NOVEMBER 16, 2022

UC Davis Journey Toward Optimizing Electrical Grid Responsiveness

David Trombly

UC Davis

- 40k Students
- 24k Faculty & Staff
- 1000+ Buildings, ~250 over 10,000 SF
- 11.3M SF total; 5,300 acres Land
- Founded 1905, Average Building Age: > 40 years
- $20M annual electricity spend
- 211M kWh/year electricity (average house is 11K kWh/year)

UC Davis

- Collaborations between faculty, students and staff on innovation, campus as a living lab projects, and accomplishments of key initiatives
- Many student internships with operations
- Project-based courses
- Deep dedication to sustainability at all levels

Optimizing Grid Responsiveness

UC DAVIS

Challenge

Achieve 100% renewable electricity goal

Integrate onsite production with state grid needs

Optimally dispatch large electrical loads

Expand use of electricity storage

Solution

Using AVEVA PI System to optimize dispatching of large cooling equipment and respond to grid emergency events

Adjusting building operations

Expanding backup capability

Using AVEVA PI System to improve electricity scheduling accuracy

Benefits

Leading the way for large campuses to help solve state challenges

$150K annual baseline cost savings

$240K savings/payments during recent heat event

Improved resiliency/reliability

AVEVA

Carbon Neutrality Initiative

UC, a national leader in sustainability, has pledged to become carbon neutral by 2025, becoming the first major university to accomplish this achievement.

Global climate disruption is impacting the planet in ways never experienced in human history. Warmer temperatures are contributing to changing weather patterns that cause more intense storms and heavier rainfall in some places, while elsewhere drought is parching the land. Glaciers are melting at an accelerated rate and oceans are rising.

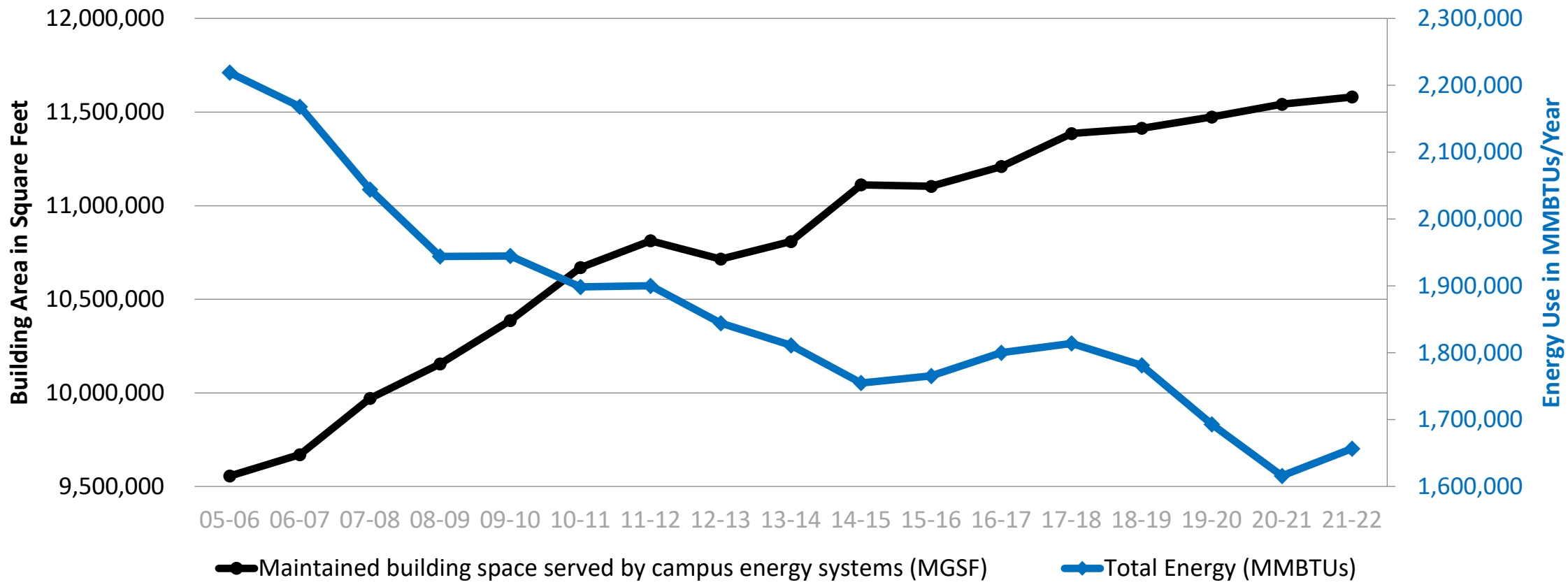
The overwhelming scientific consensus is that climate change is being driven by the release of carbon dioxide into the atmosphere, primarily from the burning of fossil fuels.

The University of California has responded to this growing environmental crisis with direct action aimed at ending its reliance on fossil fuels.

