CALFLEXHUB SYMPOSIUM

SEPTEMBER 24 | 8am-6pm PT

JINGJING LIU

PETER GRANT

JOHN POWERS

PIERRE DELFORGE

JOE BOURG

PROJECT SHOWCASE: RESIDENTIAL AND SMALL COMMERCIAL

Jingjing Liu, Technology Researcher III, Berkeley Lab; **Peter Grant,** Technology Researcher II, Berkeley Lab; **John Powers**, Founder and CSO, Elexity; **Pierre Delforge**, Head of Product and Operations, Harvest Thermal; **Joe Bourg**, Vice President, Olivine

CalFlexHub

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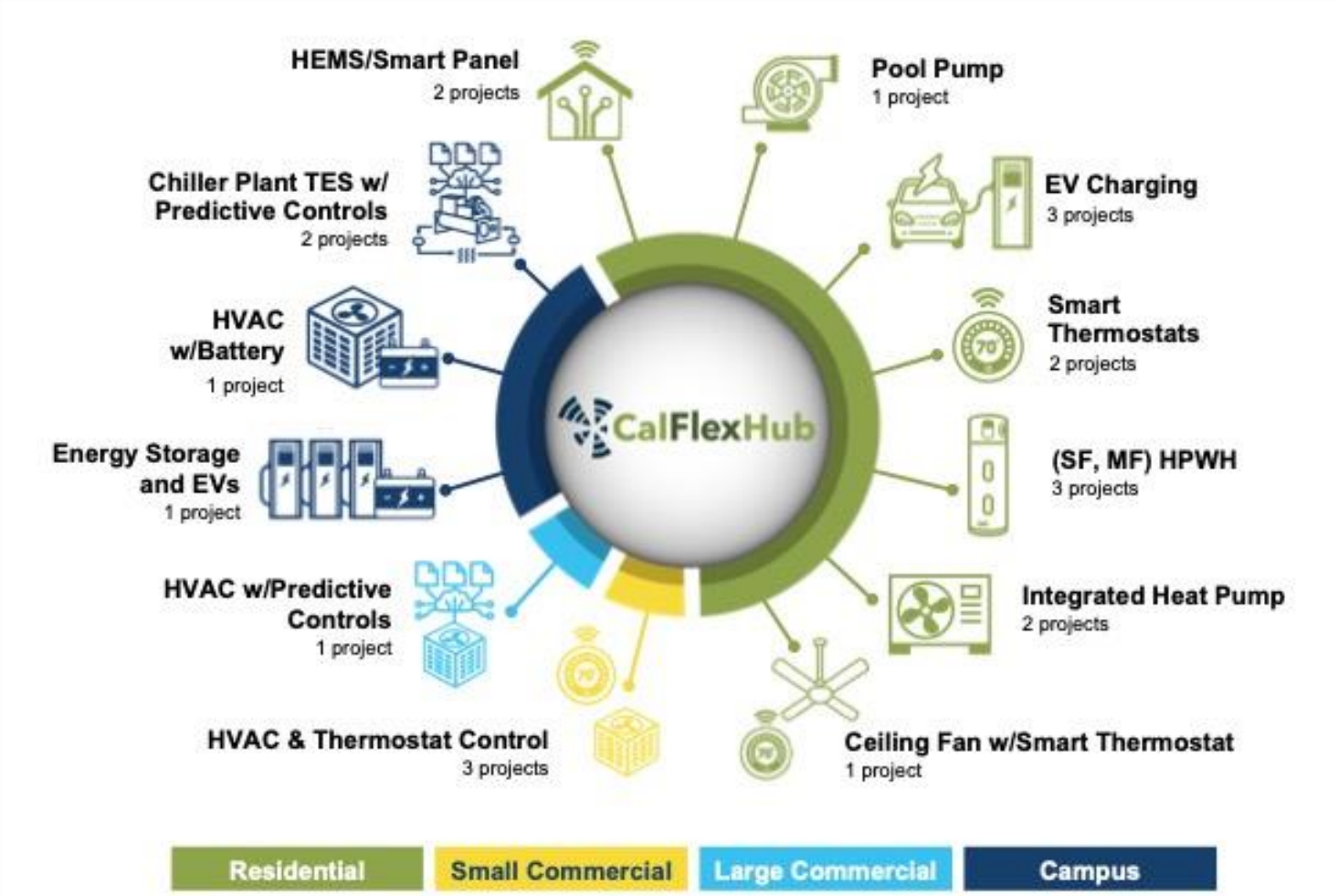
MOMENTUM

2024

Panelists Introduction

- Joe Bourg, Vice President, **Olivine**
- Pierre Delforge, Head of Product and Operations, **Harvest Thermal**
- John Powers, Founder and CSO, **Elexity**
- Peter Grant, Technology Researcher II, **Berkeley Lab**
- Jingjing Liu, CalFlexHub Program Manager, **Berkeley Lab (Moderator)**

CalFlexHub Technology Portfolio



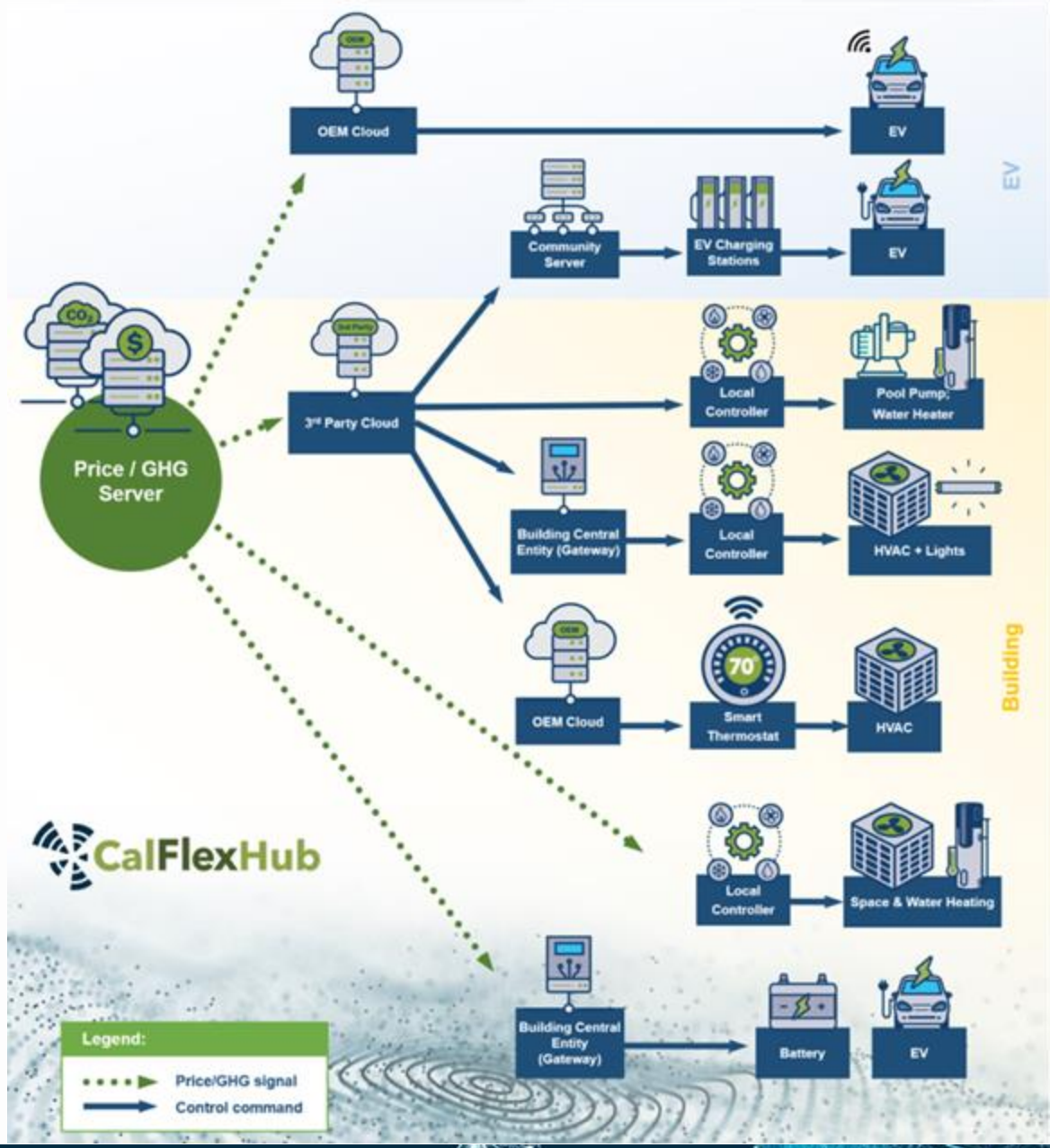
- **21 demo projects**
- **106 existing** test sites
- **40 DAC / 21 LI** sites
- **3 new** sites (SF, SC)
- **hundreds** of **EVs (new)**

