DOCKETED

Docket Number:	21-IEPR-06
Project Title:	Building Decarbonization and Energy Efficiency
TN #:	239952
Document Title:	Presentation - Grid Interactive Efficient Buildings Technology, a Case Study and the Demand Response Potential Study
Description:	S1.2A Mary Ann Piette, LBNL
Filer:	Raquel Kravitz
Organization:	Lawrence Berkeley National Laboratory
Submitter Role:	Public Agency
Submission Date:	10/4/2021 12:17:10 PM
Docketed Date:	10/4/2021

Grid Interactive Efficient Buildings: Technology, a Case Study and the Demand Response Potential Study

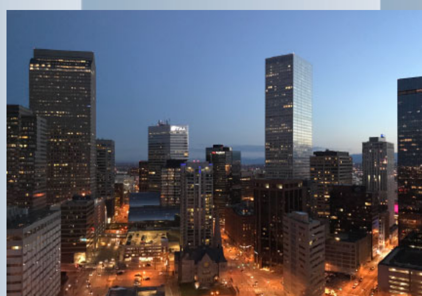
Presentation to the IEPR Workshop on GEBs
Sep 24, 2021

Mary Ann Piette
Division Director, Building Technology and Urban Systems
Research Sponsors: US DOE BTO, CPUC and CEC

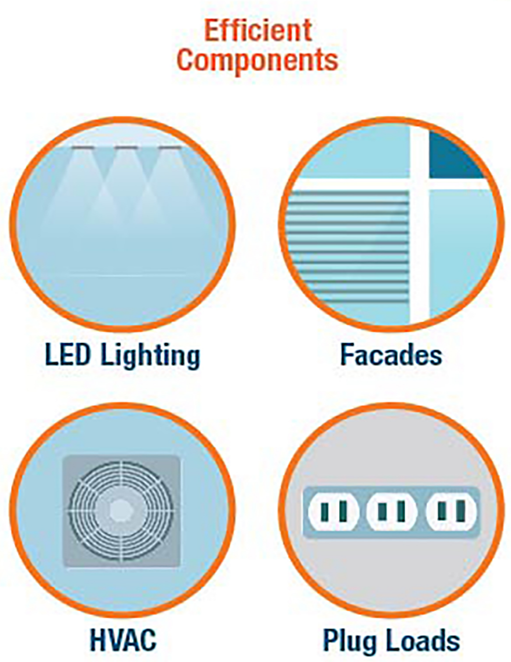
Issues Motivating Advanced Buildings Technologies

Oil Embargo	Indoor Health	Urbanization	Changing Electric Grid	Climate Change	Equity Energy and Environmental Justice

