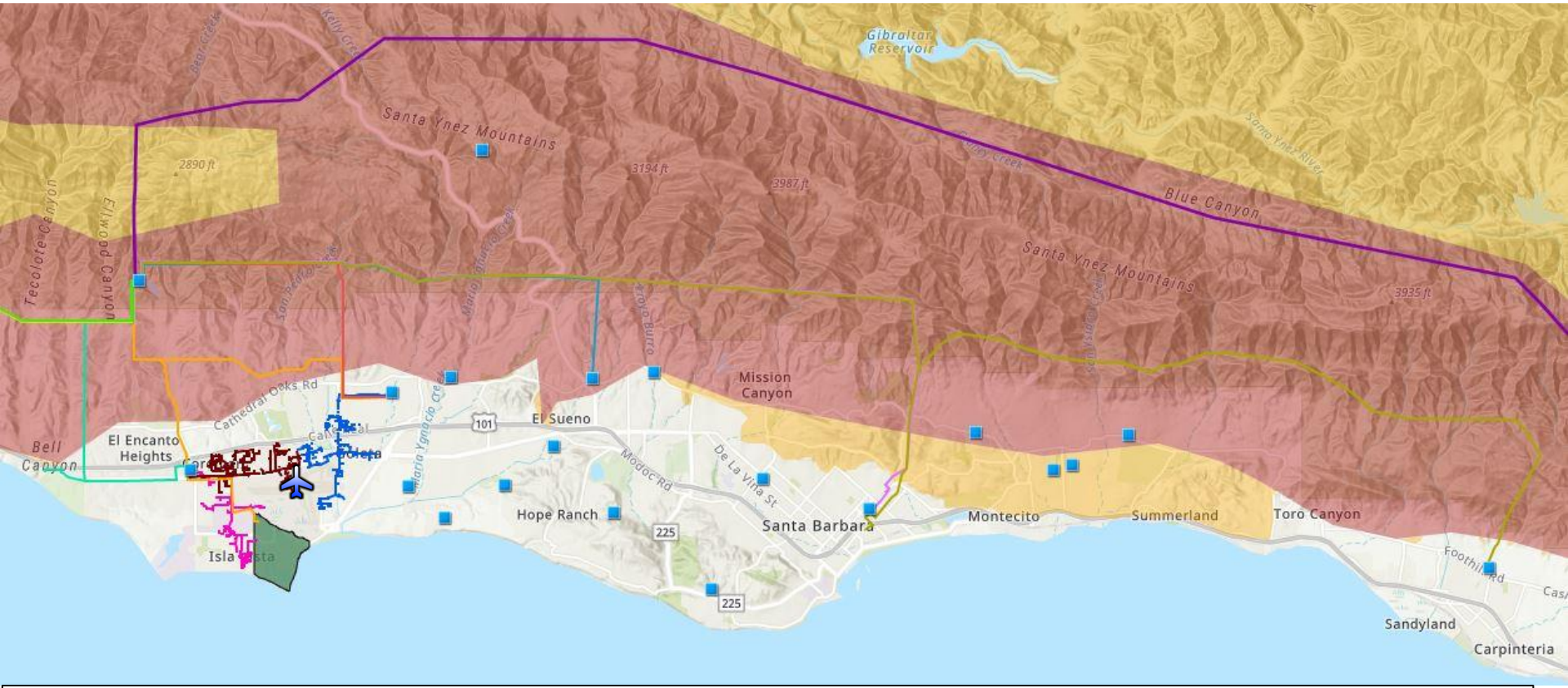
Santa Barbara Unified School District
District-Wide Solar PV Energy and Resiliency RFP
PV, BESS, and EV Charge Site Plan
5/18/2020

Goleta Load Pocket (GLP)

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.

