California
Energy Commission
Research & Development

Solar + Storage Projects for Peak Load

Energy Research and Development Division

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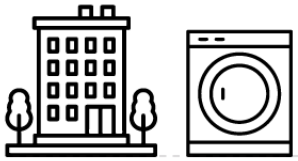
Energy Generation Research Office
January 11, 2022

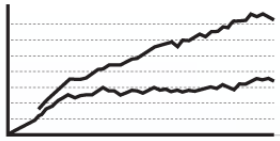
California Energy Commission

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

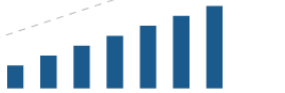
Public Utilities Commission (CPUC)

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

$846 MILLION

385 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

$151 million invested

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

Building Decarbonization

$194 million invested

Improving the affordability, health, and comfort of buildings.

Grid Decarbonization & Decentralization

$207 million invested

Improving the cost competitiveness and performance of key technologies.

Industrial & Agricultural Innovation

$119 million invested

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

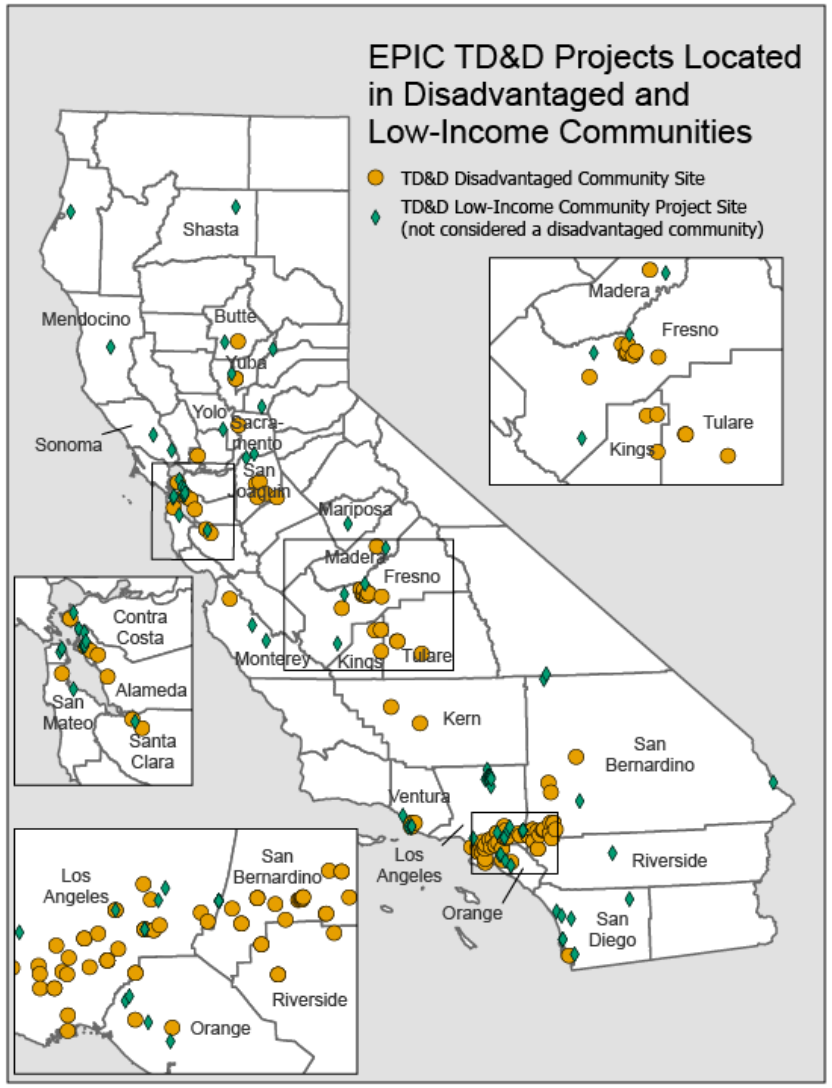
Transportation Electrification

$32 million invested