Breakdown of Existing Test Sites:

Single Family	**68**
Multifamily	**25**
Small Commercial	**8**
Large Commercial	**1**
Campus	**4**
EVSE	**28**

Technology Performance

- **EV charging** and **integrated heat pump systems** with hot water storage can **shift load for several hours** to access lowest electricity prices
- **Model Predictive Controls (MPC)** can shift significant load and reduce energy cost in **large buildings and campus central plants**
- **Residential and small commercial HVAC** can provide significant load shed during **short periods**



Joe Bourg, **Olivine**

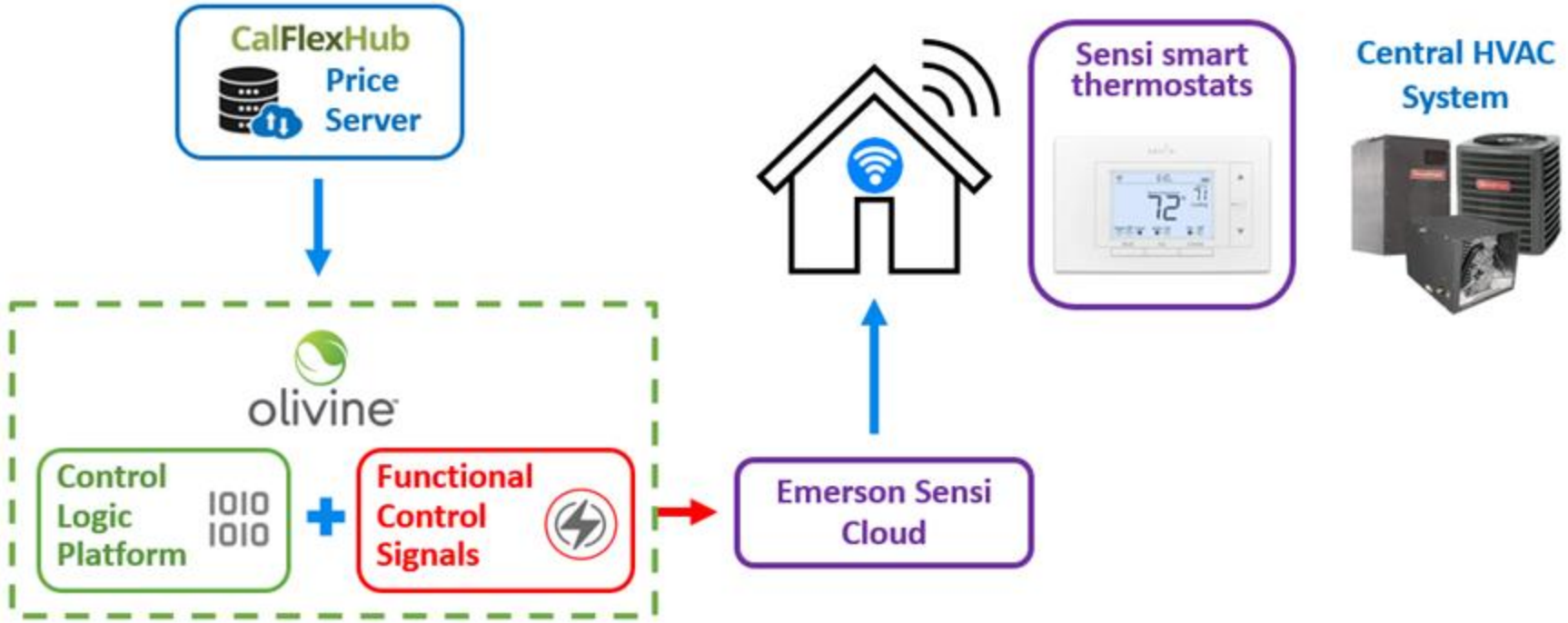
Contact: jbourg@olivineinc.com

Emerson Sensi Smart Thermostats Respond to Dynamic Prices

Test Sites: 38 thermostats distributed across 30 participating households (primarily residing in single-family detached homes and townhomes) served by Pacific Gas & Electric and Southern California Edison. 5 households are in a DAC and 13 households are in a LI area.

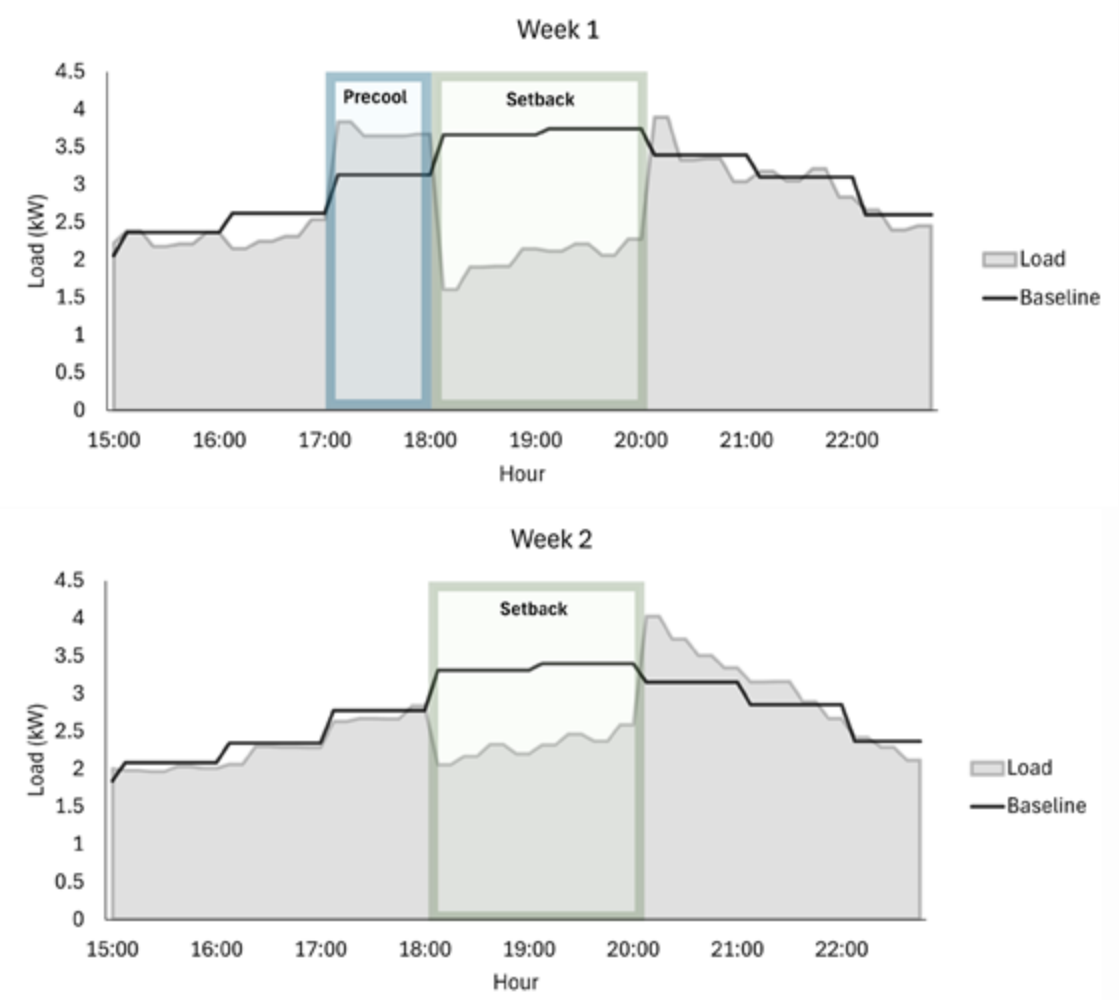
Sector/Building Type	Residential; SF Homes
Technology & End Use	Smart Thermostat; HVAC
Communications Pathway	3rd party (Olivine cloud ➡ OEM cloud ➡ thermostat ➡ AC
Expected Grid Benefit	Current summer peak + emergency reliability
Testing Status (Timeline)	Tested in July 2024 (cooling, summer price)

