CALFLEXHUB SYMPOSIUM

NOVEMBER 3 | 8am-4pm PT

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PROJECT SHOWCASE: **FIELD PROJECT OUTLOOK**

SPEAKERS: Peter Grant, Senior Scientific Engineering Associate, Berkeley Lab; **Tristan De Frondeville,** CEO, SkyCentrics; **Joe Bourg,** Vice President, Olivine; **Rich Brown,** Research Scientist, Berkeley Lab

2023

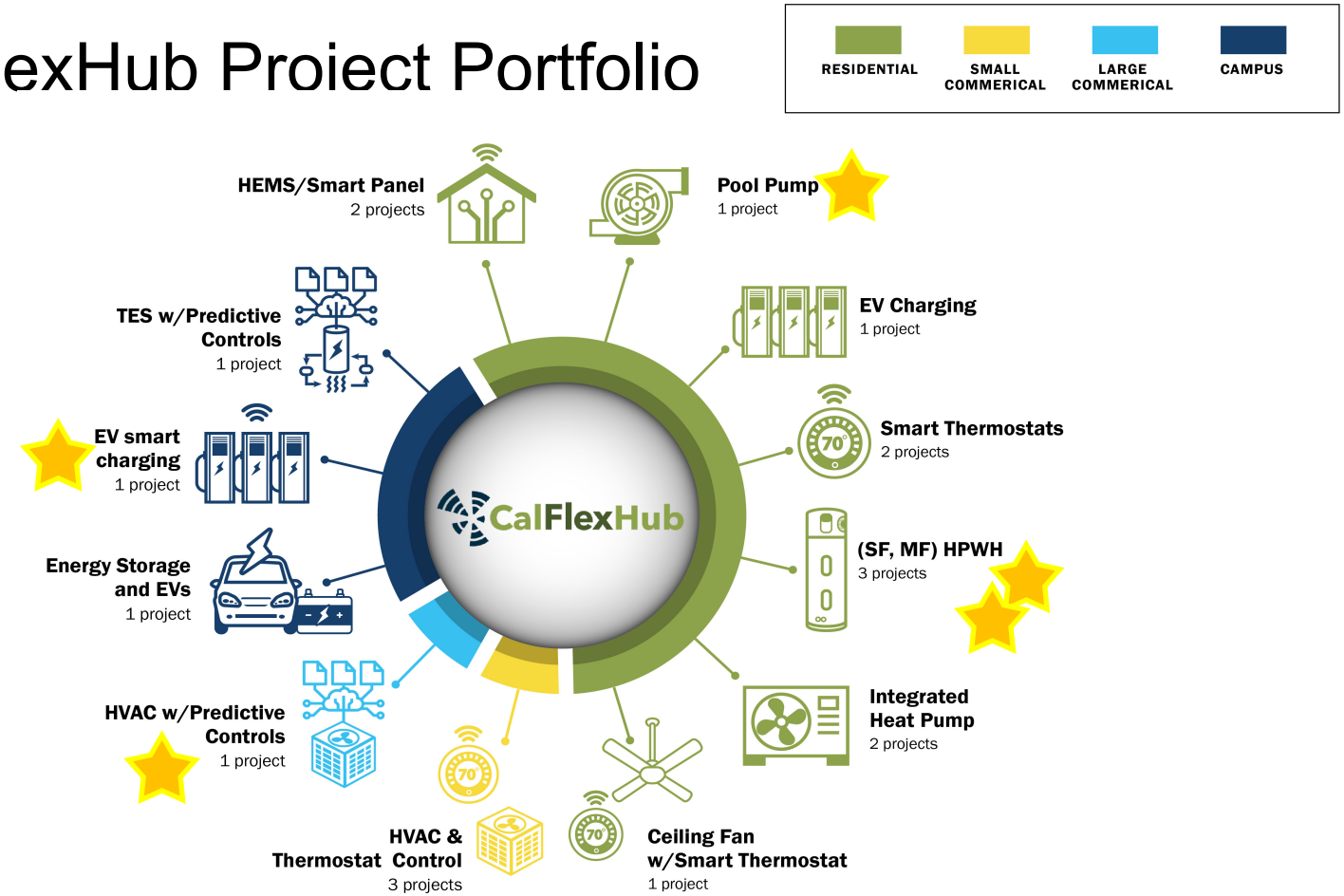
CalFlexHub

BERKELEY LAB

STATE OF CALIFORNIA ENERGY COMMISSION

MOMENTUM

CalFlexHub Proiect Portfolio



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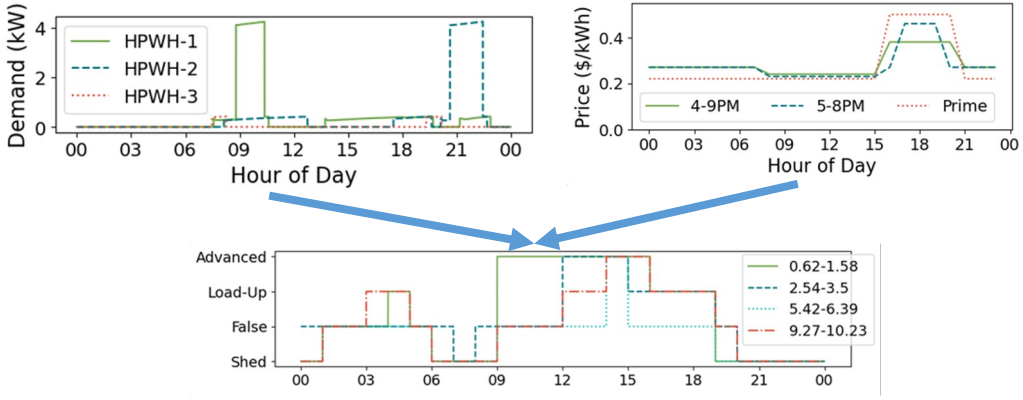
Develop and Validate Price- and Load-Responsive Controls for Prototype 120-volt Retrofit-Ready Heat Pump Water Heaters



Test Site(s): 10+ single family homes

