California
Energy Commission
Research & Development

Solar + Storage Projects for Peak Load

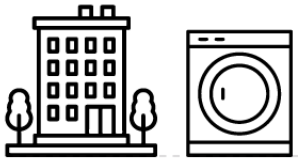
Energy Research and Development Division

Angie Gould
Energy Generation Research Office
November 10, 2020

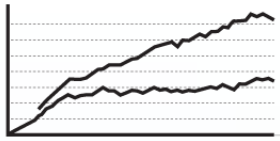
California Energy Commission

1974: WARREN-ALQUIST ACT PASSED

Created the Energy Commission



Set building and appliance efficiency standards



Forecast electricity demand

Support R&D into non-conventional energy sources

The Energy Commission is committed to promoting a **clean, affordable, and reliable** energy supply for **all Californians.**

OTHER ENTITIES ENGAGED ON ENERGY

Public Utilities Commission (CPUC)

Independent System Operator (CAISO)

Air Resources Board (CARB)

PRIMARY FUNCTIONS OF THE

CALIFORNIA ENERGY COMMISSION

Advancing State Energy Policy

Investing in Energy Innovation

Developing Renewable Energy

Preparing for Energy Emergencies

Achieving Energy Efficiency

Transforming Transportation

Overseeing Energy Infrastructure

Intergovernmental Collaboration

CEC's Electricity R&D Program

EPIC: Electric Program Investment Charge

Project investments align with California's climate and energy goals, accelerating their achievement

$718 MILLION AWARDED TO 328 PROJECTS

Project Categories

Entrepreneurial Ecosystem

Resilience and Safety

Grid Decarbonization and Decentralization

Building Decarbonization

Transportation Electrification

Industrial & Agricultural Innovation

CALIFORNIA'S INVESTMENT IN CLEAN ENERGY INNOVATION

EPIC is California's premier public interest research program investing over $130 million annually to unleash innovation.

Entrepreneurial Ecosystem
$143 million invested

Through EPIC, the CEC is building a world-class ecosystem supporting clean energy entrepreneurship.

Resiliency & Safety
$106 million invested

Helping communities, businesses, and public agencies build a safer, more resilient energy system.

Building Decarbonization
$170 million invested

Improving the affordability, health, and comfort of buildings.

Grid Decarbonization & Decentralization
$154 million invested

Improving the cost competitiveness and performance of key technologies.

Industrial & Agricultural Innovation
$113 million invested

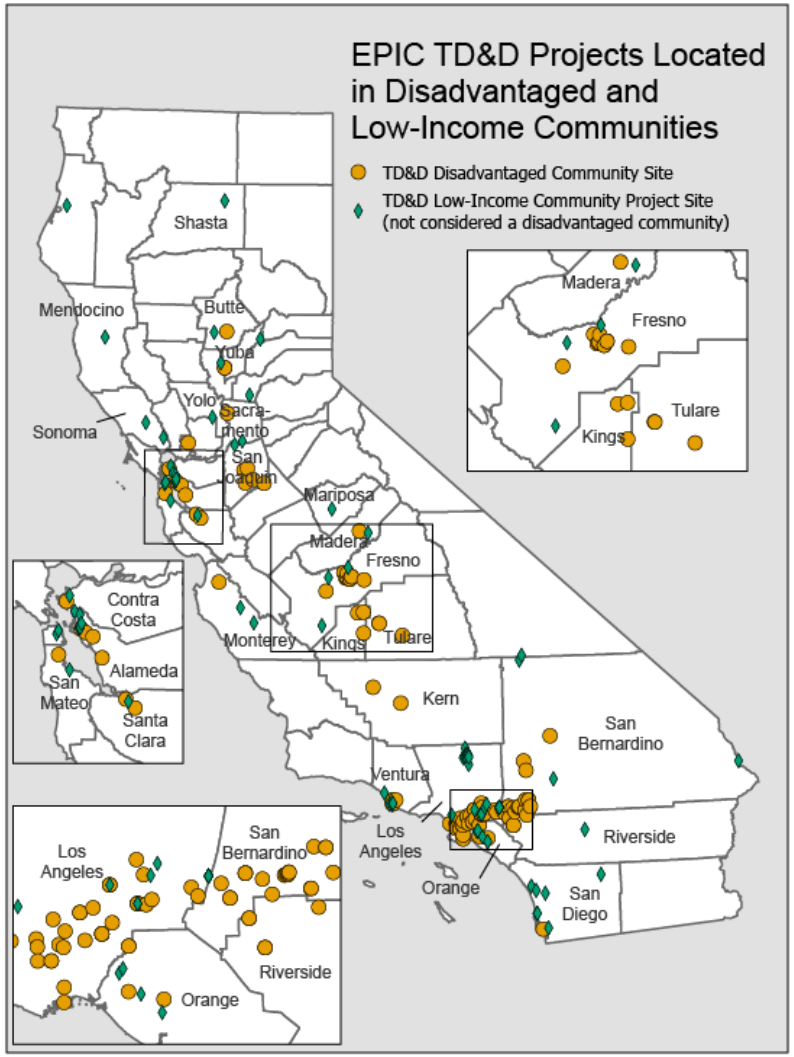
Scaling specialized technology solutions to drive energy efficiency without compromising production.

Transportation Electrification
$33 million invested

Supporting advances that reduce the cost of electric vehicle ownership and support the grid.

**Total investment, 2012-2019*

Investing Equitably in Technology Demonstration & Deployment



65%

Of all EPIC Technology Demonstration and Deployment funds have been awarded to projects sited in a

