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Lessons from the California Demand Response Potential Studies and Flexible Demand Appliances

SB 49 Workshop

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Research sponsored by the Calif PUC and the DOE Building Technologies Offices

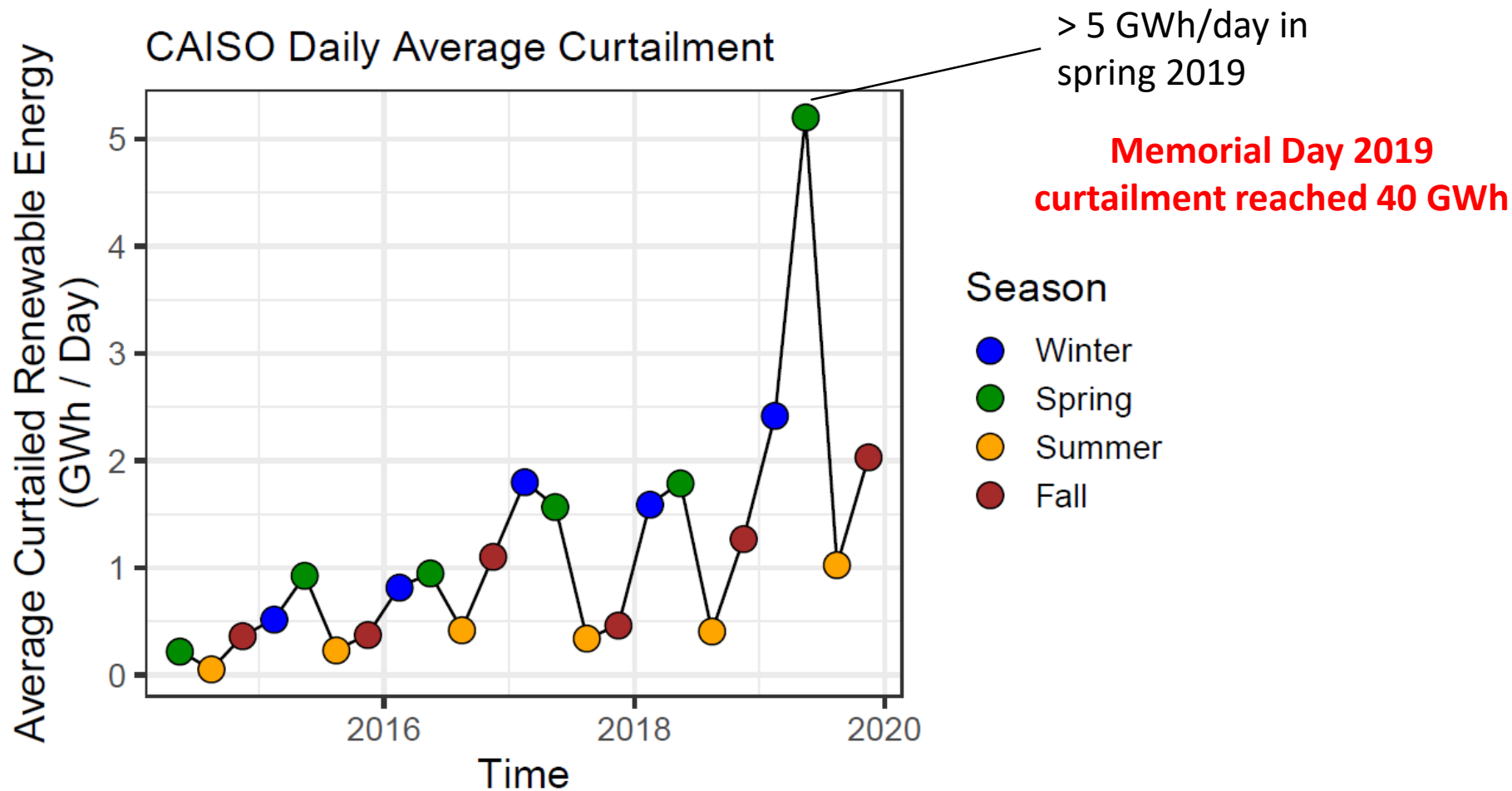


Agenda

- ◆ Introduction to Demand Response Potential Studies
 - Phase 1 and 2 – Shape, Shift, Shed and Shimmy (2016-2018)
 - Phase 3 – Shift – included electrification (2019-2020)
 - Phase 4- will include residential appliances (2020-2022)
- ◆ Cost Data for Connected Devices
- ◆ Summary and Future Directions

Growing Challenge

