

ET Summit 2024

Presented by



A Design, Development and Testing Framework for Demand Flexible Technologies

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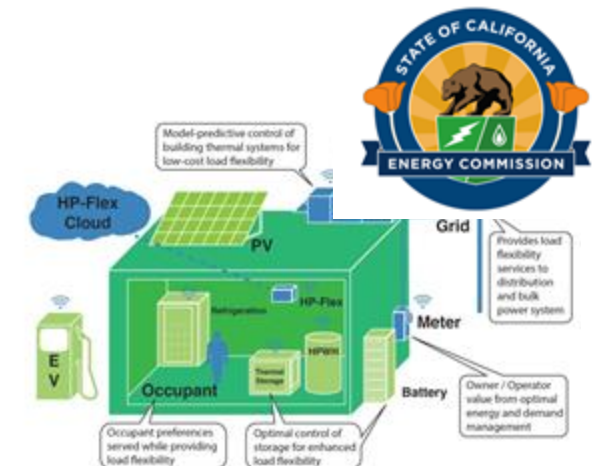
Mark Martinez, SCE



Lawrence Berkeley
National Laboratory



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Energy for What's Ahead®





Key Takeaways

- Evaluating demand flexibility is challenging
- Lab and field tests have limitations for certain technologies
- We can use FLEXLAB + Modeling to reduce tech risk and cost
- This process can benefit vendors, customers and Utilities
- Example: Development and test of demand flexible controls for Heat Pumps (yes they work)