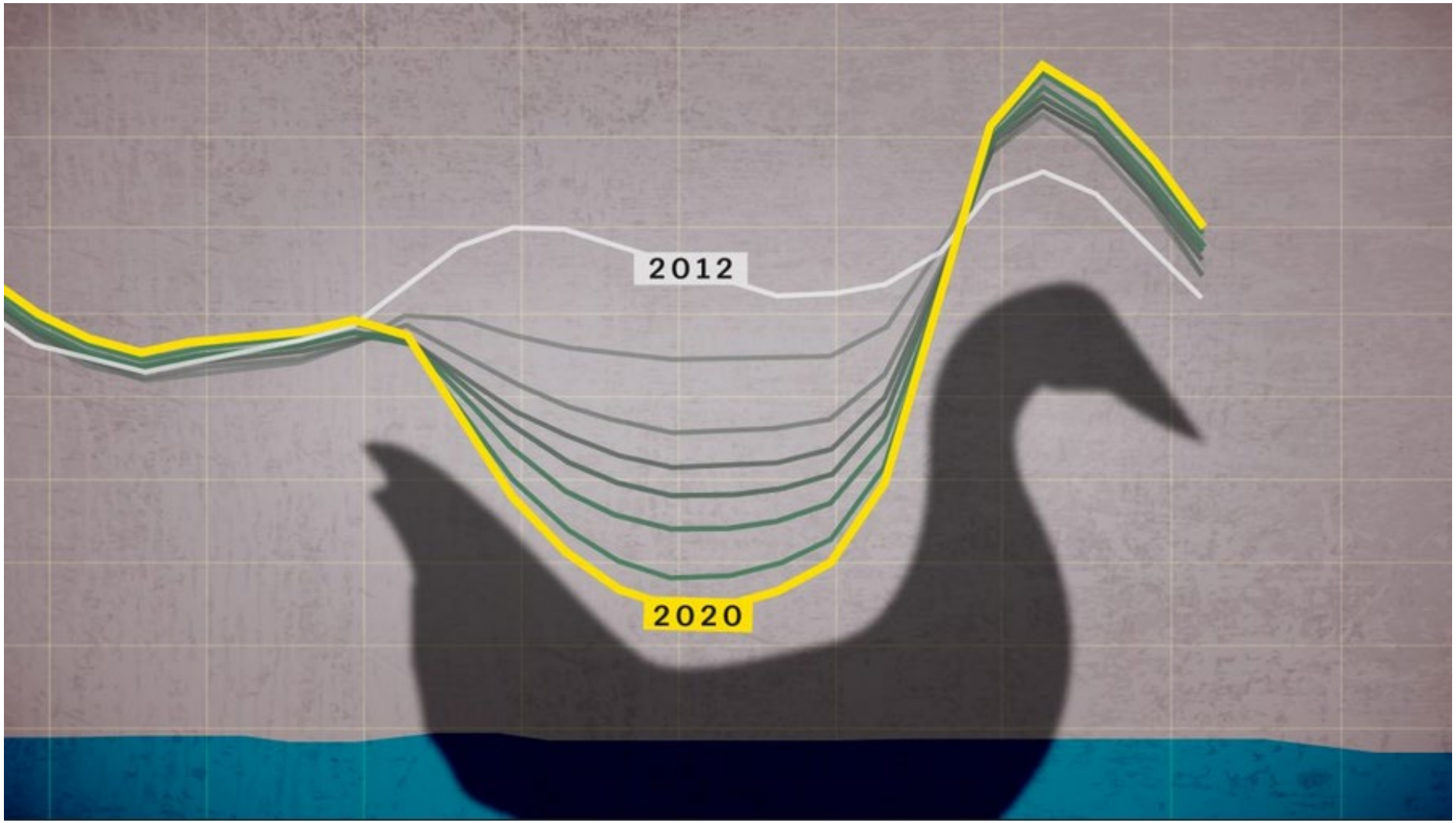
In November 2013, President Janet Napolitano announced the Carbon Neutrality Initiative