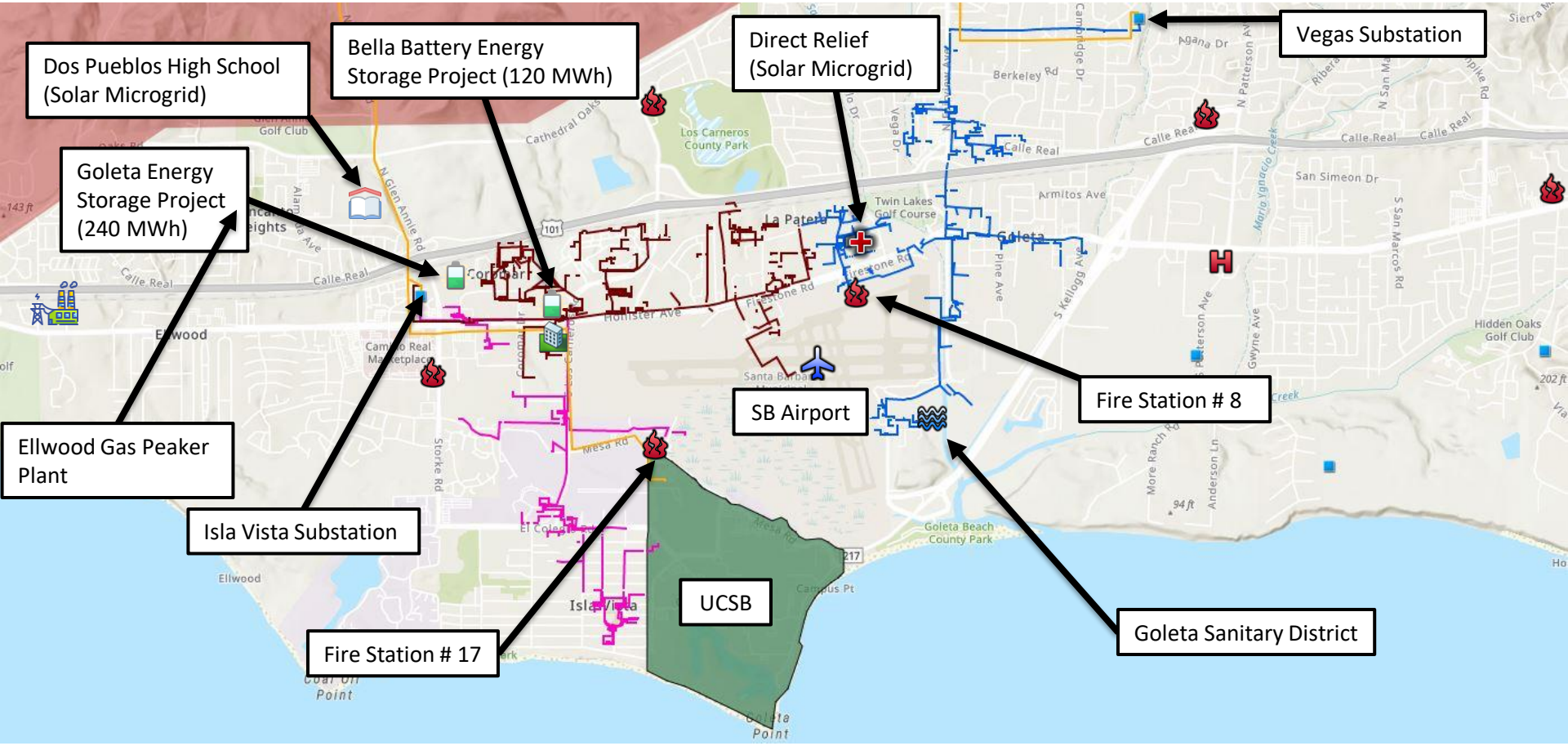
Core load area of the GLP



Legend

- 220 kV Transmission
- Santa Barbara Airport
- Substations
- Tier 3 Fire Threat
- Tier 2 Fire Threat
- UCSB
- 16kV Gladiola Feeder
- 16kV Gaucho Feeder
- 16kV Professor Feeder
- Feeder #4157
- Feeder #3556
- Feeder #4311
- Feeder #3559
- Feeder #4169
- Feeder #4227
- Feeder #3565

Target 66kV feeder serves critical GLP loads



Legend

- 66 kV Feeder #4311
- Substations
- Tier 3 Fire Threat
- 16kV Gladiola Feeder
- 16kV Gaucho Feeder
- 16kV Professor Feeder
- Santa Barbara Airport
- University of California Santa Barbara
- Dos Pueblos High School
- Fire Stations
- Goleta Sanitary District
- Goleta Valley Cottage Hospital
- Direct Relief
- Deckers
- Planned Battery Energy Storage