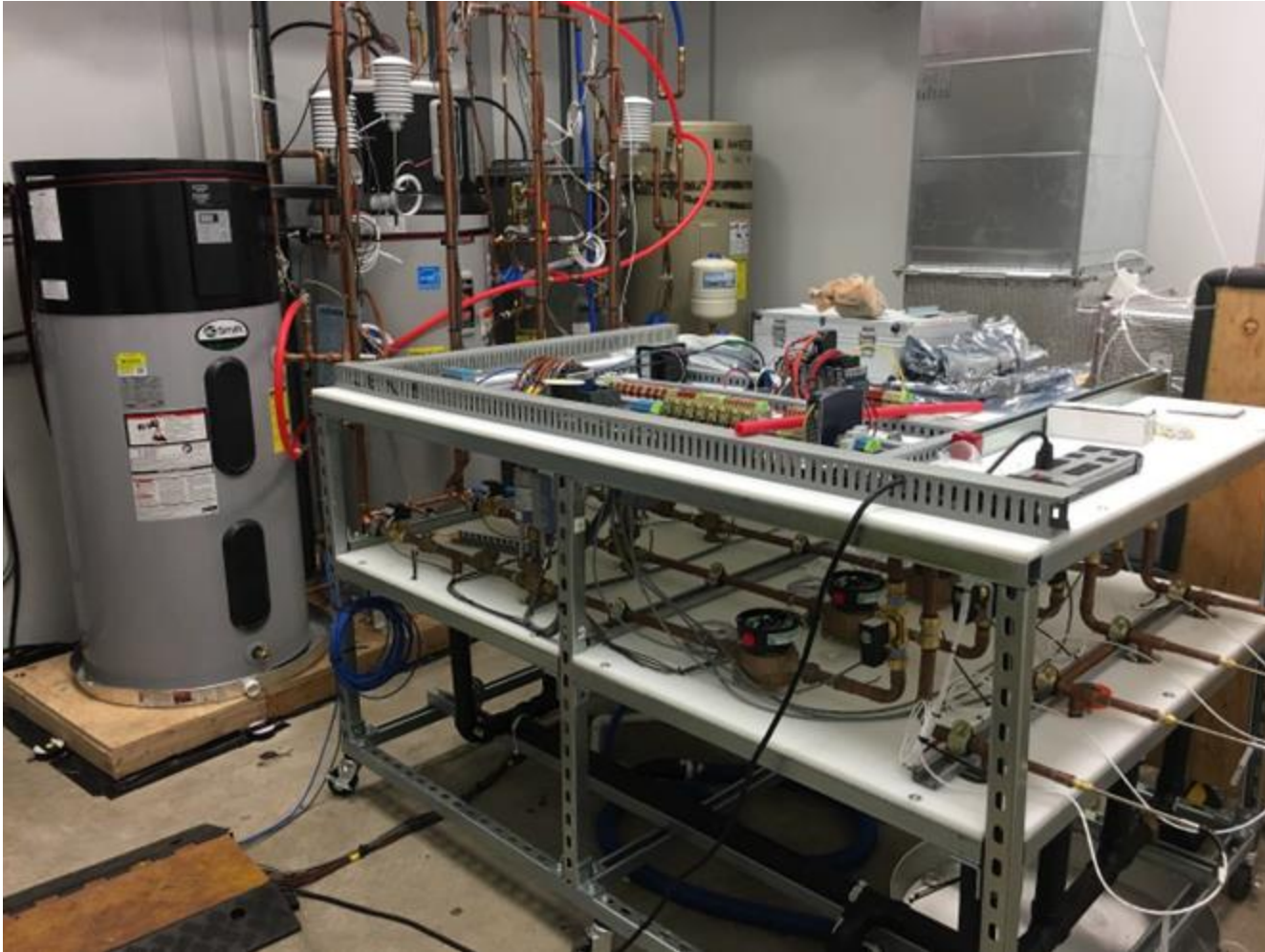
Motivation

Let me introduce you to our new magic Demand Flexible Technology



Does it work?

Lab Test



Advantages:

- Highly controlled environment

Disadvantages:

- Conditions may not be realistic

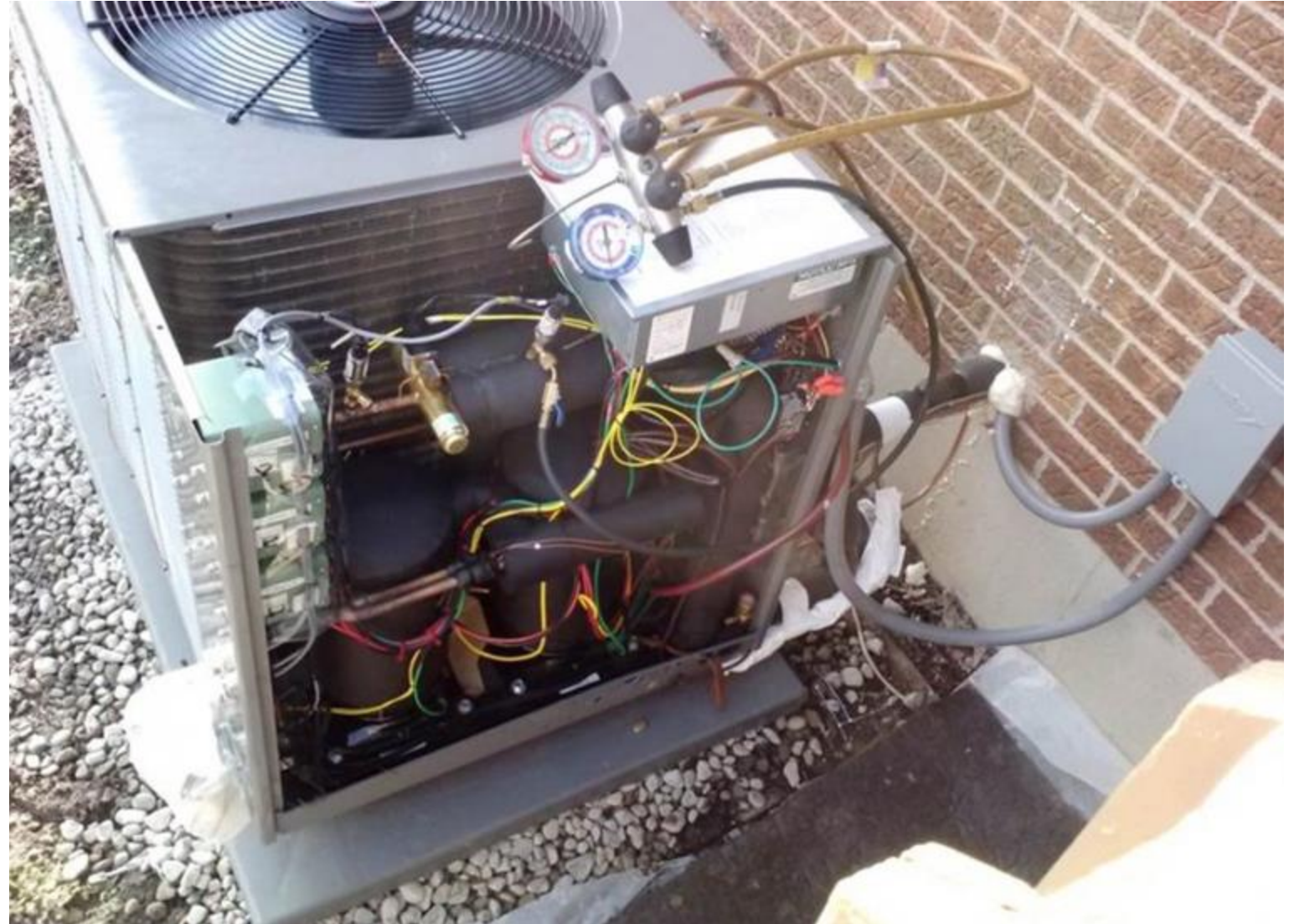
Field Test

Advantages:

- Realistic conditions

Disadvantages:

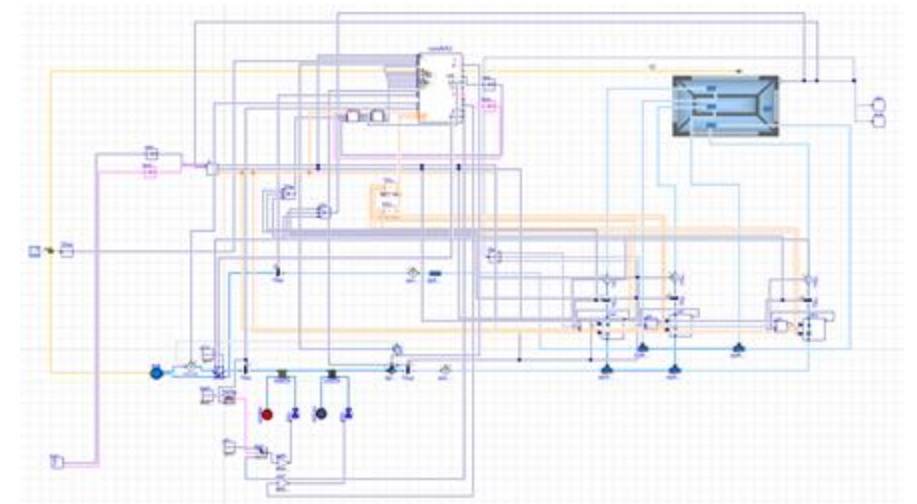
- Very expensive (\$\$\$)
- Take a long time
- May not be representative of all customers (hard to generalize)



FLEXLAB

+

Physics-Based Models



(Hardware in the Loop)

Decarbonization -> electrification -> heat pumps



Reduce U.S. building emissions 65% by 2035 and 90% by 2050 vs. 2005 while enabling net-zero emissions economy wide and centering equity and benefits to communities

CUTTING GOALS

- Equity** – Advance energy justice and benefits to disadvantaged communities
- Affordability** – Reduce energy burden and technology costs so all can benefit
- Resilience** – Increase the ability of communities to withstand and recover from stresses

STRATEGIC OBJECTIVES

- Increase building energy efficiency**
Reduce on-site energy use intensity in buildings 35% by 2035 and 50% by 2050 vs. 2005
- Accelerate on-site emissions reductions**
Reduce on-site GHG emissions in buildings 25% by 2035 and 75% by 2050 vs. 2005
- Transform the grid edge**
Reduce electrical infrastructure costs by tripling demand flexibility potential by 2050 vs. 2020
- Minimize embodied life cycle emissions**
Reduce embodied emissions from building materials and construction 90% by 2050 vs. 2005



CALIFORNIA'S CLIMATE PLAN LAYS THE ROADMAP TO 2045

- CUT AIR POLLUTION 71%**
- SLASH GREENHOUSE GAS EMISSIONS 85%**
- DROP GAS CONSUMPTION 94%**
- CREATE 4 MILLION NEW JOBS**
- SAVE CALIFORNIANS \$200 BILLION IN HEALTH COSTS DUE TO POLLUTION**