Sector/Building Type	Single family residential Multifamily residential w/ individual water heaters
Technology & End Use	Water heating
Communications Pathway	Cloud-based intelligence Signals sent via CTA-2045B or API
Expected Grid Benefit	Up to 3.5 GW of peak load avoided Up to 3.5 GW of mid-day solar absorption
Testing Status (Timeline)	Beginning installations Testing Nov - Jan

Communication Architecture

- Intelligence located on the cloud
- Converts price schedule into load shifting control signals
- Sends:
  - CTA-2045B signal
  - API set temperature change

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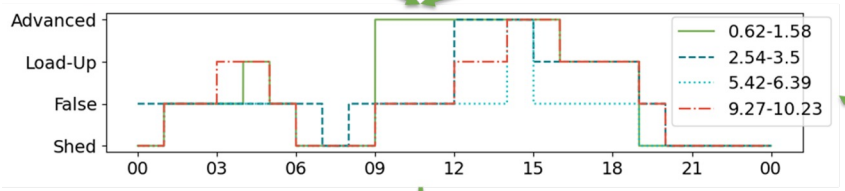
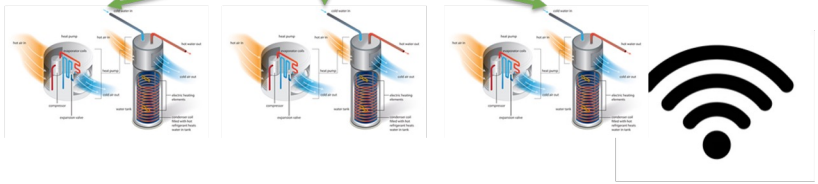
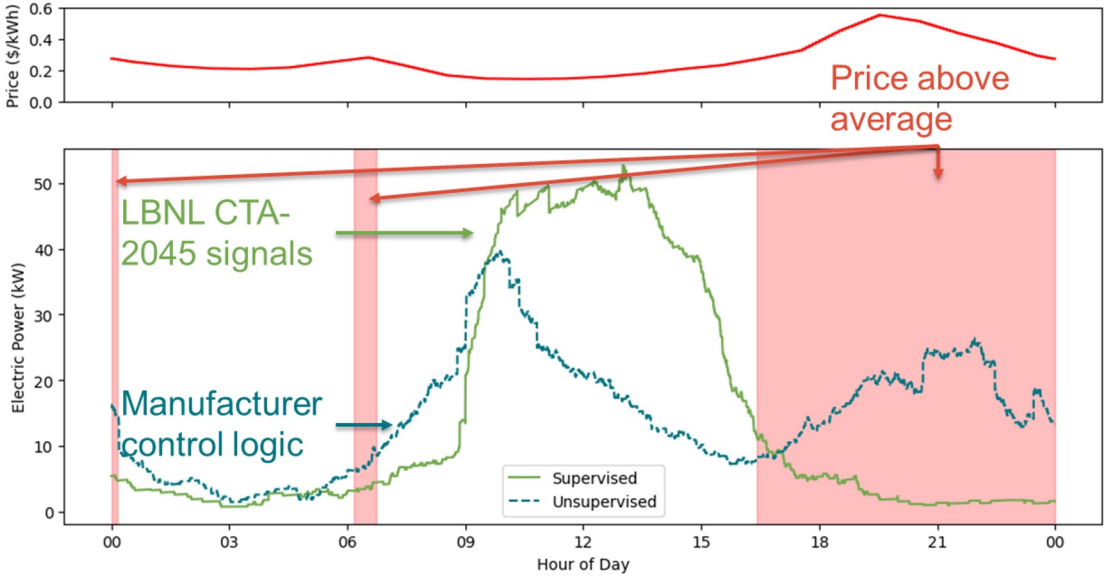