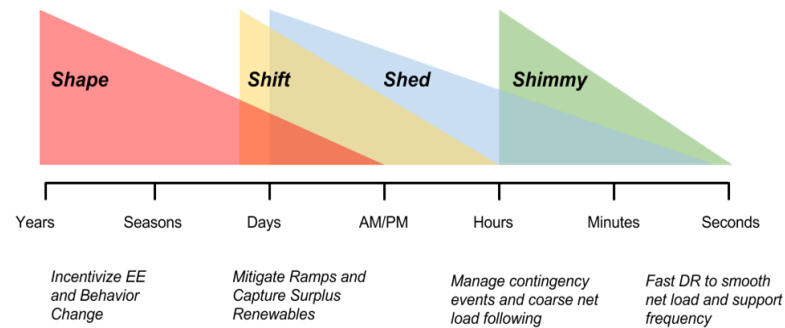
Curtailment Increases Every Year



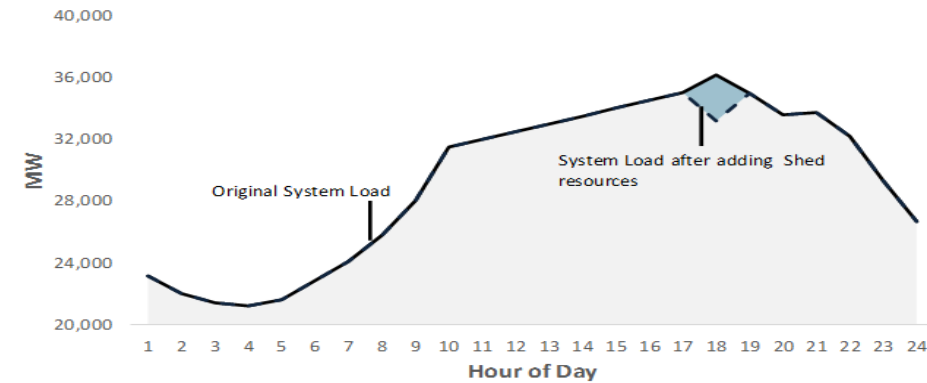
DR Potential Study Objectives

- ◆ Evaluate potential for DR to meet California’s resource planning needs and operational requirements
- ◆ Provide analysis to support DR policy based on a bottom-up model
 - “Order Instituting Rulemaking to Enhance the Role of Demand Response in Meeting the State’s Resource Planning Needs and Operational Requirements” (13-09-011)
- ◆ Identify opportunities for DR products and programs to assist in meeting long-term clean energy goals
- ◆ Evaluate opportunities for electrification and load shifting