DISADVANTAGED-OR LOW-INCOME COMMUNITY

This investment level

FAR OUTSTRIPS

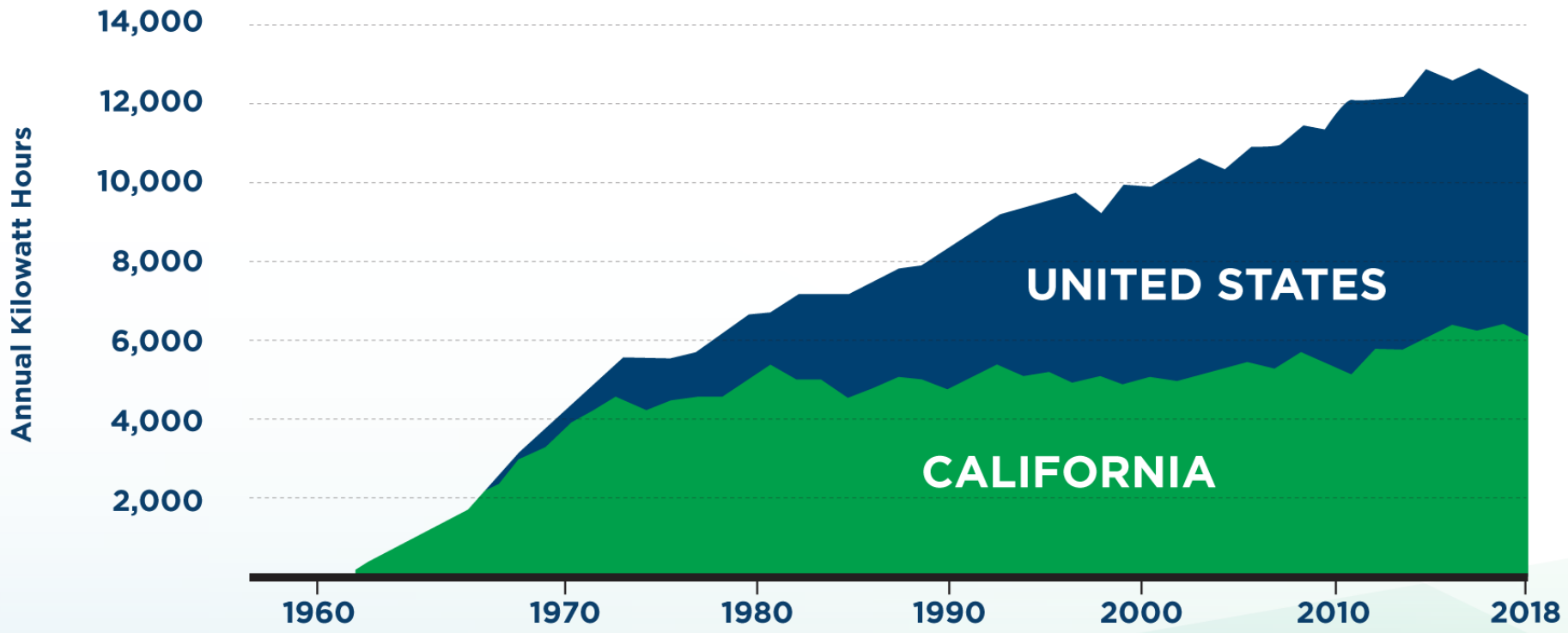
the mandate of

AB523

California's Electricity Landscape

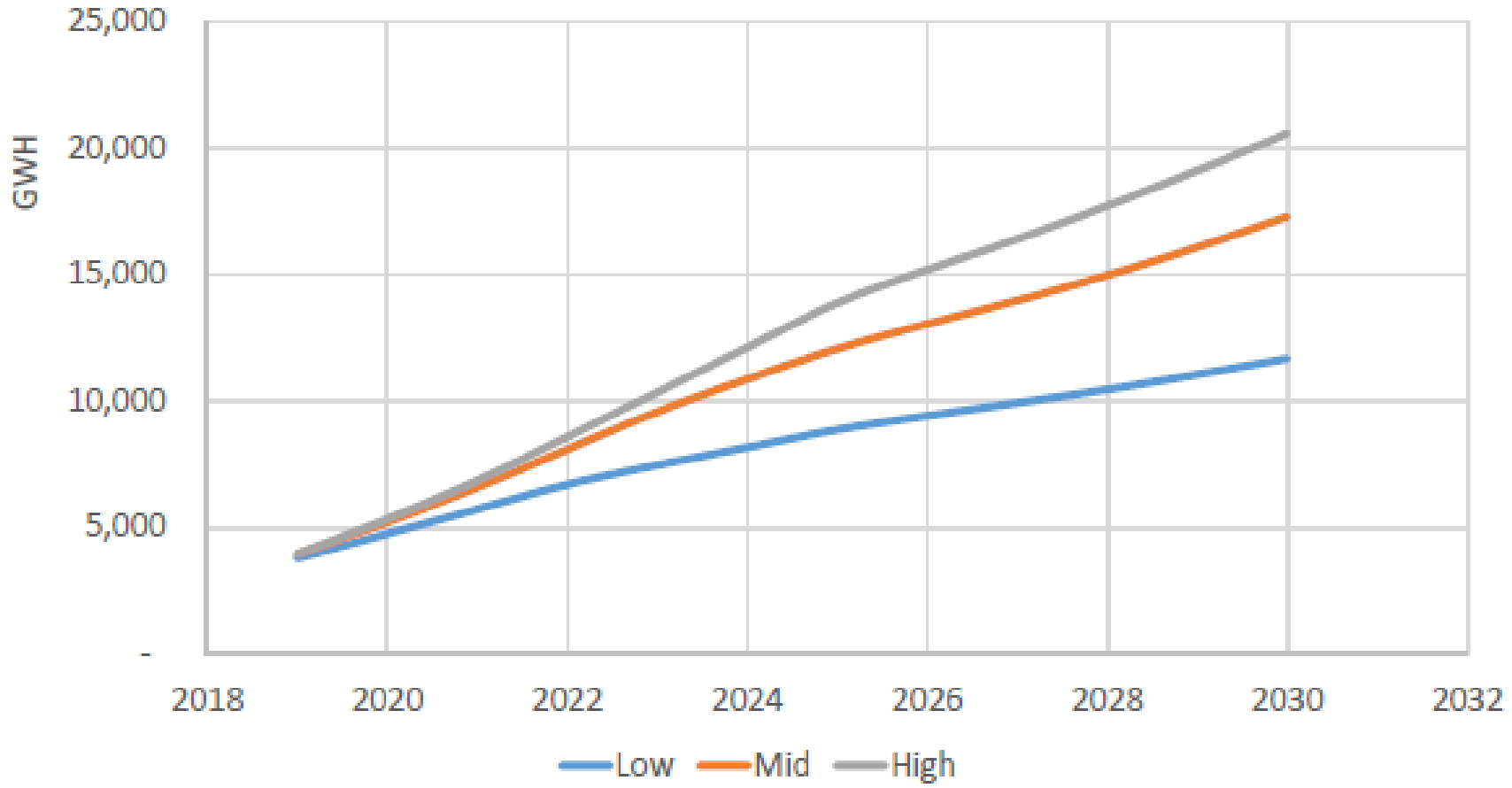
CA VS. U.S. ENERGY USE

Californians use **half** the per capita electricity as the rest of the U.S.