Communication Architecture

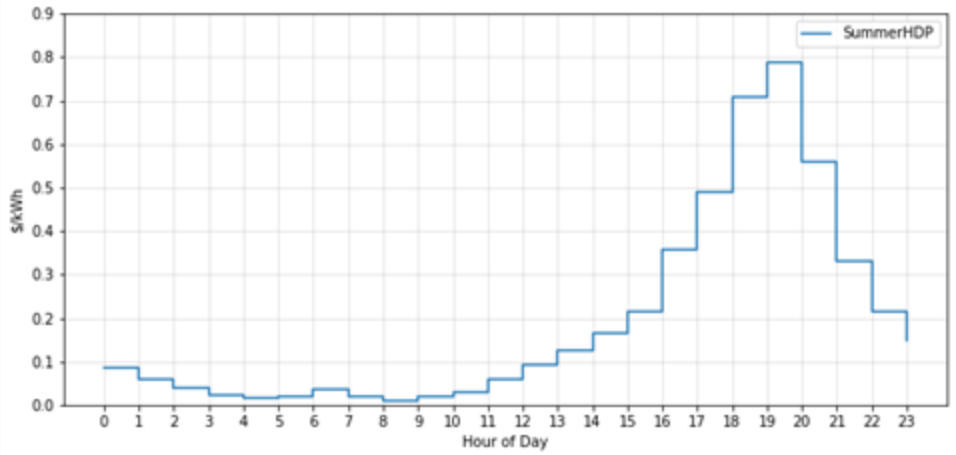


- Day-ahead 24-hour dynamic price or GHG signal retrieved
- Dynamic-price informed control logic
- Olivine cloud-to-Sensi cloud dispatched customer setpoint changes

Field Test #1: Summer Test

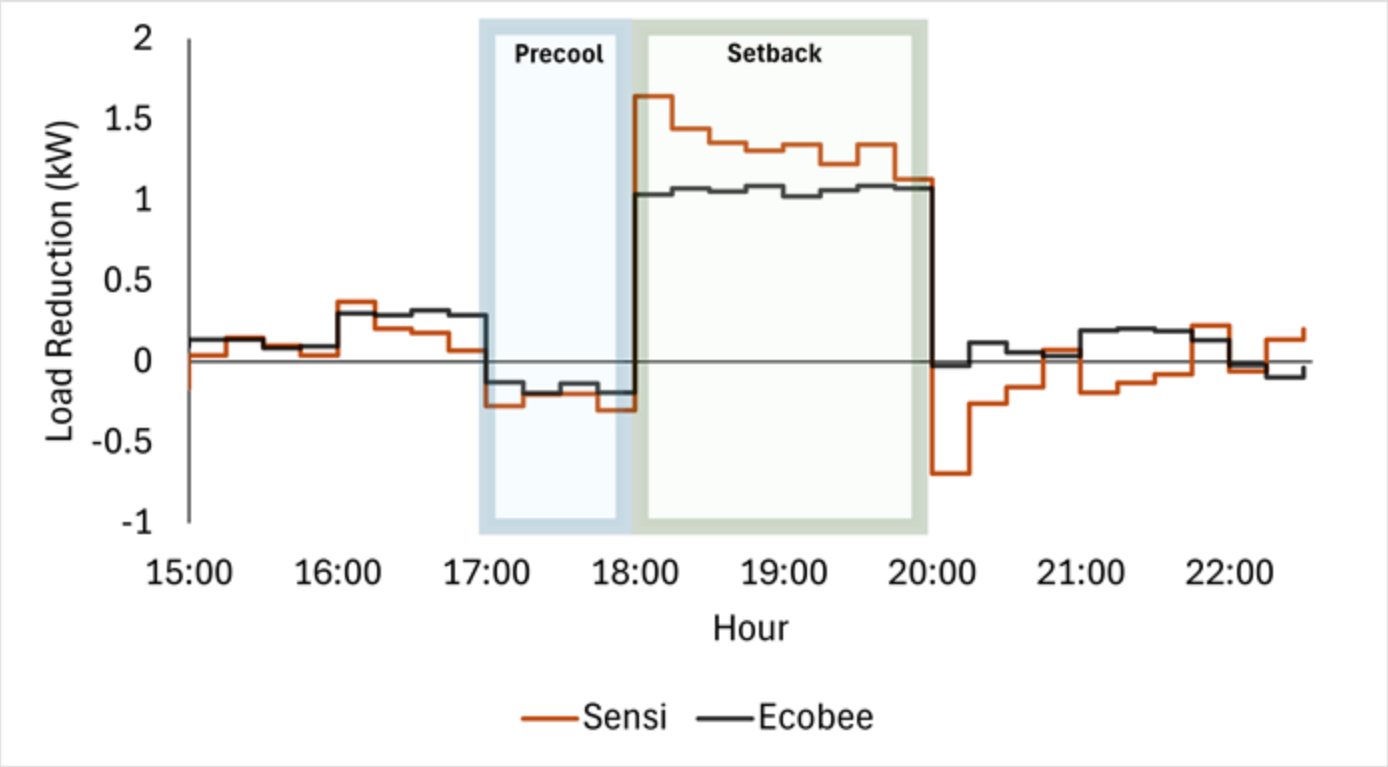


- Clear response to the control signals is seen
- Lack of a precool period increases snapback
- Delivery of ~2.7 kWh for a 2-hour setback period. ~$2.02 of direct bill savings per the dynamic rate