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

Total investment, 2012-2020

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

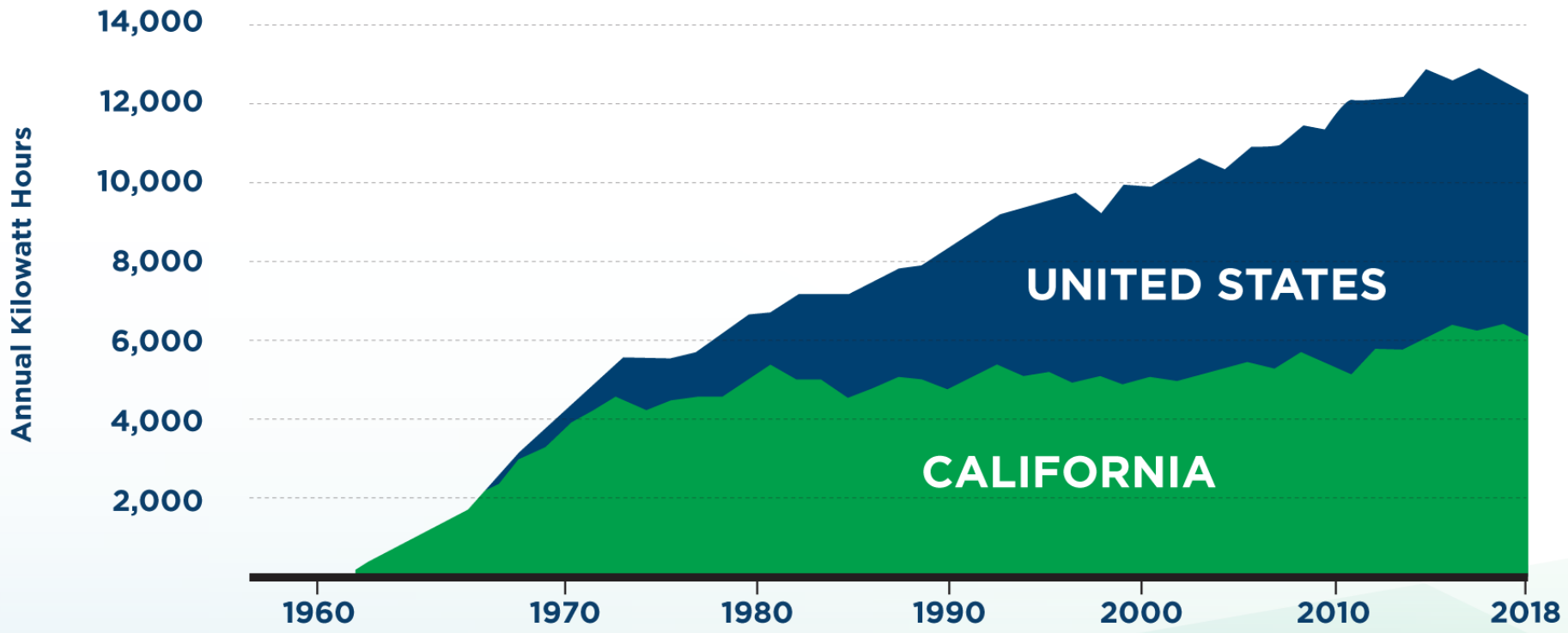
the mandate of

AB523

California's Electricity Landscape

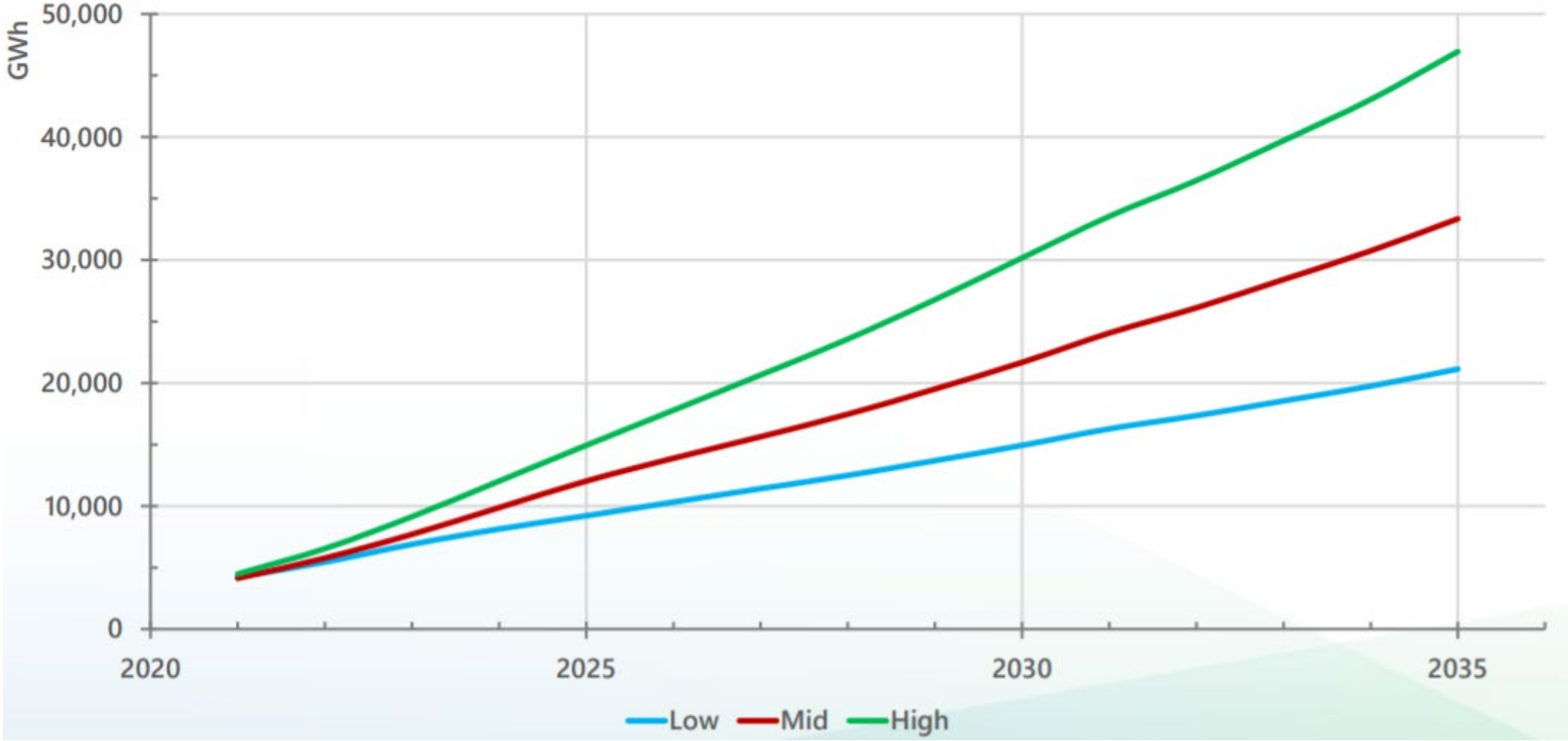
CA VS. U.S. ENERGY USE

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



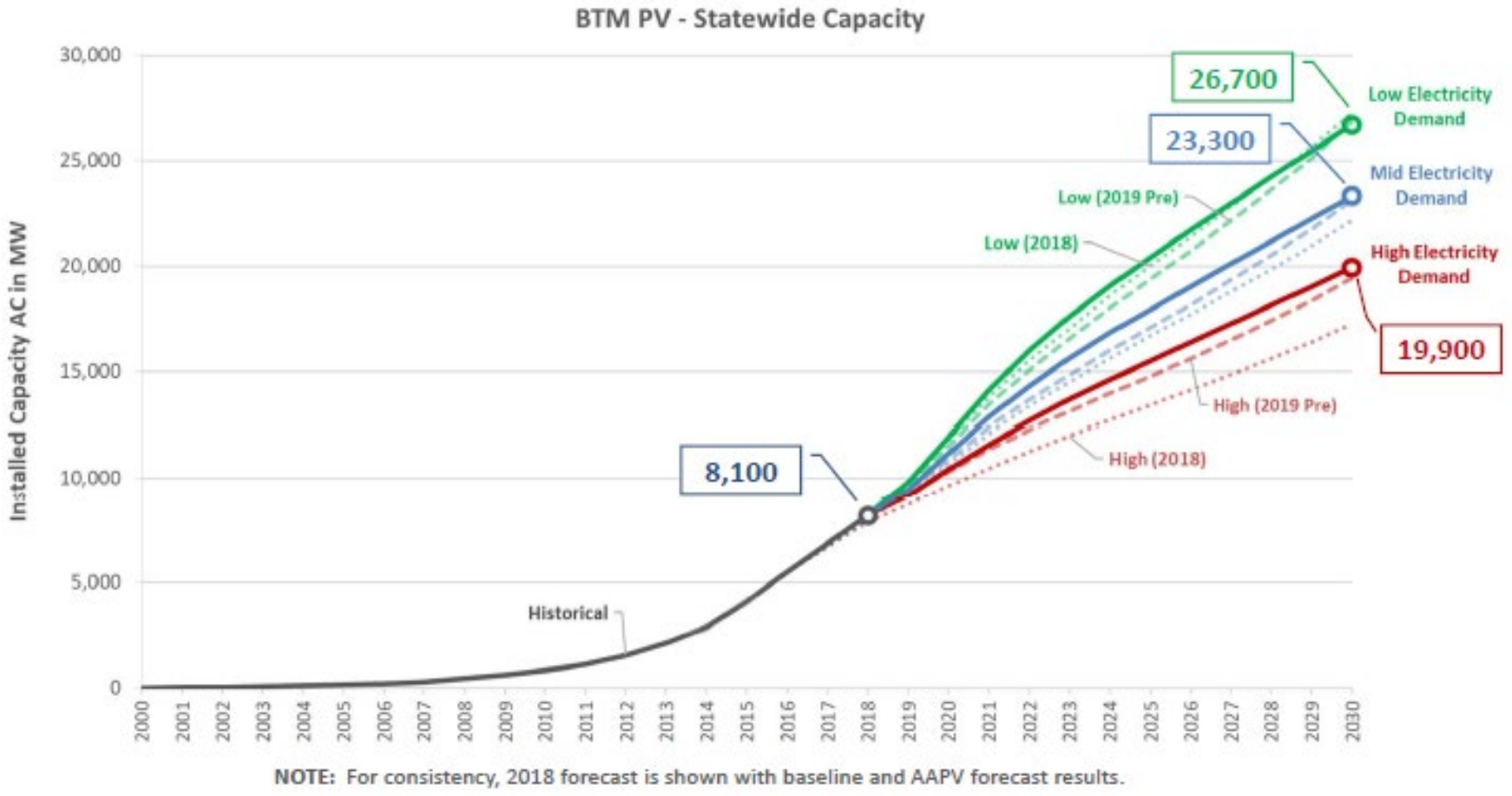
Source: California Energy Commission

Forecasted Increases in Electricity Demand from Transportation



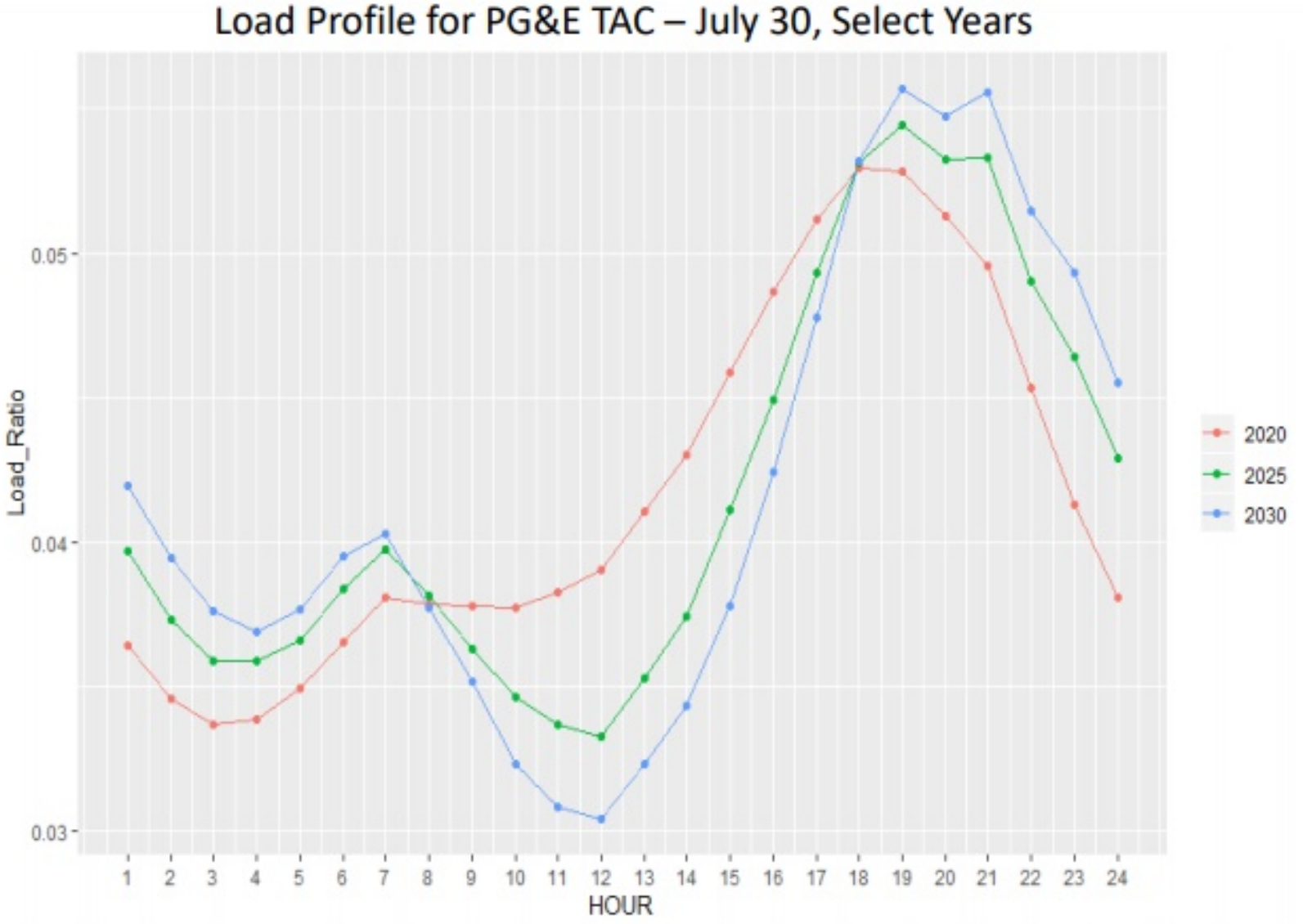
Source: CEC, 2021 Integrated Energy Policy Report