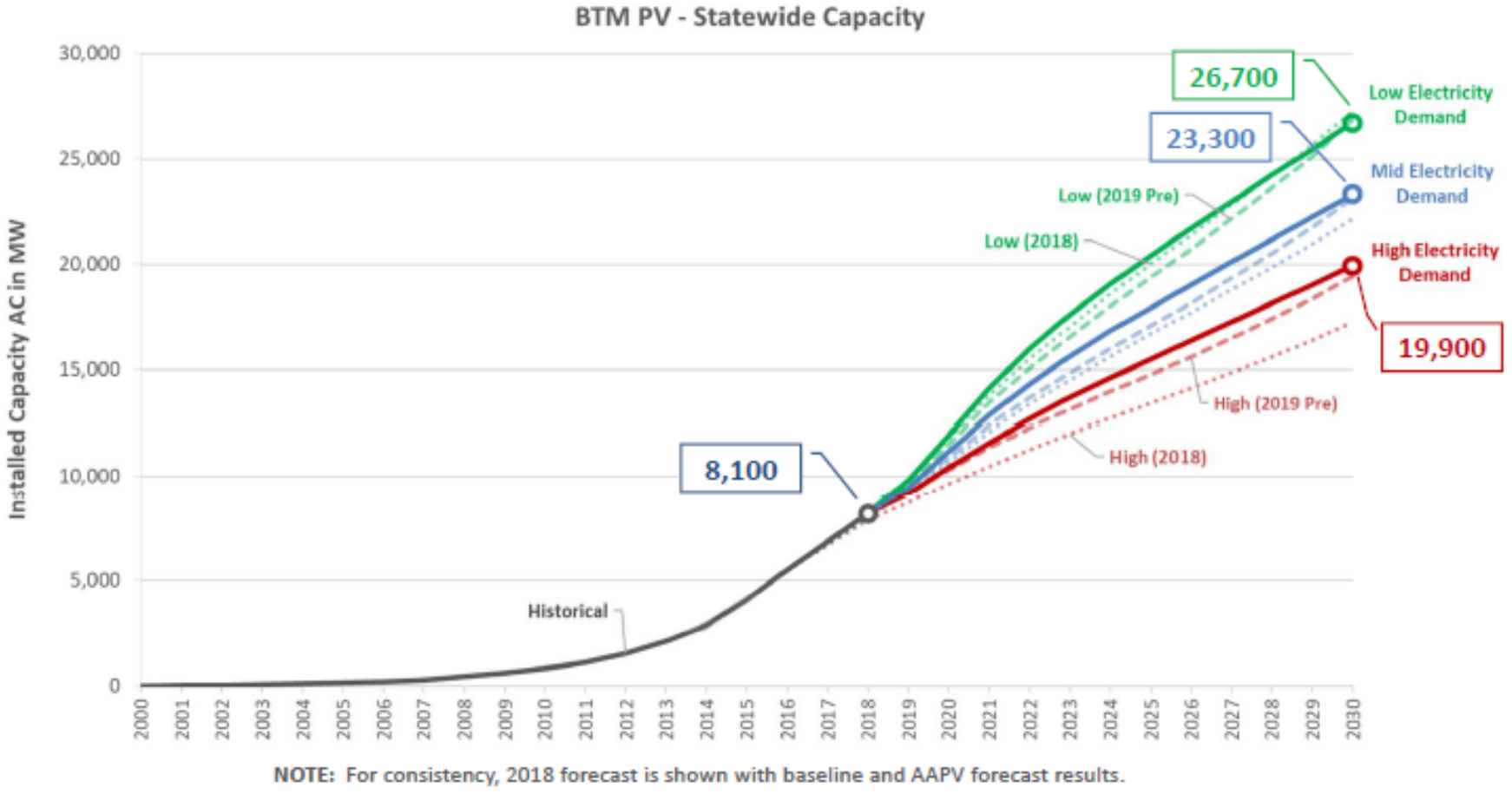
Source: California Energy Commission

Forecasted Increases in Electricity Demand from Transportation



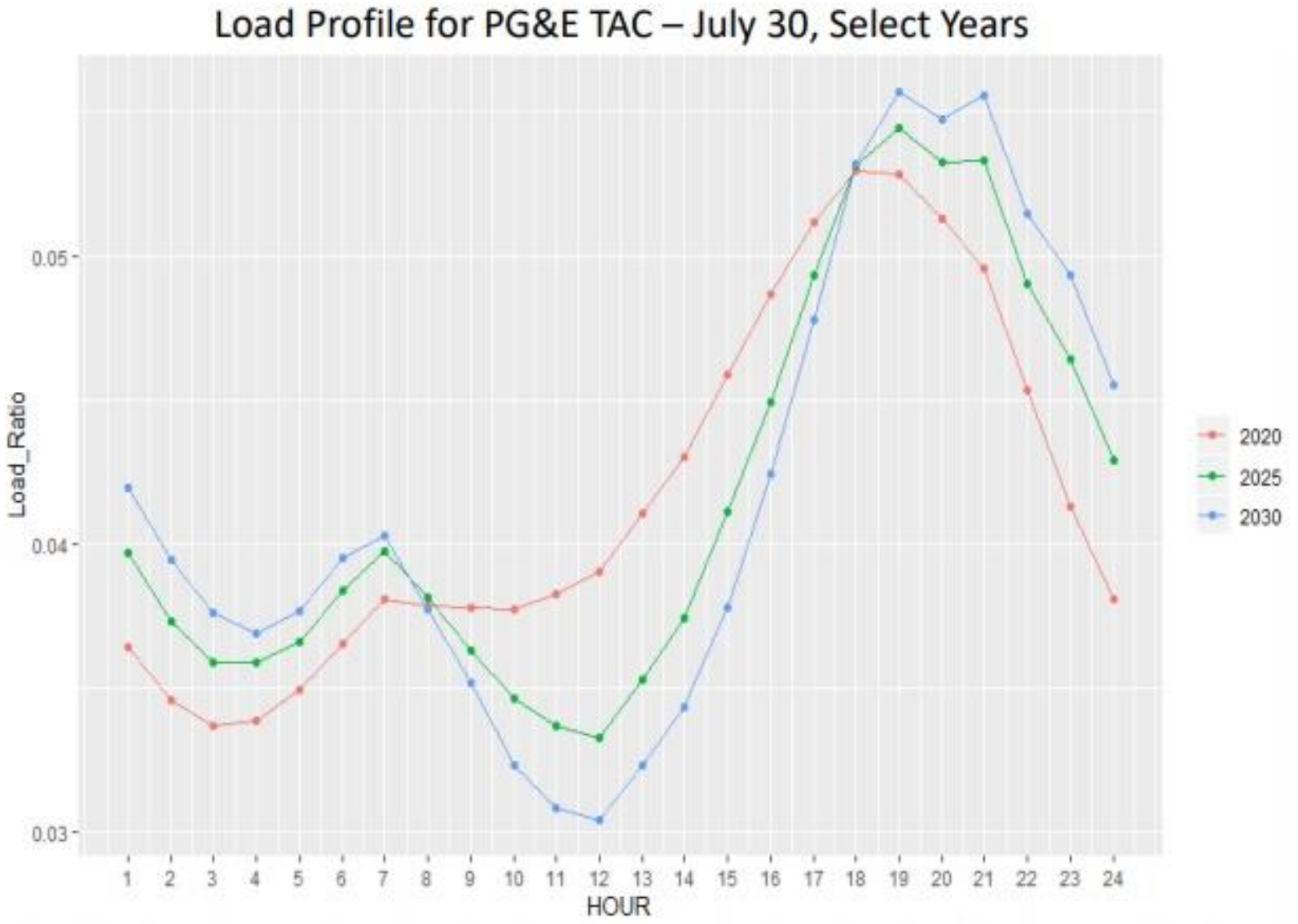
Source: 2019 Integrated Energy Policy Report

