CADMUS

Alliant Energy

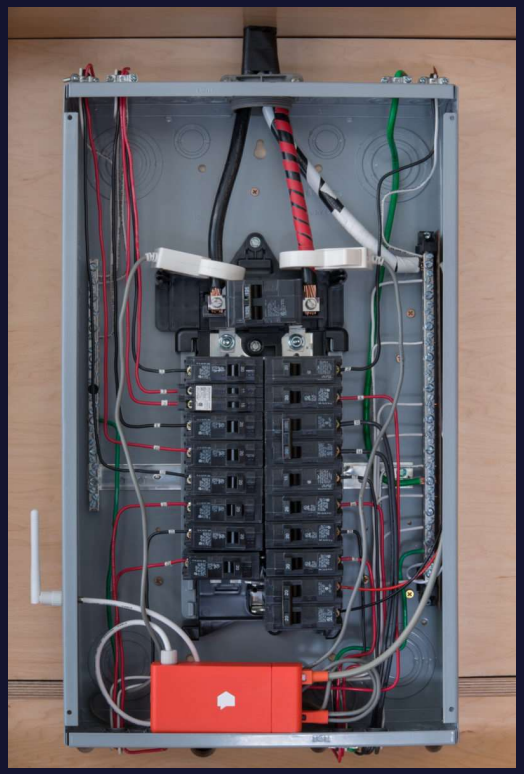
The Smart Home Data Stream

Opportunities and Challenges in Device-Level Energy Monitoring

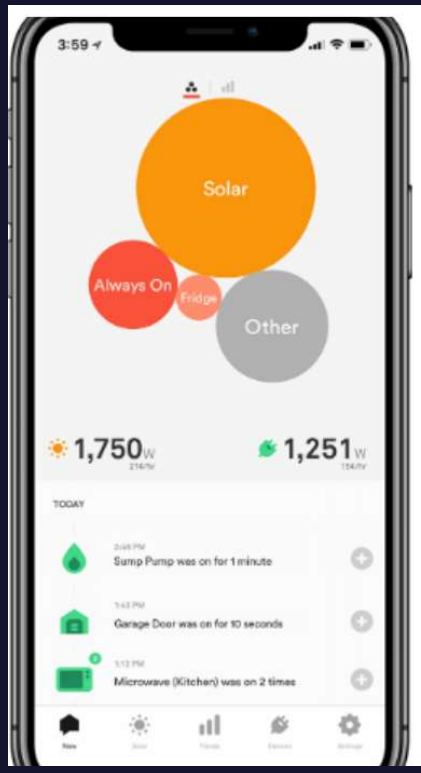
Amalia Hicks, Ph.D.