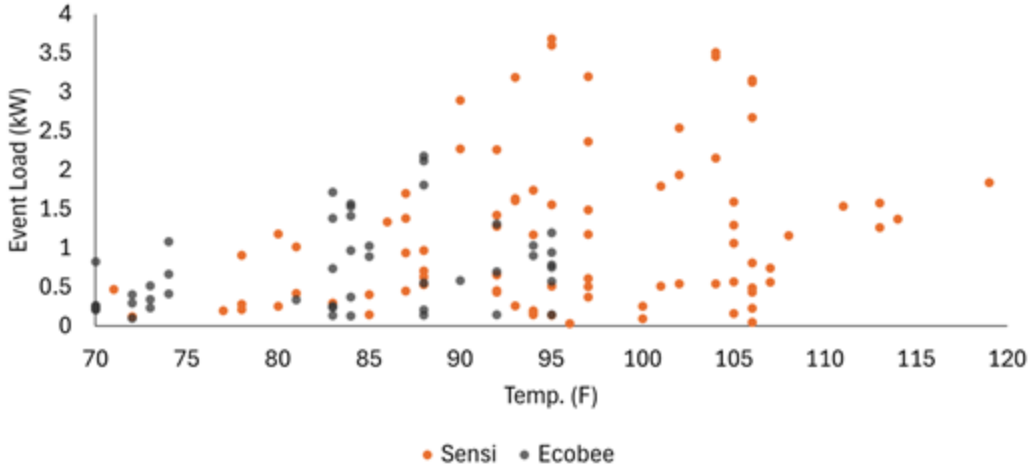


CalFlexHub SummerHDP Rate Profile

Smart Thermostat Response Comparison



- Sensi sites showed higher load reduction than ecobee sites
- Sensi sites had larger whole premise loads than ecobee sites
- Sensi testing days were warmer than ecobee testing days



Pierre Delforge, **Harvest Thermal**

Contact: pierre@harvest-thermal.com

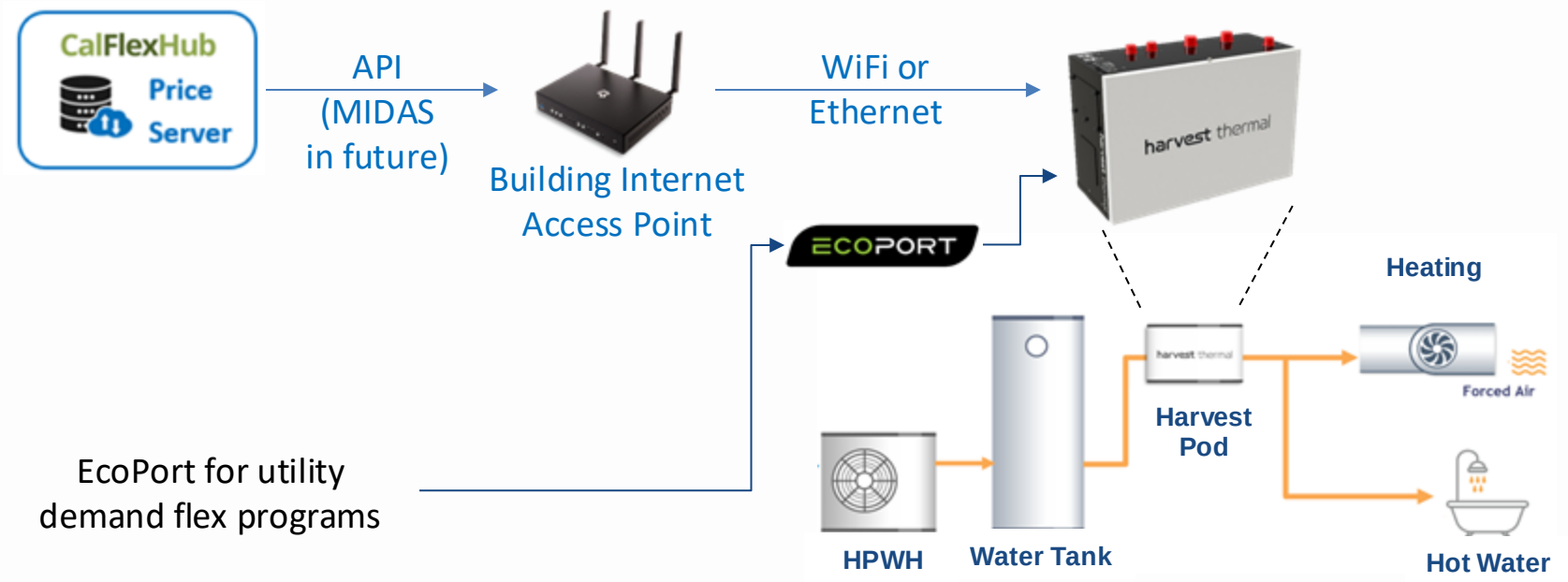
Residential Space & Hot Water Heating with Integrated Heat Pump + Thermal Energy Storage

Test Sites:

6 garden-style apartments with individual gas HVAC and DHW systems, owned and managed by Eden Housing in San Jose

Sector/Building Type	Residential Low and Moderate Income Multi Family
Technology & End Use	Integrated HVAC + hot water + thermal energy storage
Communications Pathway	Property Internet ⇨ Harvest Pod ⇨ heat pump and air handler
Testing Status/Timeline	Installation October, testing November to January

Communication Architecture



Harvest Pod:

- Price signal analysis
- Thermal energy storage charge and discharge control
- Air handler control
- Energy use and delivery reporting at minute-level

Recruitment – Challenges

- LMI multifamily sector is primarily rental properties:
  - **Split incentive**: owner decisions driven by **first cost**, tenants stand to benefit from energy **bill savings**.
    ⇨ **Incentives** are key to drive adoption in rental properties
  - **Price signal/customer tariff alignment:** CFH dynamic price signal not fully aligned with TOU tariff. Price-sensitive tenants ⇨ $100 gift cards to offset energy cost penalty
  - **Connectivity**: can't use tenant Internet ⇨ property or cellular Internet

Key Learnings

- **Demand Flex** and **Thermal Energy Storage** can shift most home **heating** and **DHW** load **off-peak** cost-effectively
- Demand Flex can **reduce energy burden**, make heat pumps affordable for all
- Demand Flex **incentives** and **financing** needed to drive equitable adoption of new technologies
- Highly differentiated utility **tariffs** needed to create customer value

