CalFlexHub Final TAC Meeting

Review Final Report · Executive Summary (DRAFT)

July 9, 2026
Lawrence Berkeley National Laboratory (LBNL)

ENERGY TECHNOLOGIES AREA
BERKELEY LAB

Agenda

- Roll Call (5 min)
- CalFlexHub Overview (8 min) – Mary Ann
- CalFlexHub Key Results (25 min) – Task Leads
- Knowledge Transfer / Future Work (5 min) – Marco
- Open Discussion (up to 45 min)

TAC Members (LSEs)

Southern California Edison — Energy for What's Ahead	Sean Gouw
PG&E	Albert Chiu
SDGE	Kate Zeng
SMUD	Denver Hinds
LA DWP Los Angeles Department of Water & Power	Omar Elayyan
Sonoma Clean Power	Geof Syphers

TAC Members (State Agencies)

Brad Williams, Energy Research & Development Division
Haile Bucaneg, Efficiency Division
Jeffrey Lu, Fuels & Transportation Division
Karen Herter (Former)
Stefanie Wayland, Efficiency Division
Tiffany Mateo, Efficiency Division

Achintya Maddur, Energy Division

California ISO

Jill Powers, Infrastructure & Regulatory Policy Manager
Peter Klauer, Senior Advisor, Smart Grid Technology

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TAC Members (Industry)

Aggregators:

Vish Ganti (DERSec)

Jennifer Chamberlin (ENGIE)

John Anderson (Renew Home)

Max Frey (THG Energy Solutions)

Industry Associations:

Andrew Brooks (AEA)

Peter Crabtree (BEST Center)

David Holmberg (NIST)

Kate Strickland (SEPA)

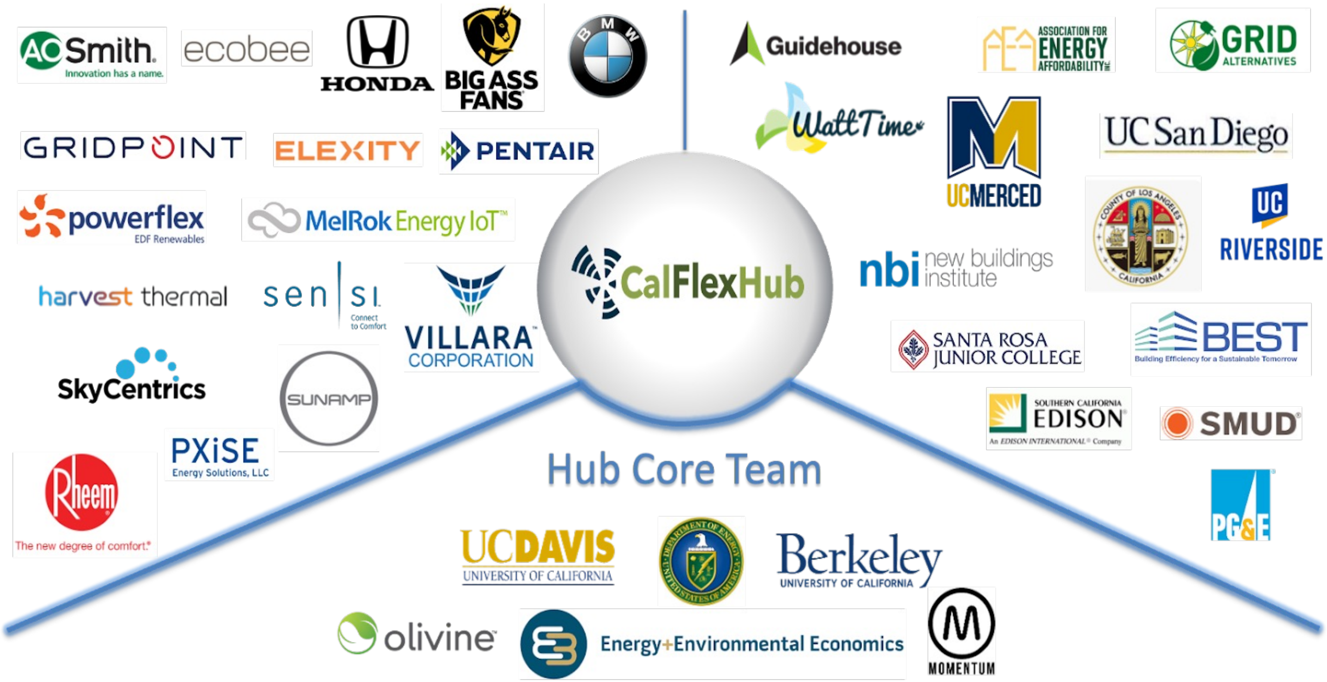
Other:

Geoff Wickes (NEEA)

Project Purpose and Approach

- **CalFlexHub advanced load-flexible technologies** that enable electric end uses to become elastic, affordable, reliable grid resources (Fall 2021 to present).
- **Supported California's goal of 7,000 MW of shiftable load by 2030** — modifying demand rather than increasing supply.
- **Hourly-changing retail prices communicate grid conditions & incentivize customers** to shape their usage.
- **Multidisciplinary team**: industry, utilities, academia, technology vendors, nonprofits. Major partners: **Momentum, Olivine, UC Davis, UC Berkeley, and E3.**
- **Evaluated, developed, and demonstrated load-flexible technologies** for buildings and electric vehicles (EVs) — assessing grid impact and cost-effectiveness.