Forecasted Increases in BTM PV Capacity



Source: CEC, 2019 Integrated Energy Policy Report

Peak Load Shift

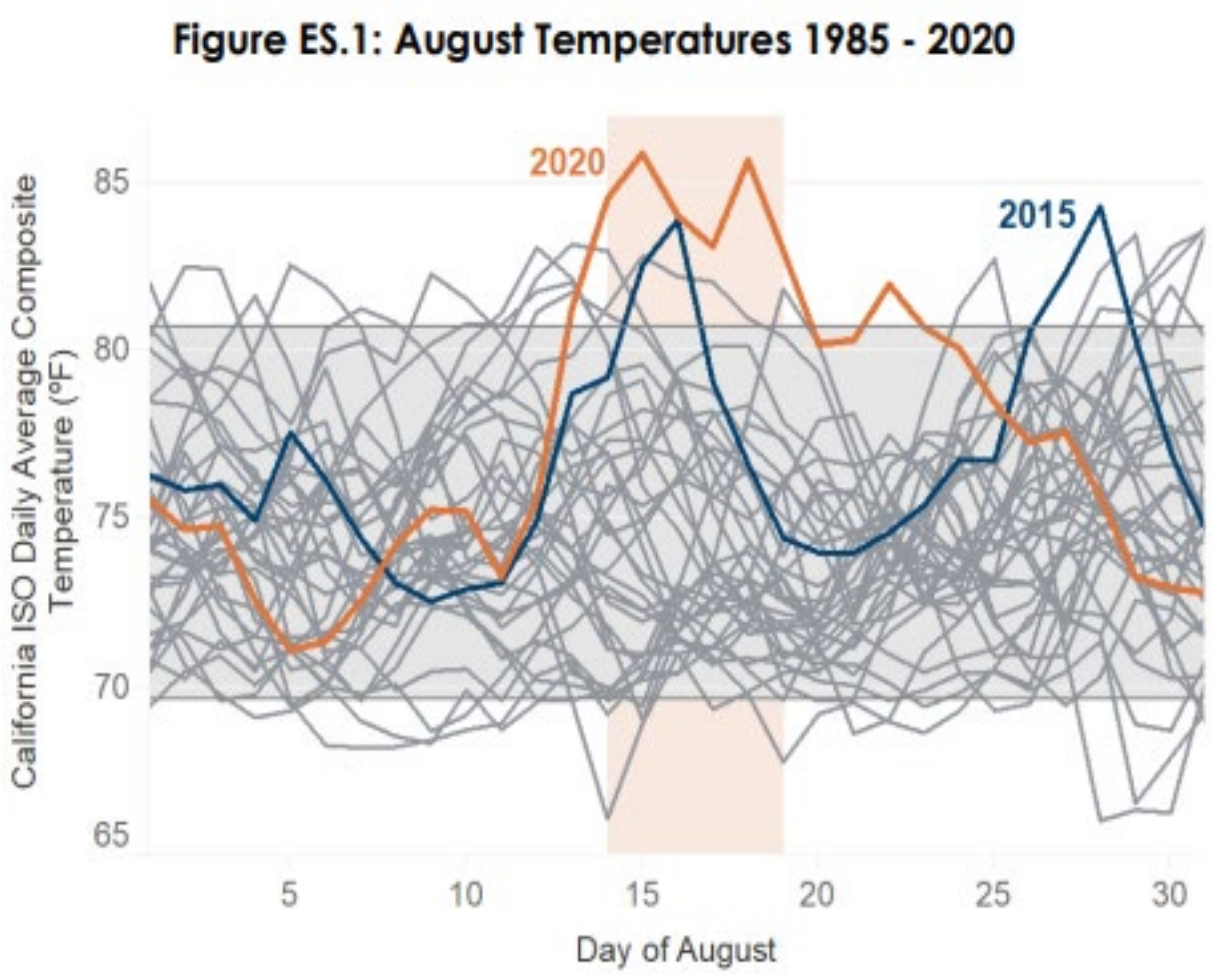


Source: CEC, 2019 Integrated Energy Policy Report

Heat Waves Stress California's Grid

- August 14-15, 2020: high heat combined with a reduction in the supply of available generation led to rolling blackouts
- September 4-6, 2020: 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
  - Goals:
    - Create a standardized solar + storage solution for buildings and communities
    - Decrease soft costs
    - 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 • Use virtual net energy metering (VNEM) • Backup power to critical shared loads	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 small/medium commercial 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

