California Load Flexibility Research and Deployment Hub

Presentation to the CalPlug Workshop
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Research Sponsors: US DOE BTO, CPUC and CEC

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CalFlexHub seeks to

Advance the capability of buildings to provide a flexible electricity load for the State of California.

- Identify, evaluate, develop, and demonstrate pre-commercial, load-flexible pre-commercial technologies

- Standardize the signals used to communicate dynamic price and GHG information to these technologies

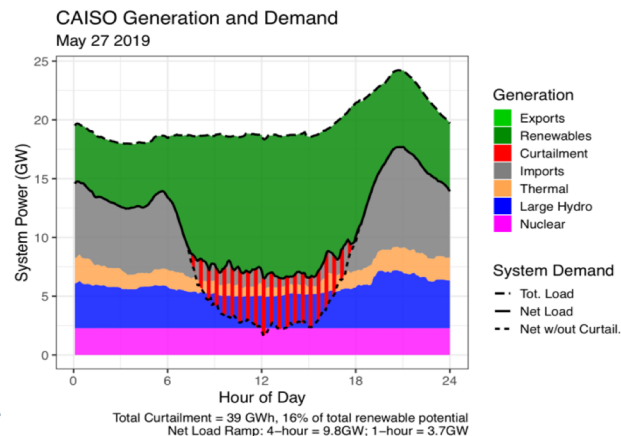- Emphasis is Load Shaping DR but CalFlexHub will also evaluate supply-side DR

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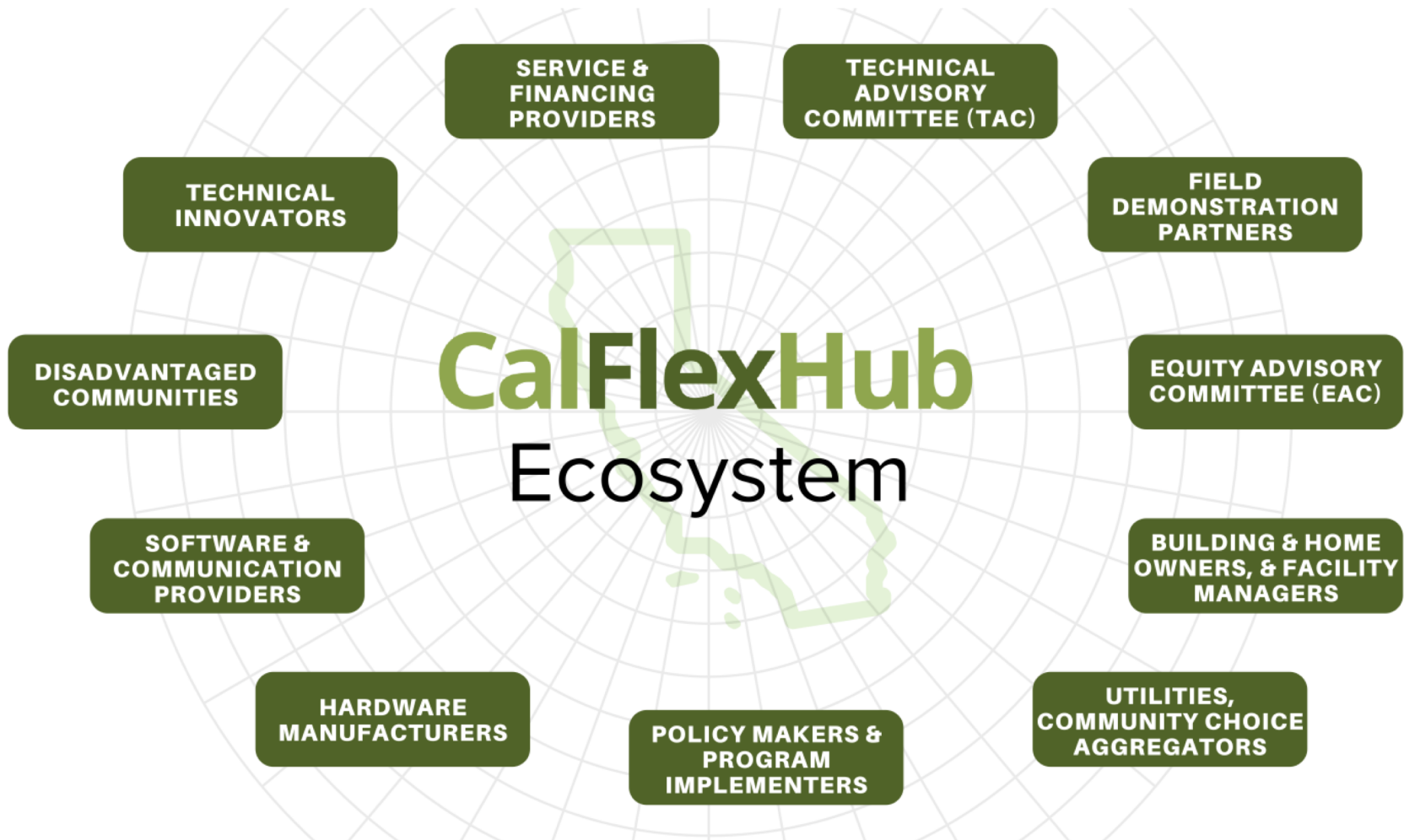BERKELEY LAB