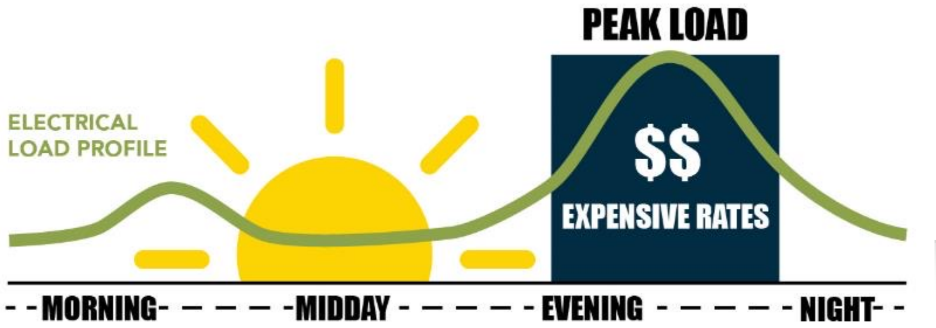
CalFlexHub Partners



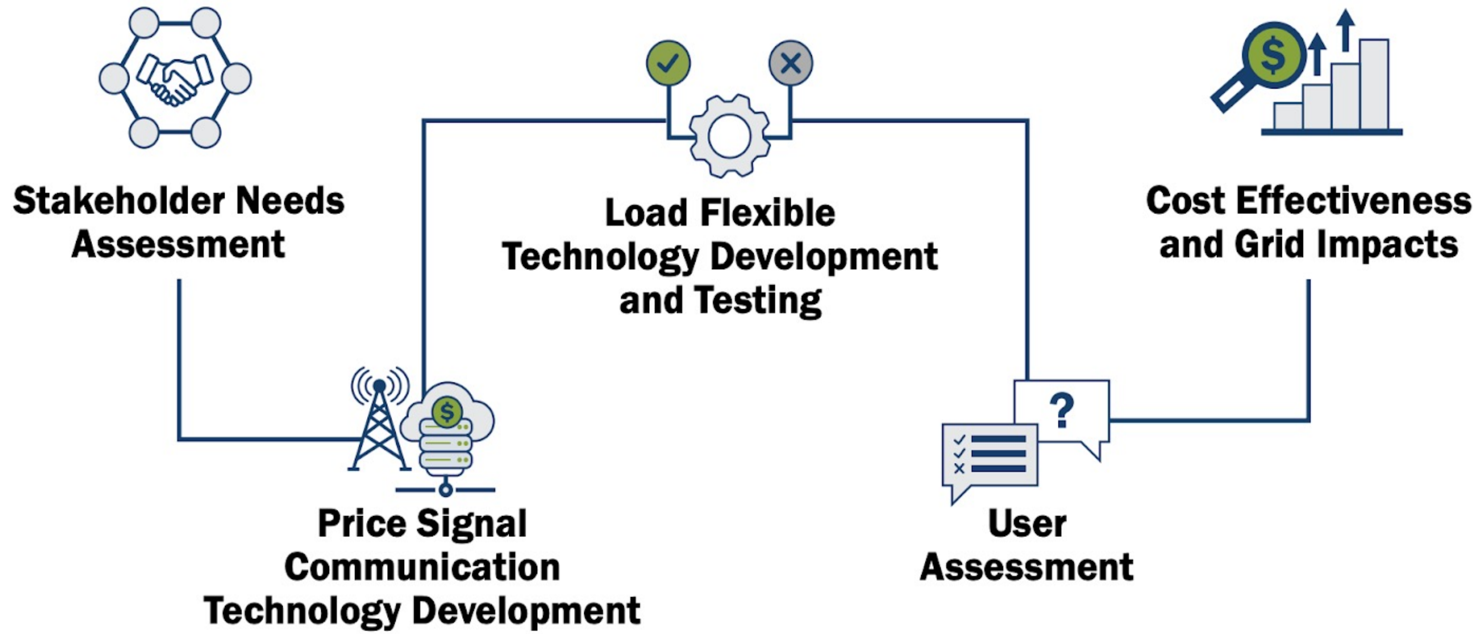
Compare Dynamic Pricing with Traditional Demand Response

- **Beyond traditional DR,** which only rewards load reduction during DR events on peak days with no incentive to shift to low-price, abundant-supply hours.
- **Dynamic retail prices** eliminate the need for an estimated baseline: customers cut their bill simply by using less when prices are high.
- **Smooths the steep net-load ramp** between abundant midday generation and the late-afternoon peak — directly supporting grid reliability.
- **Still delivers peak-day reductions** whenever dynamic prices reflect grid stress.