Aggregators



Simulation Results

Finalizing site recruitment - Expect test results within 1-2 months



- Qualitative
  - Shifted load from high price (red background) to low price (white background) times
- Quantitative
  - 29% cost savings
  - 75% peak period kWh reduction
  - 102% mid-day kWh increase
- Comparison to status-quo
  - Not customized to behavior: 12% cost savings

Key Learnings

- Collaborating with IRB helps get Human Subjects Protocol approved quickly
- Customizing control to on-site behavior can significantly improve results
- Need to focus on easy deployment

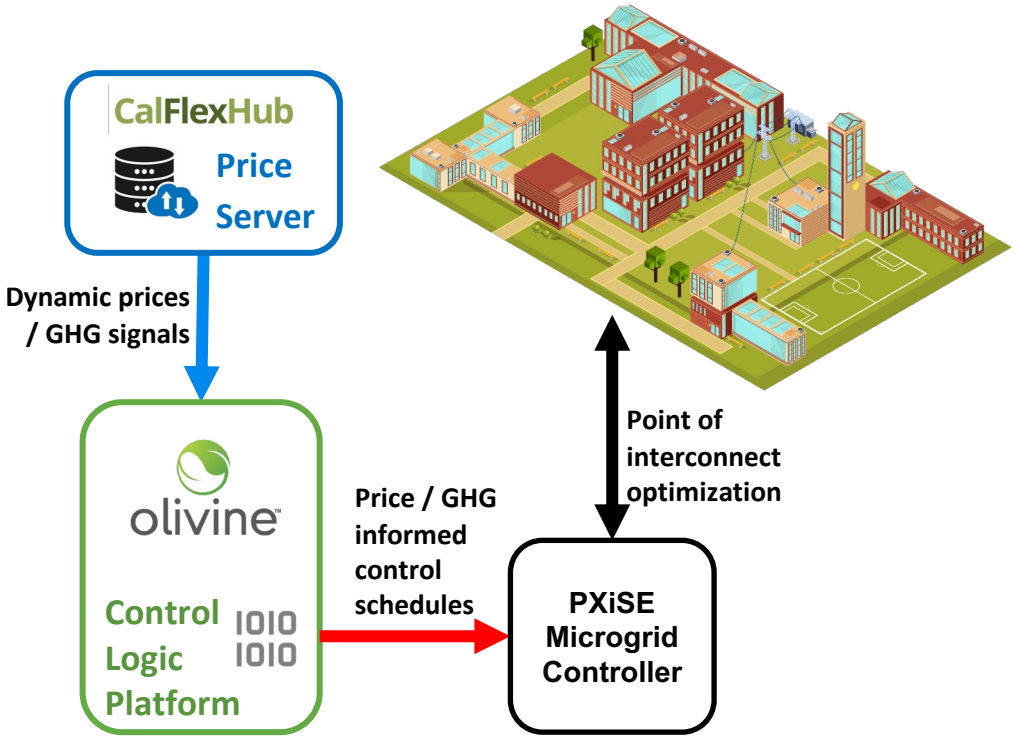
Santa Rosa Junior College
Battery Firmed Multi-Building HVAC

Test Site: 26 buildings, including a mix of lecture and classroom buildings, dining services, library and administration offices.