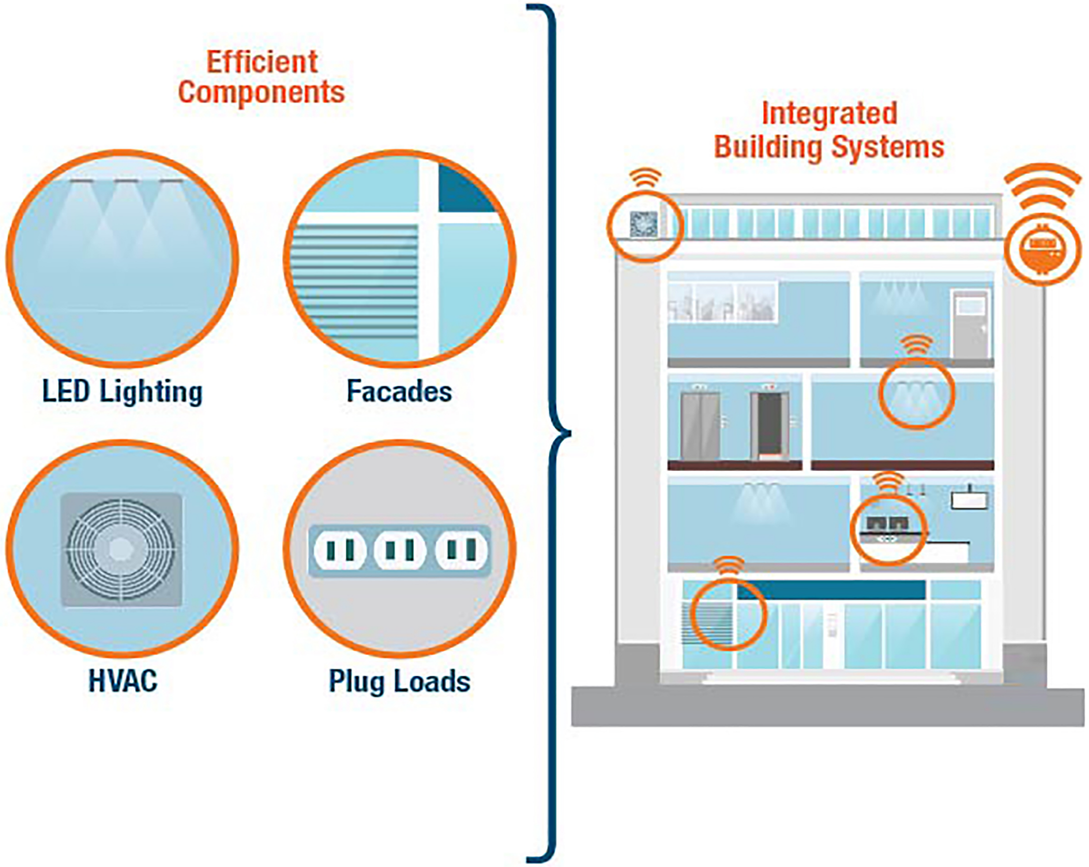
TIME



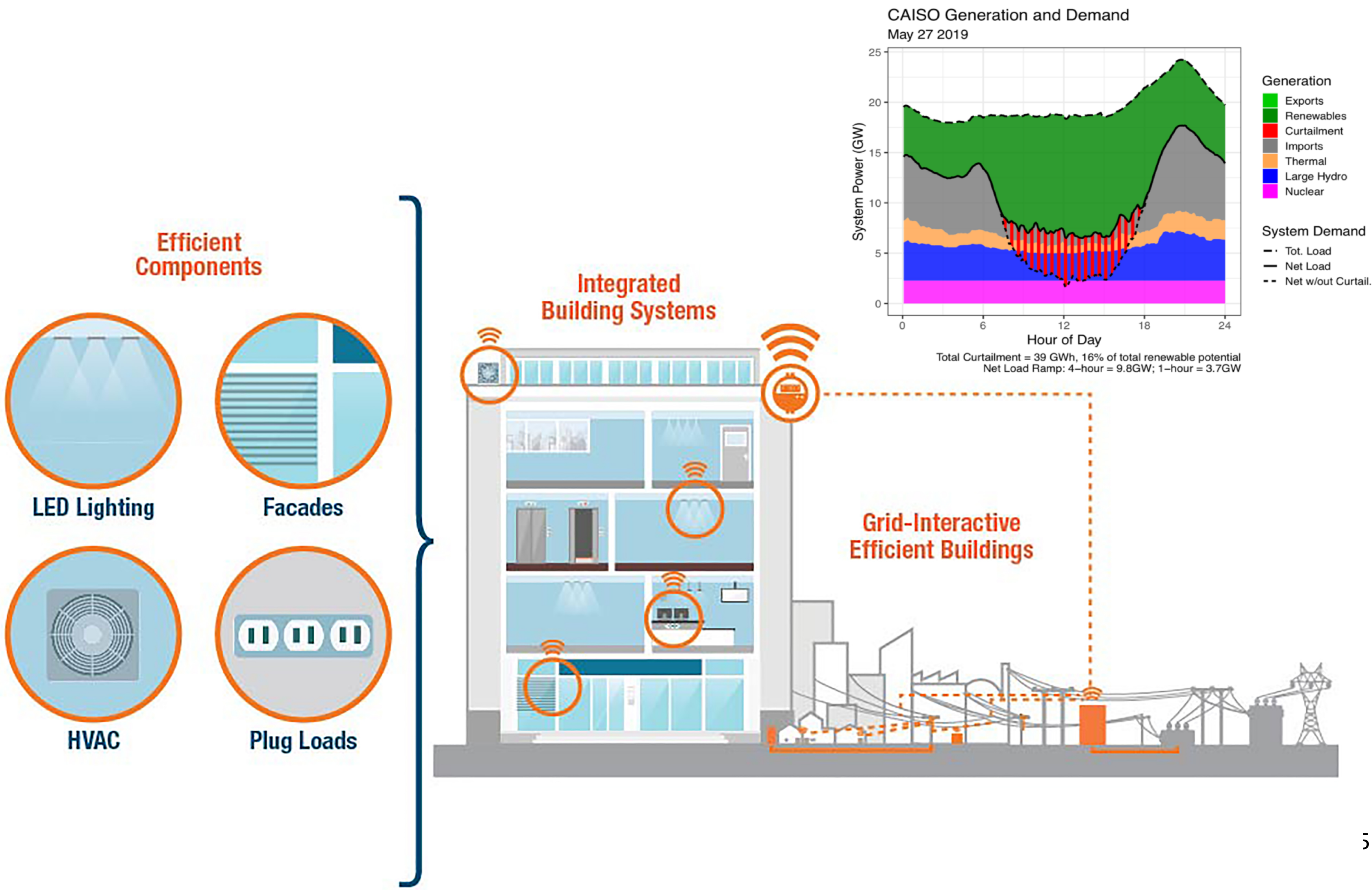
Grid Interactive Efficient Buildings Use Efficient Devices