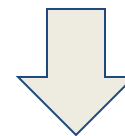


SOUTHERN CALIFORNIA EDISON
Energy for What's Ahead™

COUNTDOWN TO 2045

- DECARBONIZE ELECTRICITY**
100% RETAIL SALES 100%
- ELECTRIFY TRANSPORTATION**
90% OF VEHICLE 75%
- ELECTRIFY BUILDINGS**
95% OF BUILDINGS 70%
- USE LOW-CARBON FUELS**
48% NON-ELECTRIC ENERGY 43%
- SINK REMAINING CARBON**
75 MMT CARBON SINK FOR MMt

CARBON NEUTRALITY BY 2045



Reduced GHG footprint by using low global warming potential refrigerants

Greater heating efficiency and capacity at 5T compared to the latest ENERGY STAR heat pumps

45%

Increased utility bill savings

Improved comfort of home occupants

Advanced controls for grid flexibility and demand response

More efficient across broader range of operations to provide utility bill savings for part load

U.S. DEPARTMENT OF ENERGY



Can they provide demand flexibility?

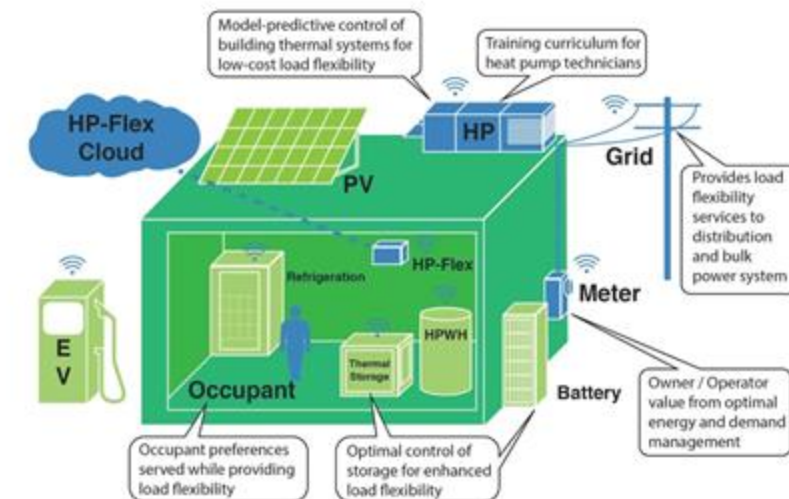
Heat pumps for Small Commercial Buildings

Status quo

- Native controls are **not typically demand or price responsive**, do **not coordinate** operation of multiple units.

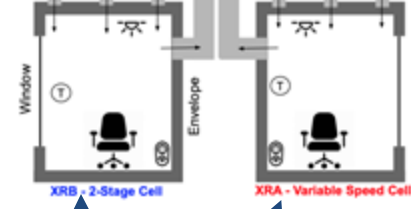
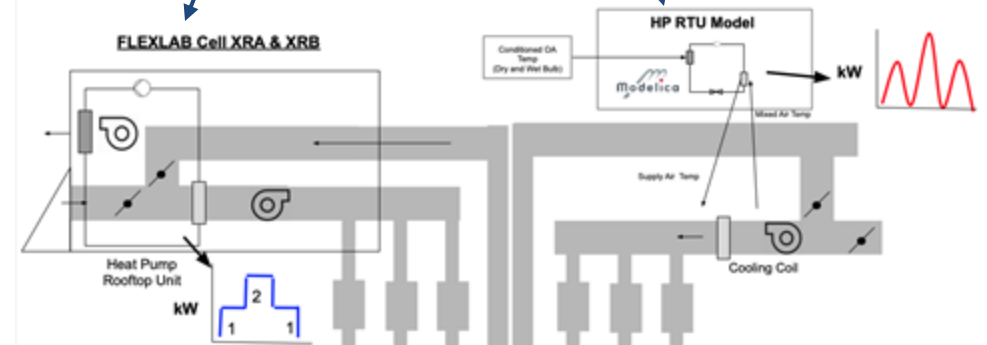
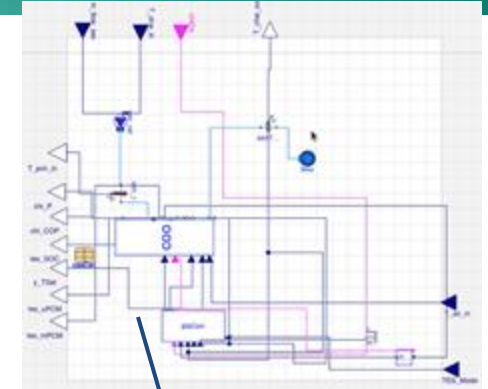
What we want to test:

- A new control “platform”:**
 - Shifting load by responding to **dynamic prices**
 - Reducing **peak load**
 - Reducing **GHG emissions**
 - Maintaining **comfort**

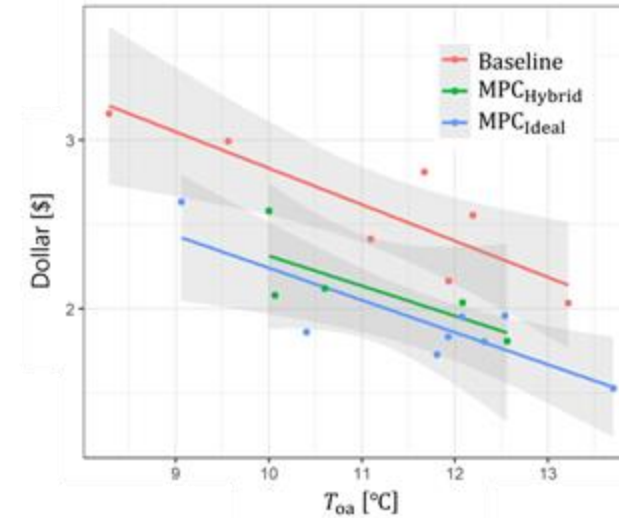
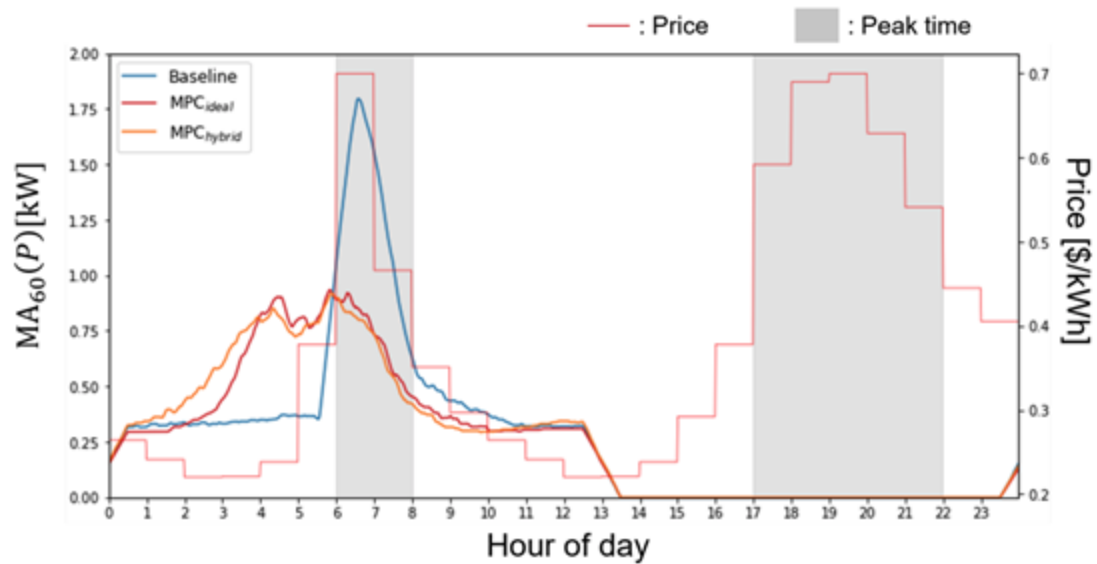


Test Setup

- **System tested:** RTU-HP
- **Baseline system:** Calibrated Model of a HP-RTU in the Loop
- **Demand Flexibility Tested:** Load Shift via Dynamic Prices (CalFlexHub/MIDAS)
- **Control Algorithm Tested:** Model Predictive Controls (MPC)
- **Baseline Algorithm:** Rule-based