Mary Ann

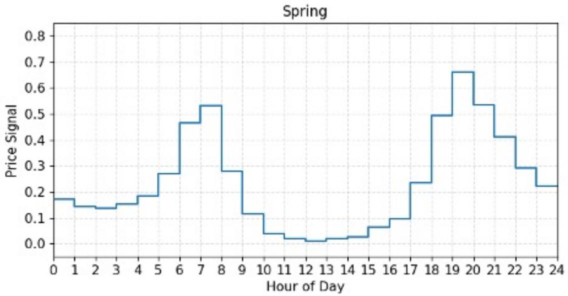


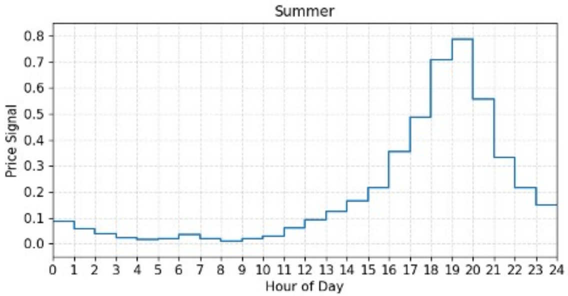
Key Tasks in CalFlexHub



Price Signal Communication Technology

- **Synthetic hourly price profiles** created based on historical CAISO net-load data, illustrative days for all four seasons.
- **Spring** shows the classic “duck” curve (AM/PM peaks); summer peaks in the evening.
- Hosted on the **CalFlexHub price server** (LBNL partner Olivine) and the CEC's **MIDAS** repository.
- **CalFlexHub led development of OpenADR 3** with the OpenADR Alliance — rapid adoption by CA IOUs, now being integrated into MIDAS, and used in over a dozen countries.
- **Free Affiliate Program** let manufacturers test integration with hourly prices.