"We are the University of California, and there is no

UC Davis Energy Journey

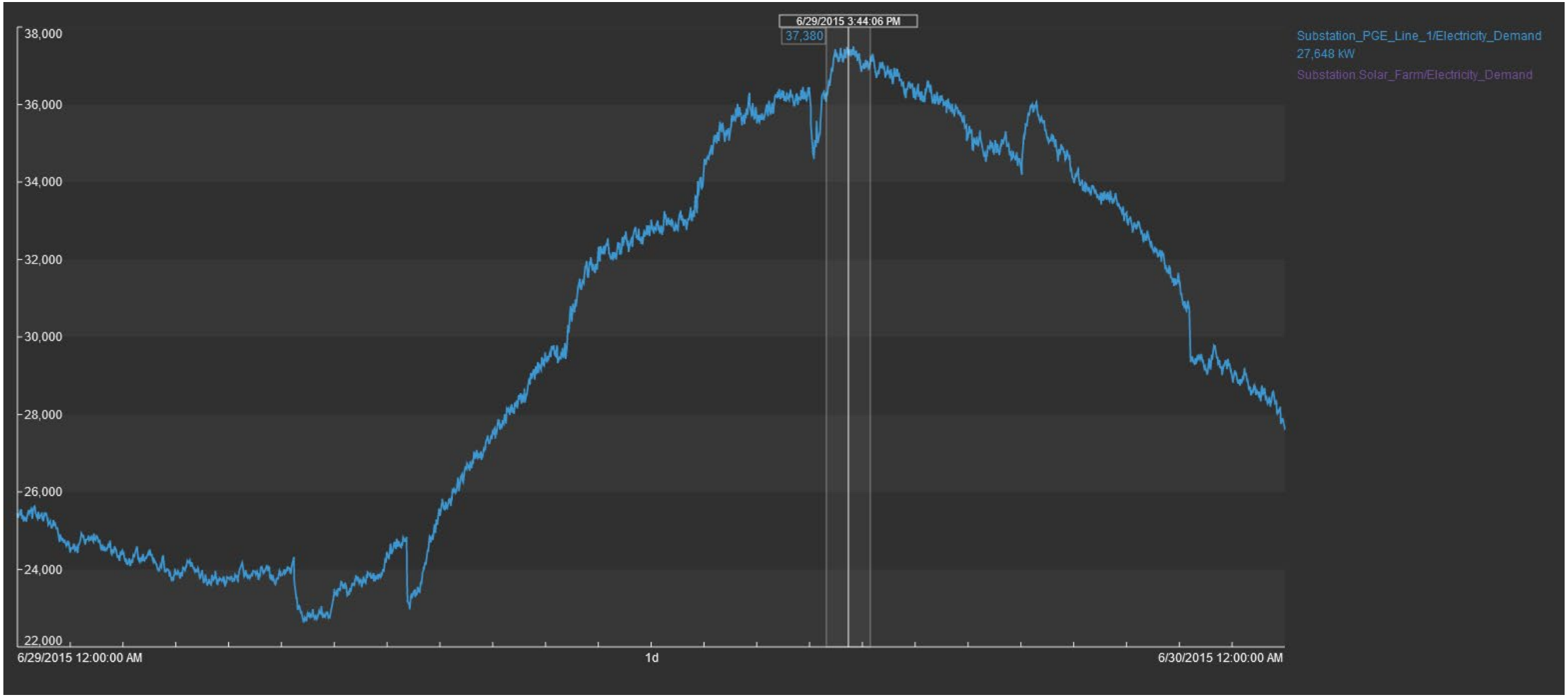


Duck Curve

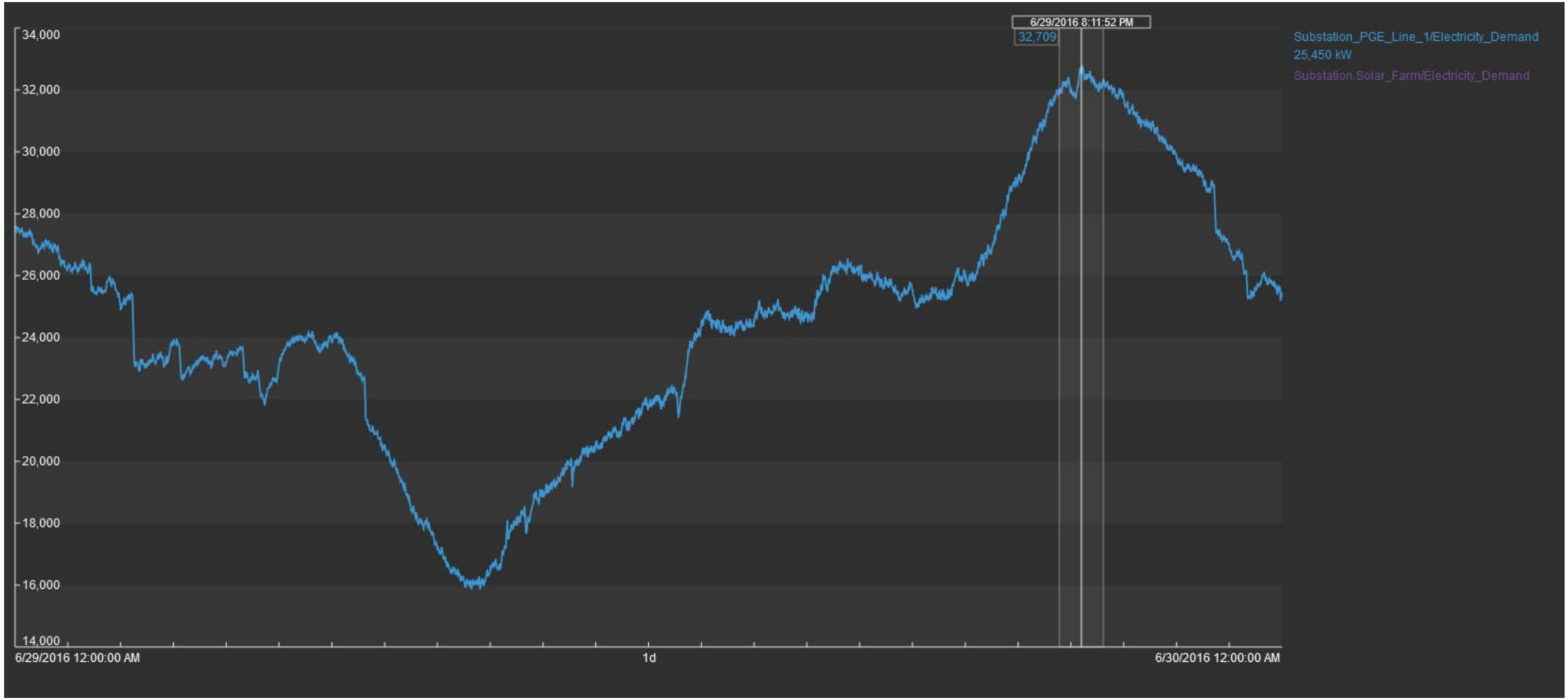



13.7 MWAC behind the meter solar farm; ~15% of total electricity

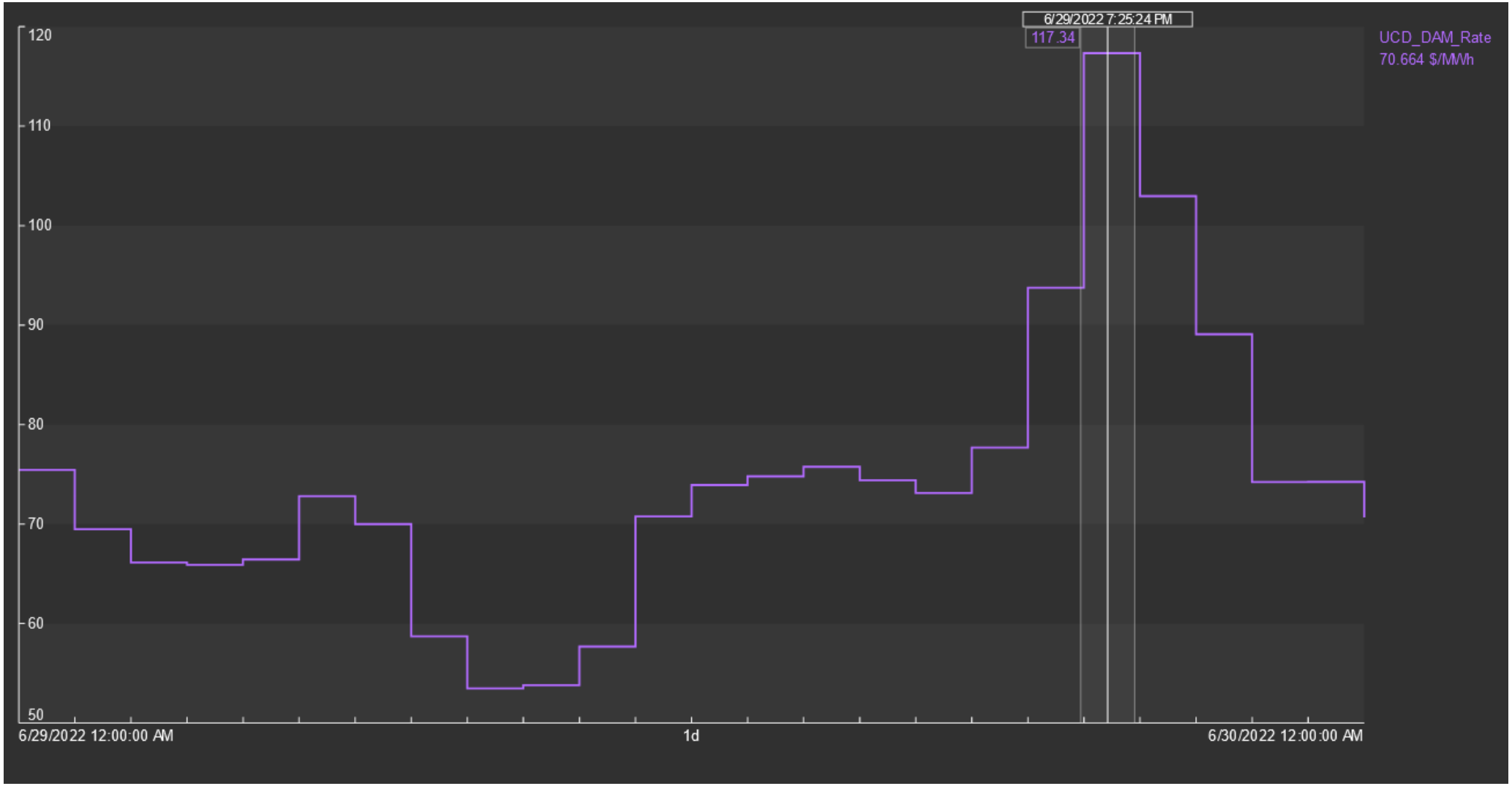
Grid Draw Before Solar Farm



Grid Draw After Solar Farm



Electricity Price – Grid Supply



Duck Curve Solutions

- Base load power
- Flexible loads
- Storage (battery, energy storage, etc)
- How can UC Davis help?

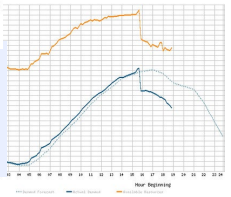
Chiller/Energy Storage Tank System (like a battery)