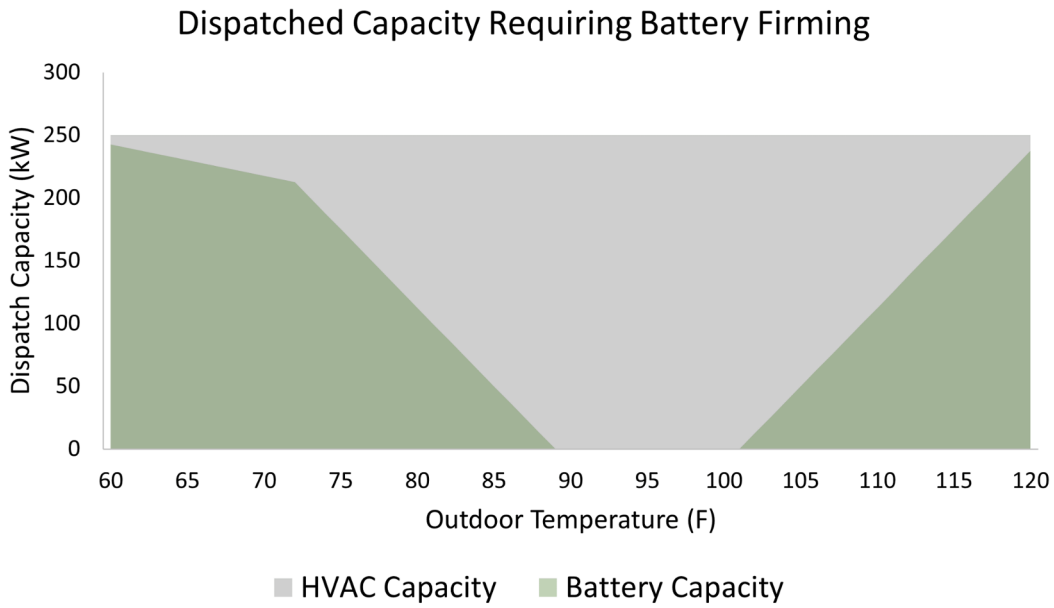
Sector/Building Type	Campus; C&I
Technology & End Use	Microgrid Controller / Building Automation System / HVAC Control w/ Battery Firming
Communications Pathway	3rd party (Olivine) cloud -> OEM cloud -> BAS -> HVAC and BESS
Expected Grid Benefit	250 kW load shifting response to dynamic signal; summer peak and emergency reliability
Testing Status (Timeline)	Functional Test in November 2023 Field Test # 1 June 2024

Communication Architecture

- Battery firmed multi-building HVAC
- PXiSE microgrid controller accesses price informed control schedules through Olivine's APIs
- PXiSE incorporates kW capacity commitments specified in control schedules into existing optimization
- Campus wide 6˚F HVAC setback with battery to firm unmet capacity
- Capacity commitments measured and controlled at the microgrid point of interconnection



Key Learning Objectives



Develop a profile of the campus wide battery firming threshold

Process:

Dispatch a range of capacity (kW) levels for each test period. A different value daily. Using battery submeter data and whole premise meter data, analyze the HVAC capacity and battery capacity delivered as a function of outdoor temperature.

Objectives:

Determine the minimum dispatch level requiring battery firming as a function of outdoor temperature.

Determine the ratio of HVAC capacity to battery capacity delivered as a function of outdoor temperature