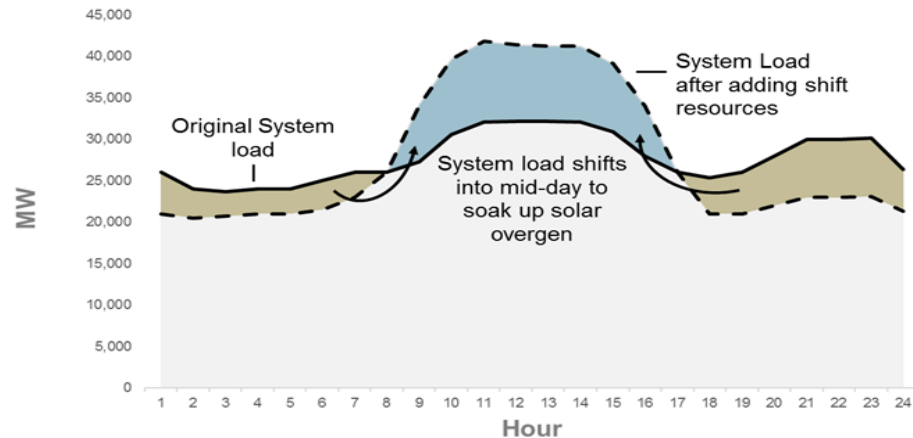
DR Service Types Providing Grid Needs



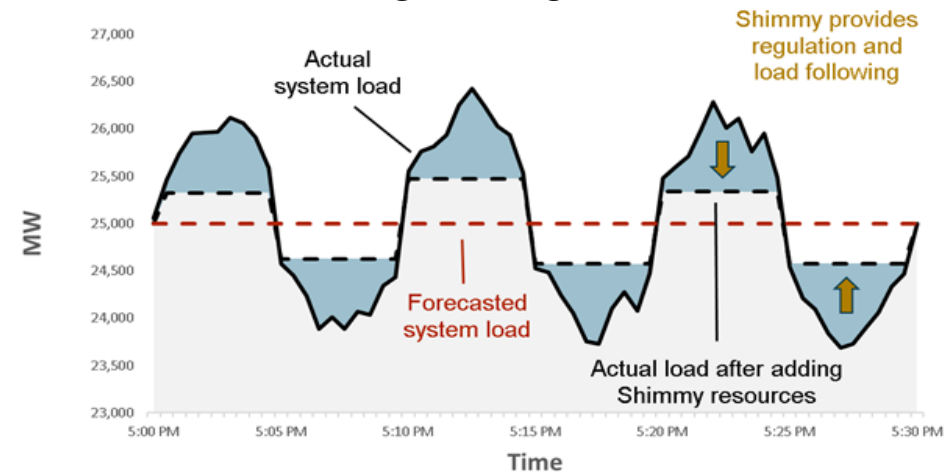
Shed Service: Peak Shed DR



Shift Service: Shifting load from hr to hr to alleviate curtailment/ overgeneration