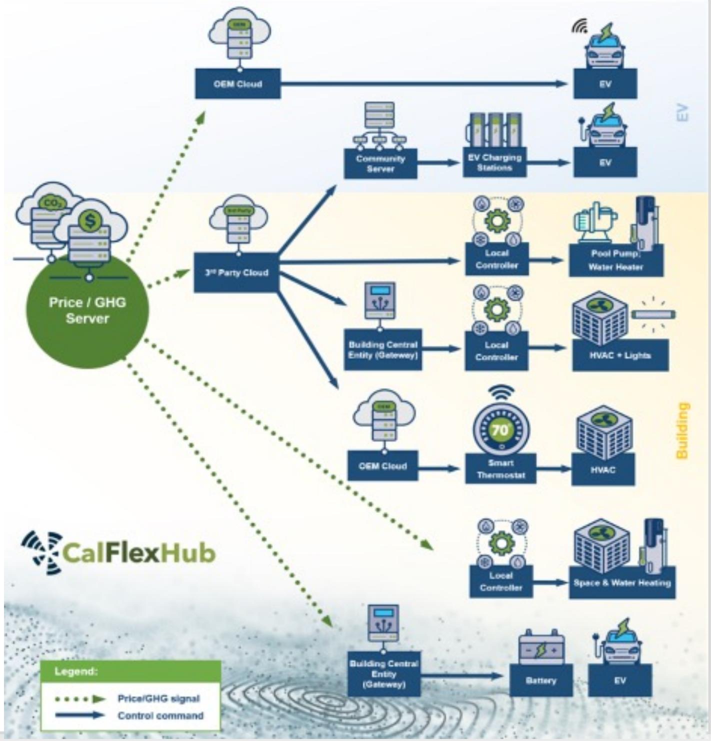




Four Communication Pathways to the Device

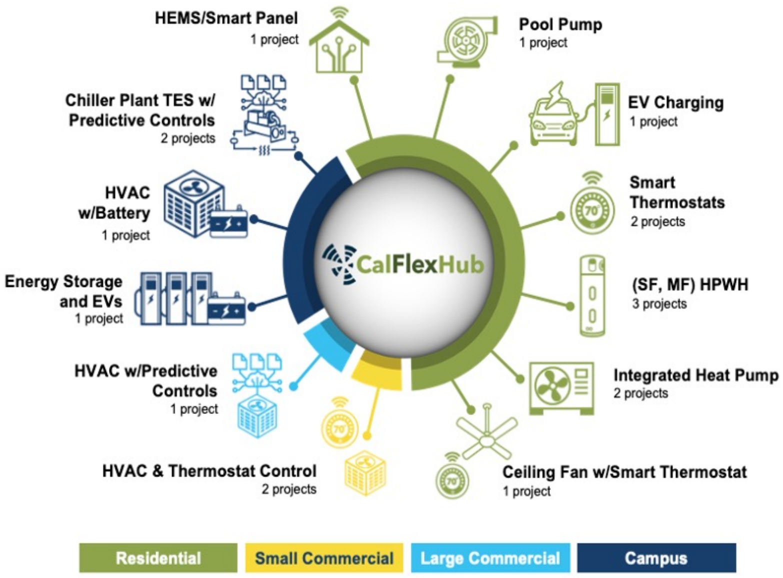
1) Original equipment manufacturer (OEM) cloud
2) Third-party automation service provider
3) Central building gateway
4) Directly to the device

- Combinations are possible. **Architecture choice** affects **customer cost, user experience, and device interoperability**.
- Scaling dynamic-price response will require new **business models** to commercialize and support these technologies — further research needed on the **customer experience**.



Technologies Developed and Demonstrated

- 18 distinct technology projects across residential and commercial sectors.
- Strategic focus on **mass-market** residential solutions.
- **Thermal**: connected thermostats, heat-pump space conditioning, HPWHs, integrated heat pump systems with thermal energy storage (IHP+TES), advanced HVAC controls.
- **Electrical**: pool pumps, smart panels, stationary batteries, EV charging controls.
- New predictive-control algorithms developed for all building sectors.



Field Demonstrations at a Glance

18
demo projects

95
field sites
81 residential · 11 commercial · 3 campuses

544
days of testing
(late 2022 – early 2026)

245
housing units
(81 residential bldgs)

53
sites at ≥ 75th pct
CalEnviroScreen 4.0

938
electric vehicles

Load Impact — Residential Buildings

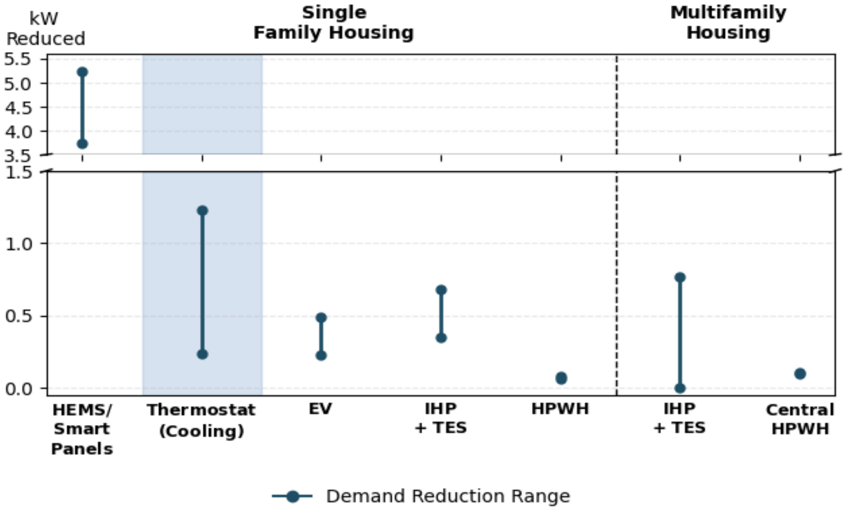
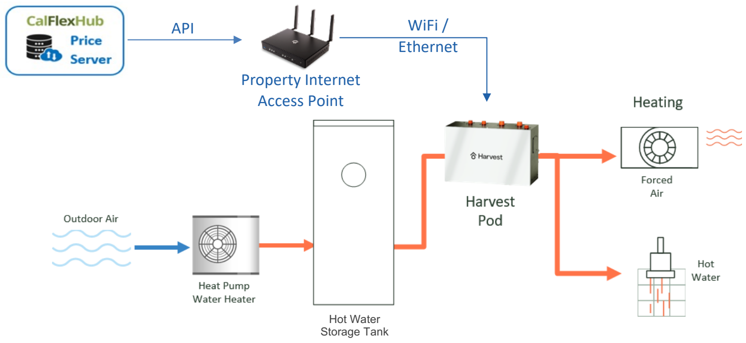