Determine dispatch price threshold levels for firming with battery discharge

Low Cost Cellular Shifting

Residential pool pumps & water heaters
Multi-family and commercial water heaters

SkyCentrics

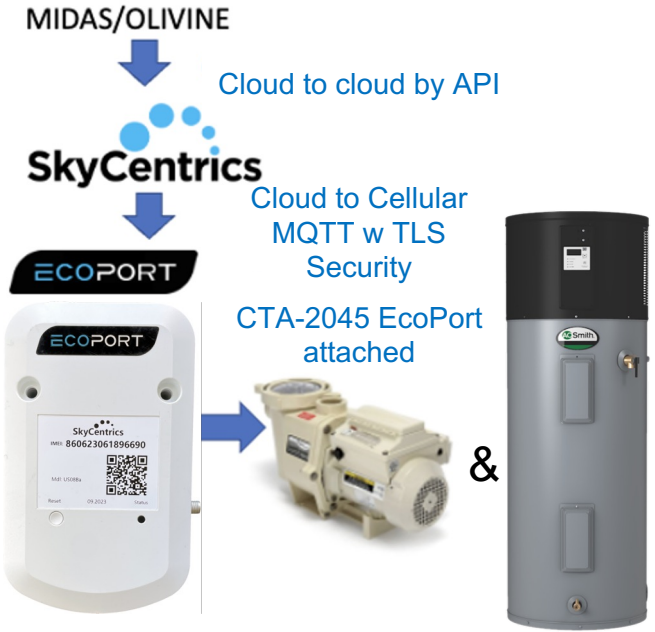
Test Site(s): 20 pool sites, 1 K12 school district, 2 multi-family, 10 bay area cities

Sector/Building Type	Residential Multi-Family Commercial
Technology & End Use	Cellular CTA-2045 EcoPort Water Heating, Pool Pumps
Communications Pathway	Cellular
Expected Grid Benefit	13 M CA water heaters 1 M CA Pools Over 3% of grid - shiftable
Testing Status (Timeline)	Installed October 24 Shifting and quantifying now

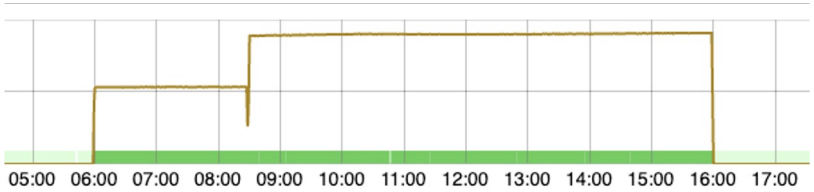
Communication Architecture

- The SkyCentrics OpenADR and CTA-2045 EcoPort platform can accommodate multiple paths to devices
  - Low Cost Cellular
  - Wi-Fi
  - API

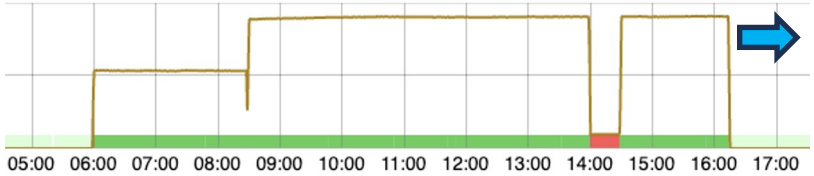
- Daily Schedule stored locally for resilience to lost connectivity



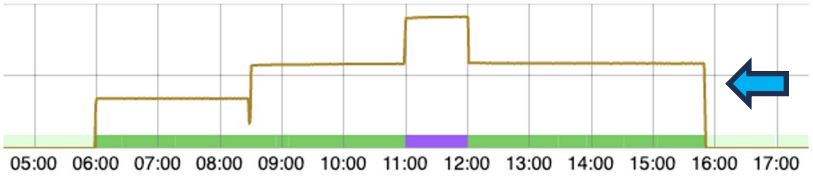
Test Results – Pool Algorithm



Normal Pump Schedule 6 AM – 4 PM



Shed 30 minutes, compensates with additional time



Load Up 60 minutes, compensates with less time

- IntelliConnect Pool Pump Control has internal algorithm to maintain daily pump total while responding to grid price signal (translated to CTA-2045 by SkyCentrics cloud)

Test Results – Multi-Family

Load Shape: Market Rate Shed: 6-9 AM, 6-9 PM						
Gallons Per Day Per Person		17	19	21	23	25
Percentile Day		50%	69%	84%	93%	98%
Storage, Capacity	(210 gal, 320kBTU/hr)	0.61	0.55	0.5	0.5	0.46
	(270 gal, 280kBTU/hr)	0.57	0.52	0.49	0.45	0.43
	(330 gal, 260kBTU/hr)	0.52	0.48	0.43	0.39	
	(410 gal, 240kBTU/hr)	0.61	0.55	0.51		
	(490 gal, 220kBTU/hr)	0.65	0.61	0.57		
	(590 gal, 200kBTU/hr)	0.73	0.68	0.65	0.61	
	(690 gal, 190kBTU/hr)	0.78	0.76	0.75	0.71	
	(780 gal, 180kBTU/hr)	0.81	0.79	0.77	0.72	
	(860 gal, 170kBTU/hr)	0.87	0.83	0.81	0.79	0.77
	(930 gal, 160kBTU/hr)	0.92	0.87	0.83	0.81	0.79
	(1000 gal, 150kBTU/hr)	0.96	0.91	0.87	0.83	0.81
	(1050 gal, 140kBTU/hr)	0.99	0.94	0.89	0.85	0.82
	(1100 gal, 130kBTU/hr)	1	0.97	0.92	0.88	0.85
	(1150 gal, 130kBTU/hr)	1	0.99	0.94	0.9	0.87
	(1190 gal, 120kBTU/hr)	1	1	0.97	0.93	
	(1230 gal, 120kBTU/hr)	1	1	0.98	0.95	