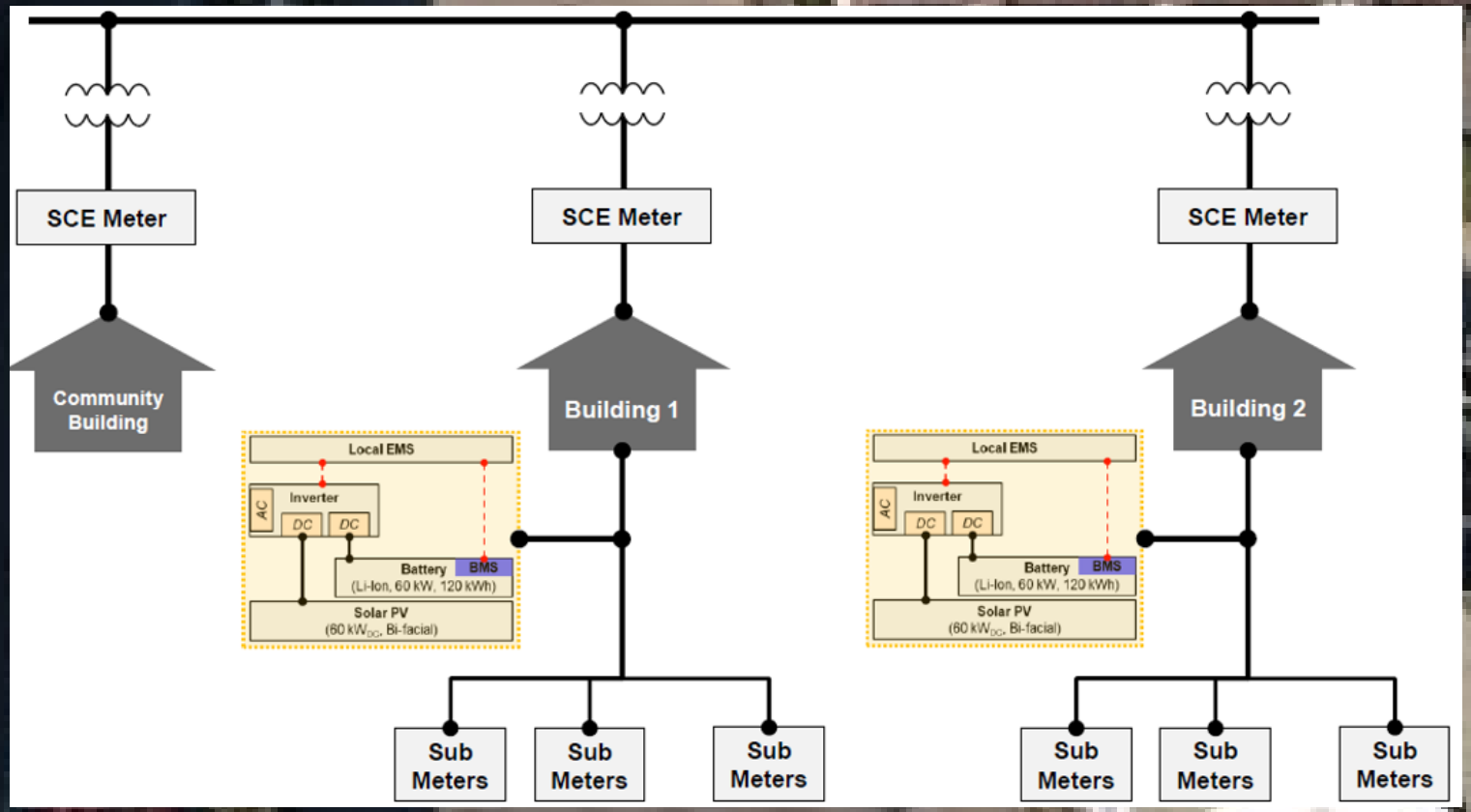
- Bifacial PV: target efficiency ~23%; can help commercial and multifamily buildings with roof area constraints
- Integrate PV + storage with smart inverters for peak demand management, utility-controlled distribution grid flexibility, etc.
- Demonstrate platform that can manage both loads (connected devices) and storage to optimize PV use and reduce evening peaks
- Integrate DC mini grids to eliminate conversion losses for PV to meet HVAC and lighting loads and further enhance system efficiency
- Expected benefits of the system:
  - Energy savings of 151 MWh annual (10% from reduction in losses) from solar generation
  - Energy consumption savings ~25% between 4PM to 9PM TOU compared to baseline
  - Reduction of evening kW demand by 8.6% during TOU peak period

Willowbrook: Site Design

Building 1

Community Building

Building 2



Willowbrook: Peak Load Reduction

- Loads that can be shifted: cooling/heating
- Battery is 120kW/220kWh
- Collecting advanced metering infrastructure (AMI) data to set baselines and determine operation
- Four control strategies were performed:
  1. **TOU Management & Peak Shaving**: Futureproofing against rate changes for vulnerable populations
  2. **Solar Balancing**: Local load balancing with solar PV to get ready for electrification of buildings while avoiding distribution upgrades
  3. **GHG Emissions Reduction:** Managing storage to reduce GHG emissions from grid power used
  4. **Demand Response:** Meet grid needs by participating in Demand Response Auction Mechanism (DRAM)