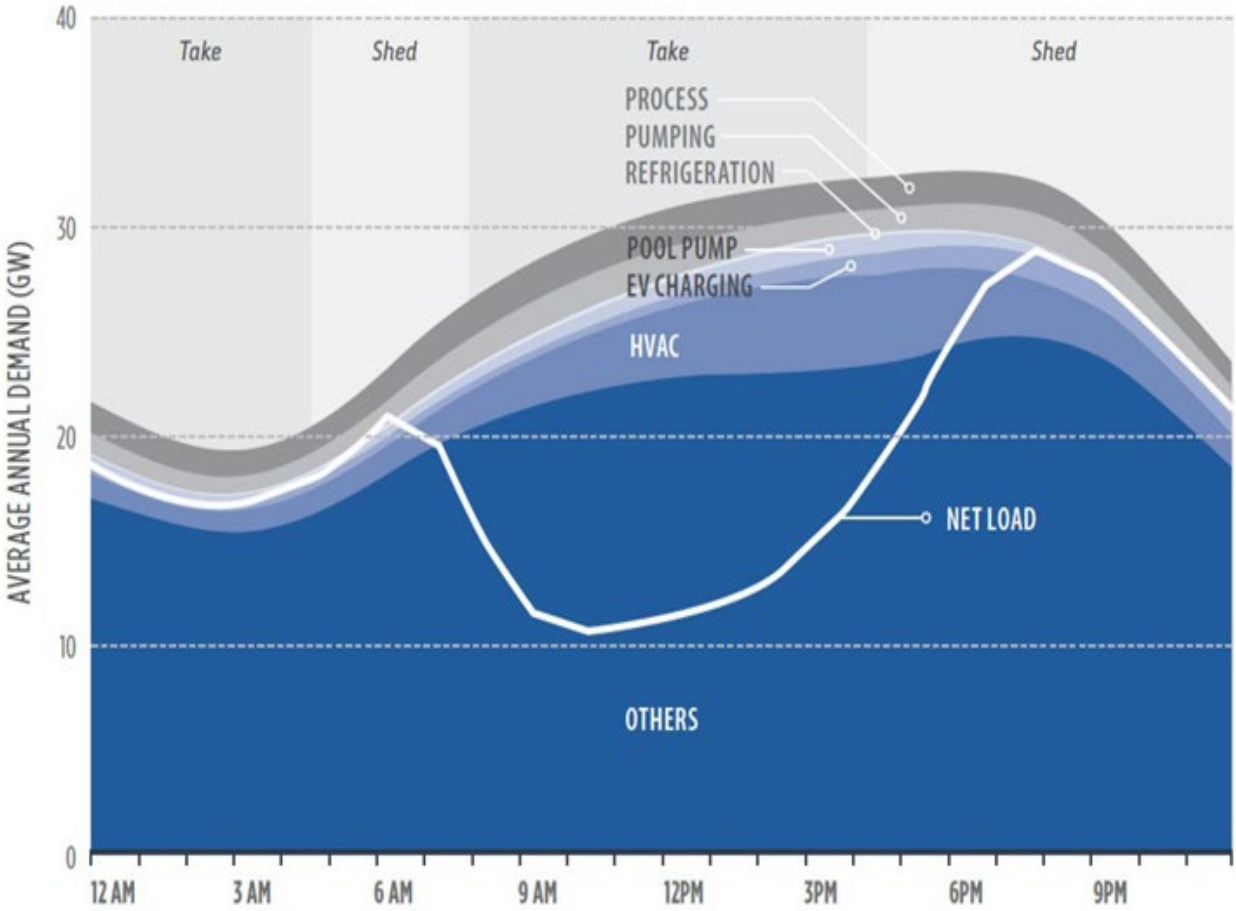


Shimmy Service: Load Following & Regulation DR



End-use disaggregation & forecasting

Figure 3: Average Annual Load Shape with Shift able Load Uses



Source: CPUC Working Group on Load Shift January 31, 2019

Phase 3 end-uses modeled

Sector	End use
Residential	Plug loads
	Pool pumps
	Space cooling
	Space heating*
	Water heating*
	EV charging
	Other
Commercial	HVAC
	Lighting
	Refrigeration
	EV charging
	Other
Industrial	Process
	Pumping
	Other

Additions for Phase 4

- ◆ Residential appliances
- ◆ Commercial space heating
- ◆ Commercial water heating

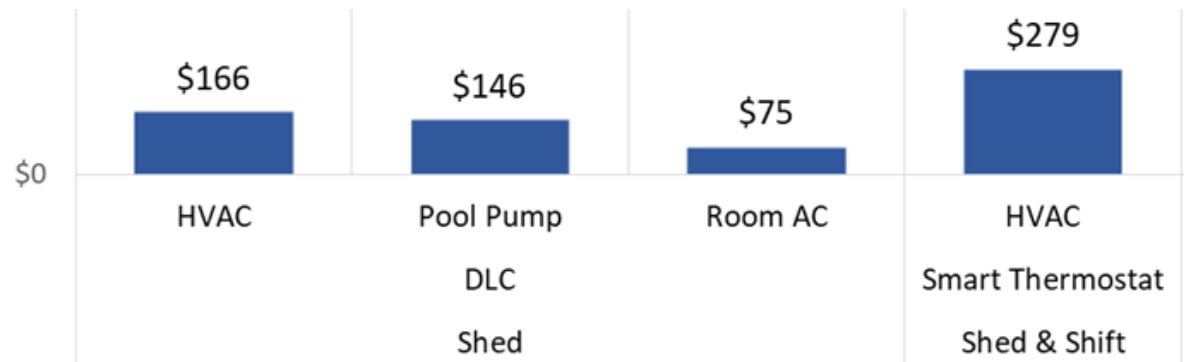
*Electrification estimates new in Phase 3