Load Shape: Market Rate Shed: 5-9 PM						
Gallons Per Day Per Person		17	19	21	23	25
Percentile Day		50%	69%	84%	93%	98%
Storage, Capacity	(210 gal, 320kBTU/hr)	0.74	0.71	0.68	0.63	0.59
	(270 gal, 280kBTU/hr)	0.71	0.64	0.59	0.56	0.52
	(330 gal, 260kBTU/hr)	0.7	0.65	0.63	0.6	0.57
	(410 gal, 240kBTU/hr)	0.56	0.53	0.47	0.47	0.48
	(490 gal, 220kBTU/hr)	0.63	0.58	0.53	0.55	0.49
	(590 gal, 200kBTU/hr)	0.75	0.7	0.65	0.59	0.55
	(690 gal, 190kBTU/hr)	0.85	0.79	0.74	0.67	0.63
	(780 gal, 180kBTU/hr)	0.93	0.86	0.82	0.78	0.78
	(860 gal, 170kBTU/hr)	1	0.98	0.92	0.72	0.73
	(930 gal, 160kBTU/hr)	0.98	0.87	0.84	0.83	0.81
	(1000 gal, 150kBTU/hr)	1	0.97	0.95	0.91	0.88
	(1050 gal, 140kBTU/hr)	1	1	1	0.97	0.93
	(1100 gal, 130kBTU/hr)	1	1	1	1	0.98
	(1150 gal, 130kBTU/hr)	1	1	1	1	1
	(1190 gal, 120kBTU/hr)	1	1	1	1	0.97
	(1230 gal, 120kBTU/hr)	1	1	1	1	0.98

Table 2. Market Rate Housing Load Shift Simulations

- Two year data used in a similar multi-family heat pump central system installation by SkyCentrics, Mitsubishi, and EcoTope in Seattle
- CA installations expected to offer even better results in milder climates

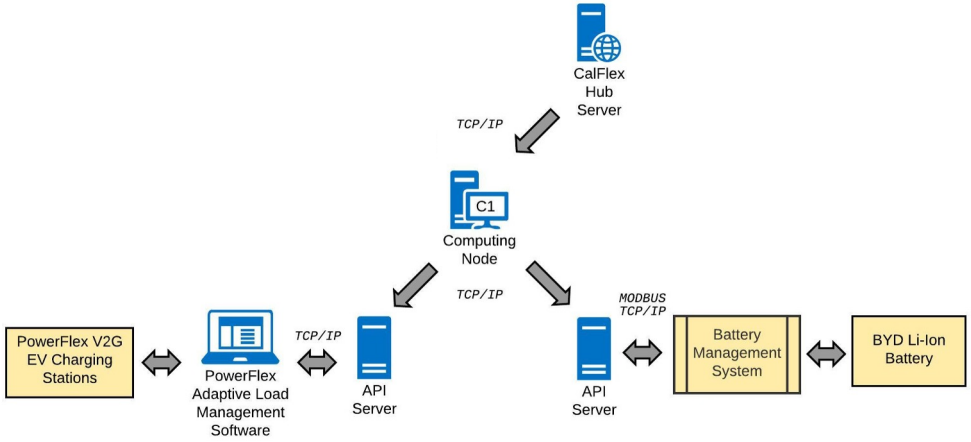
https://www.bpa.gov/-/media/Aep/energy-efficiency/emerging-technologies/20230829-mitsu-co2chpwh-bayview-towers-report.pdf

Key Learnings

- New CTA-2045 Pool Pump Controller designed for 1x day Demand Response
- Algorithm needs to accommodate multiple times per day for Price Control
- Multi-family heat pump a big opportunity thanks to large loads, one owner or decision maker
- Cities have some high use water heaters (fire stations), but otherwise, very shiftable load opportunity