John Powers, **Elexity**

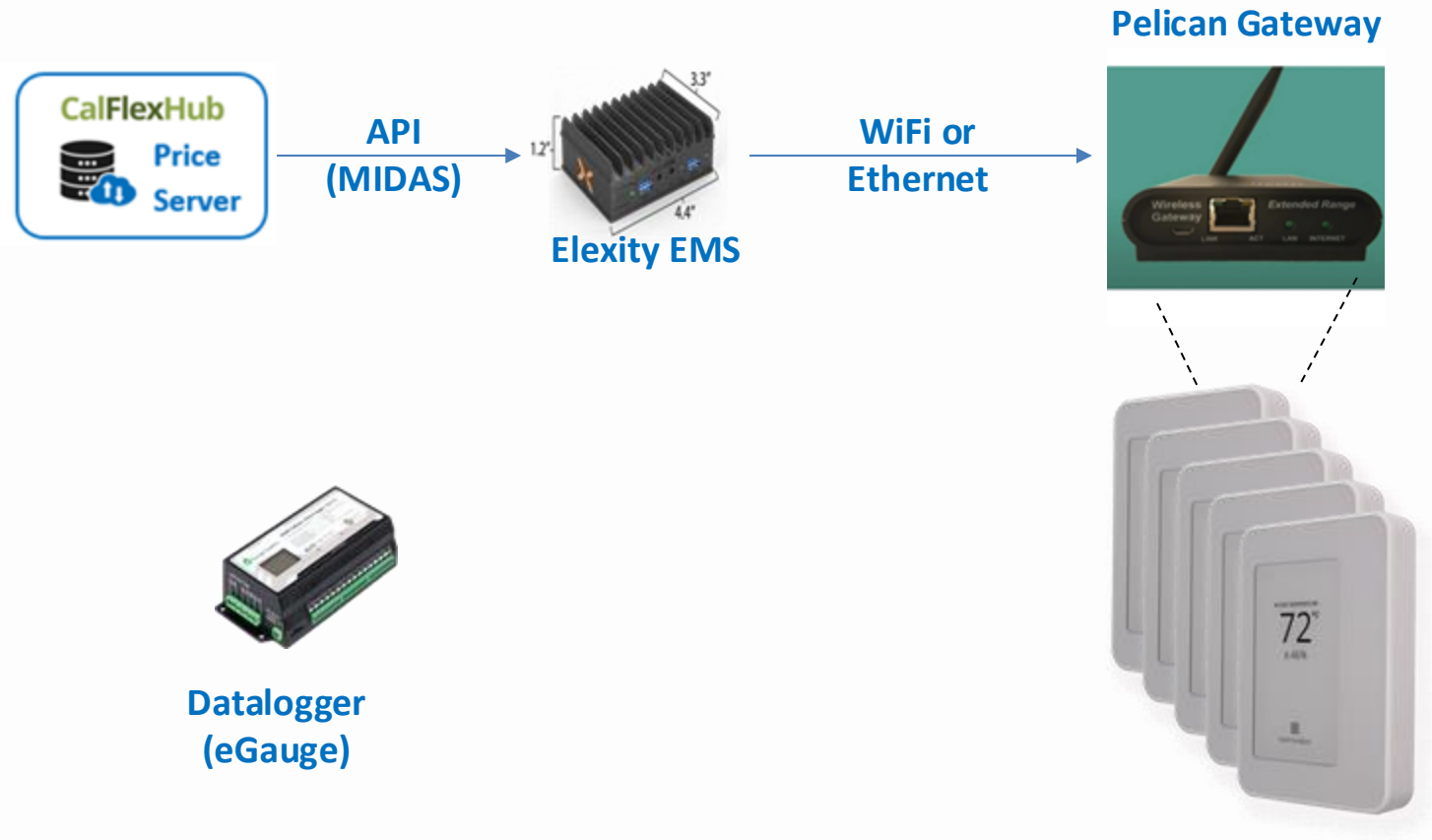
Contact: john@elexity.io

Coordination of Multiple Commercial Thermostats in Commercial Buildings in Response to Price Signals

Test Sites: two participating buildings (research / office buildings at UC Davis) served by PG&E (23 thermostats). Two additional commercial customers with 40+ thermostats and EV charging stations . . . Coming soon!

Sector/Building Type	Commercial; office / research
Technology & End Use	Smart Thermostat; HVAC
Communications Pathway	3rd party (Elexity cloud ➡ OEM cloud ➡ thermostat ➡ AC
Expected Grid Benefit	Current summer peak, daily shifting, + emergency reliability
Testing Status (Timeline)	Tested in August 2024 (cooling, summer price)

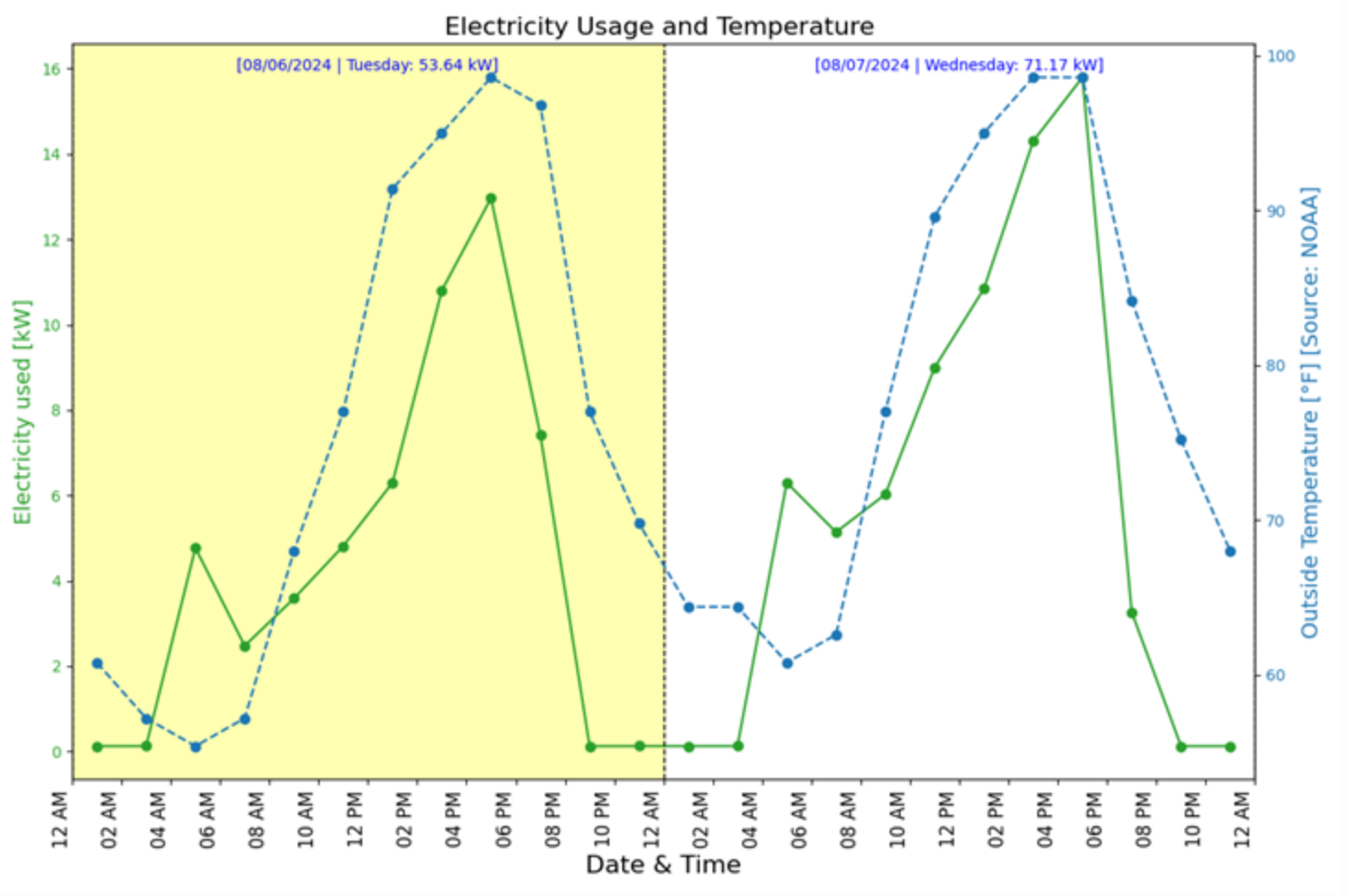
Communication Architecture



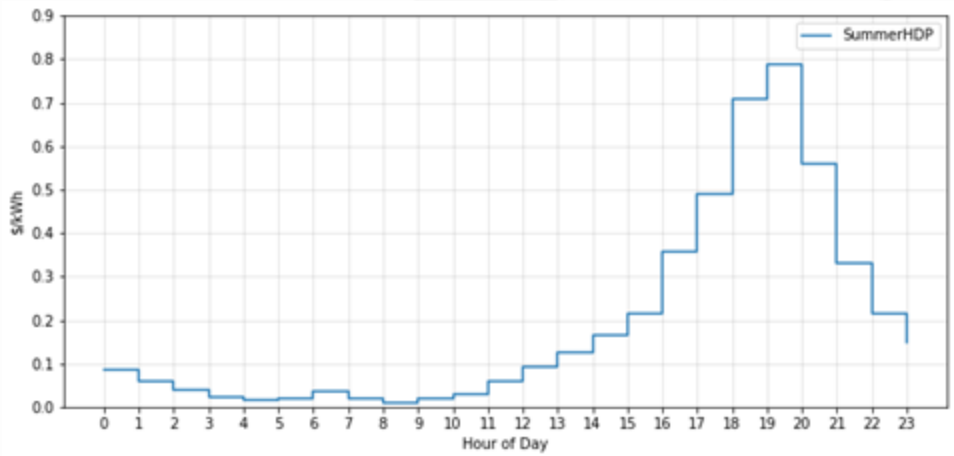
Elexity EMS:

- Price signal analysis
- Coordinated setpoint control of multiple thermostats (Pelican)
- Demand and energy reporting at minute-level

Field Test: Summer



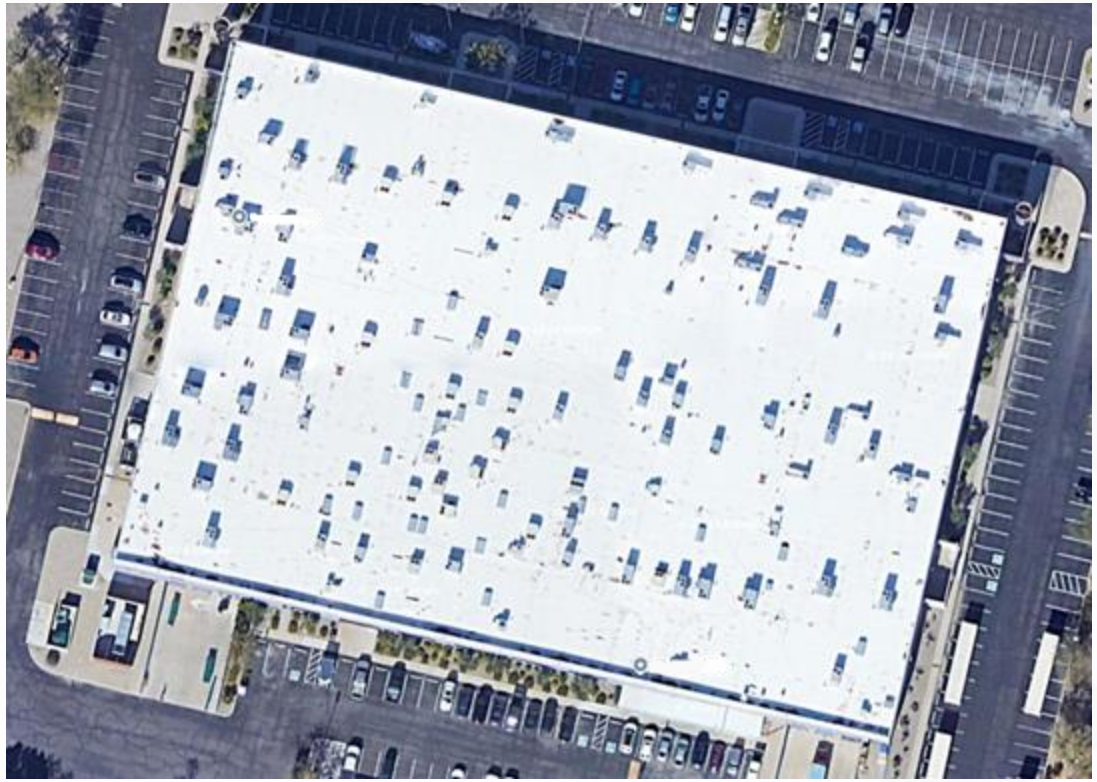
- Clear response to the control signals is seen
- Precooling works…but…
- Price differentials for HVAC are not as big as they look!
- Can only (mostly) precool in hours adjacent to highest cost



CalFlexHub SummerHDP Rate Profile

Key Learnings

- **Commercial Buildings Rock!**
  - Higher thermal mass than residential → better
  - More diversity of package units than residential → better
  - Accustomed to complex rates → better
- Coordination of Units is Key
  - Prices to Devices? NO / Prices to Deciders? YES
- Timid Rate Design will Kill Load Flexibility
  - Go Big or Go Home
- Demand Flex **incentives** and **financing** needed to overcome new technology mistrust and drive equitable adoption



Peter Grant, **Berkeley Lab**

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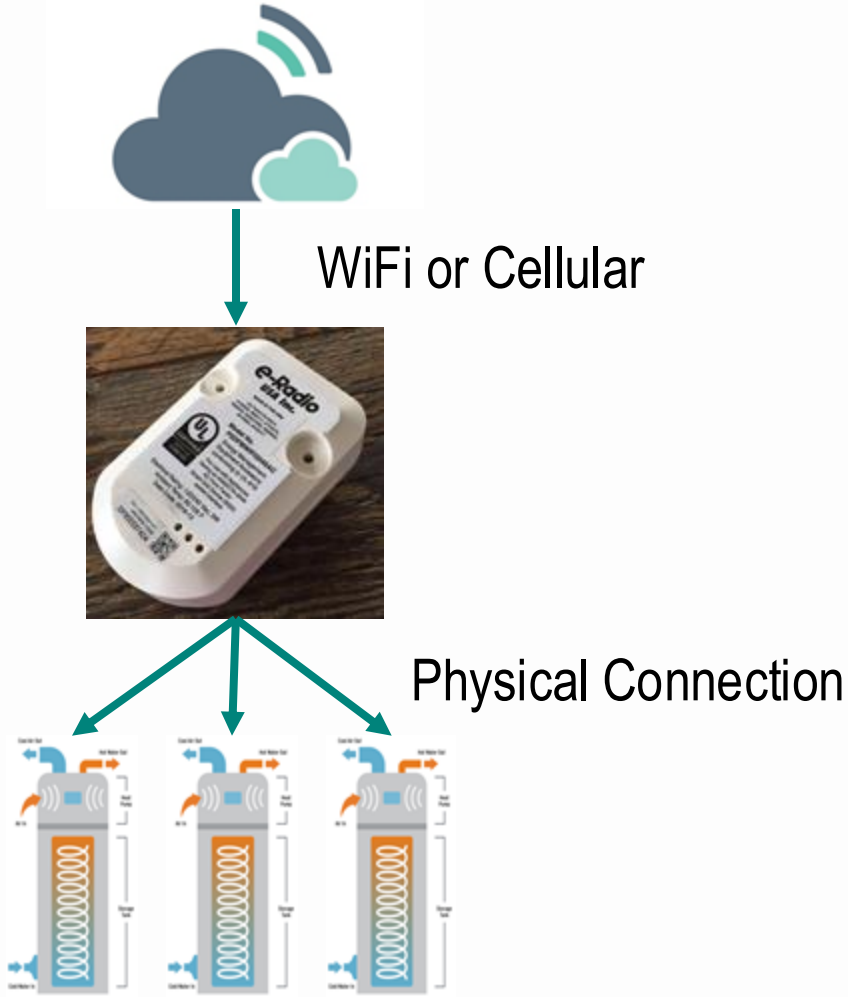
Price- and Load-Responsive Controls for Heat Pump Water Heaters