11% of total campus electricity

Chiller Dispatch Optimization

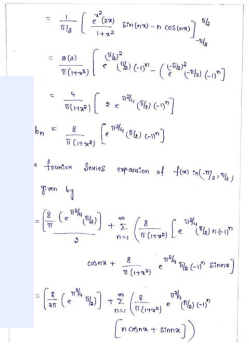
California ISO

Electricity Price (CAISO API)



Weather Forecasts

Load Predictions (Machine Learning)



UFL Interface

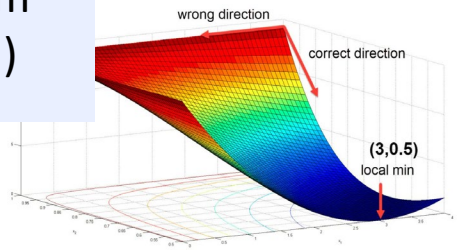
PI Web API

Chiller/Chilled Water System Performance (AVEVA System Platform)

RDBMS Interface

AVEVA PI System

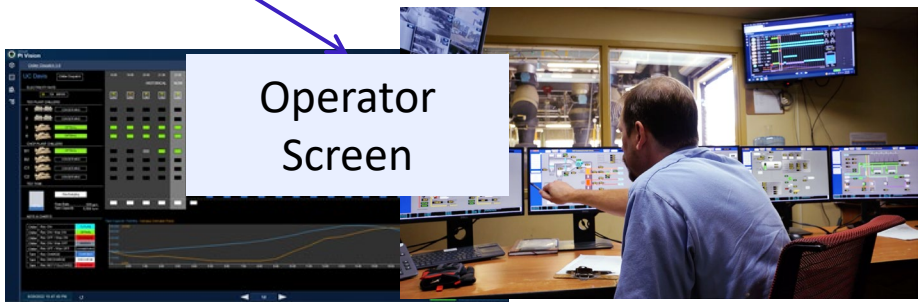
Optimization Algorithm (Python)



OPC Interface

PI Vision

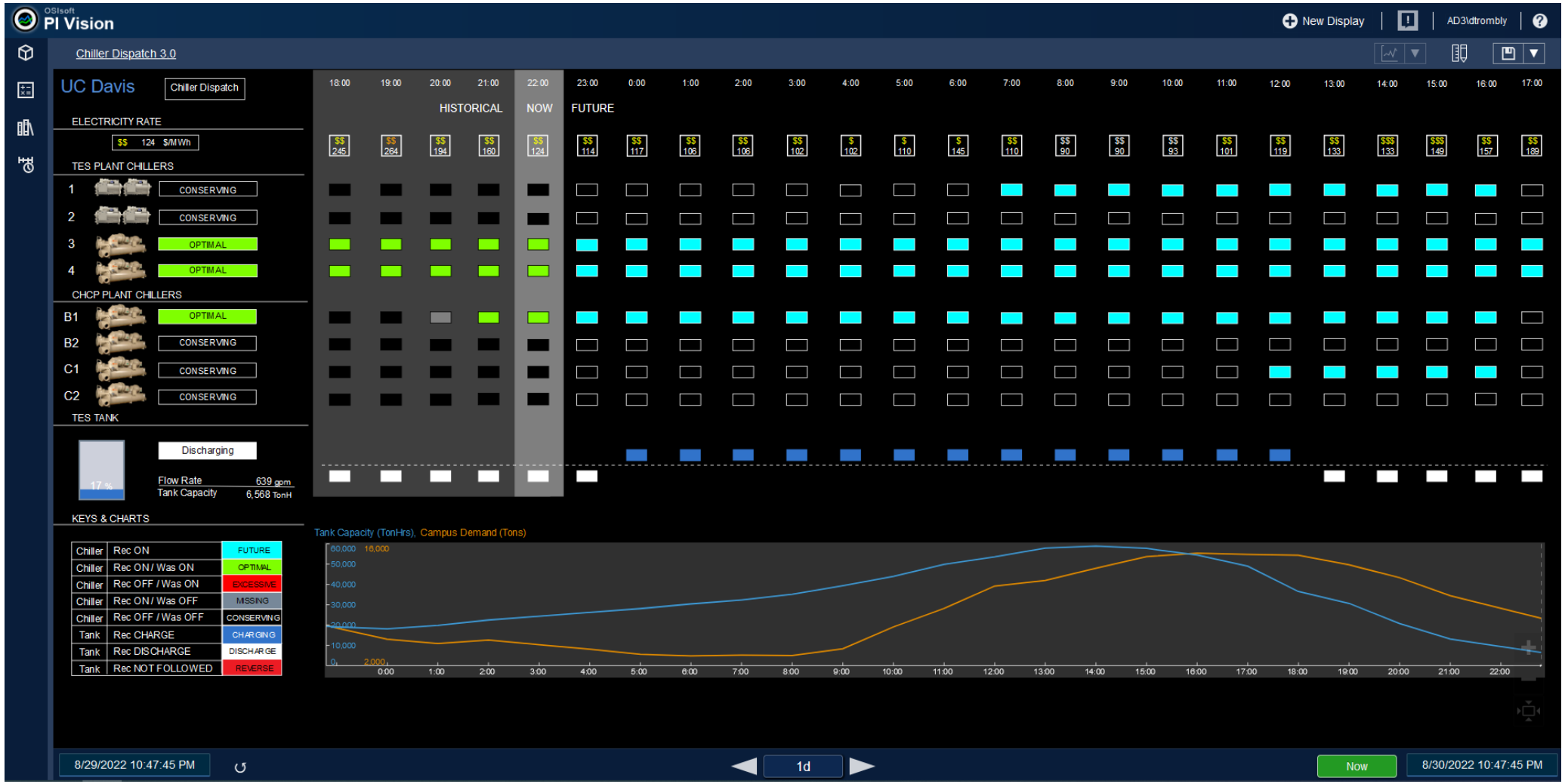
Electricity Metering (Schneider Electric ION)