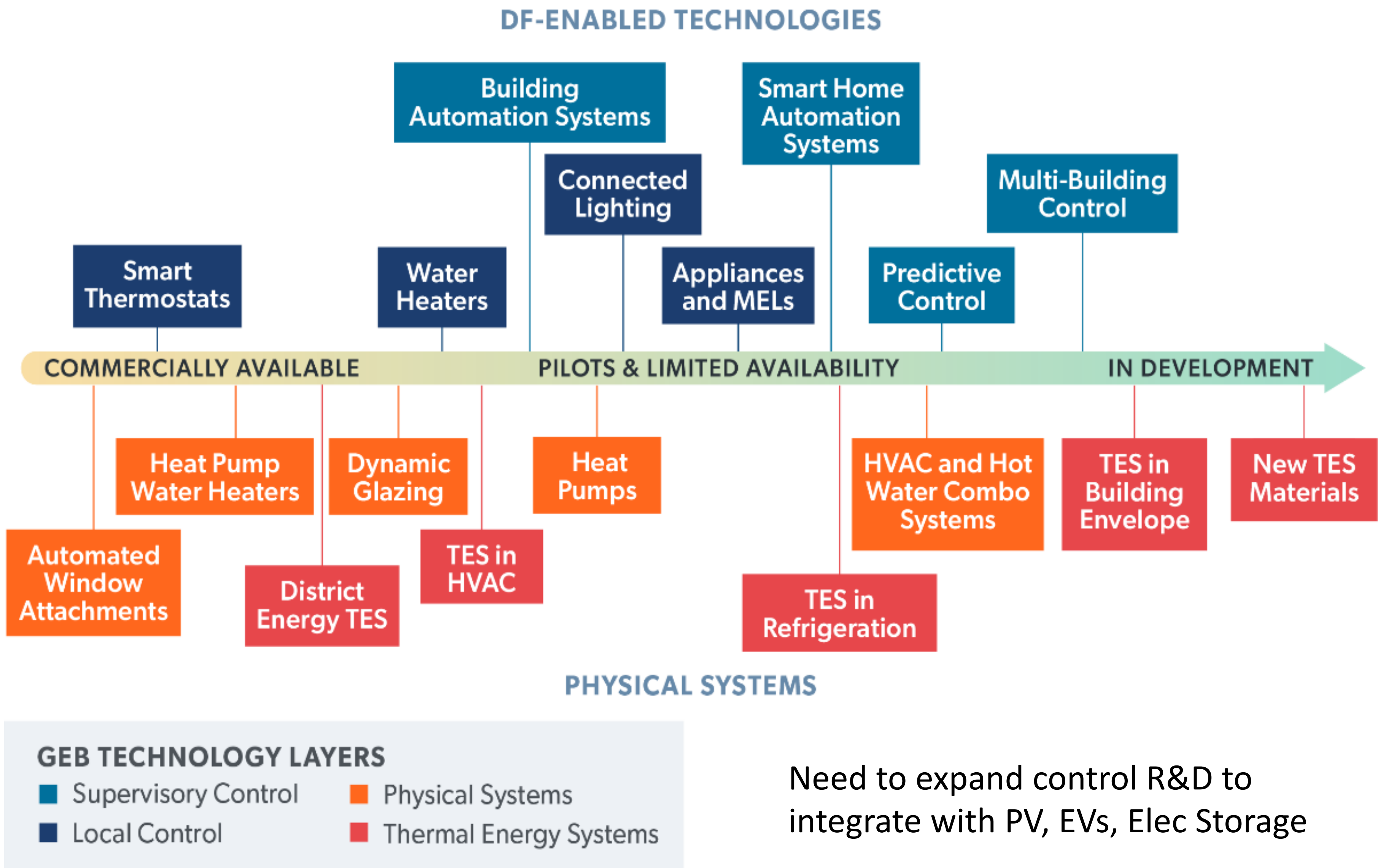
Grid Interactive Efficient Buildings Are Integrated



Grid Interactive Efficient Buildings (GEBs) Communicate with Grid and Optimize Use of Clean Energy



GEB Technology Will Unlock Opportunities to Improve Building Efficiency plus Deep Grid-Interactivity