The Technology

Electric Panel Install



Customer App



5:15pm
Garage door opened

5:20pm
Kitchen lights turned on

6:30pm
Iron was on for 8 minutes

7:45pm
Dryer turned off

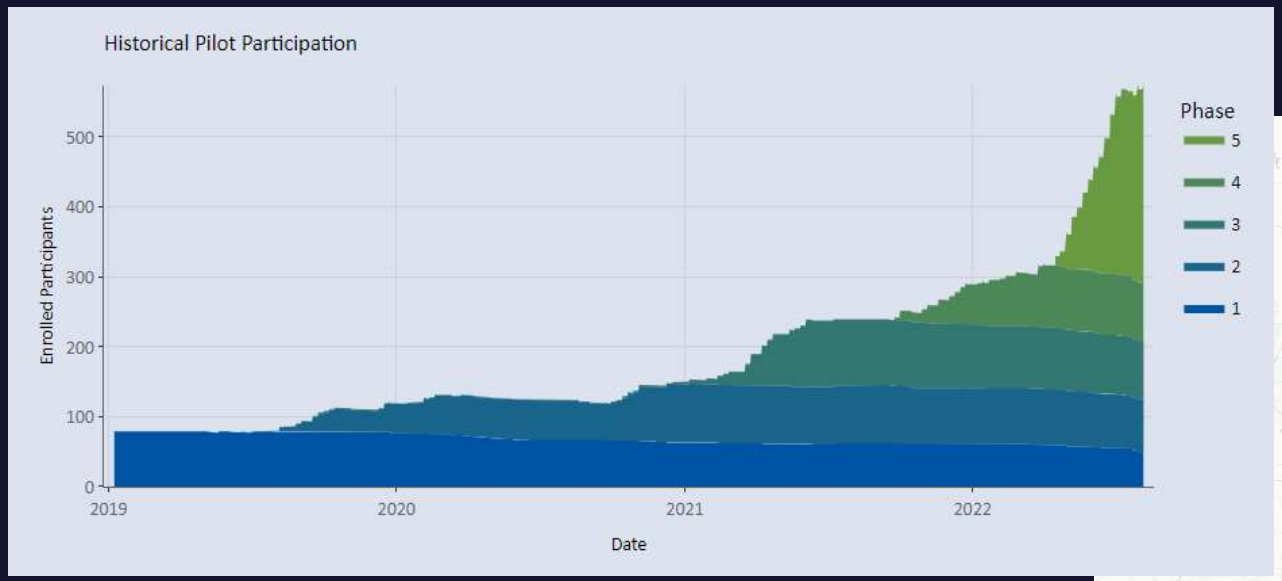
Pilot Goals

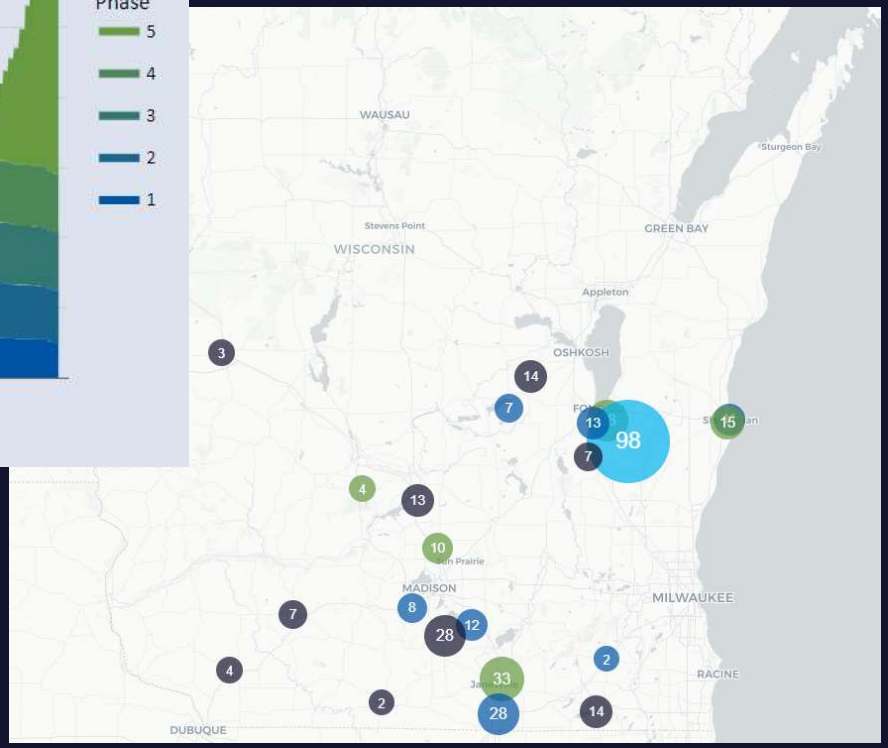
1. Determine potential for cost-effective energy savings through device replacement/servicing

2. Measure behavioral savings obtained through
   - Exposure to appliance-level energy use info
   - Customer messaging (high use alerts, etc.)