The Solution:
Prices To Devices

A future where building loads receive continuous price information and adjust their electricity consumption automatically for maximum affordability, reduced carbon content, or a mixture of both.

Signals will include Watt Time signals.

Assume the future will include grid-informed tariffs: TOU, CPP, RTO

CAISO Generation and Demand
May 27 2019

Generation
- Exports
- Renewables
- Curtailment
- Imports
- Thermal
- Large Hydro
- Nuclear

System Demand
- Tot. Load
- Net Load
- Net w/out Curtail.

Total Curtailment = 39 GWh, 16% of total renewable potential
Net Load Ramp: 4–hour = 9.8GW; 1–hour = 3.7GW

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CalFlexHub Ecosystem

- SERVICE & FINANCING PROVIDERS
- TECHNICAL ADVISORY COMMITTEE (TAC)
- TECHNICAL INNOVATORS
- FIELD DEMONSTRATION PARTNERS
- DISADVANTAGED COMMUNITIES
- EQUITY ADVISORY COMMITTEE (EAC)
- SOFTWARE & COMMUNICATION PROVIDERS
- BUILDING & HOME OWNERS, & FACILITY MANAGERS
- HARDWARE MANUFACTURERS
- POLICY MAKERS & PROGRAM IMPLEMENTERS
- UTILITIES, COMMUNITY CHOICE AGGREGATORS

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Equity

CalFlexHub seeks to benefit all Californians, including those from disadvantaged communities.

Target technologies will be practical, affordable, and reliable.

Signals will be broadcast over the internet and via FM radio waves—accessible to virtually every household and business in California.
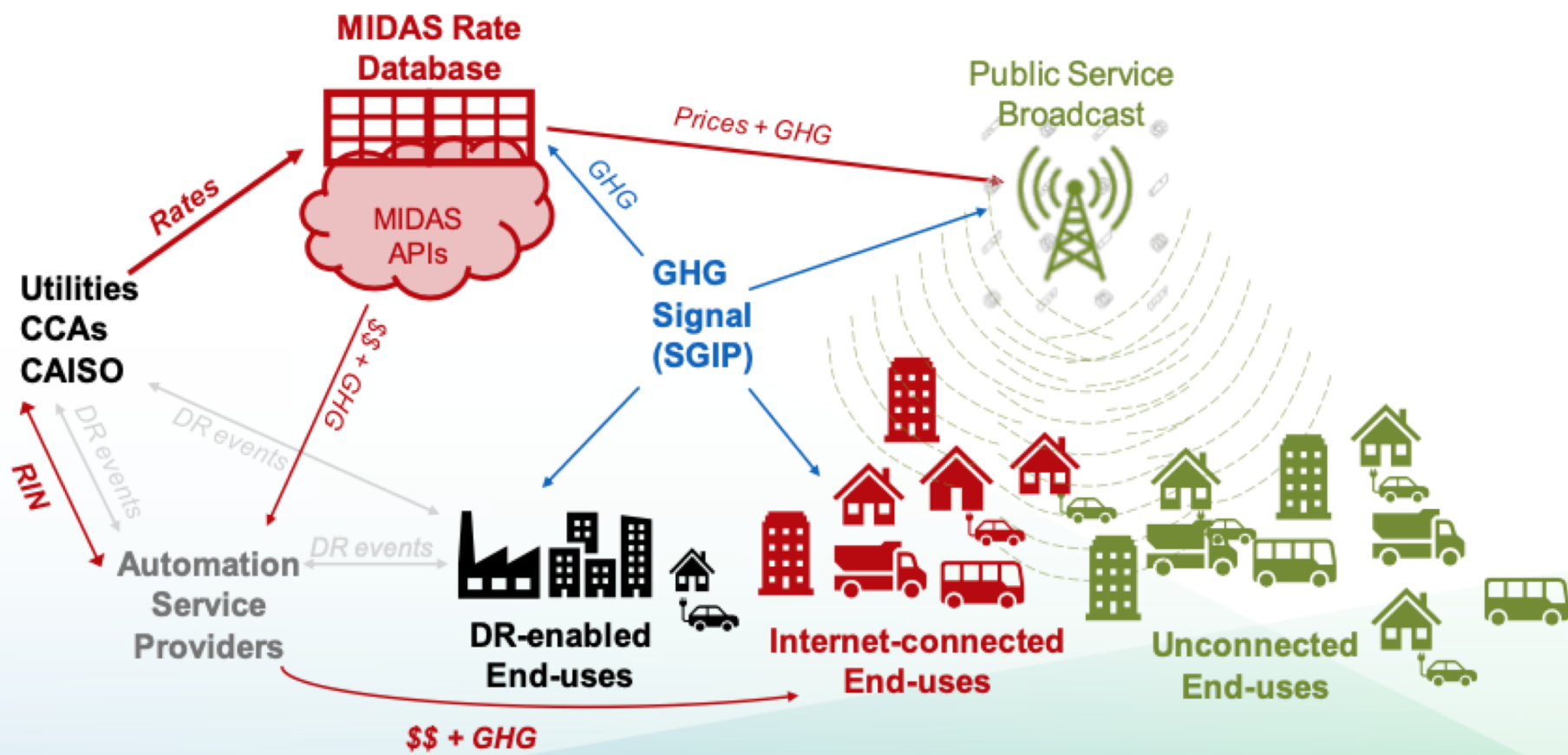
Funded and Cost Share Partners