Forecasted Increases in BTM PV Capacity



Source: 2019 Integrated Energy Policy Report

Peak Load Shift

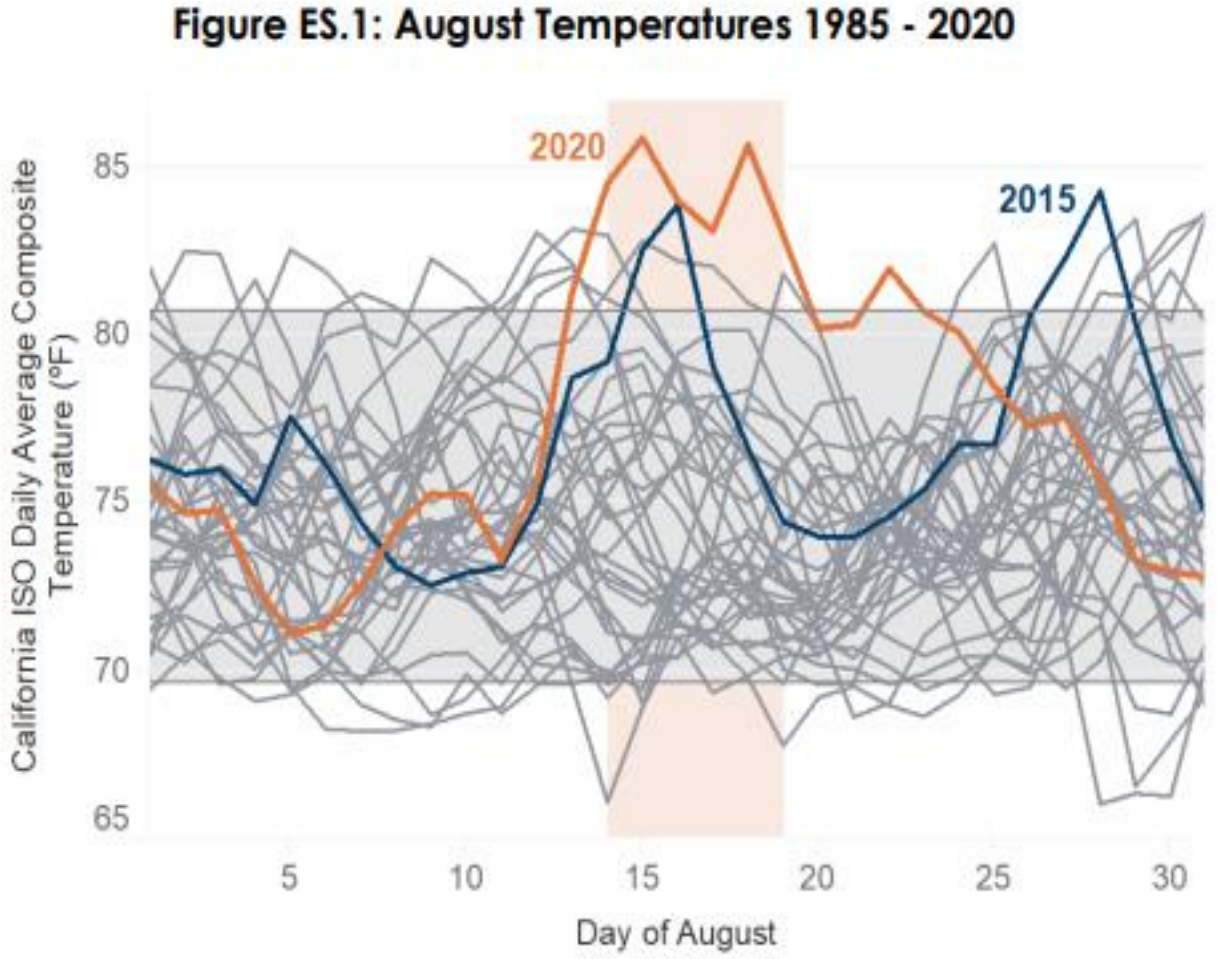


Source: 2019 Integrated Energy Policy Report

Heat Waves Stress California's Grid

- August 14-15: high heat combined with a reduction in the supply of available generation led to rolling blackouts
- September 4-6: another heat wave; record-setting temperatures in LA
  - Utility-scale generators asked to supply additional power
  - R&D microgrid and solar + storage projects asked to reduce load
  - Rolling blackouts were avoided

California expects more extreme heat in the future due to climate change.