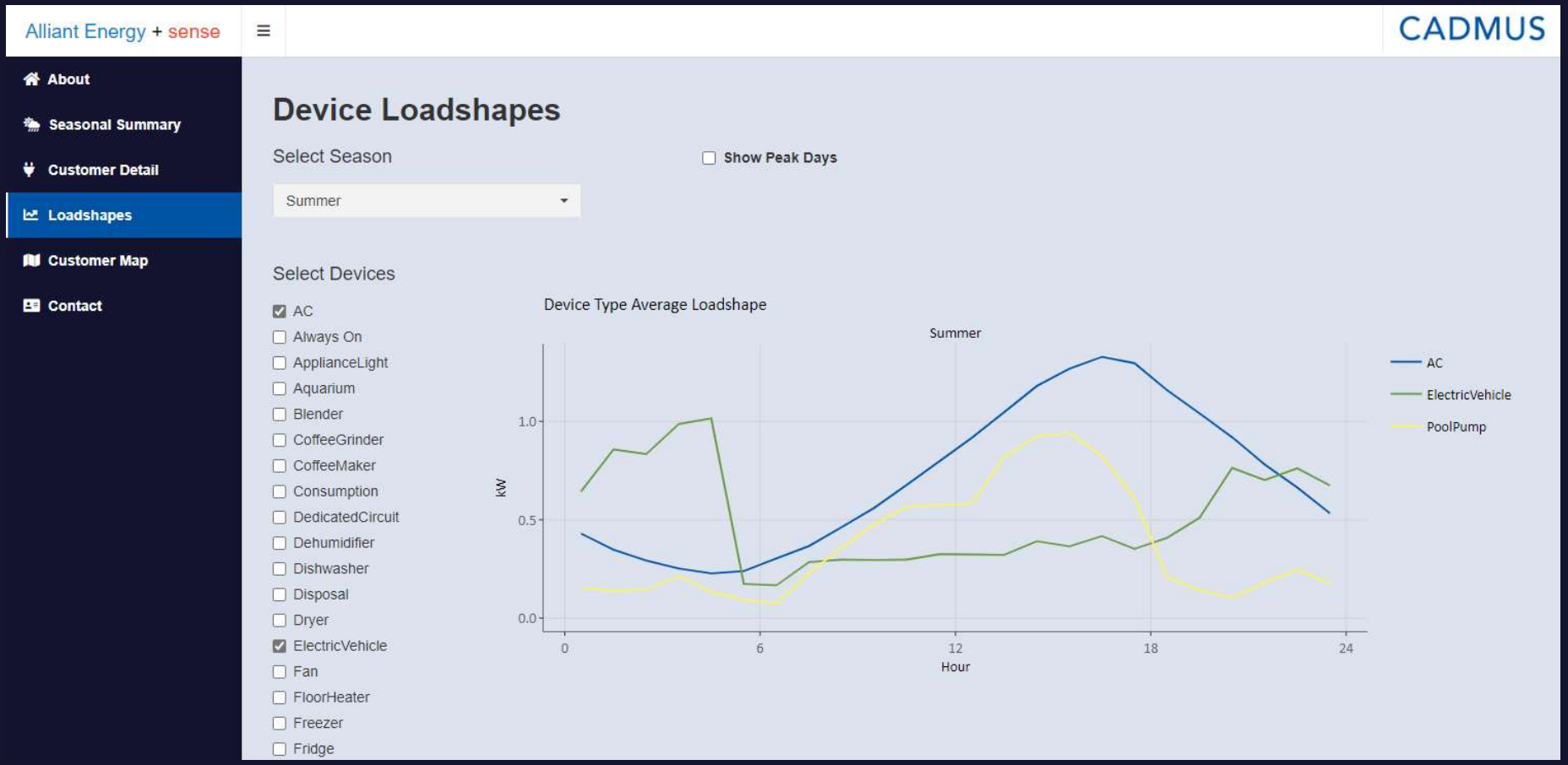
3. Opportunity assessment for demand response