CalFlexHub includes 23 other partners, industry, building owners
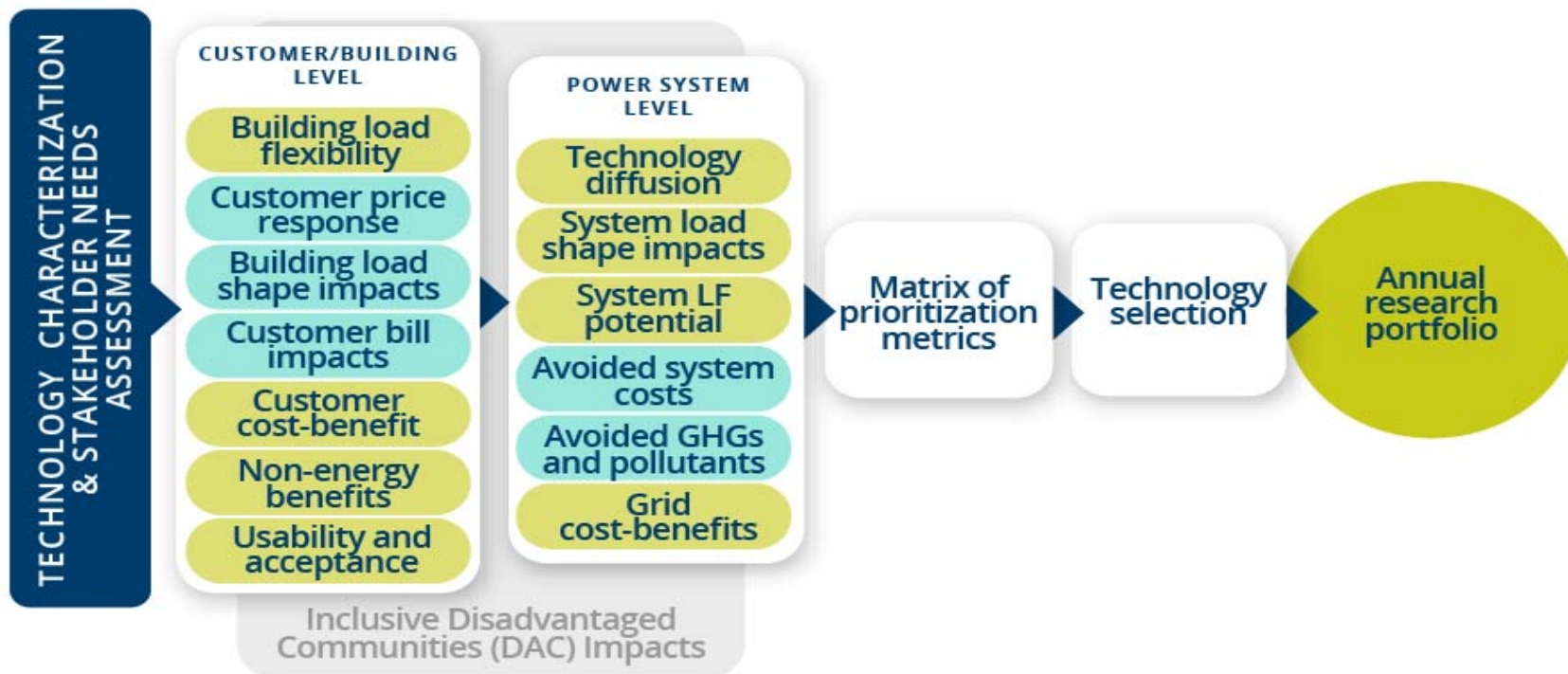
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Long-term Vision: Public Broadcast
Time-varying rates and greenhouse gas (GHG) signals