Solar + Solicitation

Solar +: Taking the Next Steps to Enable Solar as a Distribution Asset

- Solicitation released in late 2016; included two groups focused on community-scale and building-scale solar + storage
  - Focused on pilot demonstrations of innovative solar + storage technologies and configurations
  - Goal: to create a standardized solar + storage solution for buildings and communities to decrease soft costs and enhance the value of distributed PV to utility customers and the grid
  - One of the targeted metrics: reduction of at least 15% in evening peak load

Community-Scale Projects

Location	Project Focus/Highlights	Prime Recipient
Willowbrook, CA	• Sited at a low-income multi-family disadvantaged community. • Technology solution balances a combination of grid-connected DER, including advanced solar PV, energy storage, smart inverter, a DC mini grid, and load management. • 120 kW PV Modules with 120 kW / 220 kWh Battery Energy Storage • Includes backup power to lighting and other loads at the community building	EPRI
Long Beach, CA	• Sited at a multi-use, supportive housing building at a disadvantaged community • Controller will manage onsite PV generation and energy storage while serving grid needs with demand response, load shifting, and ancillary services • 100 kW PV Modules with 150 kVA / 182.6 kWh Li-ion Battery • Islandable microgrid	UC Riverside

Building-Scale Projects

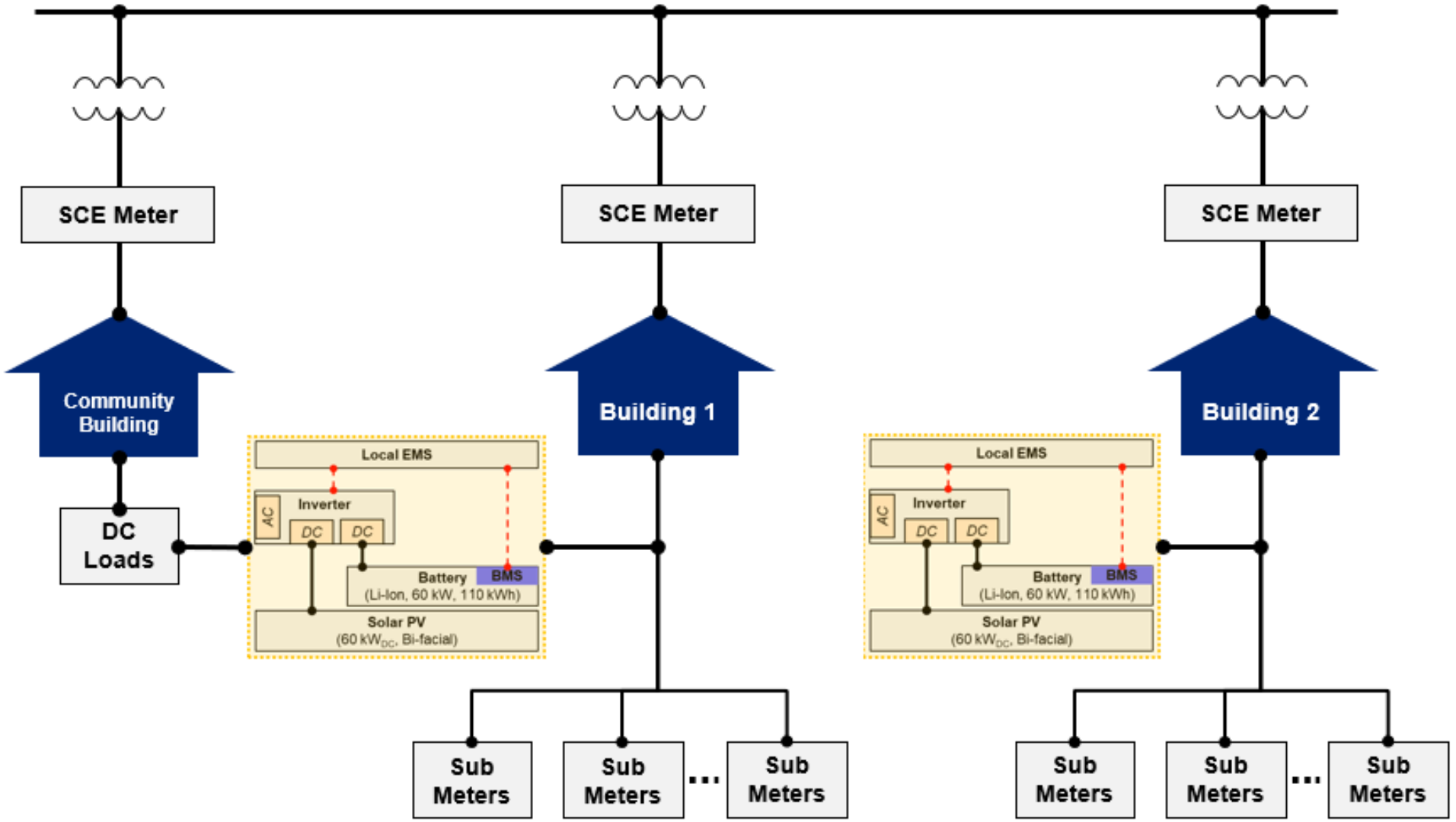
Location	Project Focus/Highlights	Prime Recipient
San Leandro, CA	• Sited at an office building in a disadvantaged community • Use of OpenBATS: Open Building Adaptive Tuning System • Assess the performance and benefits of integrated solar PV and storage along with advanced energy efficiency, demand response, and DER management technologies. • 66 kW PV with 30 kW/ 60 kWh battery storage • Backup power to critical loads.	EPRI
Blue Lake, CA	• Sited at a convenience store/fueling station in Blue Lake tribal lands, adjacent to the Blue Lake Rancheria microgrid • Developing standardized components for a Solar+ system designed specifically for the SMB sector. • Producing hardware design guidelines, integration software, and site targeting guidance. • 60 kW PV with 109 kW/174 kWh battery storage • Islandable microgrid	Humboldt State University

Willowbrook Project

Willowbrook: Project Goals

- Bifacial PV: target efficiency ~23%; can help commercial and multifamily buildings with roof area constraints.
- Integration of PV + storage with smart inverters for peak demand management, distribution grid flexibility, etc.
- Demonstrate platform that can manage both loads (connected devices) and storage to manage PV production and evening peaks and to increase efficiency of PV use.
- Integration of DC mini grids to eliminate conversion losses for PV to feed loads and further enhance system efficiency.
- Expected benefits of the system:
  - Energy savings of 231,240 kWh annual from solar PV generation
  - Reduction of evening demand by 20%
  - $11,000 electricity bill savings due to onsite generation in the first year

Willowbrook: Site Design



Willowbrook: Peak Load Reduction

- Loads that can be shifted: controllable load for pre-cooling/pre-heating.
- Battery is 120kW/220kWh.
- Collecting community scale advanced metering infrastructure (AMI) data to establish baselines and determine how to operate system.
- Two load-shifting strategies identified for the project.
  - **Customer-Centric**: The customer's comfort is prioritized over all other considerations; use of PV and battery resources maximized to support controllable loads during periods of high TOU rates.
  - **Value-Stacking**: The customer's comfort is traded-off against grid benefits by using additional real-time data from both the loads, operating data from controllable loads and PV inverter and battery.