DR Site Enablement Cost Categories

- ◆ **Fixed** initial **communication and hardware costs** for controllability “per site” for given end-use or customer premise. Costs included are telemetry, communication resource interface, and installation costs. Reported in **\$ per site**.
- ◆ **Variable** initial **costs for control technology** for controllability “per kW” (e.g., HVAC and retail lighting controls). **Reported as \$ per kW** enabled for DR services.
- ◆ **Fixed** initial **end-use control technology and communication costs** for achieving controllability “per end-use”. Costs are specific to Electric Vehicles and the Residential sector end-uses and are reported as **\$ per end-use** enabled for DR services.

Residential DR Site Enablement Costs



Further work needed to collect and compare these costs for various appliances

Demand Response Advanced Controls Framework and Assessment of Enabling Technology Costs

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August 2017



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Forthcoming Report - Grid Interactive Efficient Buildings Technologies

Data Report

Presented to: Berkeley Laboratory

Prepared by: Guidehouse Inc.

September 30, 2020

Will include costs for smart, connected technologies.

Overview and Objectives

Methodology

Key Data Sources

Notes and Assumptions

Definitions

Residential Technologies

Residential Central AC/Smart Thermostats

Residential Heat Pumps/Smart Tstats

Residential Mini-Splits

Residential Room ACs

Residential Elec Resistance Water Heaters

Residential Heat Pump Water Heaters

Residential Clothes Washers (Top-Loading)

Residential Clothes Washers (Front-Load)

Residential Electric Clothes Dryers

Residential Dishwashers

Residential Refrigerators (Side-Freezers)

Residential Refrigerators (Bottom-Freezers)

Residential Lighting

Smart Home Energy Management Systems

Residential Window Attachments

Residential Advanced Power Strips

Residential Pool Pumps

Commercial Technologies

Commercial Chillers/Ice Storage

Commercial Electric Resistance Water Heaters

Commercial Ice Machines

Walk-in Coolers/Thermal Energy Storage

Commercial Lighting (LED Troffer/Panel)