Test Results (quantitative)



	Peak [kW]	Peak Reduction [%]	Daily HVAC Energy Cost [\$]	Daily HVAC Energy Cost Saving [%]
Baseline	3.0	0%	2.6	0%
MPC _{ideal}	2.0	33%	2.0	24%
MPC _{hybrid}	1.9	27%	2.1	18%

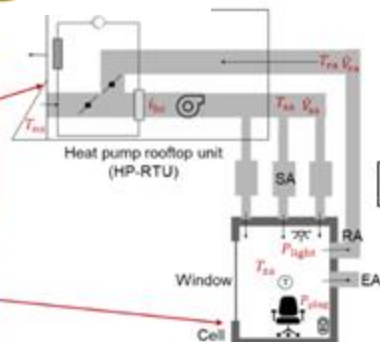


Test Results (qualitative)

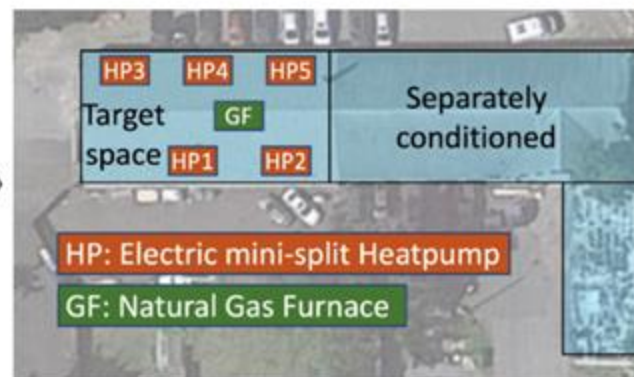
- **Performance**
 - Setting up rule-based controls to minimize cost and maintain comfort is challenge.
 - After setup MPC can respond to several grid signals without code changes
- **MPC can reduce peak load, cost/GHG, and shift load while maintaining comfort.**
 - MPC w/ no additional sensors shows similar performances to the MPC w/ more sensors
- **Interoperability**
 - Protocol translation, API integration, proprietary system are still a barrier to scale
 - Working on automatic configuration to reduce cost
- **HIL can be used to reduce tech risk and cost**
 - Debug and tweak controls
- **This process reduces risk in developing new products!**