**MIDAS - Market Informed Demand Automation Server**

Annual Technology Assessment Process

Portfolio management framework for valuation of impacts of CalFlexHub technology portfolios and development of annual research portfolio. Berkeley Lab models (green); E3 models (turquoise).

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Six Applied R&D Projects – Lab and Initial Demo Sites

|		Funded Partners	Other Partners	Location/Sites
A1	**Residential Smart Fan with Integrated Thermostat**	UCB	Big Ass Fans	UCB, Stockton Senior Center
A2	**Dynamic Heat Pump for Residential Space Heat and DHW**	UCD	Ecobee, Rheem, Carrier	UCD, Future Multi-Family Site
A3	**Dynamic Space Heat for Small Commercial HVAC**	LBNL	Melrok	LBNL FlexLab, EPIC HP-Flex Sites
A4	**Integrated Heat Pump and Cold Storage for Small Commercial HVAC**	LBNL	Sunamp, Aermec, UCD Facilities	UCD
A5	**Model Predictive Control for Dynamic Large Commercial and District Energy Systems**	LBNL, UCSD	UC Merced Facilities	LBNL, UCSD, UC Merced
A6	**Home Energy Management System to Maximize Electrical Panels with Electric Storage**	LBNL	Orison, Heila, Span.io	LBNL

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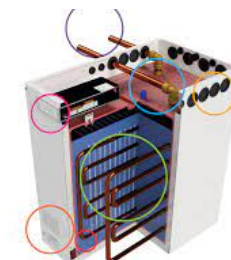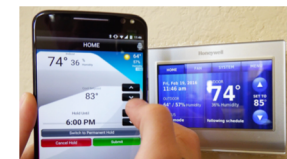
Six Technology Demonstration and Deployment Projects – Field Sites

		Funded Partners	Other Partners	Location/Sites
T7	**Integrated Small Commercial Energy Management with DERs**	UCD, Extensible Energy	Gridpoint	UCD
T8	**Integrated Heat Pump with Storage for DHW and Space Conditioning**	UCD	Villara	Nor Cal Homes
T9	**Residential HVAC and Hot Water Using Integrated Storage**	LBNL, Harvest Thermal		East Bay Homes
T10	**Household Flexible EV Charging**	UCB	BMW	California Homes
T11	**Bi-Directional EV Charging**	UCD	Honda	UCD and UCSD
T12	**Control and Coordination of Distributed Flexible Loads**	Olivine, SkyCentrics	Ecobee, Pentair, Sonoma Clean Power, Belmont Redwood Shores Schools, Richmond MSH Properties, City of Pittsburg Unified Schools, UCB Richmond Field Station	Belmont, Richmond, Pittsburg, Sonoma, LA County, and others

# CPUC Demand Response Potential Studies Explore Size and Value of GEBs
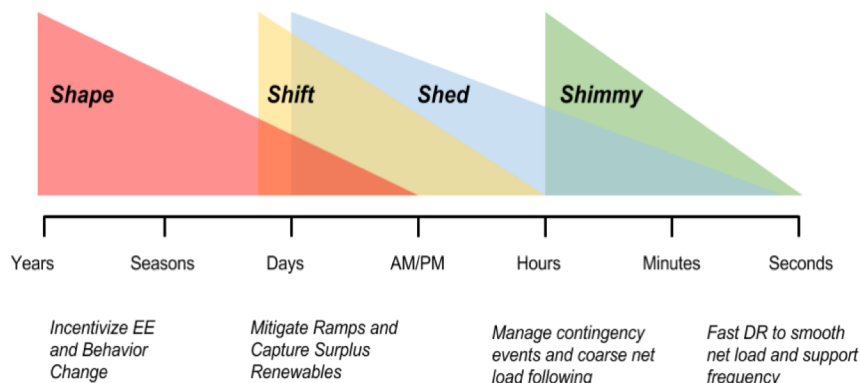
- **Shape**: persistent daily load modifications

- **Shed:** acts like virtual **generation** capacity

- **Shift**: acts like a virtual **storage** resource

- **Shimmy**: acts like a virtual **regulation**/ancillary services resource

- Phases 1, 2 and 3 provided the shed capacity (GW) and shift (GWh) from GEBs. Buildings could provide about 2 GW at $200/kW-yr Levelized cost for 2025.