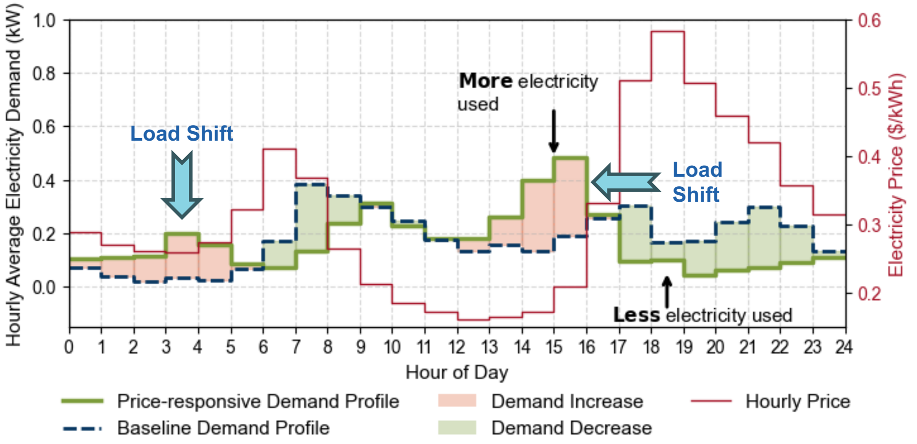
Figure 3-b: Demand reduction during high-price periods. Source: LBNL

- **Smart panels**: 3.7–5.2 kW (30–55%) — highest impact; orchestrate EVs, heat pumps, appliances.
- **Connected thermostats:** 0.6–1.3 kW (28–75%), 2-hour shift in summer.
- **EV charging (L1 & L2):** 0.2–0.5 kW per vehicle (25–45%).
- **Integrated heat pump + TES**: 0.3–0.8 kW SF; 0.05–0.8 kW MF (tank-size dependent).
- **HPWH:** ~0.1 kW (40–65%) — smallest, but year-round and least noticeable.

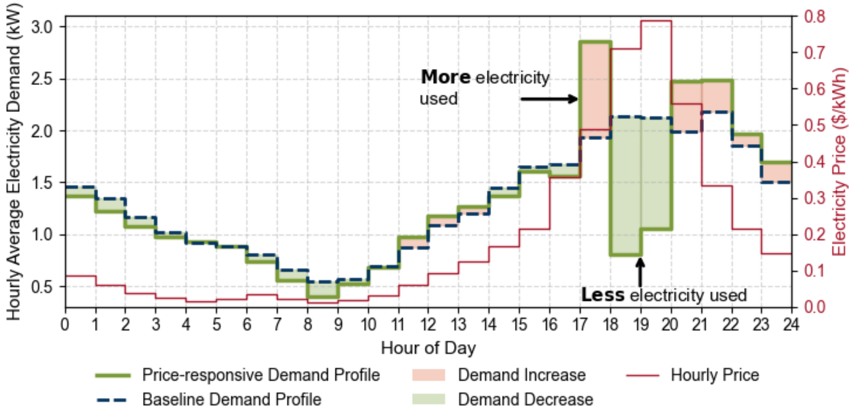
Example Technology #1 – Integrated Heat Pump with Hot Water Storage (Harvest Thermal)

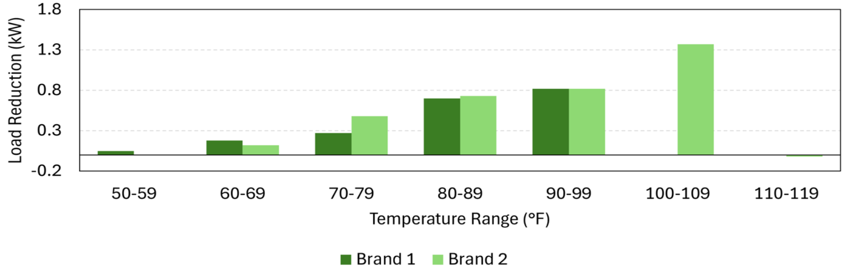


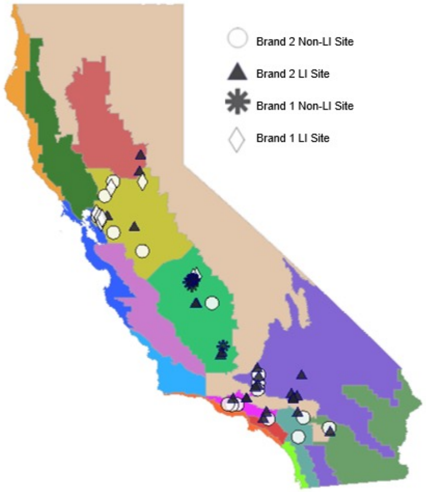
- **60-80%** of heating and hot water load shifted off-peak; **35-50%** of entire home peak energy use shifted
- No compromise on occupant comfort
- Avg. **$0.30/day (23%)** heating/hot water bill savings in winter



Example Technology #2 – Connected Thermostats (Olivine)