From the Lab to the Field

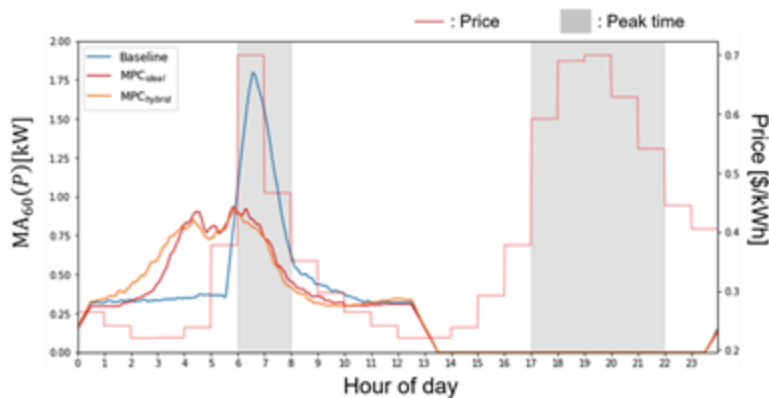
FLEXLAB



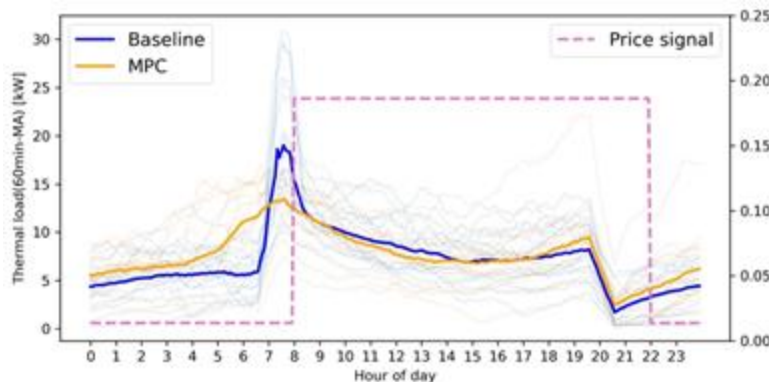
Site in NY



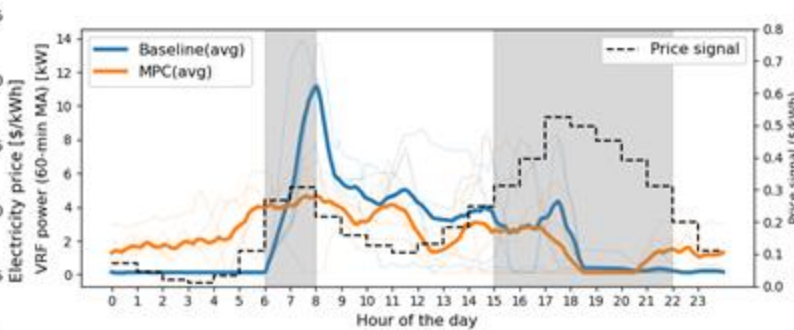
UC Davis



- HVAC Cost Savings **18-24%**
- HVAC Peak Reduction **27-33%**



- HVAC Cost Savings **27%**
- HVAC Load Shifted **23%**



- HVAC Load Shifted **21%**

From the Lab to the Field



Western Cooling Efficiency Center, UC Davis



Church of God, Menlo Park



Bethel Community Church, San Leandro



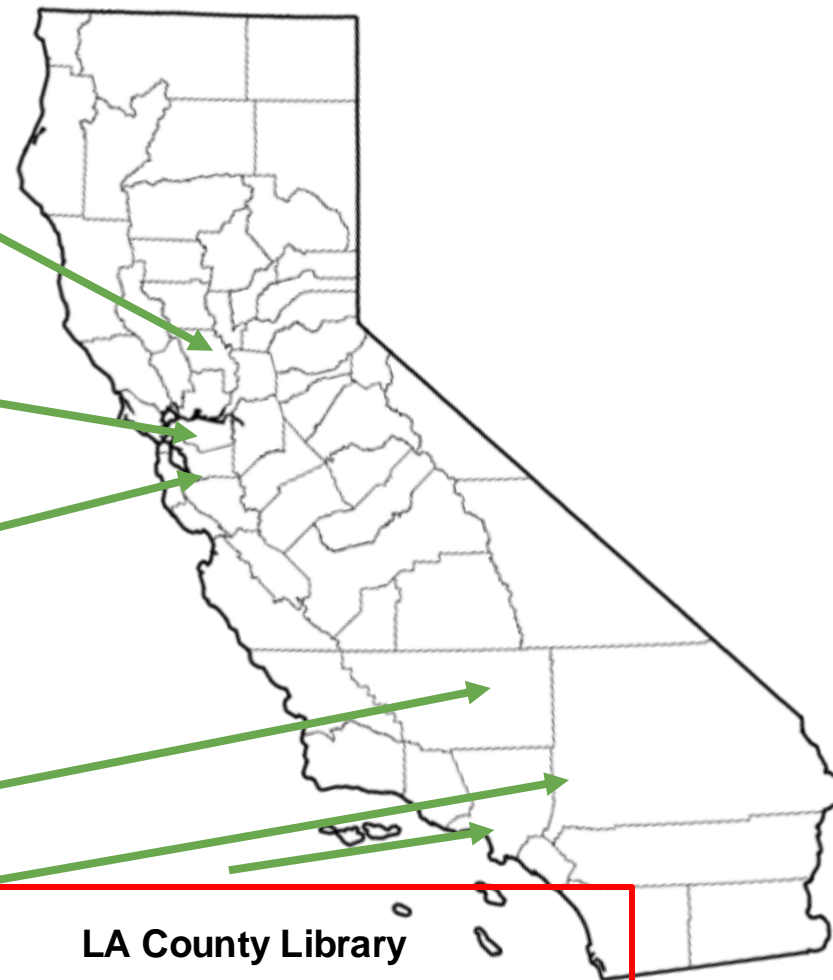
Bakersfield College



Mary's Village



LA County Library





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Thank you



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