- Current modeling (Phase 4) will cover new end-uses and update customer data.

- Key questions: **How large** is Shed and Shift resource, **where** are resources and **when** is it available, and at **what cost**?

- **Key takeaway:** Shift can play important role in California's renewable grid, but it will need to grow. We can explore ways to bring down costs and drive participation.

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Shift Supply Curve for 2030

Battery threshold (reference price)
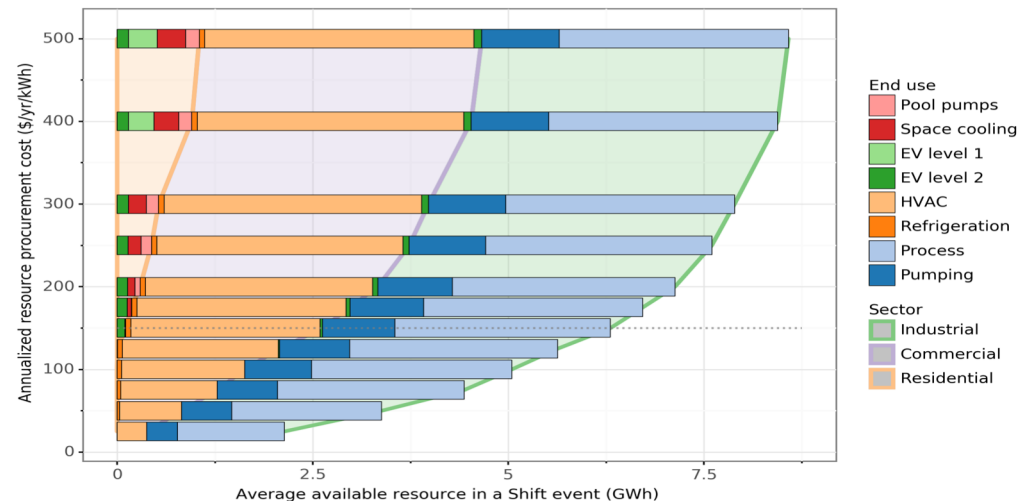
- **Shift DR** in California: 4-6 GWh of *virtual storage* cheaper than BTM batteries (~$150/yr/kWh), about 40% from buildings, a significant portion of current grid challenges.

- **Electrification** will introduce a new Shift resource, modeled in new Phase 4.

- Shift resource will be **much larger** if customer participation is higher than observed historically for Shed DR.

- With ~1 percent of load shifted in 2017, ~150 GWh of total curtailment could have been avoided (~ 50 % of curtailment), replacing non-renewable generation with zero-carbon renewable energy.

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End-Uses Considered in Cluster Load Shapes

Recent updated AMI data analysis expands scope of buildings and end uses

Residential Sector		Commercial Sector	
Building Types	**End Uses**	**Building Types**	**End Uses**
• Single-family • Multi-family • Master meter	• Cooling • **Heating** • Ventilation • Indoor Lighting • Outdoor lighting • Cooking • Dishwasher • Clothes Washer • Clothes Dryer • Refrigerator • Freezer • Pool pump • Spa heater • Spa pump • Television • Office equipment • PCs • **Water heating** • EV level 1 • EV level 2 • Rooftop PV	• Office • Retail-food • Retail-other • Dining • Lodging • Medical • Education • Assembly • Datacenter • Warehouse • Refrigerated warehouse	• Cooling • Heating • Ventilation • Indoor lighting • Outdoor lighting • Office equipment • Refrigeration • Water heating • Datacenter IT • Misc. • EV charging • Rooftop PV

Entries in **red** under development in Phase 4
Green where new in Phase 3

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Summary

CalFlexHub will support state goals in advancing demand flexibility and decarbonization in buildings

- **Evaluate capability** of building end-use systems load systems to respond to price signals

- **Identify** new technology that can deepen response

- **Understand** value of price vs carbon signal

- **Evaluate how to overcome barriers to deployment such as** usability, costs, tech capabilities