Operator Screen

AVEVA

Operator Engagement



Campus Engagement

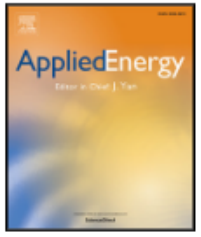
- Research paper with two professors, three grad students, three staff
- Master's thesis

Applied Energy 300 (2021) 117389

Contents lists available at ScienceDirect

Applied Energy

journal homepage: www.elsevier.com/locate/apenergy



Optimal real-time dispatching of chillers and thermal storage tank in a university campus central plant

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ARTICLE INFO

Keywords:
Energy systems optimization
HVAC
District Cooling
Central chiller plants
Process scheduling

ABSTRACT

Recent studies have indicated a great potential for applying predictive methodologies to the operation of Heating, Ventilation and Air Conditioning (HVAC) systems. Particularly for Centralized Chiller Plants with Thermal Energy Storage (TES) used for District Cooling, there is a substantial opportunity for cost savings when responding to variations in electricity price and ambient temperature. The present work addresses the problem of closed-loop scheduling of a large-scale chiller plant with TES tank under a Day-Ahead (DA) electricity price program. The main contributions include: (i) formulating the problem for a real large-scale complex system; (ii) comparing different dispatching policies with varying degrees of optimality, constraint satisfaction and operational complexity; and (iii) designing an optimization-based scheduling tool and describing its implementation and results. The proposed Mixed-Integer Linear Programming (MILP) formulation extends

Results: 9/4/22 through 9/9/22

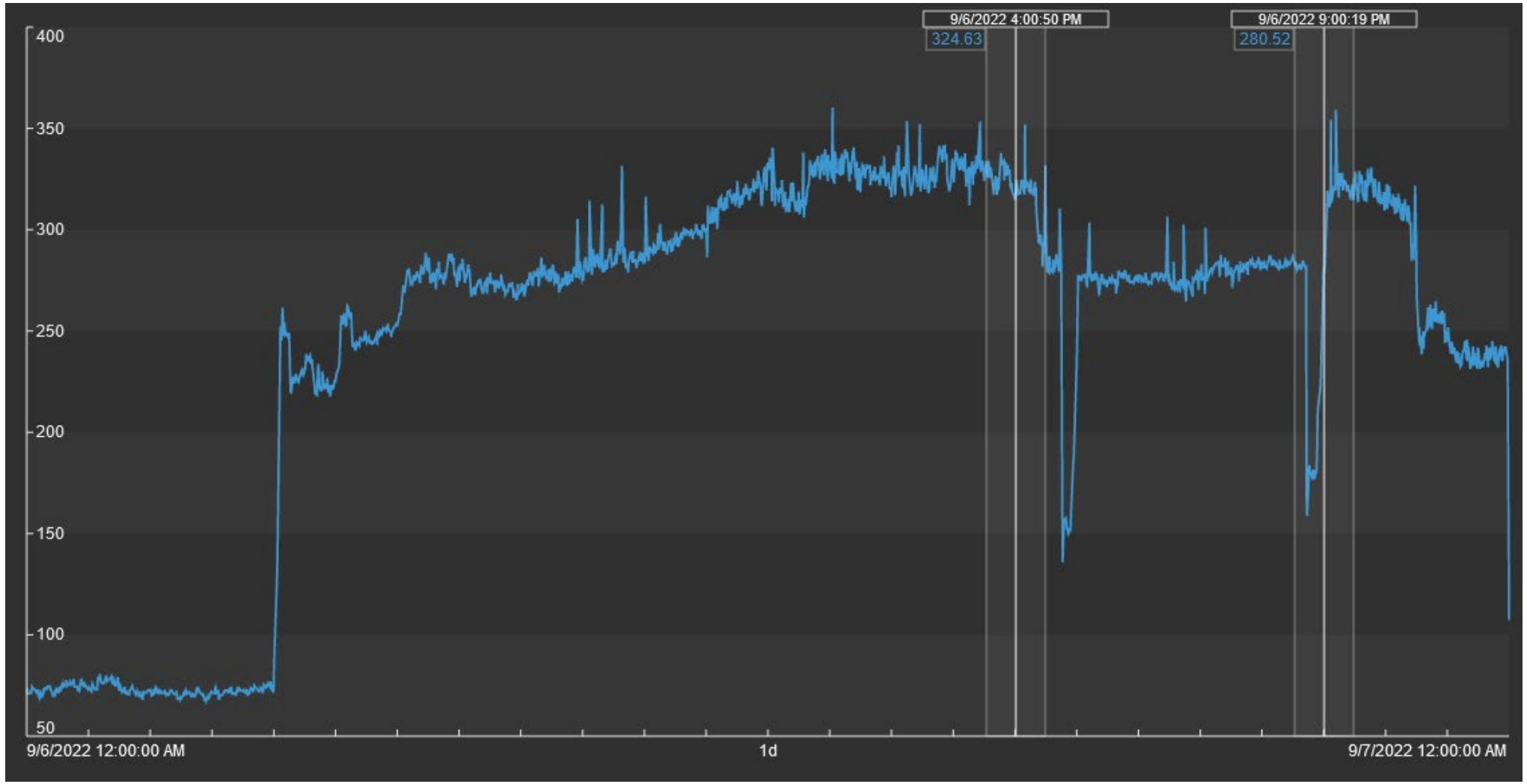
Top (kW)
Total campus power
Total chiller plant power