Target 66kV feeder grid area block diagram

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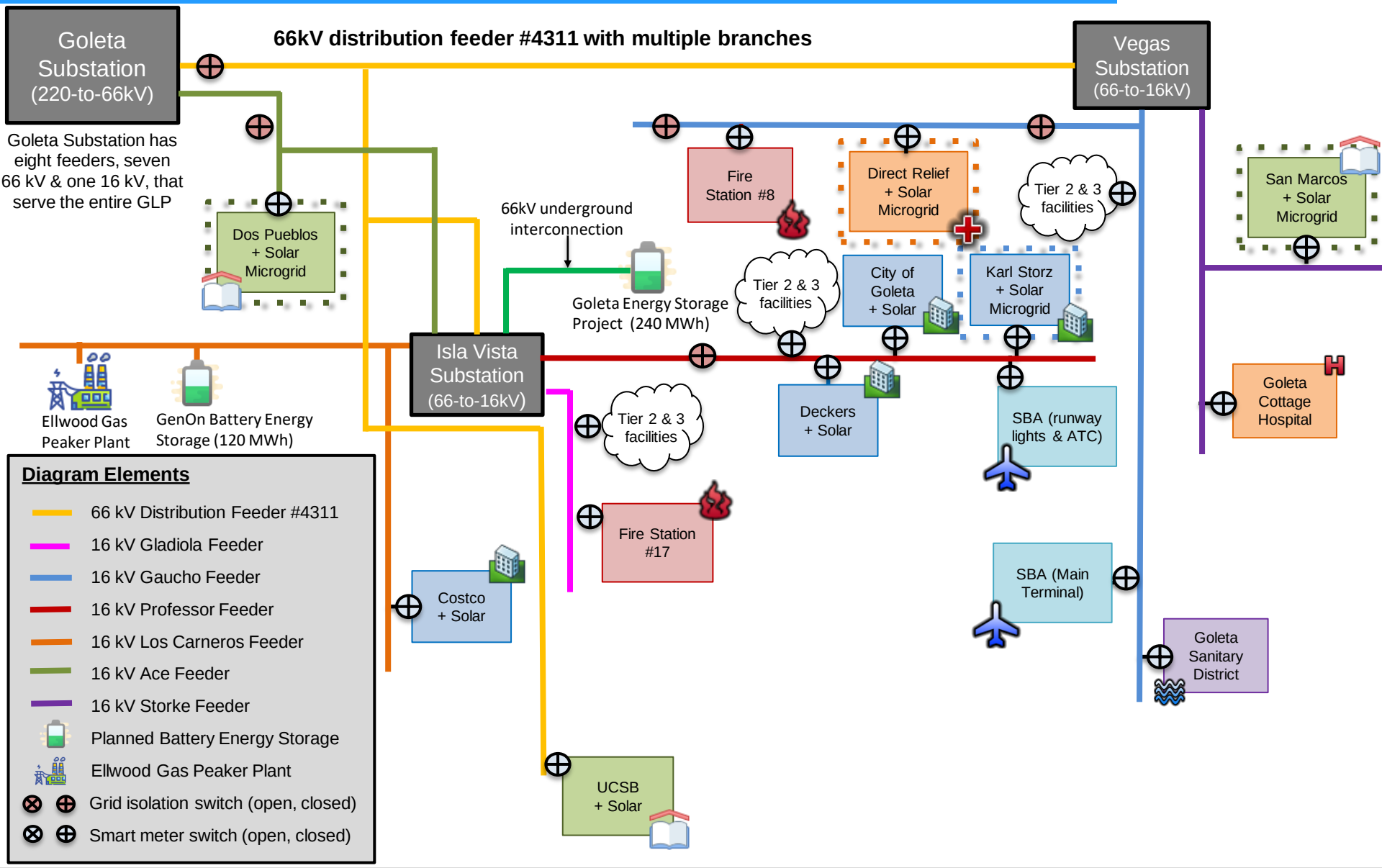

Consider a career in Sustainability

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"We came all this way to to explore the Moon, and what we discovered is the Earth."

- Bill Anders, Apollo Astronaut, 1968 Earthrise photo

You all can continue to be Solar Leaders!!!

- Share your solar knowledge with others.
- Promote solar for anyone you know with a connection to:
  - A house
  - An office
  - Roles in government, including:
    - School districts
    - Cities
    - Counties
    - State
    - Federal
- Educate people that solar can go on all types of built environments, including rooftops, parking lots, water reservoirs, and even over roads and waterways.
- I remember when my nephew was about your age and asked his Mom & Dad whether they had considered solar for their house. And presto, they got solar a few months later!!!