- An average of **0.67kW** of **load reduction**
- Avg. **$0.79/day (11%)** energy bill savings
- Load reduction is **correlated** to OAT
- **No significant impact** on load reduction from **pre-cooling** was observed
- Consistent load reduction **across brands**

Load Impact — Commercial & Campus

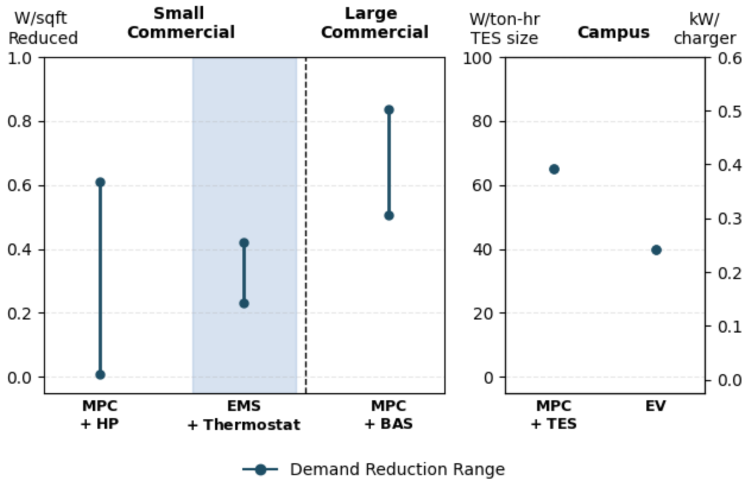
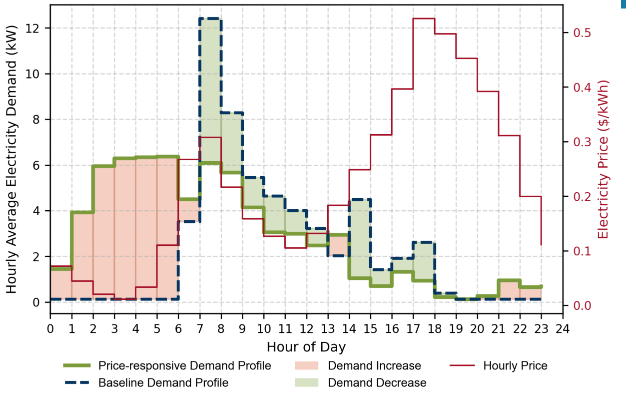


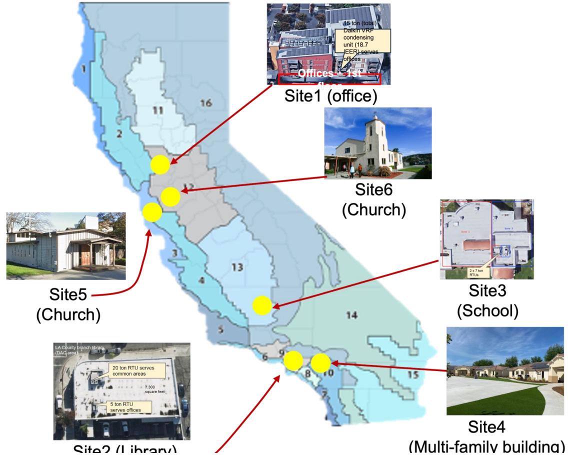
Figure 3-b: Demand reduction during high-price periods. Source: LBNL

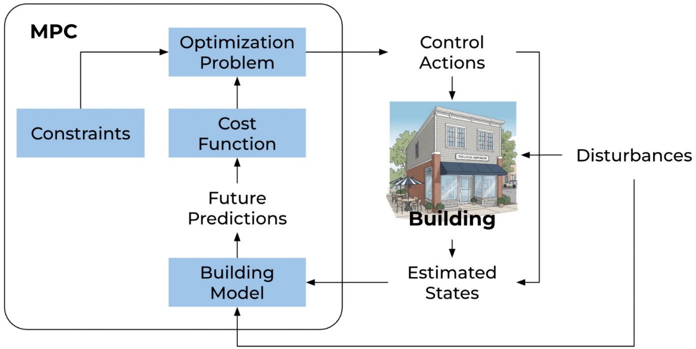
- Model predictive control (MPC) proved an effective early-stage tech for all building sizes.
- **Small commercial (MPC + heat pump):** 0.05–0.6 W/sf (5–60%), 6-hour shift.
- **Rule-based EMS + thermostat precool/setback**: 0.2–0.4 W/sf (35–75%), 2-hour shift.
- **Large office (MPC):** 0.5–0.8 W/sf (50–70%), 6-hour shift.
- **Campus chilled-water TES (MPC):** shifted 78% of central-plant cooling load (65 W per ton-hour of the 5,000 refrig. ton TES).Campus workplace EV charging (MPC): 0.25 kW/charger (50%) shifted off the AM peak.