Building Automation Systems

Dynamic Glazing/Commercial Fenestration

Commercial Envelopes/PCMs

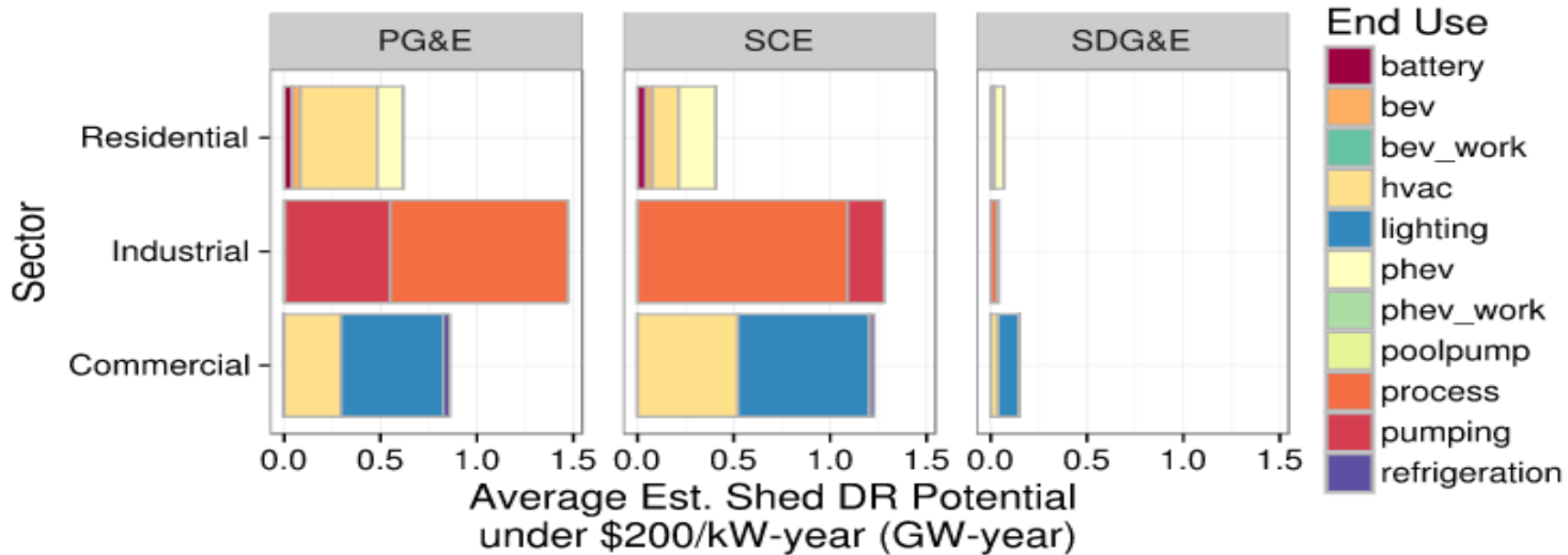
Commercial Advanced Power Strips

Example of Data from Guidehouse - Residential Central AC/Smart Thermostats

DATA	2020			2030		2040		2050		
	Current Standard	Typical	ESTAR Connected Smart Thermostat	Typical	ESTAR Connected Smart Thermostat	Typical	ESTAR Connected Smart Thermostat	Typical	ESTAR Connected Smart Thermostat	
Typical Capacity (kBTU/hr)	36	36	-	36	36	36	36	36	36	
SEER	South: 14.0	15.0-16.0	-	15.2-16.0	-	15.2-16.0	-	15.2-16.0	-	
	North: 13.0									
Average Life (yrs.)	South: 18	South: 18	8-10	South: 18	8-10	South: 18	8-10	South: 18	8-10	
	North: 24	North: 24		North: 24		North: 24				
Retail Equipment Cost (2020\$)	2,771	2,990	115	3,007	77	3,007	71	3,007	67	
	2,845	3,081	199	3,081	133	3,081	122	3,081	116	
Total Installed Cost (2020\$)	4,344	4,563	215*	4,597	177*	4,597	171*	4,597	167*	
	4,417	4,653	299*	4,653	233*	4,653	222*	4,653	216*	
Annual Maintenance Cost (2020\$)	21	21	-	21	-	21	-	21	-	
	133	133		133		133				
Reported Energy Savings	-	-	Cooling	7%	-	Cooling	7%	-	Cooling	7%
				10%			10%			10%