Bottom ($/MWh)
Day ahead market rate
Real time rate

Results in 6-day window (9/4/22 through 9/9/22)

- Baseline savings: $150k/year
- Estimated 91MWh DR provided
- Estimated $60k savings
- Estimated $180k DR payments

Grid Responsive Buildings



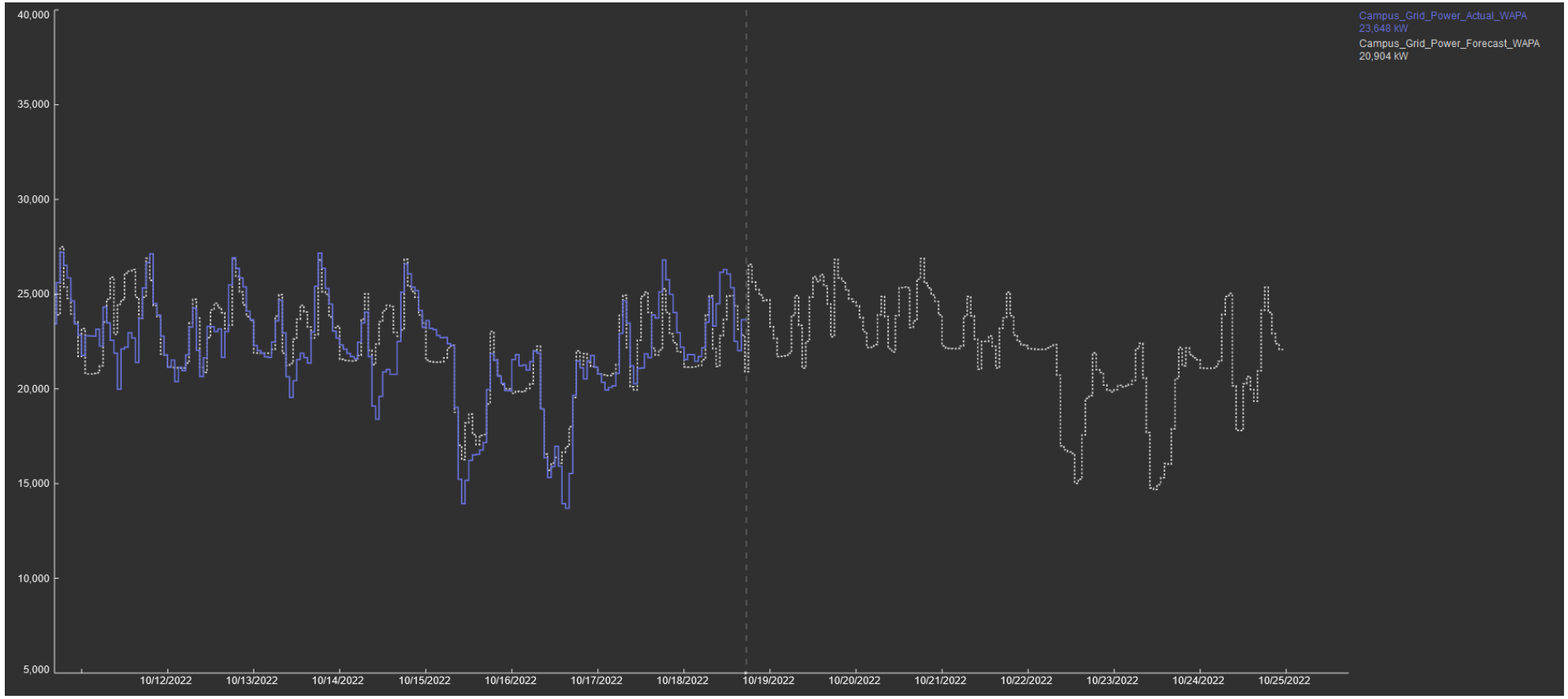
Battery Backup

- CPUC SGIP Grant for 750kW four-hour battery
- Backup of cooling plant pumps
- Economic dispatch/grid responsiveness