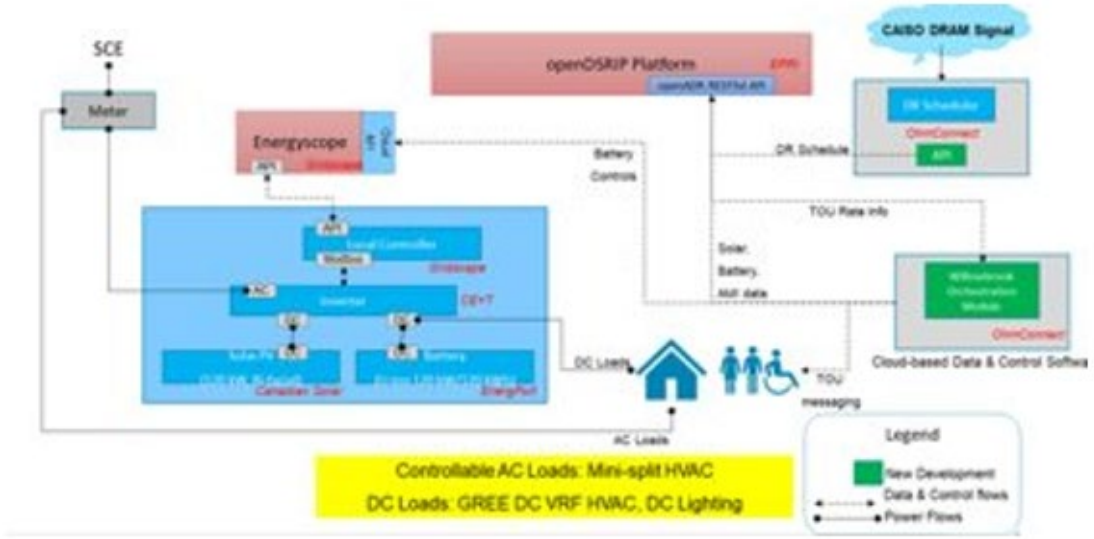


Figure 1: Hardware Control Architecture

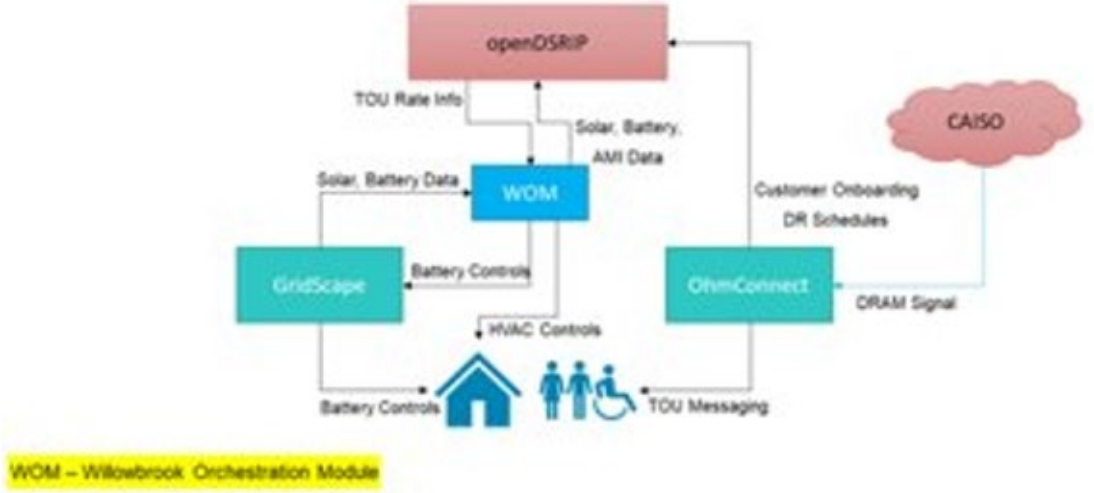


Figure 2: Software Architecture

EnergPort L3060 Battery Installation

355W Bi-facial PV Panels

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

Willowbrook: Project Status/Schedule

As of December 2021:

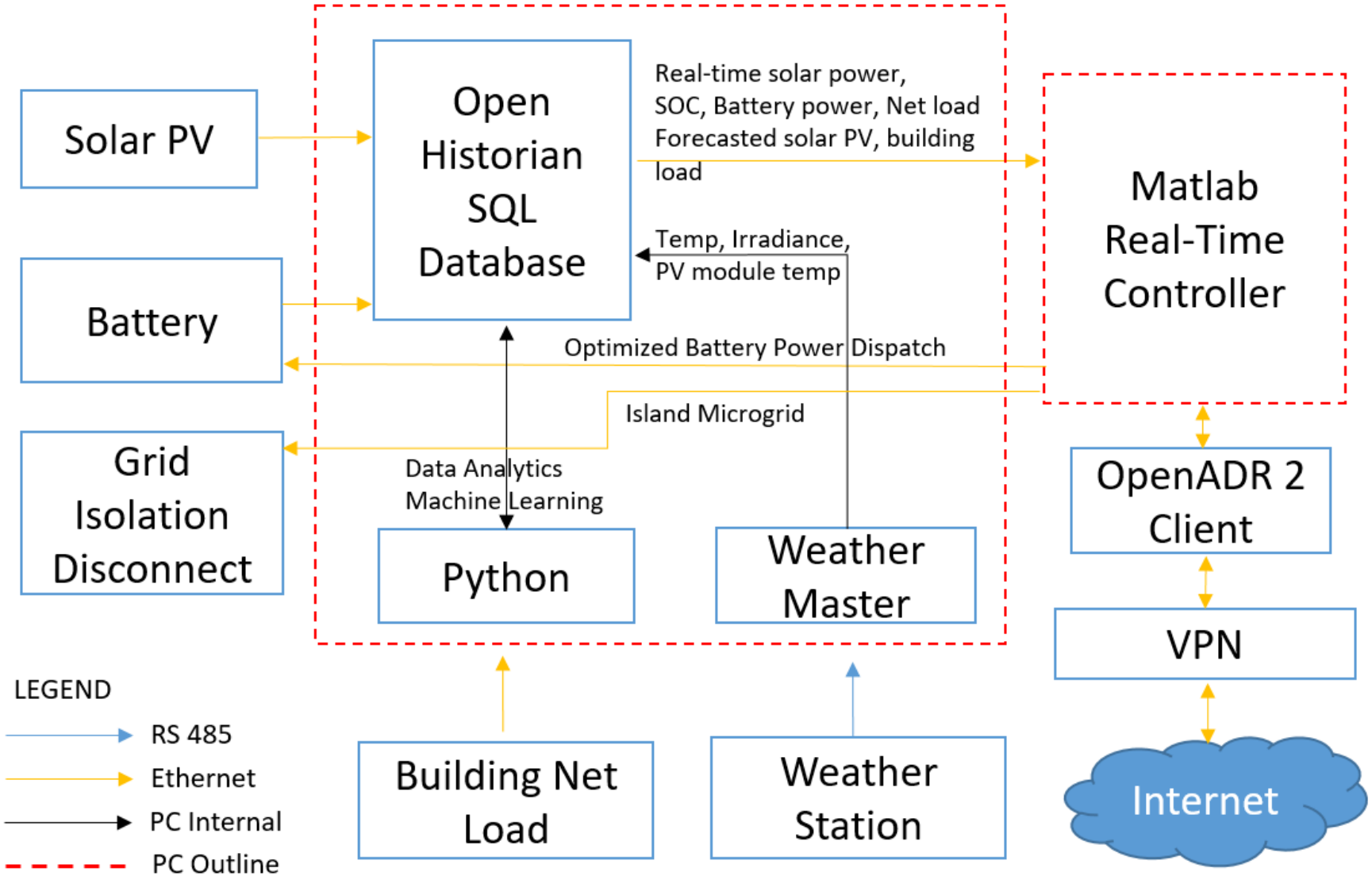
- **DC Permit and Installation**
  - Completed in November 2021
- **12 Months Data Collection**
  - Through February 2022
- **Final Report**
  - Completion by Q1 2022

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 (subject to change); 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

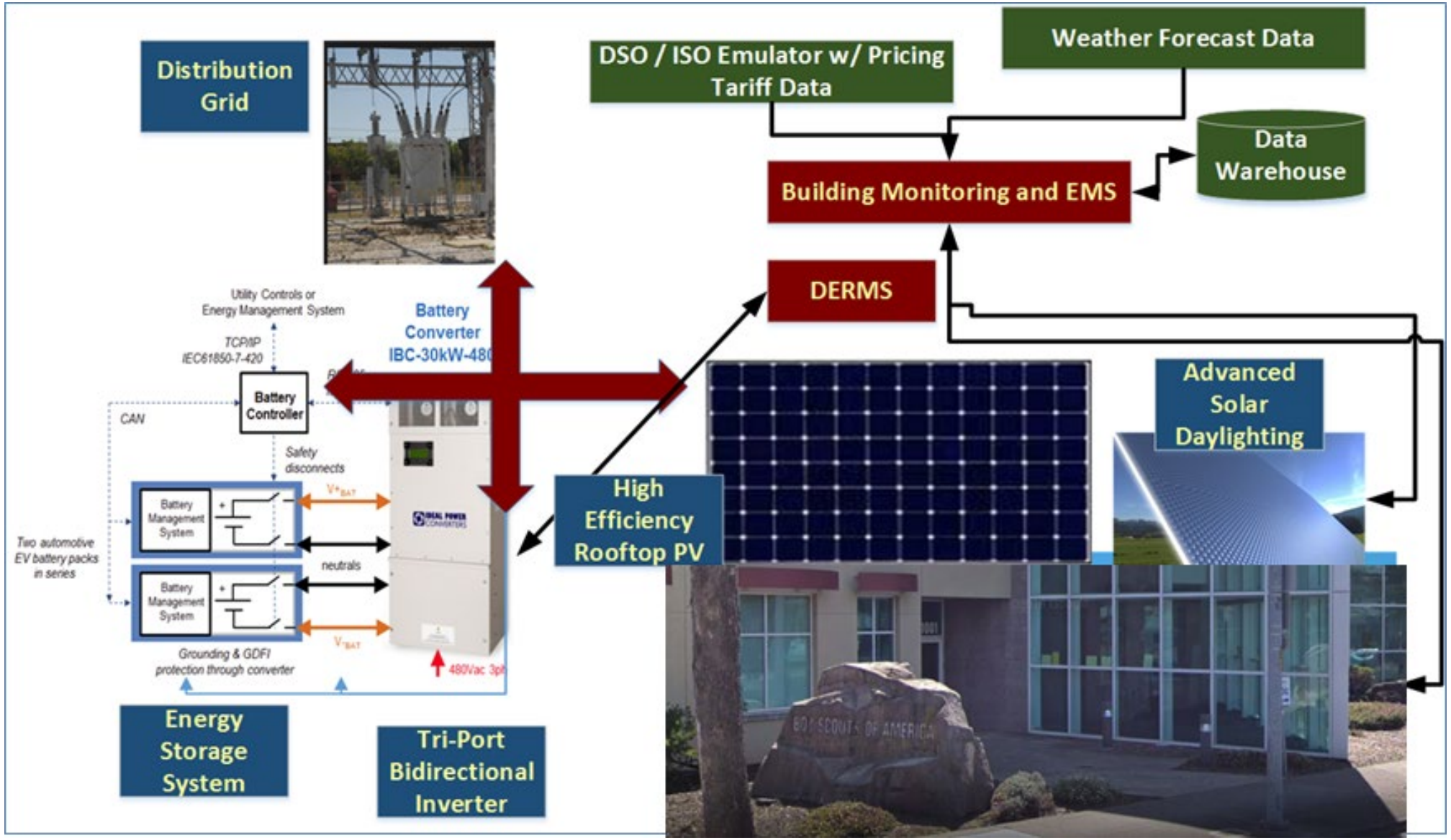
- **Building Occupancy**
  - Residency began early 2021
- **Solar PV**
  - Receiving updated quote from solar vendor
- **Battery Equipment**
  - Equipment to be delivered first half of 2022
- **Data Collection**
  - Second half of 2022