Need to expand control R&D to integrate with PV, EVs, Elec Storage

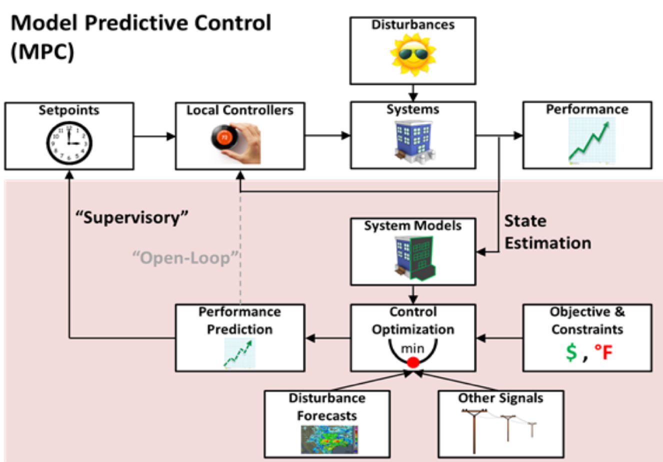
GEB Predictive Control Reduces GHG and Energy Costs

Predictive Control with PV and Thermal Energy Storage

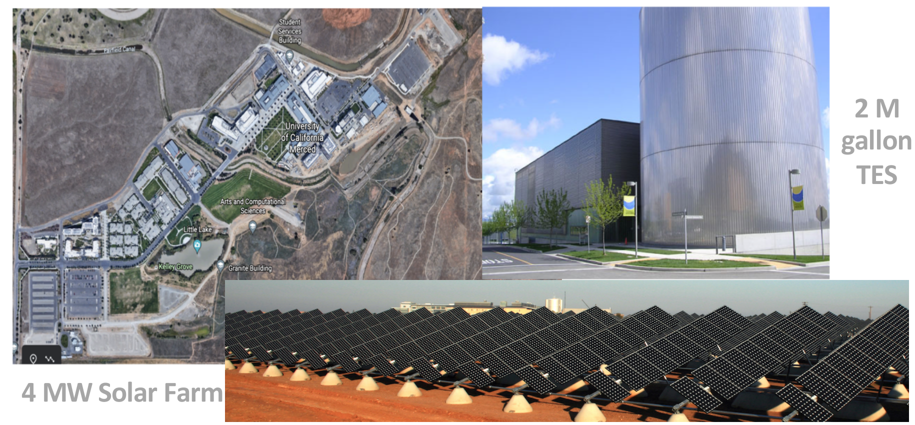
- Identified optimal control for campus chiller plants w/ TES and PV to decarbonize and stabilizing the grid

Societal/Market Impact

- CO2 reduction of ~ **1 mTCO2e/day** while reducing peak demand $.
- Approx **2500** miles in a car at 22 mpg.



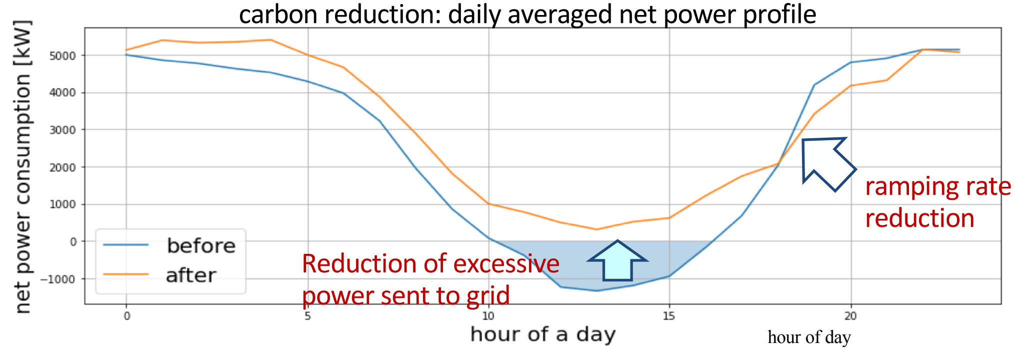
UC-Merced Campus



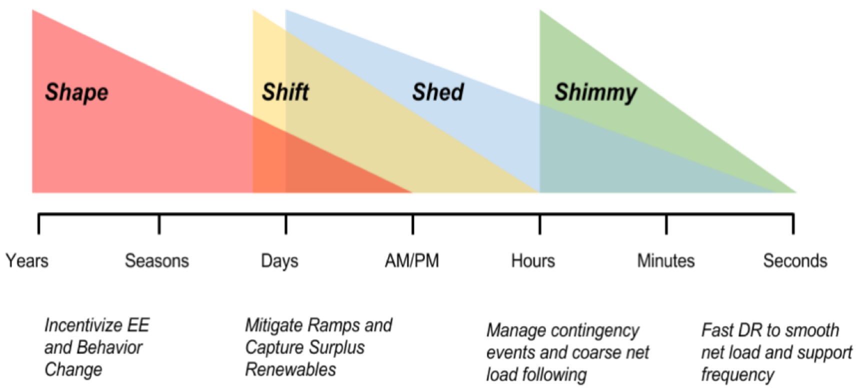
2 M gallon TES

4 MW Solar Farm

Experimental assessment of renewable energy integration and carbon reduction: daily averaged net power profile



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 takaway:** 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.