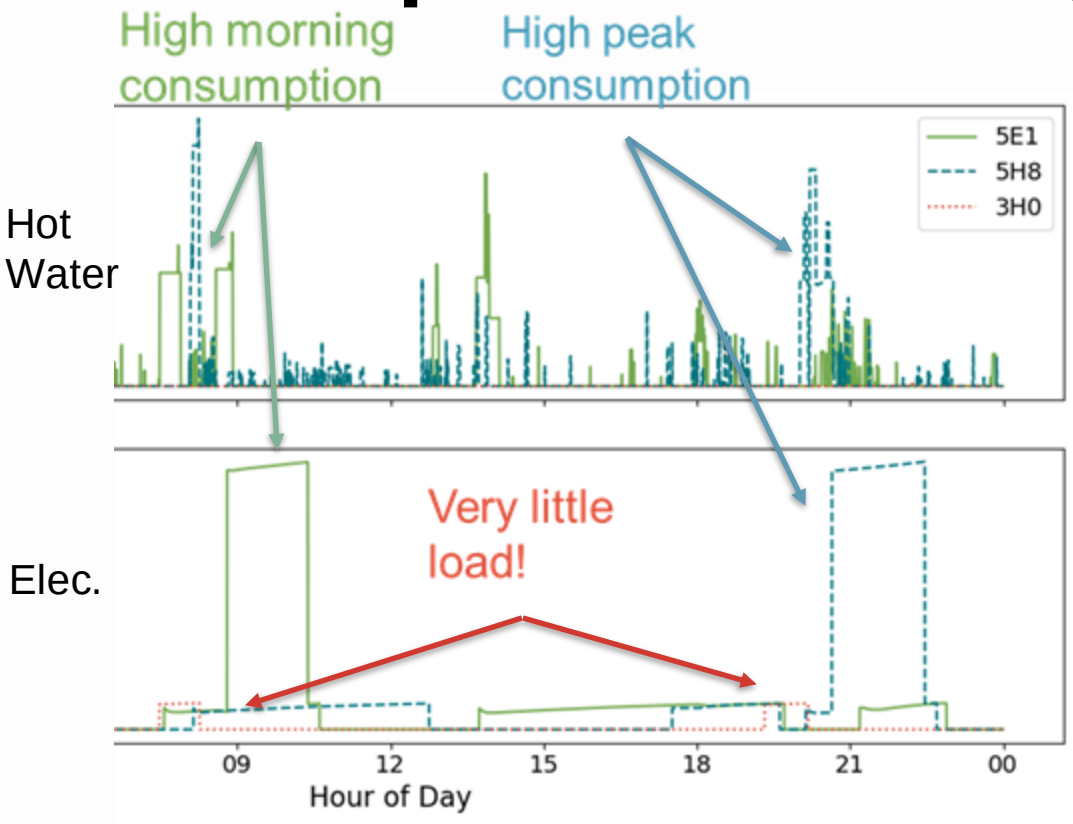


Test Sites:

10 single family residential sites with 120V HPWHs distributed throughout California

Sector/Building Type	Single family residential
Technology & End Use	Domestic hot water with thermal energy storage
Communications Pathway	CTA-2045 or Manufacturer API Local WiFi or Cellular
Testing Status/Timeline	Testing completed in summer 2024

Concept: Customizing Improves Load Shifting



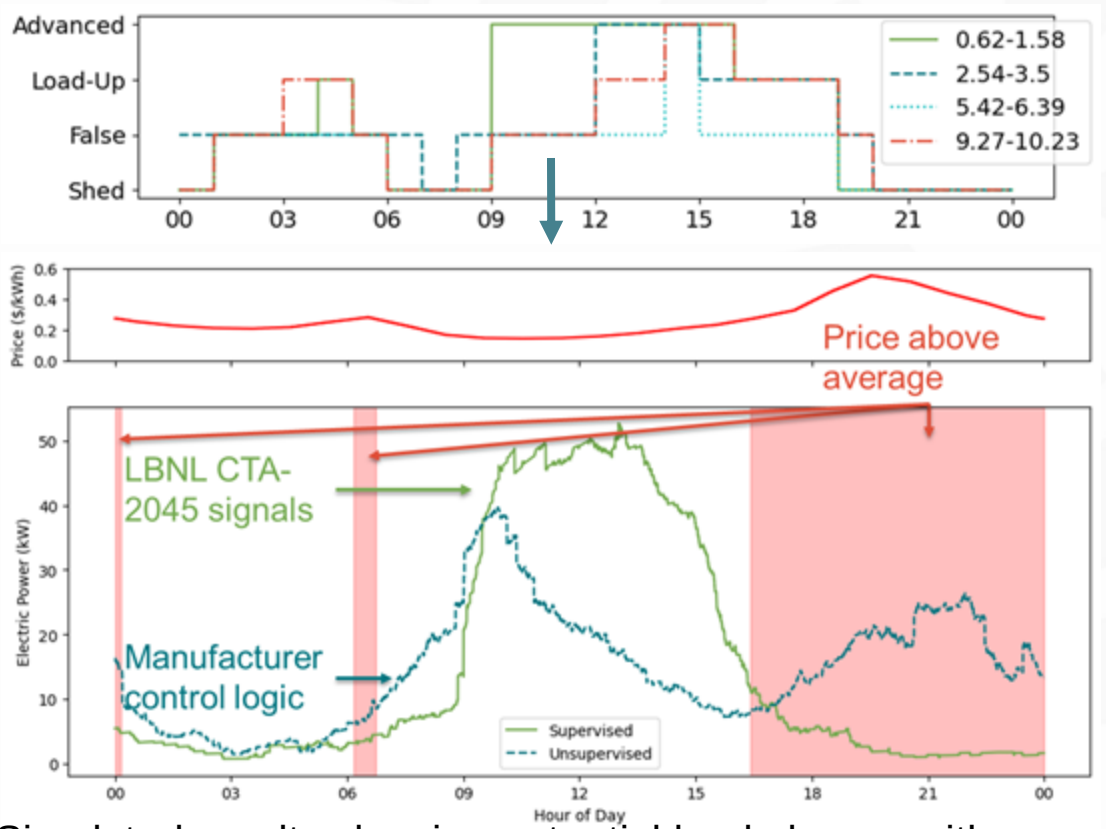
Different HPWHs need different signal schedules