Example Technology #3 – HP FLEX



- **> 650** days of active DF control across 6 sites
- **29%** load reduction during high-price periods (**36.5%** in winter)
- **~12%** daily energy bill savings
- Improved comfort



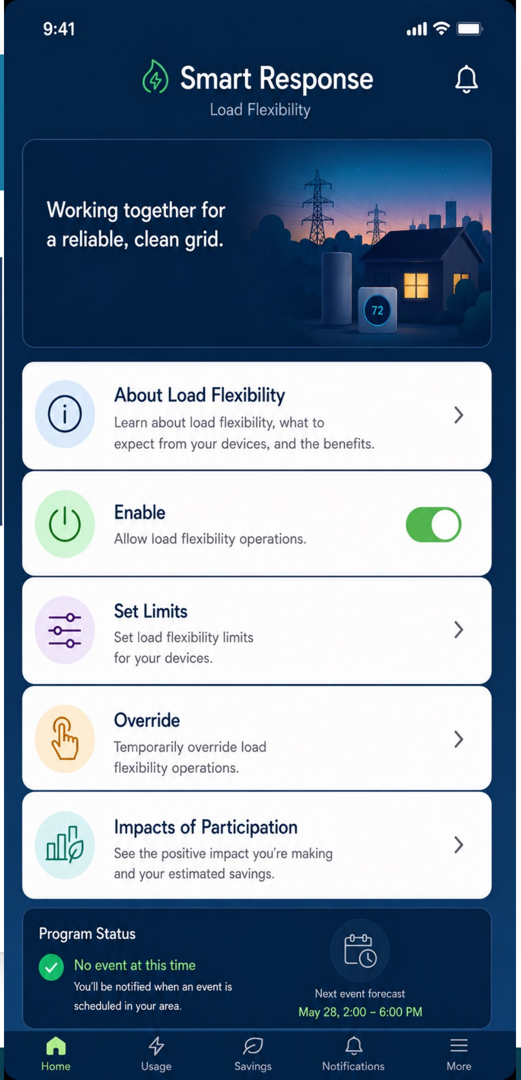


User Experience: The Social License to Automate

- **Methods:** Interviewed/surveyed ~75 users across 10 field demos

	Users	Technologies
Residential	single- & multi-family, senior & low-income	smart thermostats and fans; heat pumps for space conditioning and water heating
Commercial	building admin, managers & operators, occupants	model predictive control for district cooling, HVAC roof-top units, & BAS

- **Findings:** Users require information and control
  - **Control:** enable/disable, override, parameter-setting (e.g., setpoints)
  - **Information:** about operations and impacts (savings, community resilience)
- **Opportunities**
  - **Vendors and manufacturers:** usability and UI design
  - **Program administrators:** clear and compelling communication
  - **Researchers:** longitudinal studies