Improving Electricity Scheduling

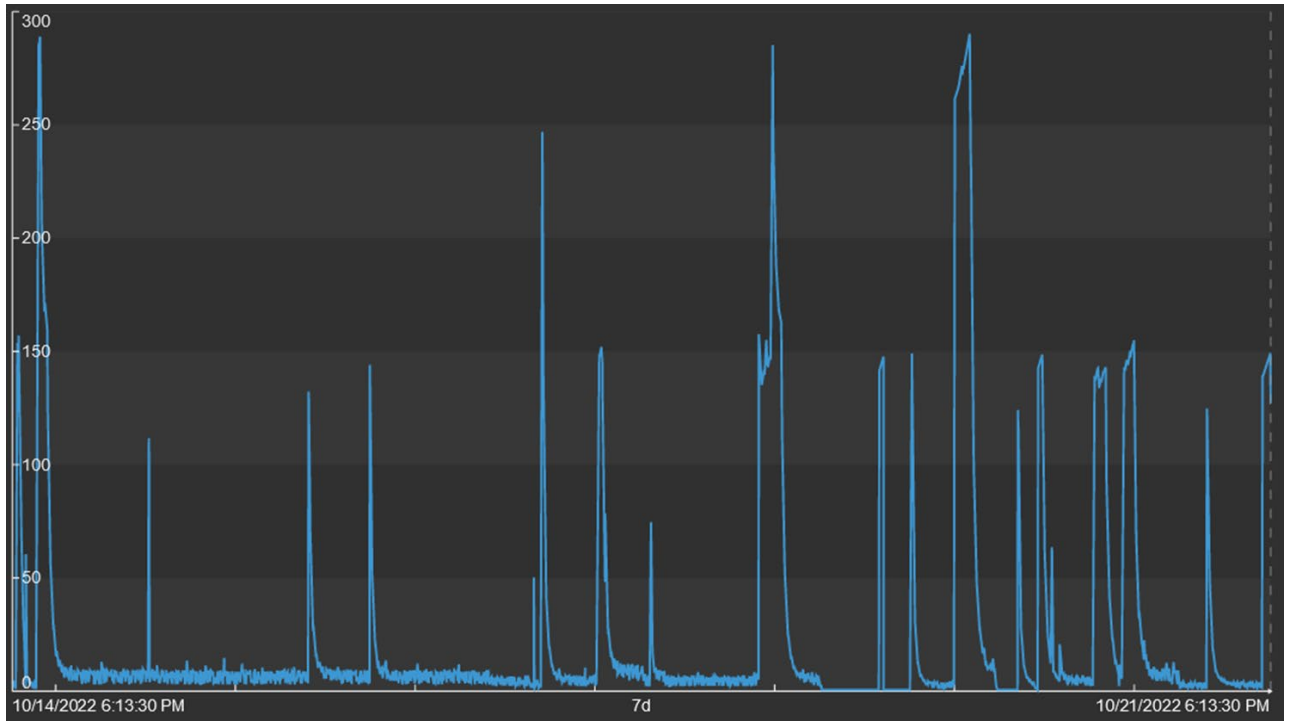
- Electricity purchased/scheduled by third party scheduling coordinator
- Desire to improve accuracy of scheduling
- Desire to have control of scheduling for future grid responsiveness