Participants





Data Dashboard



Customer Feedback

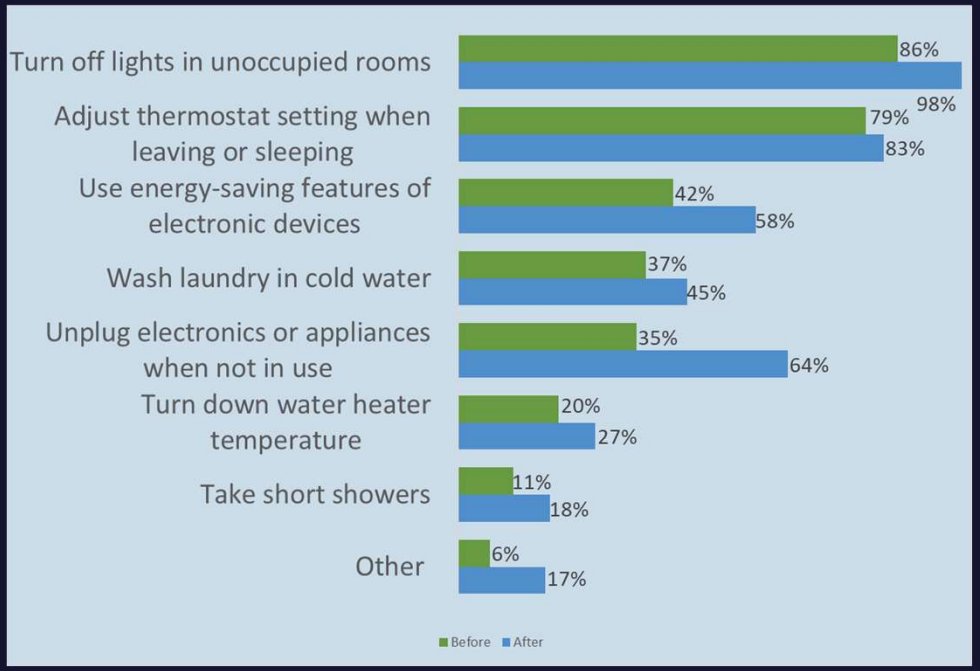
Survey Results

51% of participants saw a decrease in their monthly energy costs since accessing the Sense app

60% of homeowners changed their energy-saving behavior after participating in the program

30% of respondents sought out additional energy saving opportunities

Energy Saving Behaviors



Energy Savings Potential

Savings Opportunities

Opportunities to replace inefficient appliances

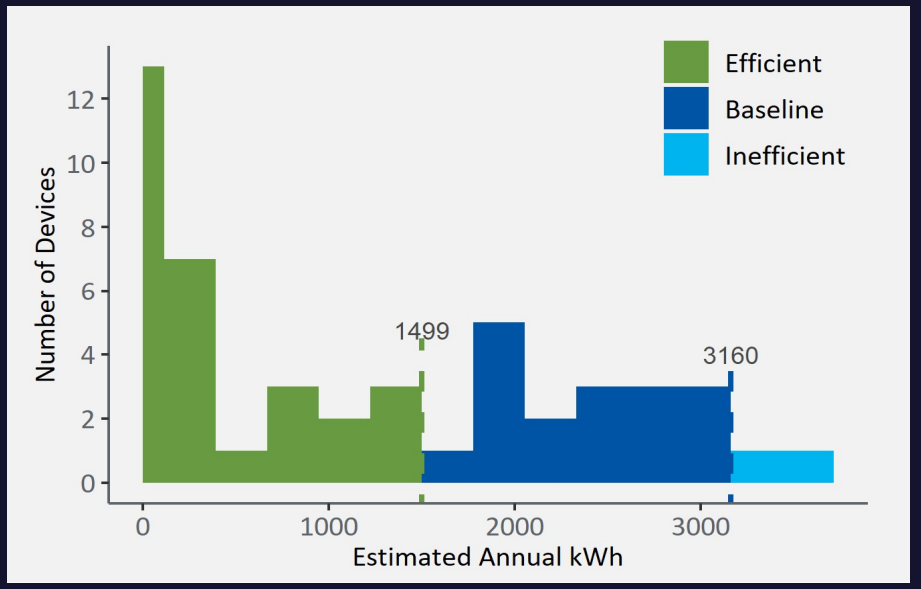
- Electric Dryers
- Refrigerators
- Water Heaters

"Always On" loads a possible source of significant savings (25% of total use)

- May be complicated by disaggregation challenges

Many homes still use incandescent lighting

Water Heaters



Appliance Replacement

Program Activities

High energy-consumption appliances identified, participants offered replacement incentive