San Leandro Project

San Leandro: Project Goals

- Assesses the performance and benefits of integrated PV and battery with advanced energy efficiency, demand response, and distributed energy resource management technologies in a commercial building
- Goals:
  - Leverage the synergies of integrated and controllable components
  - Improve distribution grid stability and reliability
  - Reduce capital costs and operational and management costs for optimal value
- Expected benefits of the system:
  - Total lifecycle cost 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 (previous year's peak) in a Public Safety Power Shutoff 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

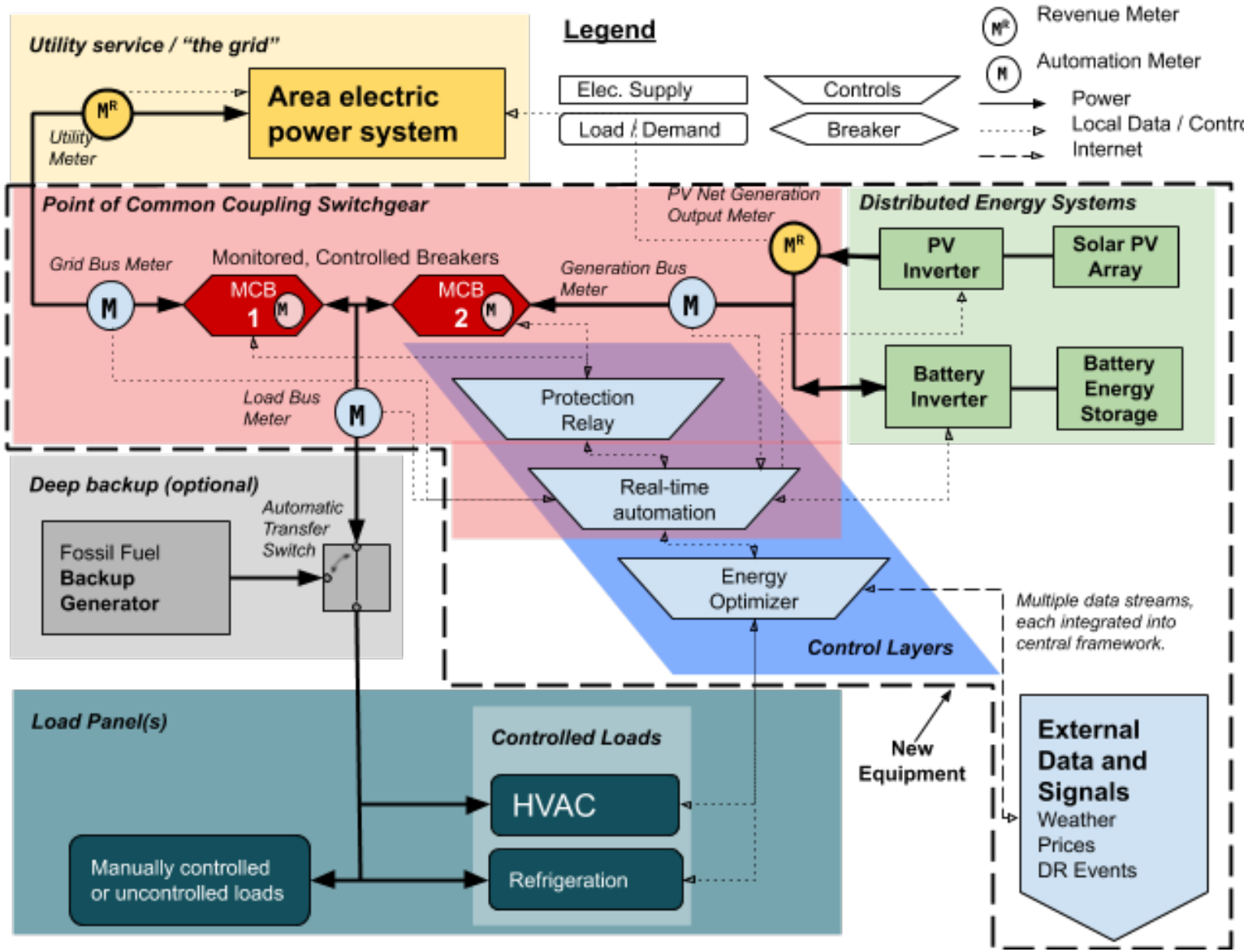
- System is operating and interconnected
- Building changed ownership
  - New owners will move in and be operational after the agreement term
  - New owners will use building as a biomedical facility that will have increased load
- Plan to demonstrate system under simulated load conditions

Blue Lake Project

Blue Lake: Project Overview

- Standardize 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
- Project benefits:
  - Cost savings of 32% in summer and 26% in winter
  - Decreased diesel consumption by 80%
  - Reduced solar curtailment by 13%

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
- Real-world use: 100% of load has been islanded using only PV and battery for up to 7 continuous hours
  - With use of onsite generator, the facility can be separated from the bulk grid indefinitely, with up to 50% supplied by onsite PV + battery and 50% supplied by onsite generator
- 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 within 8 seconds of receiving command

Blue Lake: Project Status

- Commissioned in August 2020
- Performed M&V throughout 2021
- Submitted final report and concluded in December 2021
- Advanced model-predictive building control software from TRL 6 to 7
- Team recommends development of standardized switchgear and continued deployment of microgrids to streamline future interconnection

Thank you!

Any questions?

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