Enabling Technology Modeling Framework

<u>Components:</u>

Costs

- Initial
- Operating

Performance

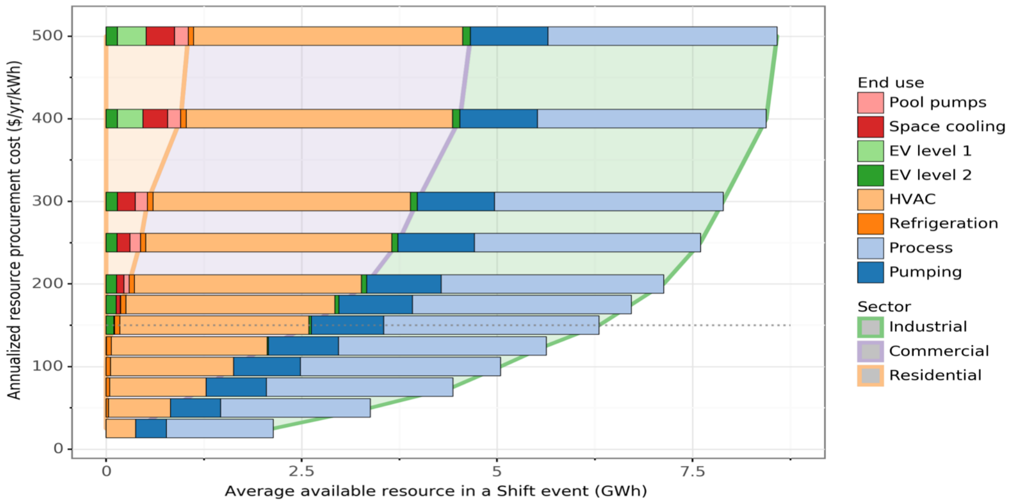
- Speed of response
- Magnitude
- Persistence

Propensity to Adopt

- Based on customer factors

Shift Supply Curve for 2030

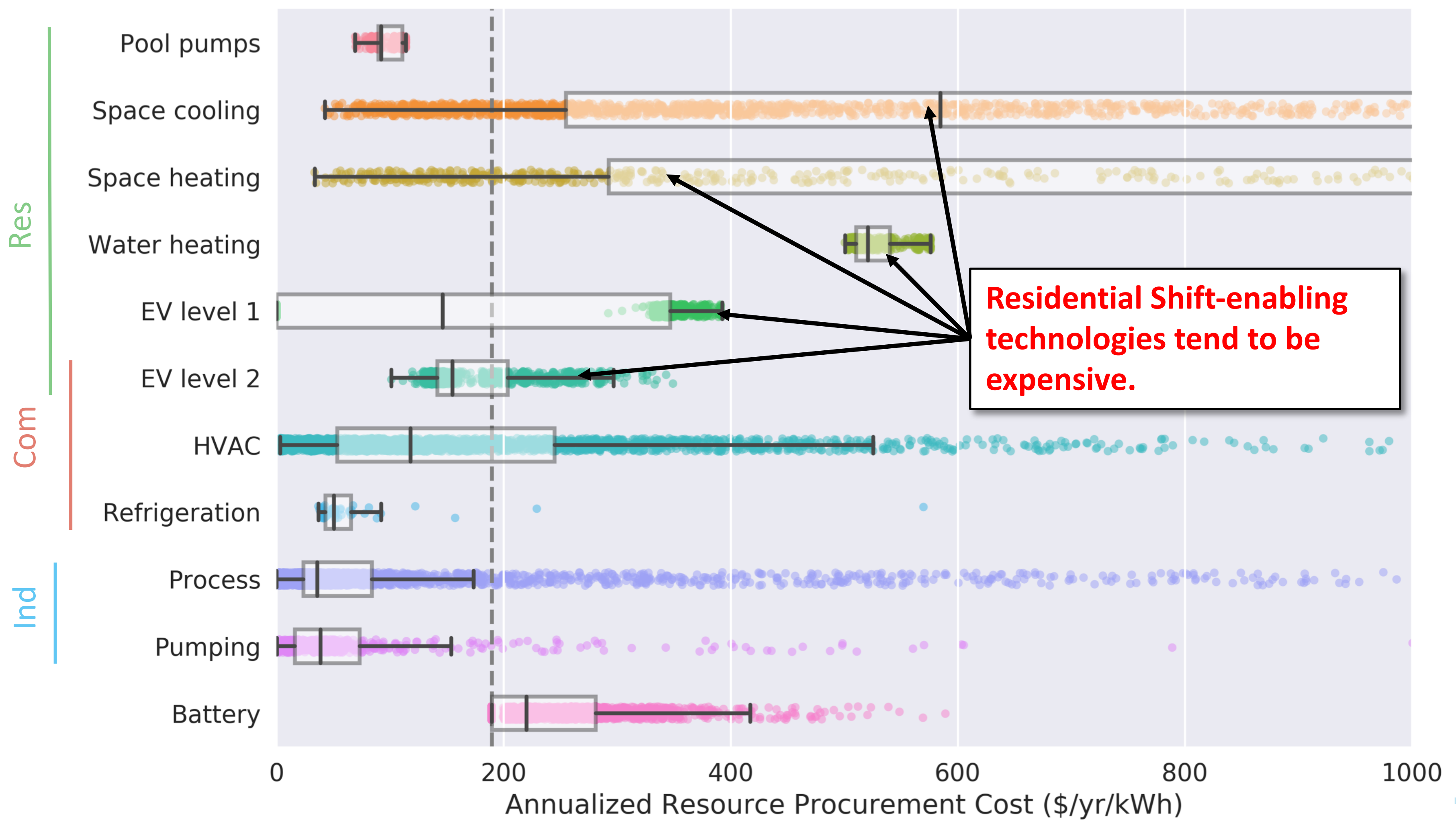
Battery threshold (reference price)