Phase 2 Shed Technology \$200/kW Price Referent

2025 Medium Case



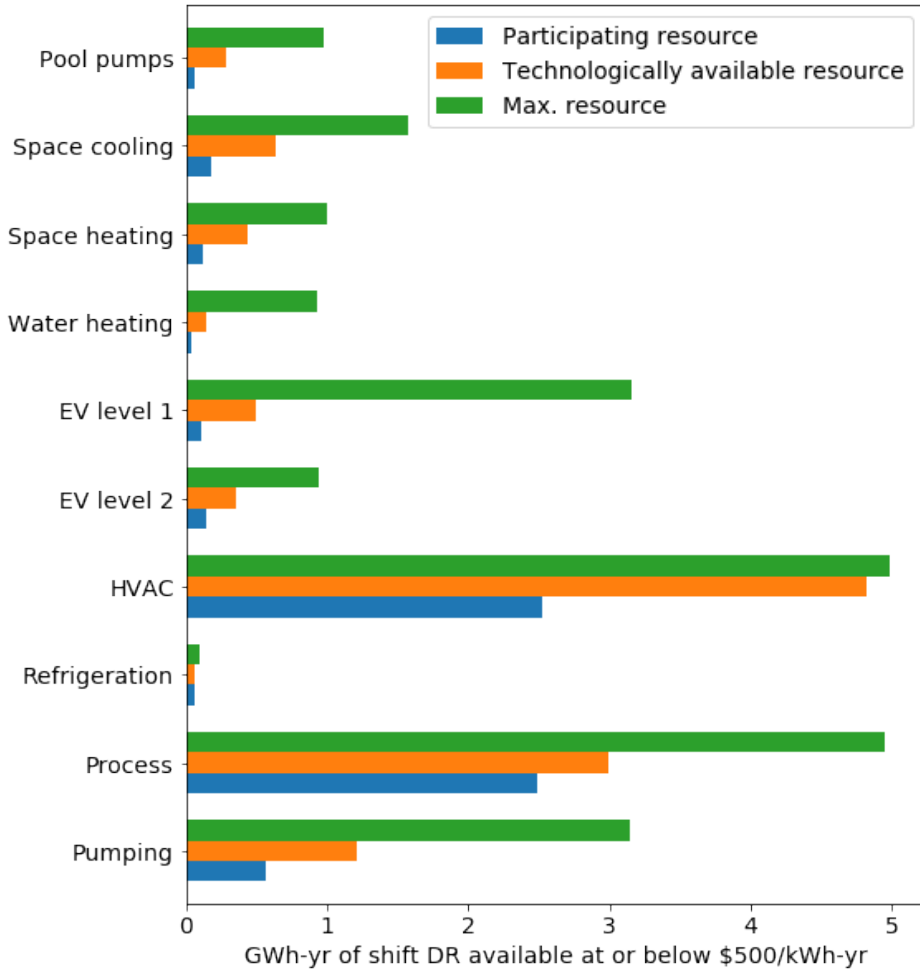
PG&E total: 3.0 GW

SCE total: 2.9 GW

SDG&E total: 0.24 GW

Total Medium Scenario: 6.1 GW

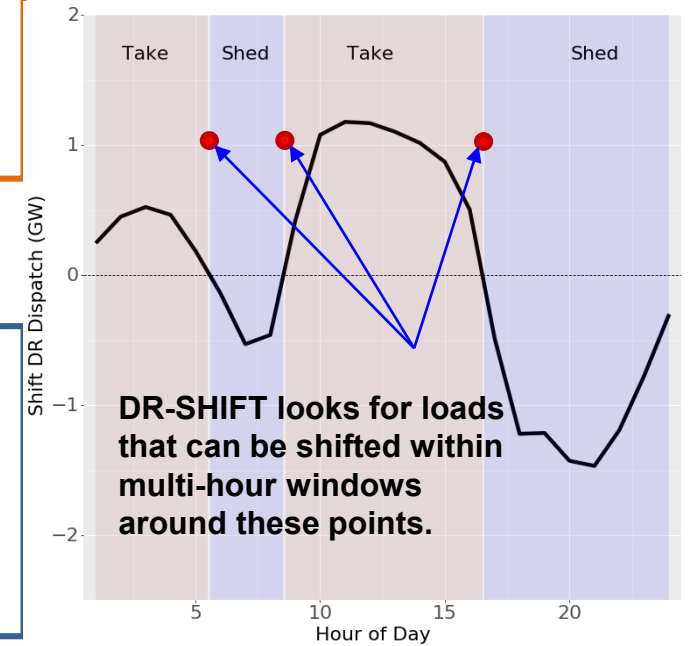
Participating vs. Shift Potential - SB49 Should Increase Customer Participation Rates



Technology cost and performance levels constrain how much shiftable load is accessible.