Improving Electricity Scheduling



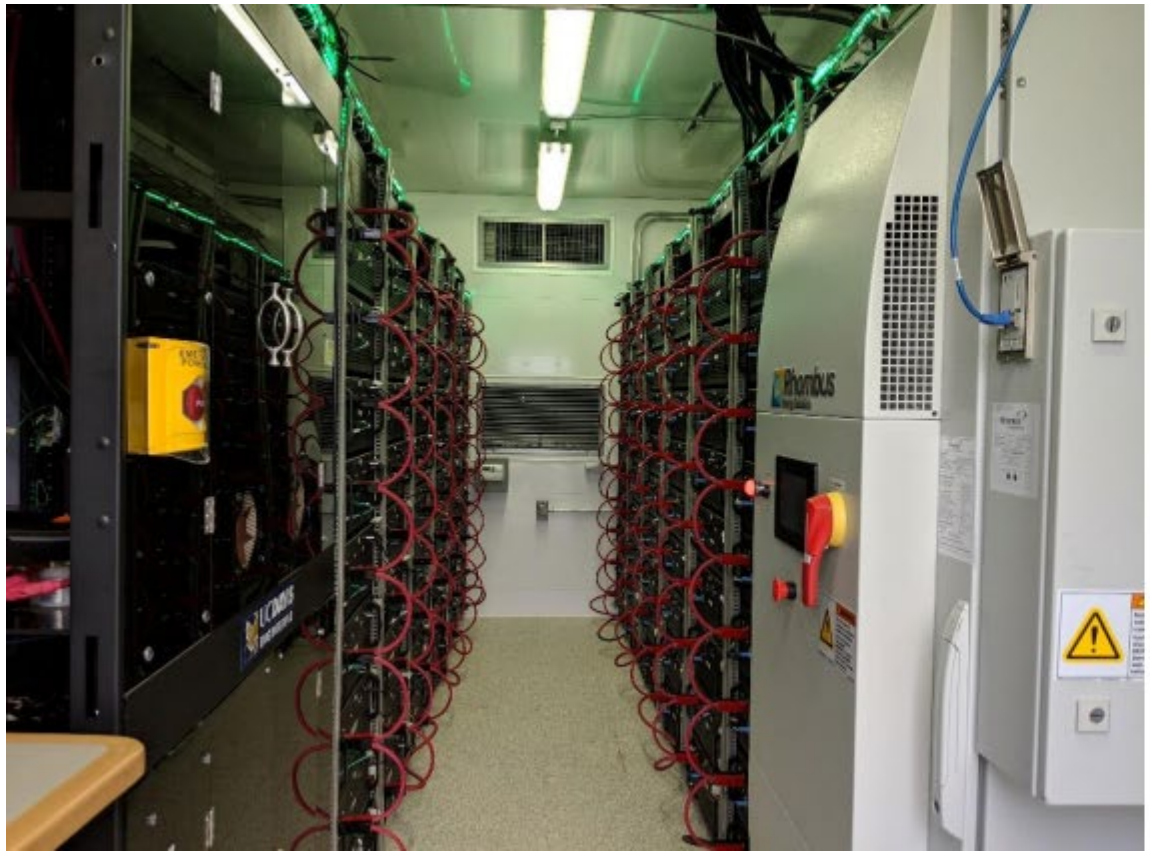
UC Davis Unitrans Electric Buses

6 Busses with 150 kW chargers

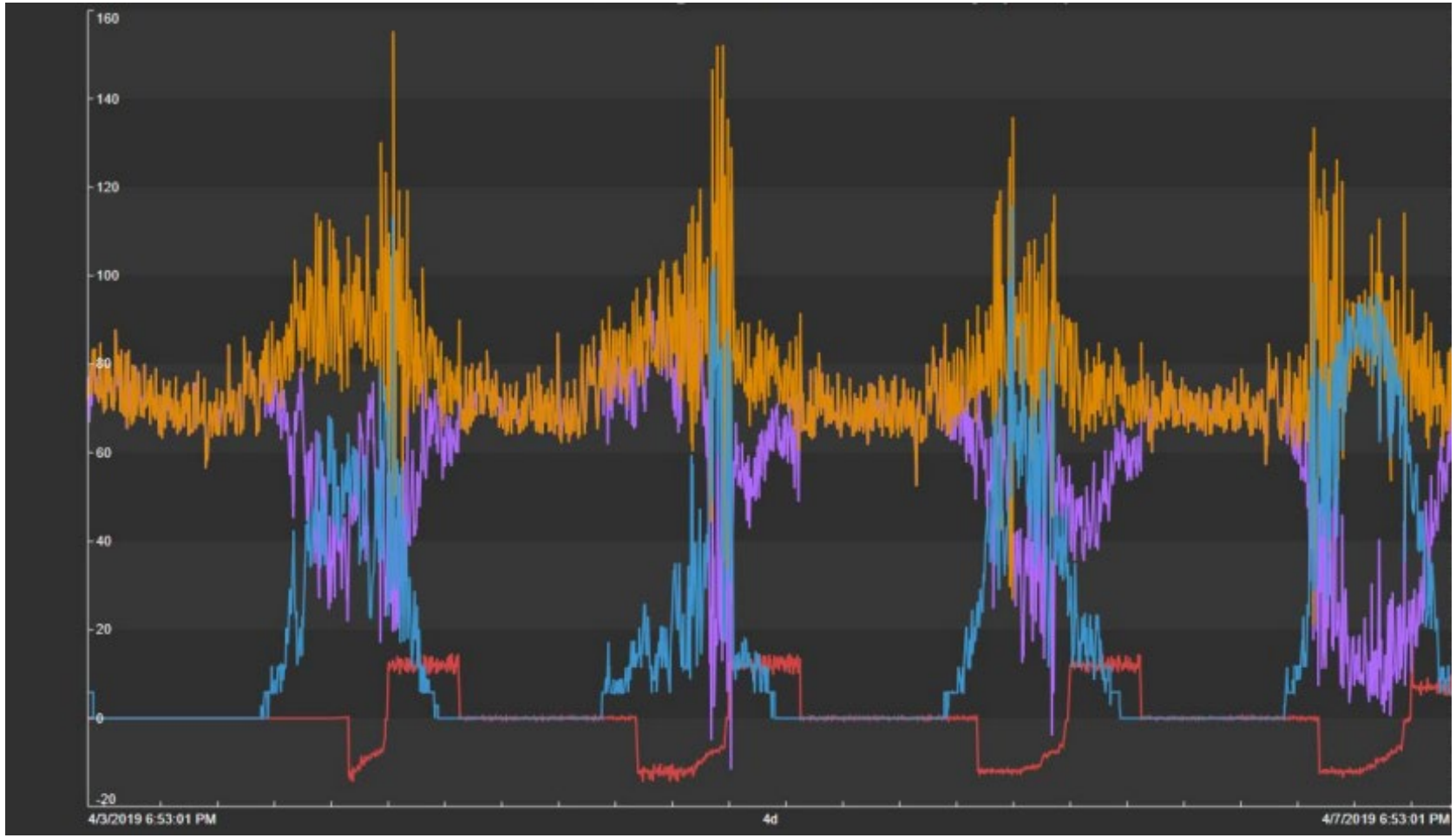


Nissan 2nd life batteries on campus

California Energy Commission Grant to UC Davis & OSIsoft joint project



Microgrid aggerate summer power

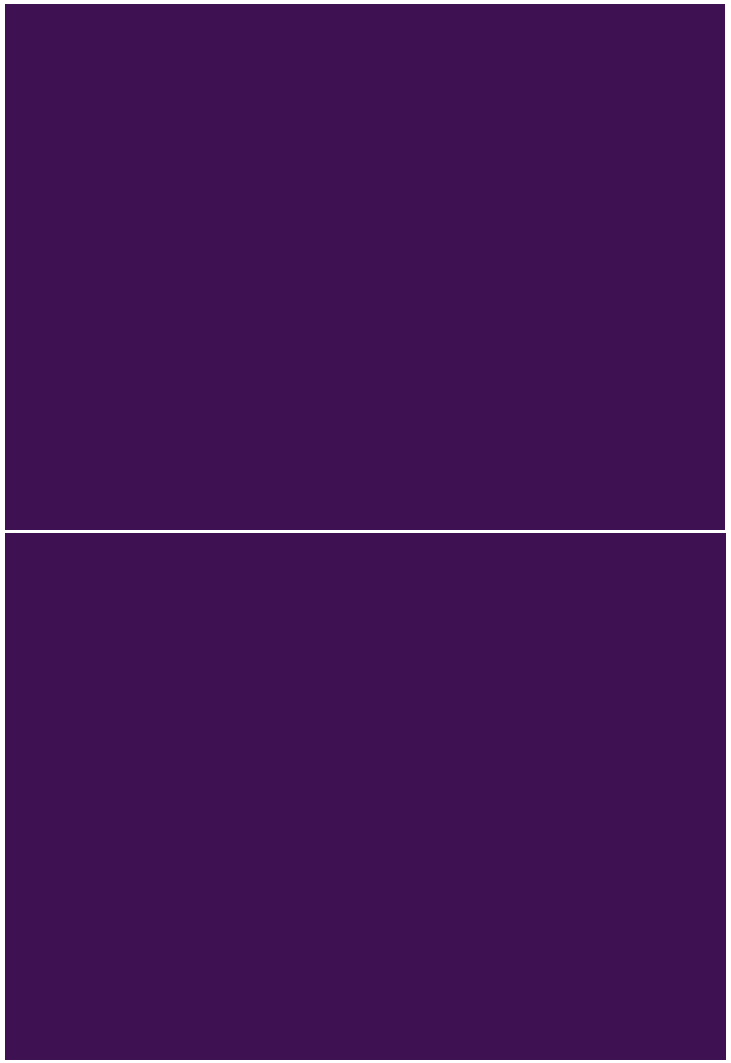


- Blue – Solar PV
- Red – Battery
- Orange – Demand
- Purple – Net Demand

- Battery charges from PV and discharges when PV drops off helping mitigate the duck curve.

Next steps

- More onsite renewables (feasibility study in progress)
- More battery back up (feasibility study in progress)
- Adjust for electrification of heating system
- Bus charging dispatching
  - Planning for 50 electric buses, ~4MW of semi-flexible load
- Expanded shifting of building loads



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Over 20,000 enterprises in over 100 countries rely on AVEVA to help them deliver life's essentials: safe and reliable energy, food, medicines, infrastructure and more. By connecting people with trusted information and AI-enriched insights, AVEVA enables teams to engineer efficiently and optimize operations, driving growth and sustainability.

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