A refrigerator, freezer, and water heater were replaced

Disaggregated data analyzed, shows significant savings

Equipment Replacement Example

	Refrigerator Estimated Consumption [kWh/yr]	Freezer Estimated Consumption [kWh/yr]
Original Appliance	427	827
Replacement Appliance	341	394
Savings	86	433

Customer Engagement

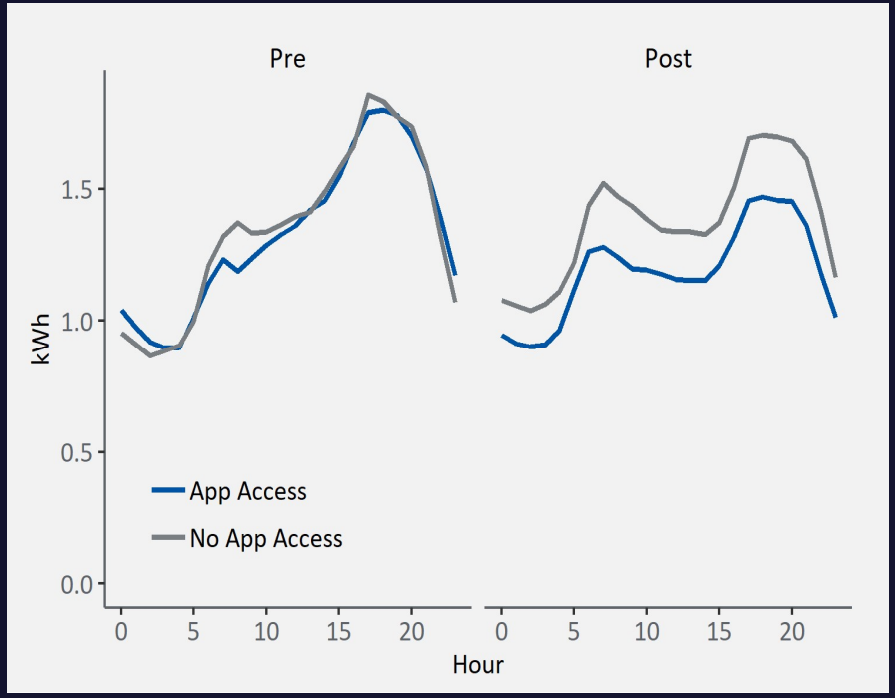
Behavioral Savings

Access to device app resulted in 6% lower daily energy use

Billing analysis shows 1-2% energy consumption savings, in line with other residential behavior programs

More data is required to achieve accurate savings estimates

Consumption Pre- and Post-app Access



Updated Energy Savings (NEW!)

2022 Billing Analysis (preliminary results)

On average, participants are consuming 4.5% less energy than matched controls

We still want more data!

Phase	N	Annual Per Participant Savings (kWh)[1]	90% Confidence Interval (kWh)	Percent Savings	Annual Pilot Savings (MWh)
Phase 1	89	387.6	±733.3	3.3%	34.5
Phase 2	90	752.9	±485.3	7.6%	67.8
Phase 3	79	289.9	±461.4	3.2%	22.9
Phase 4	78	322.3	±682.6	3.4%	25.1
All Phases Combined	336	454.2	±296.5	4.5%	152.6