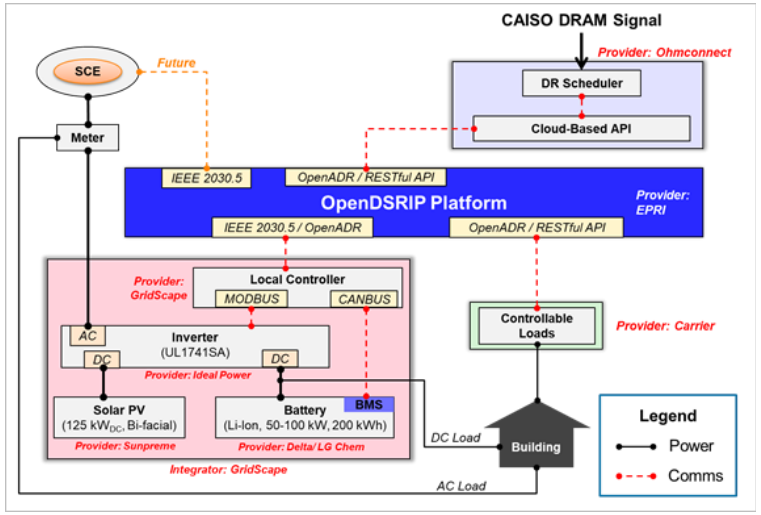


Figure 1: Hardware Control Architecture

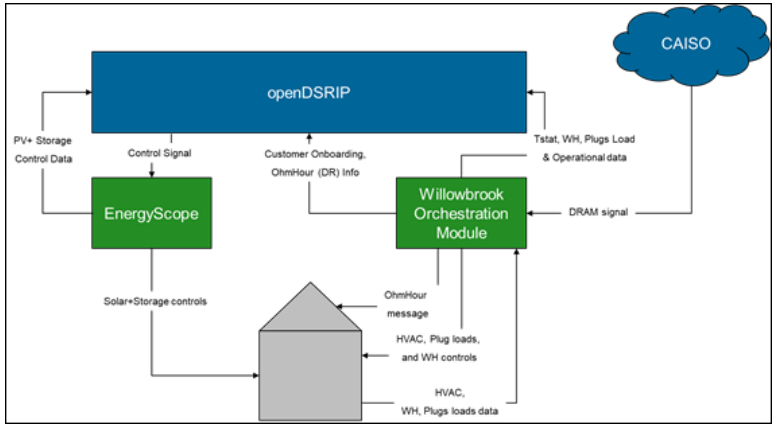


Figure 2: Software Architecture

Willowbrook: Project Status/Schedule

As of November 2020:

- **SCE Interconnection Approval**
  Completed in October 2020
- **PV/Battery Installation**
  Anticipated completion by November 2020
- **Final Inspection/Permit to Operate**
  Anticipated for January 2021
- **12 Months Data Collection**
  Anticipated to start on February 2021
- **DC Mini-Grid**
  Anticipated completion by Q1 2021

AC Concentration Panel, (2) 30kW Inverters, and 60 kW/110kWh Battery Energy Storage System