California Ratepayer Benefits — Technology Payback

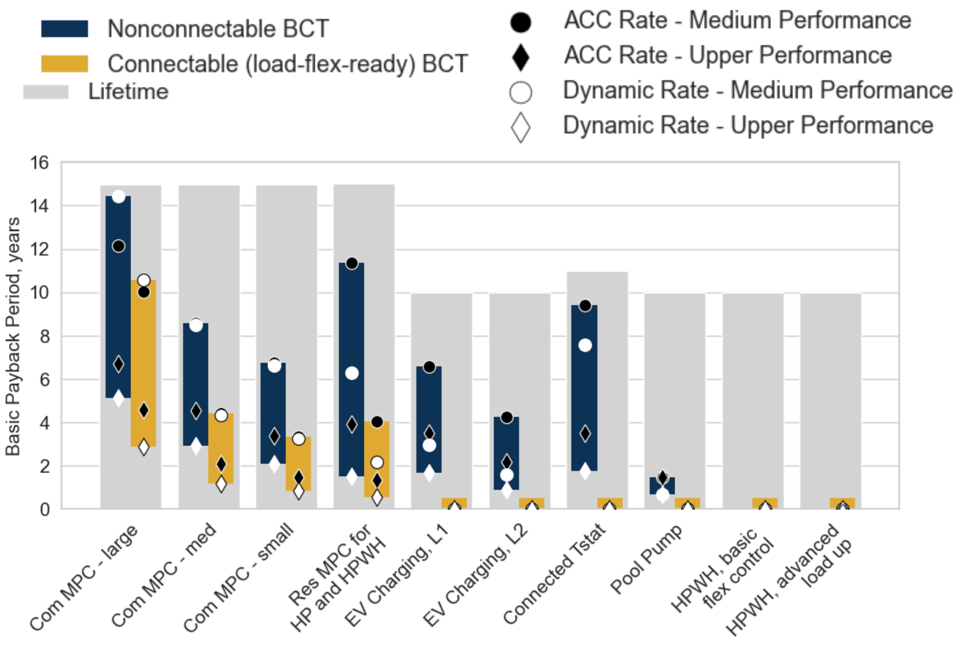
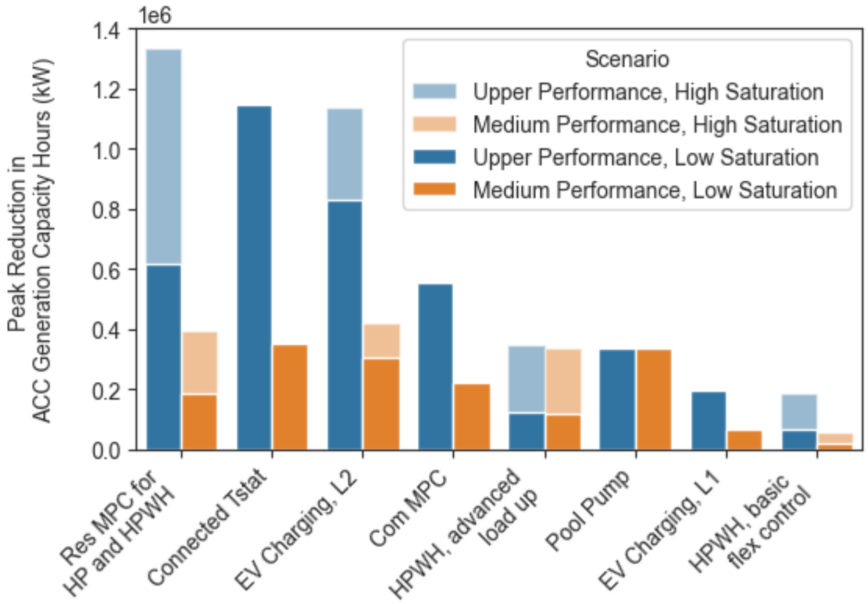


Figure 4: Population-average payback ranges across scenarios. Source: LBNL

- LBL and Guidehouse developed cost assumptions; E3 modeled dispatch & bill impacts with RESTORE model.
- Simulated population based on results with uncertainty distribution – PBP results shown are averages
- EV charging and Pool pump price response can save $200-400/yr on ACC-based rate, but up to $1000/yr on CalFUSE-based dynamic retail rate
- Connected thermostats: up to $300/yr savings; sensitive to performance level assumption (60% vs 90% shed depth)
- HPWH: $100–$200/yr savings; Only considered installed base of communicable devices in the analysis
- Commercial MPC: Savings vary widely by building size. Significant up-front commissioning costs that scale with building size, but low PBP possible
- A hypothetical $10/mo service fee would erode value for several residential technologies.

Statewide Grid Impact Potential (2030)



- Technical potential in 2030 — all eligible customers assumed to adopt price-responsive flexibility
- Moderate performance: 1.4–1.7 GW peak reduction
- Higher performance: 3.2–3.7 GW
- EV charging is largest potential contributor due to high flexibility
- Residential space conditioning is the other primary contributor due to large potential customer base and highly coincident baseline loads

Knowledge Transfer & Market Impact

+2.6	~$45M	300+
avg. technology readiness-level gain	follow-on funding secured	stakeholders engaged

- EASY-SHIFT price-responsive control algorithm (HPWH, HVAC heat pumps, pool pumps) — strong industry interest; a few manufacturers planning to license from LBNL.
- Training delivered to PG&E WatterSaver and SCE SmartShift Rewards programs — both integrating LBNL's HPWH Adaptive Load Scheduling Framework.
- Many technologies now advancing in California utilities' dynamic-rate pilots; EVs lead participation.

Barriers & Future Work (I)

Technology Vendors and Researchers

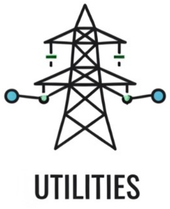
- Analyze **technology costs & cost-compression opportunities**
- Turn prototypes into commercial **packaged solutions**
- **Advance interoperability** (BACnet, Modbus, APIs)
- Reduce MPC **implementation time/cost** (semantics, AI)

Barriers & Future Work (II)

Policymakers & Funding Agencies

- Identify **public investments to reduce adoption cost**
- **Fund incentives, infrastructure, targeted outreach**
- Understand **emerging business models** (OEM vs. ASP tradeoffs)

Barriers & Future Work (III)



Utilities

- Provide clear, predictable **customer incentives & value**
- Run **large-scale, multi-year studies** with control groups
- Explore **programs beyond retail dynamic rates**
- Design **customer-centric programs** (education, comfort, feedback)

Thank you!

Open Discussion