DR-Path includes a customer participation model based on historical participation, which curtails participation. New engagement models may help.

These GWh-yr are available each day
Sometimes twice a day



Residential Appliances

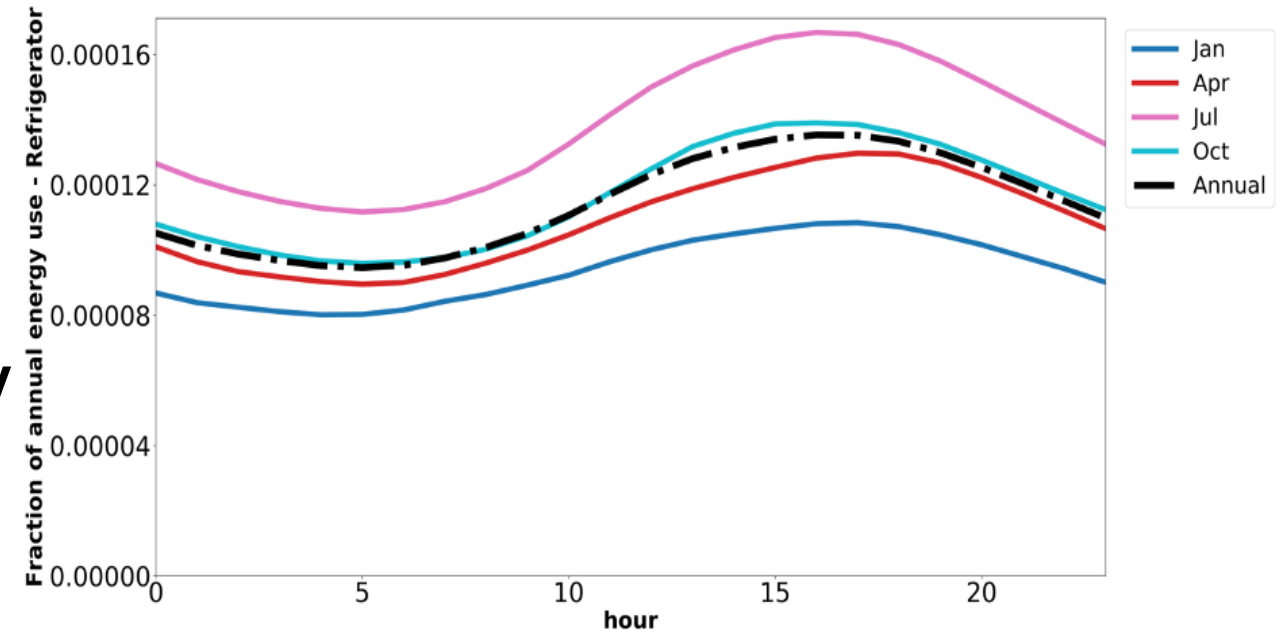
◆ Phase 4 study will include

- ❑ Refrigerator
- ❑ Freezer
- ❑ Washer and Dryer
- ❑ Dishwasher
- ❑ Domestic Hot Water

◆ Data from CEC 2019 load shape study by ADM Associates

- ❑ Residential end use load shapes
- ❑ Modeled across 12 climate zones in CA
- ❑ Data normalized by sector, building type and end use

Sample load shape for refrigeration end use



Summary and Future Directions

- ◆ Flexible loads are critical to support California's clean energy policies.
- ◆ New efforts to model flexible appliances will quantify the value of load shedding and shifting.
- ◆ New sources of data are becoming available to understand the costs and benefit of load flexible technologies.

References

<https://buildings.lbl.gov/potential-studies>

(Covers DR Potential Studies - Phases 1, 2 and 3)

<https://emp.lbl.gov/publications/demand-response-advanced-controls>

Demand Response Advanced Controls Framework and Assessment of Enabling Technology Costs

Thank you!