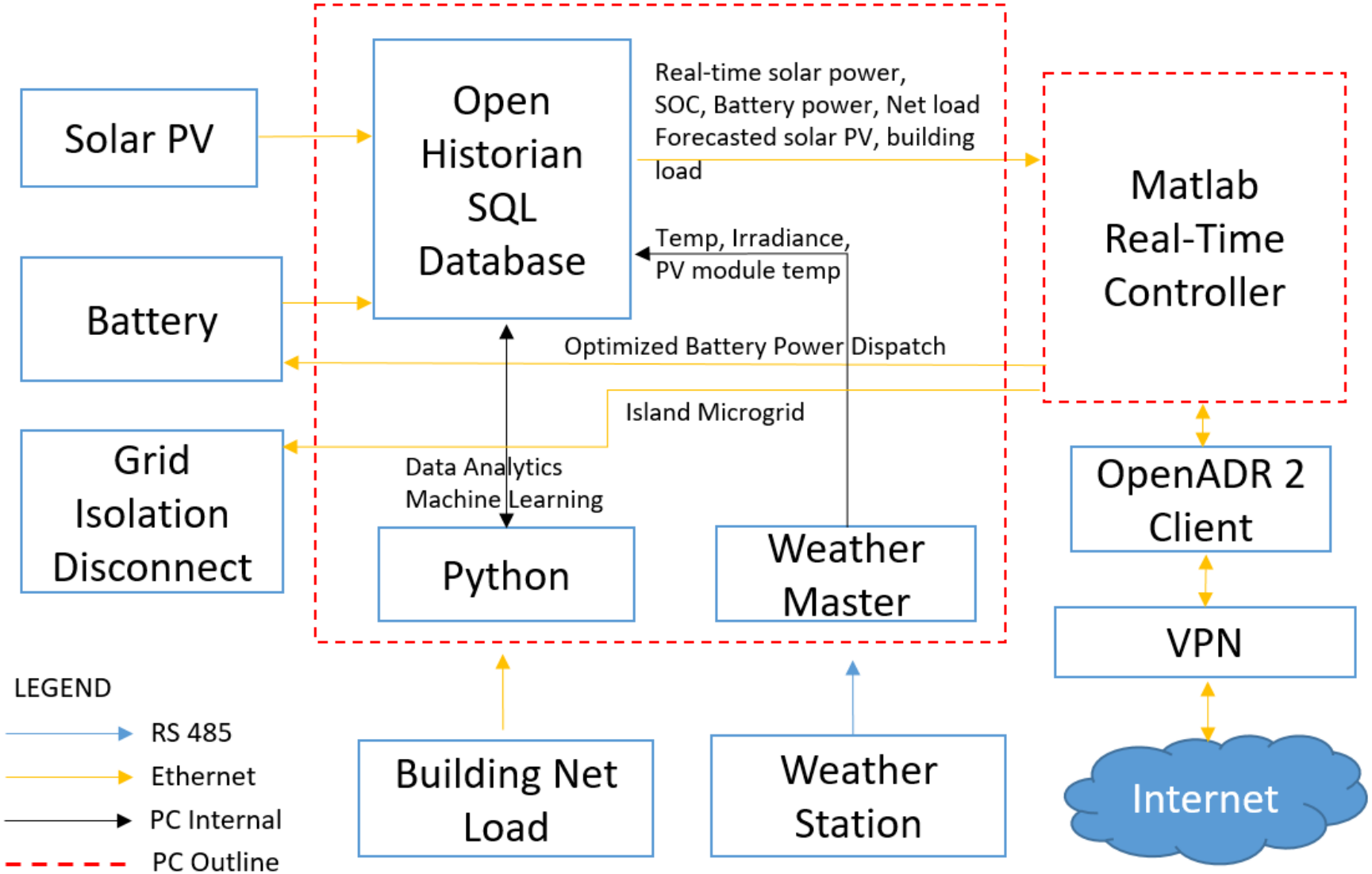
355W Bi-facial PV Panels

Long Beach Project

Long Beach: Project Goals

- Deploy microgrid with islanding capabilities at a new low-income, supportive housing mixed-use building that can provide back-up power to tenants.
- Develop energy management system that optimizes operation of PV generation and energy storage to reduce electricity bills for tenants, shave peak demand, and perform dispatchable grid services.
- Assess how a smart inverter providing autonomous grid services affects the performance of the solar plus storage system and vice-versa.
- Expected benefits of the system:
  - $29,203 electricity bill savings due to onsite generation in the first year
  - $262,800 electricity bill savings over a ten-year period
  - $190,507 peak demand charge reduction over a ten-year period

Long Beach: Site Design



Long Beach: Peak Load Reduction

- 100 kW Solar PV (22% efficiency), 150kW/182kWh Li-ion battery; no back-up diesel generator on-site.
- Building load is ~146 kW, and 100% can be shifted or separated from the grid.
- Using battery only without PV, can load shift or separate from the grid for ~1 hour and 15 minutes.
- Load shifting and separation could be done multiple times a day for various durations depending on solar production, building loads, and state of charge of the battery.

Long Beach: Project Status

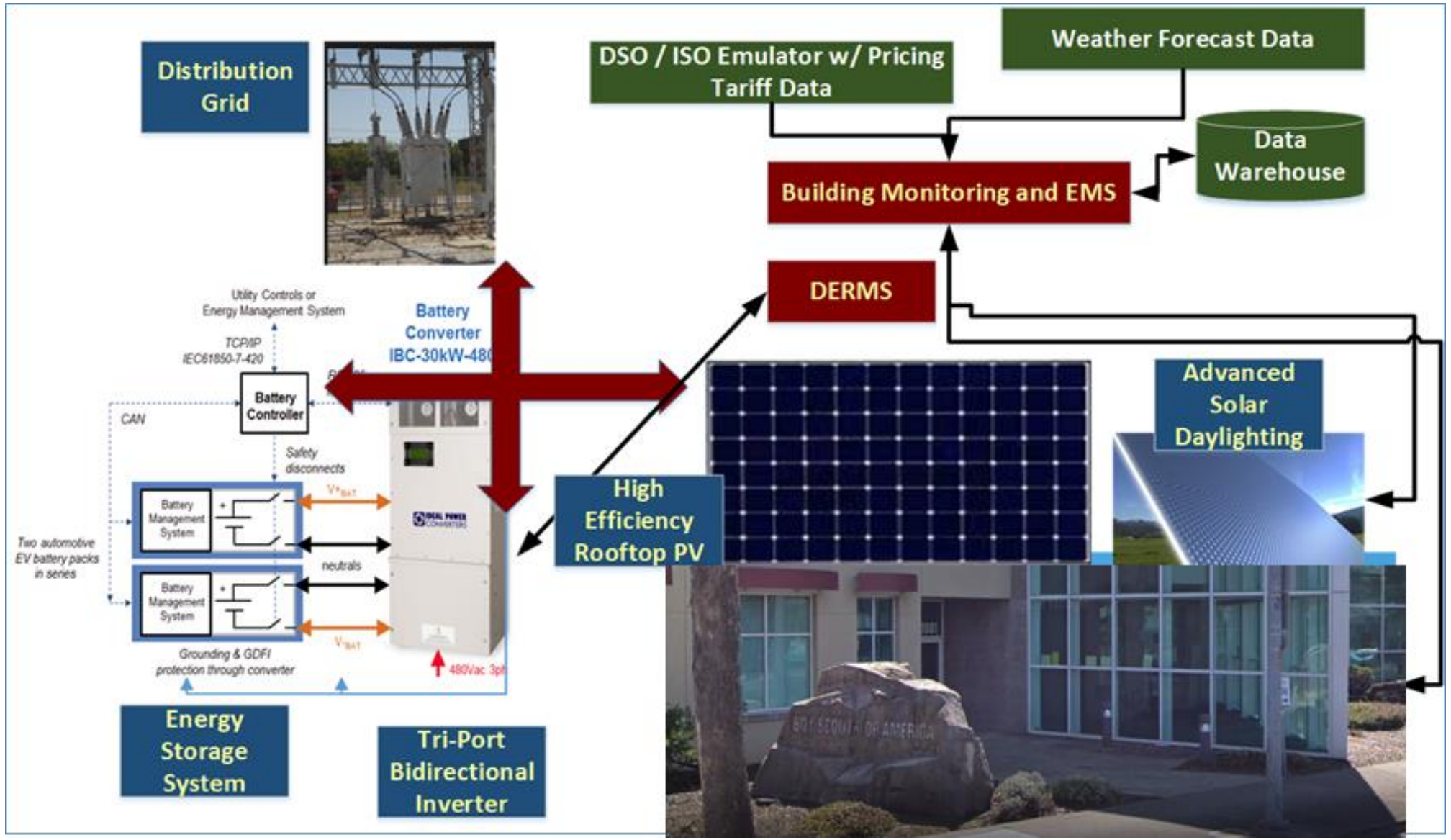
- **Building Occupancy**
  - Q1 2021
- **Solar PV Permit**
  - Submitted September 2020
- **Equipment Delivery**
  - Battery onsite
  - Rest of equipment: 3rd week of November 2020
- **Data Collection**
  - Q1 2021

San Leandro Project

San Leandro: Project Goals

- Assesses the performance and benefits of integrated PV and battery along with advanced energy efficiency, demand response, and distributed energy resource management technologies in a commercial building setting.
- Goal: to leverage the synergies of integrated and controllable components to improve distribution grid stability and reliability while also enabling the commercial customer to reduce both capital costs and operational and management costs for optimal value.
- Expected benefits of the system:
  - Total lifecycle cost (capital cost, installation, and operations and maintenance) for a behind the meter PV and battery system is expected to be reduced by up to 10%
  - Electricity bill savings of $22,000 annually