- **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.

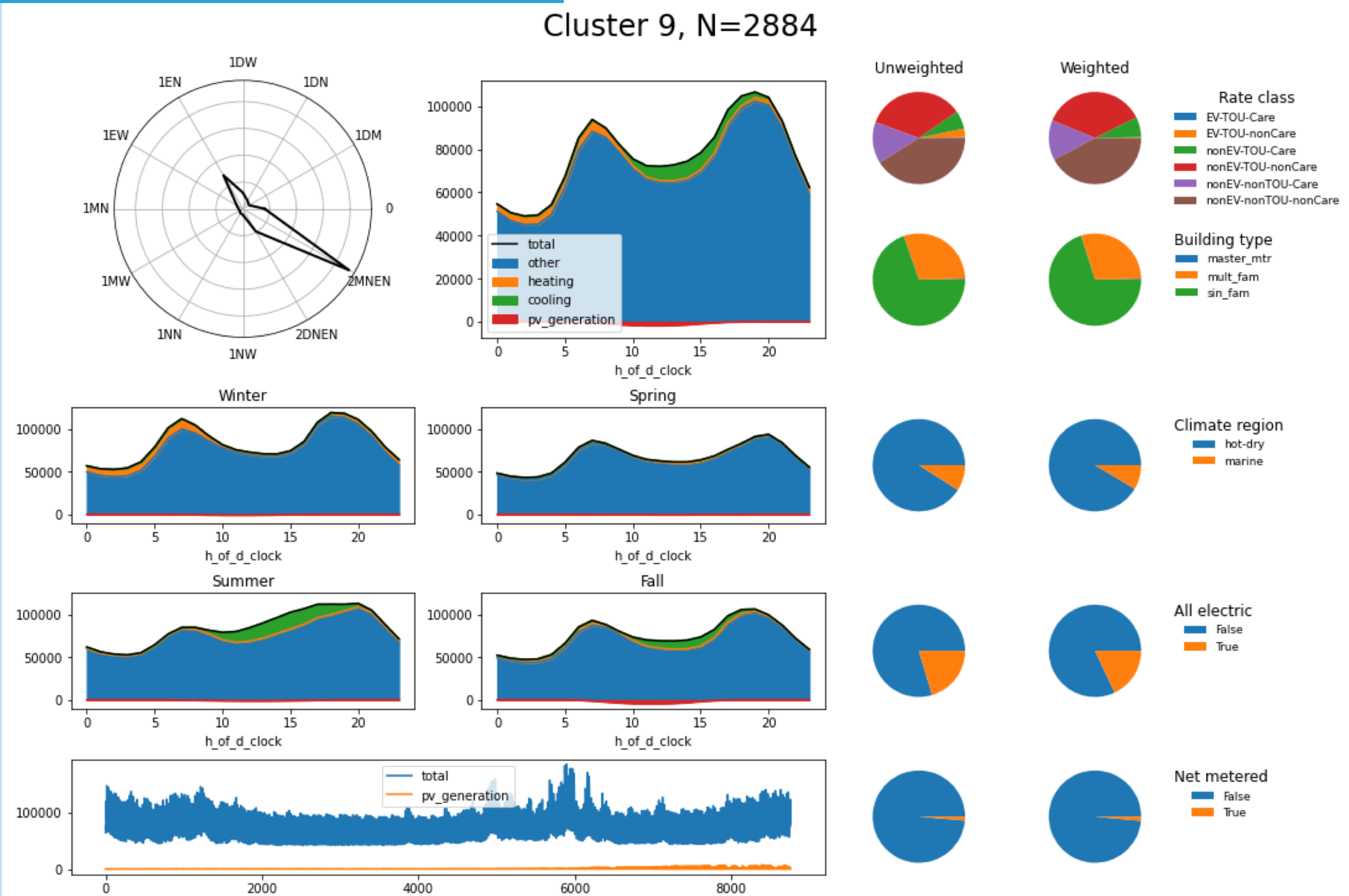
Cost Barriers to Enabling Shift

Reducing technology costs can unlock new resources



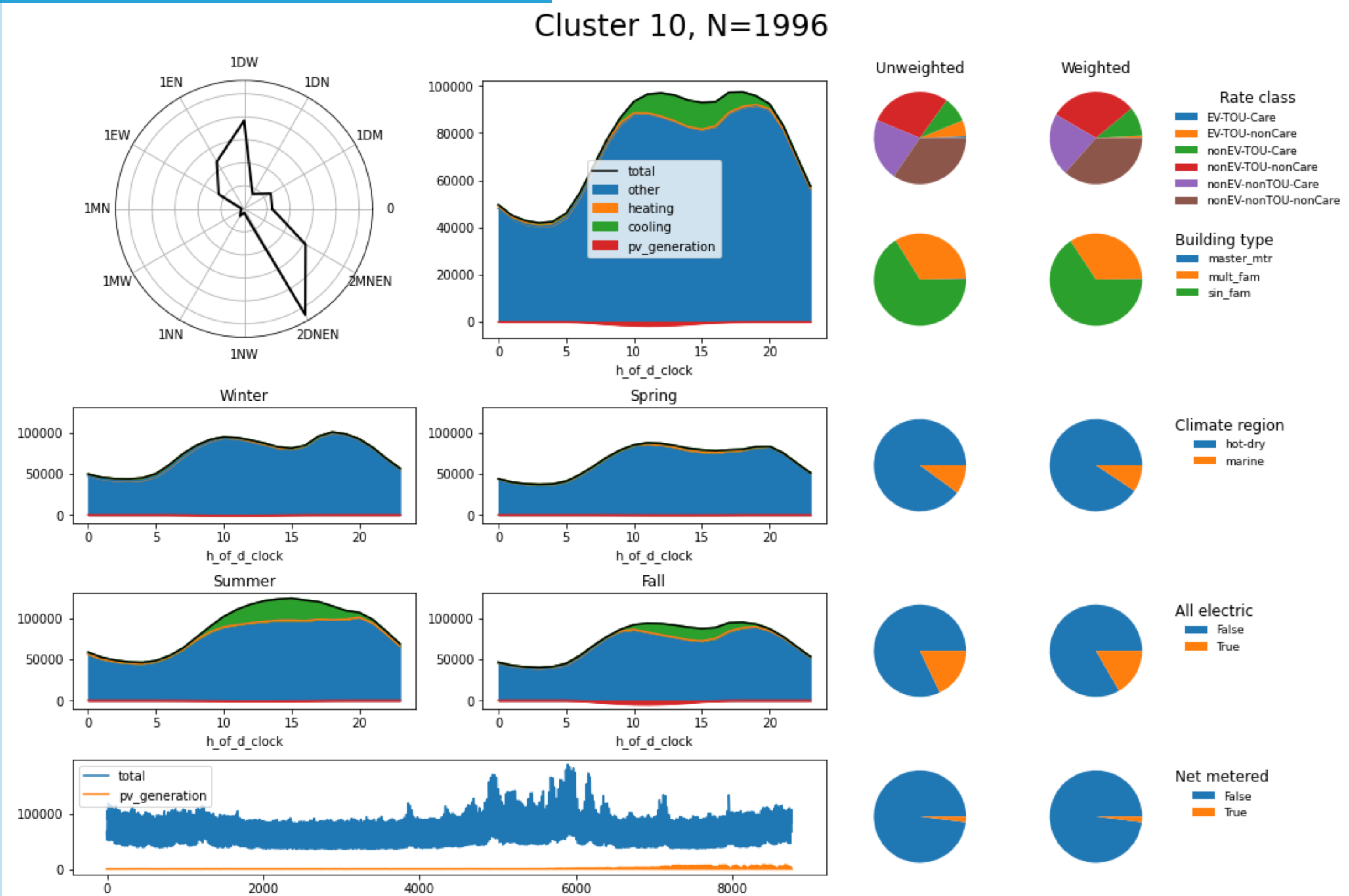
New Load-Shape Clusters

Residential: double-peakers