Flexible Electric Vehicle and Battery Energy Storage Charging

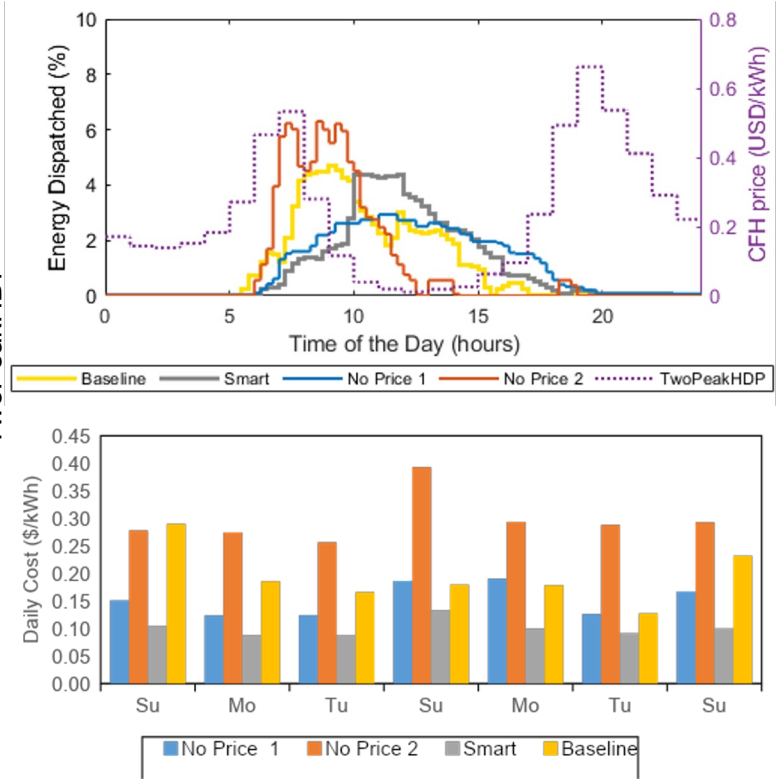
Keaton Chia, UC San Diego



Sector; Building Type	1.5 MW / 1.9 MWh stationary battery energy storage system (BESS) 20 electric vehicles (Evs)
Technology & End Use	Model Predictive Control / Energy Management System (EMS)
Communications Pathway	PowerFlex Data -> Local MPC server -> PowerFlex Control -> EVs BESS data --> Local MPC server □ BESS control.--> BESS
Expected Grid Benefit	• Load shifting in response to dynamic utility signal
Testing Status (Season/signal tested)	• May - June 2022 EV • June – July 2023 BESS

Communication architecture: EV charging stations operated by industry partner PowerFlex follow a price signal, first independently and then jointly with the support of a battery energy storage system (BESS).

Electric Vehicle Field Test Summary & Takeaways



Top: Daily profile of Tuesday for four EV charging strategies. Bottom: One week of daily costs (normalized) for four EV charging strategies.

- Benchmark: EV charging with no price signal:

No Price 1 (simulated): constant power for the entire plug duration;

No Price 2 (simulated): maximum charging power until energy demand is satisfied;

Baseline (actual): power optimized with no price signal.

- Smart charging (actual) strategy follows price signal and shifts charging peak towards noon.

% Energy ≤ $0.1/kWh	Su	Mo	Tu	We	Th	Fr	Sa
No Price 1	65.7	67.8	66.2	55.8	58.0	66.3	58.9
No Price 2	31.8	22.4	24.3	6.0	24.5	18.0	18.8
Smart	75.6	78.3	77.3	64.3	75.3	75.7	74.2
Baseline	22.8	45.2	47.9	46.8	51.5	62.8	31.0

Battery Energy Storage System (BESS) Field Test Summary & Takeaways

- BESS discharges at peak prices and charges at minimum prices
- ~$1,000 daily revenue opportunity from arbitrage
- Higher arbitrage opportunity with two peak pricing

Test Date	Price Curve	Daily Revenue
07/22/2023	TwoPeakHDP	$1,226
07/23/2023	TwoPeakHDP	$1,347
07/29/2023	SummerHDP	$1,018
07/30/2023	SummerHDP	$1,023
08/06/2023	SummerLDTOU	$893