San Leandro: Site Design



San Leandro: Peak Load Reduction

- Can shift or separate all 57 kW (this year's peak) in a PSPS or forced disconnect scenario
- When serving all load with storage, can contribute 60kW of solar to the grid; up to 120kWh can be fed back to the grid in 2 hours
- Separation from grid can be indefinite if operating only critical loads

San Leandro: Project Status

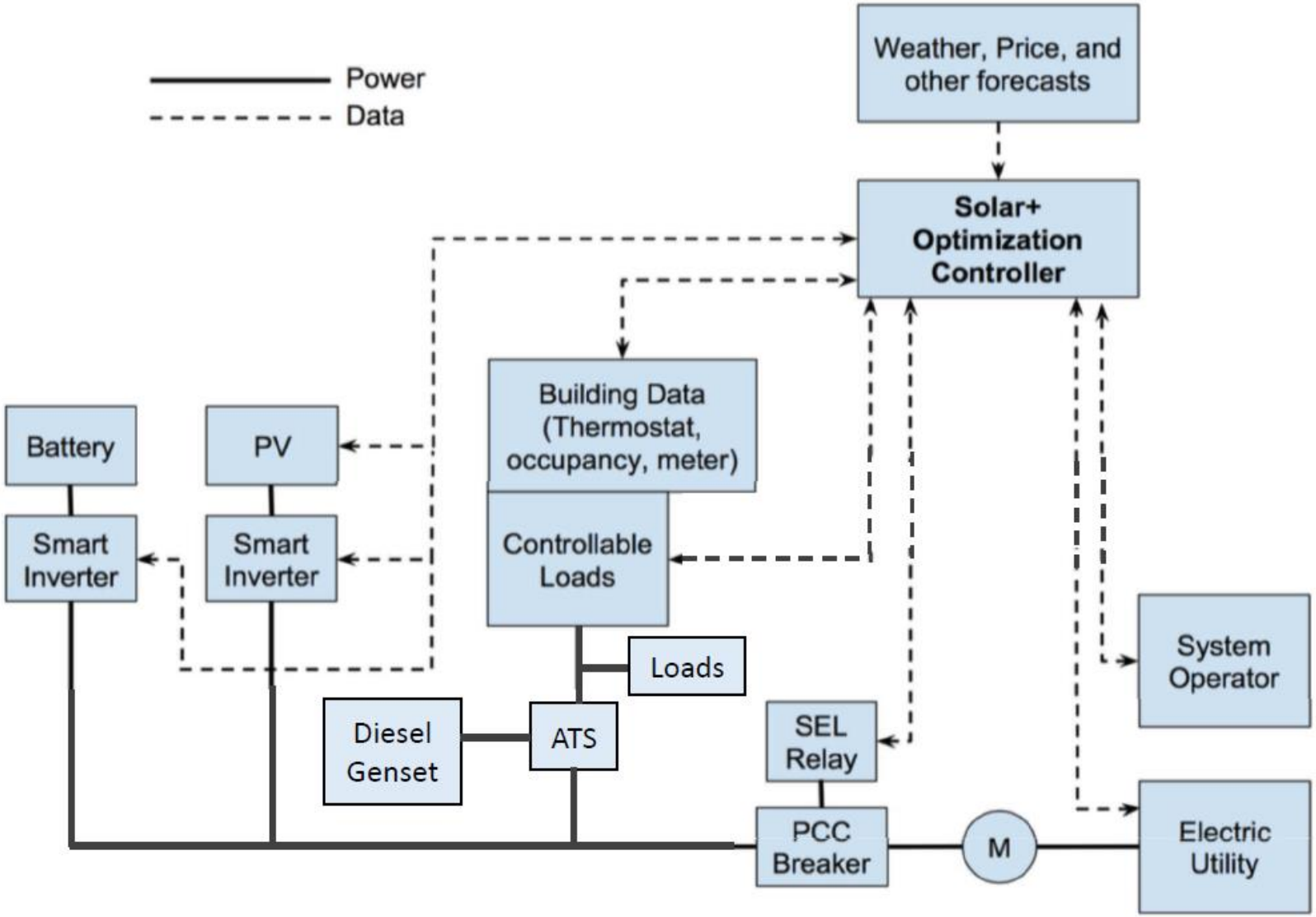
- Some delays due to COVID
- PV and batteries installed; awaiting interconnection
- Expected to start collecting performance data Q1 2021

Blue Lake Project

Blue Lake: Project Goals

- Develop standardized components for PV and battery system for small/medium commercial buildings (SMB).
  - Focus on convenience stores/fueling stations; also applicable to other SMB sectors.
- Project designed to innovate across three key priority areas necessary for technology scale-up:
  - Hardware design guidelines.
  - Integration software.
  - Site targeting.
- Expected benefits of the system:
  - Energy, demand charge savings of $0.20/W of PV/year
  - DR value of $0.20/W of PV/ year.
  - Reduce the costs of installing solar PV, battery, and smart inverter equipment by ~33%.

Blue Lake: Site Design



Blue Lake: Peak Load Reduction

- Successful demo of load-shedding and islanding in response to September 2020 heat wave.
- Average load of the site: ~35.5kW; peak load: 49.6kW.
  - 100% of peak can be separated from the grid or shifted; were the site load greater, up to 160kW of load could be shifted.
- Real-world use: 100% of load has been islanded using only PV and battery for up to 7 continuous hours.
  - With use of non-renewable diesel generation, the facility can be separated from the bulk grid indefinitely, with up to 50% of this supplied by onsite PV battery, and 50% supplied by onsite diesel.
- Under ideal conditions, 100% of the site load can be shifted for a cumulative total of approximately 16 hours per day.
- Battery fully dispatchable and capable of shifting the entire site load in response to active commands within 8 seconds of receiving them.

Blue Lake: Project Status

- PV and battery installed onsite
- Interconnection and Permission to Operate obtained in August 2020
- Responded to load shedding calls during this year's fire season in CA (September 2020)
  - Successfully islanded from grid and served onsite load without use of onsite diesel backup generator
- Submitting draft final report in November 2020

Thank you!

Any questions?

Angie Gould

angela.gould@energy.ca.gov