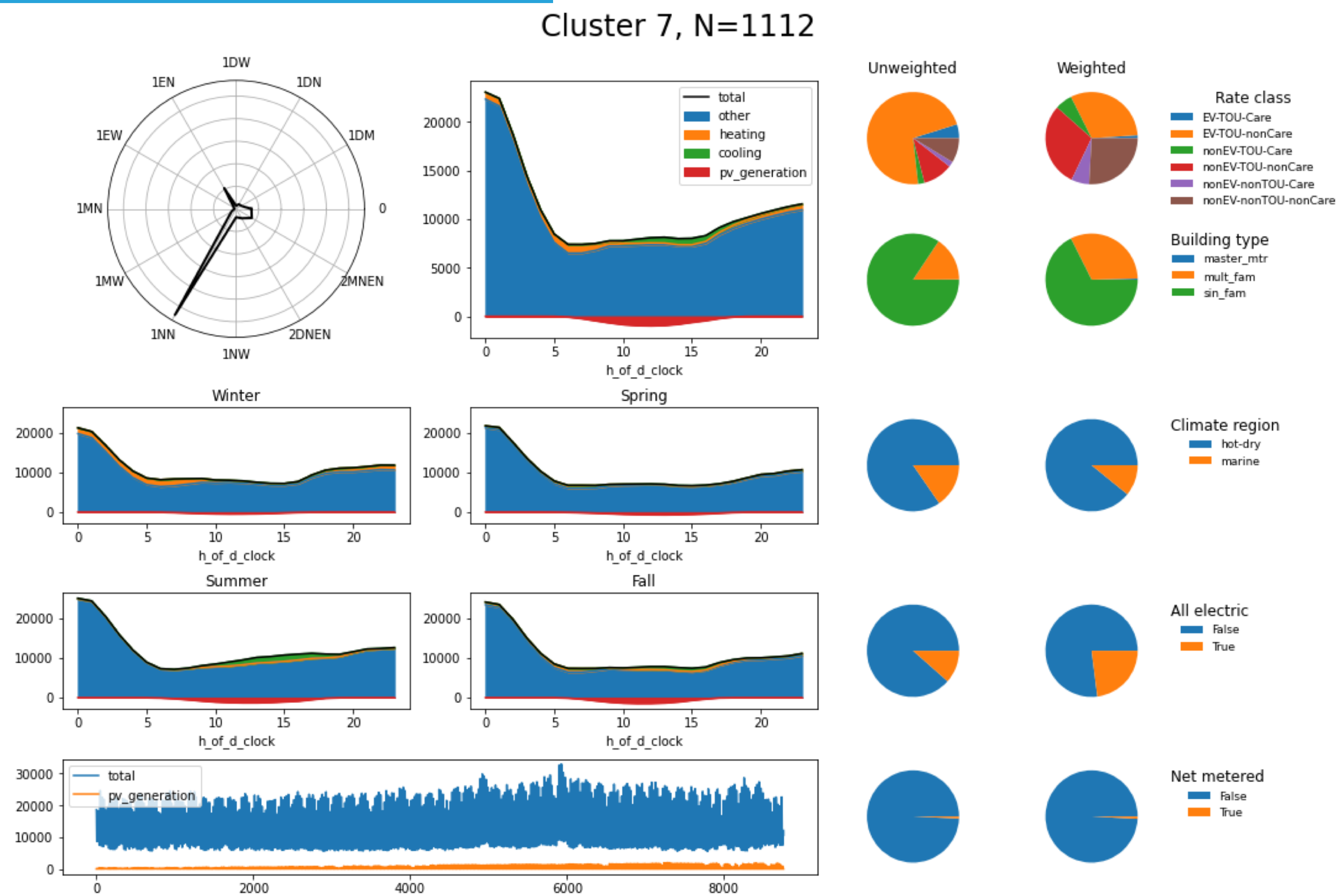
New Load-Shape Clusters

Residential: daytime occupants



New Load-Shape Clusters

Residential: EV rate responders



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 from AMI data in Phase 4

Summary and Future Directions

- **GEBs are critical for decarbonization**
- **Key technologies**: heat pumps, envelope, controls, communications, integration with EVs, PV, storage
- **Customer Engagement**: We need more of it!
- **The California Load Flexibility Research and Deployment Hub**: will enable automated flexible demand