5E1: Precharge tank in morning

5H8: Precharge tank in early afternoon

3H0: Do nothing

Customized CTA-2045-B Signal Schedules



Simulated results showing potential load shapes with a fleet of 148 HPWHs

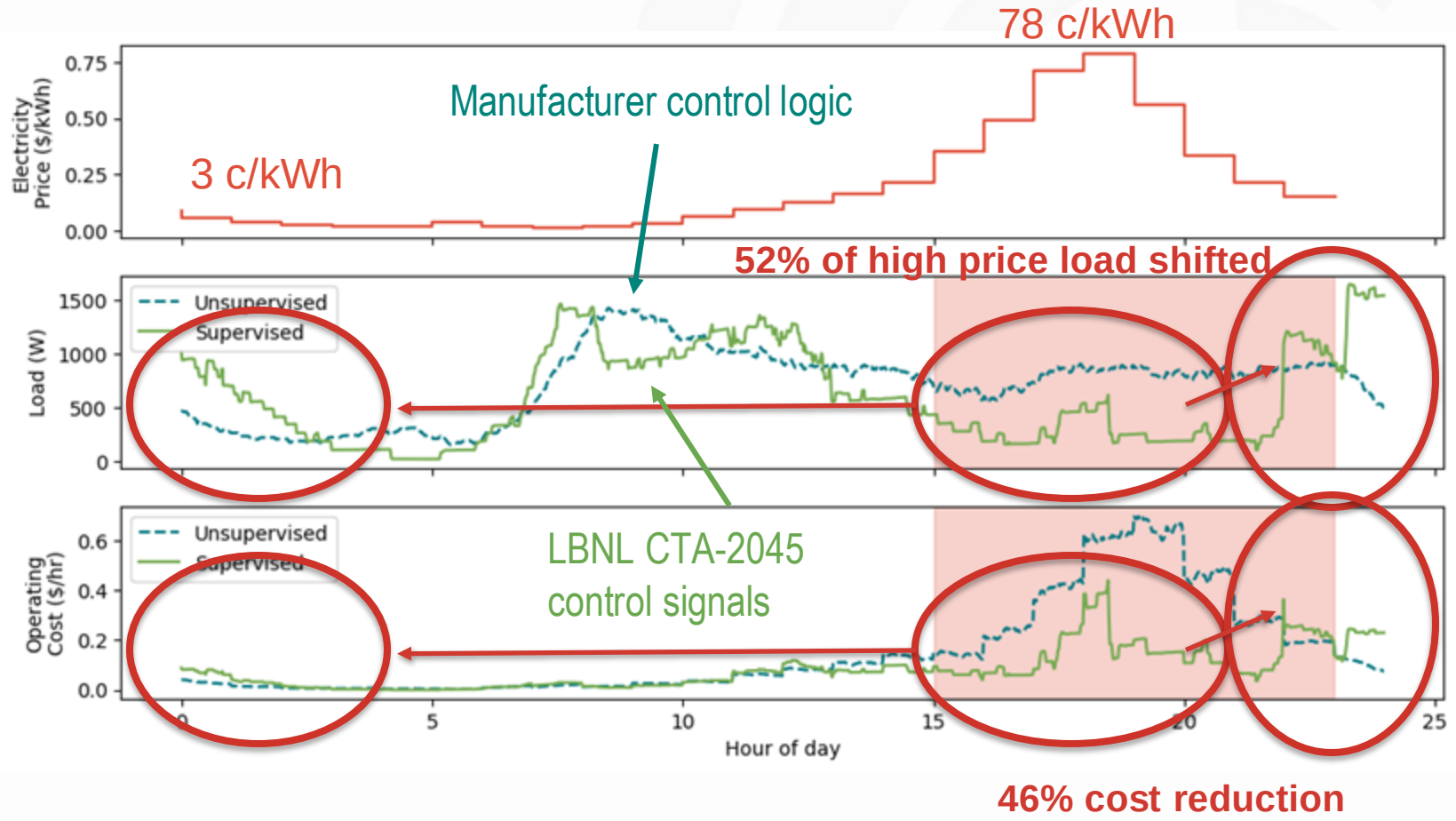
Field Results: CalFlexHub SummerHDP

Fleet Details

10 heat pump water heaters
120V plug-in ready products
California
Single family
CTA-2045 (**Not** B)
No Advanced Load Up

Results

52% of high-price load shifted
46% electricity cost reduction



Advanced Load Up: It's Important

Situation: Not all manufacturers enable the CTA-2045 Advanced Load Up (ALU) signal
ALU: Increase set temperature, increase energy stored in tank

Question: How does that impact results?

Method

Simulated
148 HPWHs
Title 24 DHW use

Results

ALU:

- Decreases operating costs
- Decreases high-price kWh
- Increases solar absorption

Impact

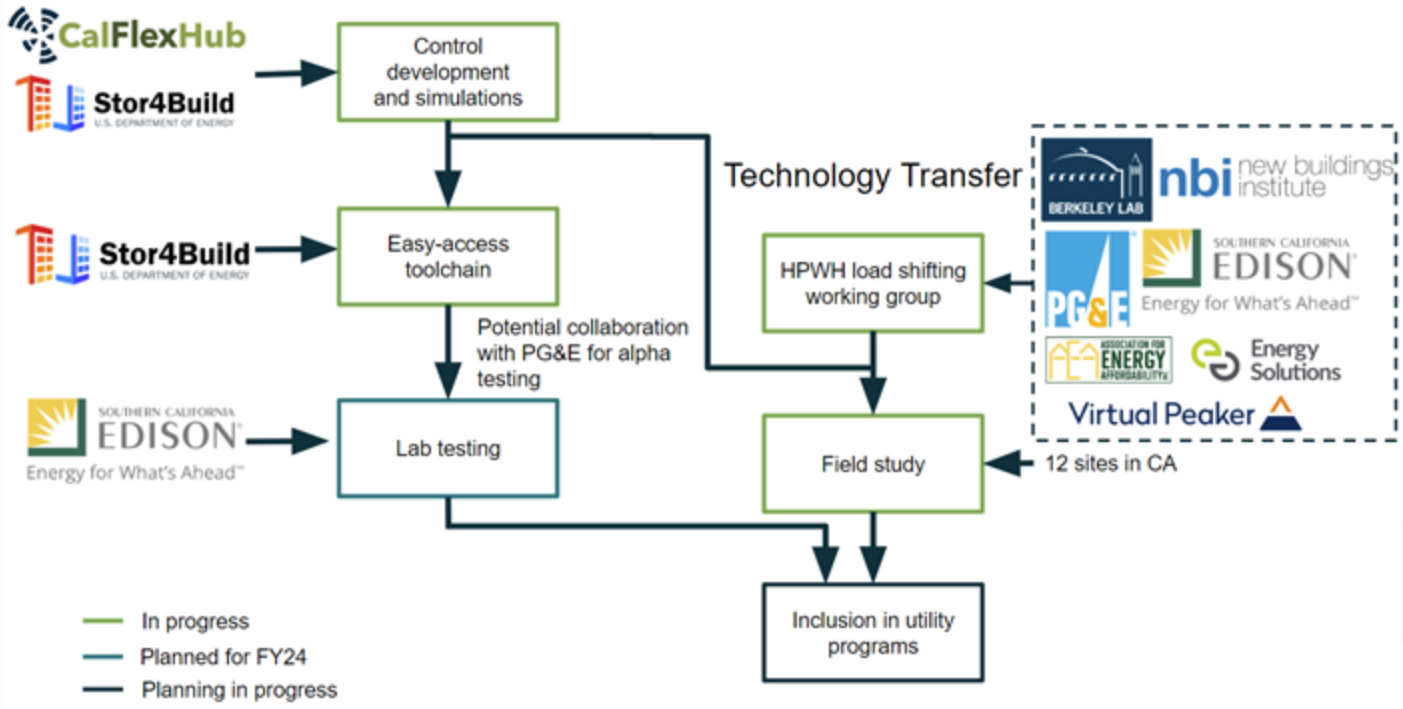
	Operating Cost (%)	Peak kWh (%)	Mid-Day kWh (%)
Without ALU	-32%	-29%	+14%
With ALU	-53%	-60%	+65%

Key Learnings

- Price-responsive load shifting for HPWHs **is possible today**
- Cost reduction **better with advanced load up (53% w/ ALU vs 32% w/o ALU)**
- **Large price changes** yield better results
- CTA-2045 ***module/installation costs pose challenges***

Next steps

- Performing lab testing in 2025 (expected)
- Expanding to more manufacturers in 2025 (expected)
- Providing deployment tools to utilities (late 2024 & 2025)



PANEL DISCUSSION

Thank you!

Contact: jingjingliu@lbl.gov