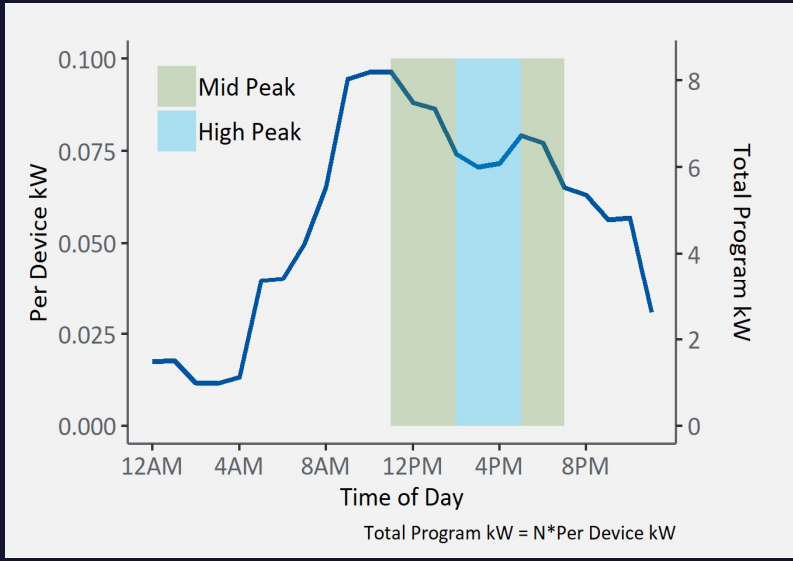
[1] Based on 2022 savings estimates

Load Shifting Potential

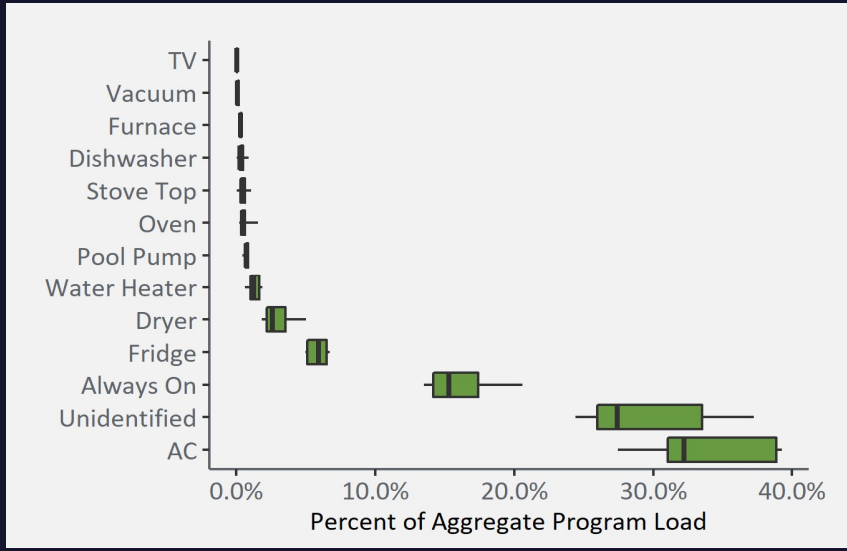
Best opportunities for demand reduction

- Air conditioners
- Dryers
- Water heaters
- Pool pumps

Electric Dryers



MISO Peak Day



Demand Response Program (NEW!)

Summer 2022 – Test Phase

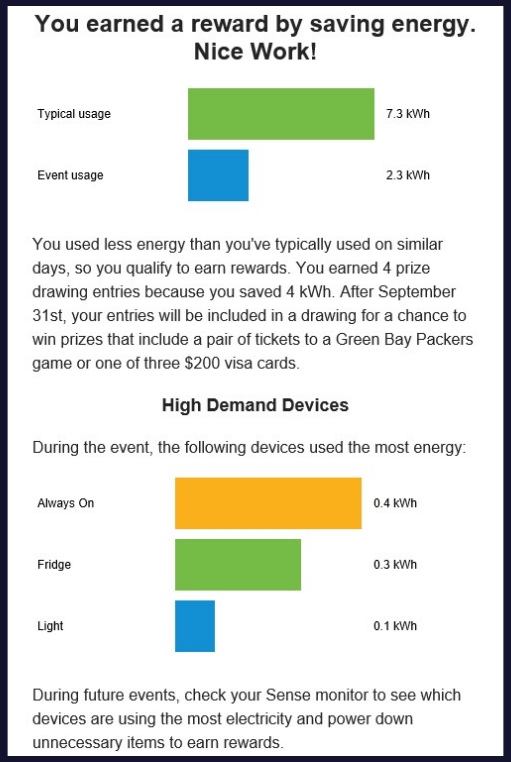
~600 homeowners participated in a test DR event from 2-6 pm on August 16th

App access shows them which devices are using the most energy, in real time

Sweepstakes entries and gift cards earned through saving energy during peak events, as compared to similar "normal" days

Demand Reduction: 0.3 MW total
0.5 kW per participant

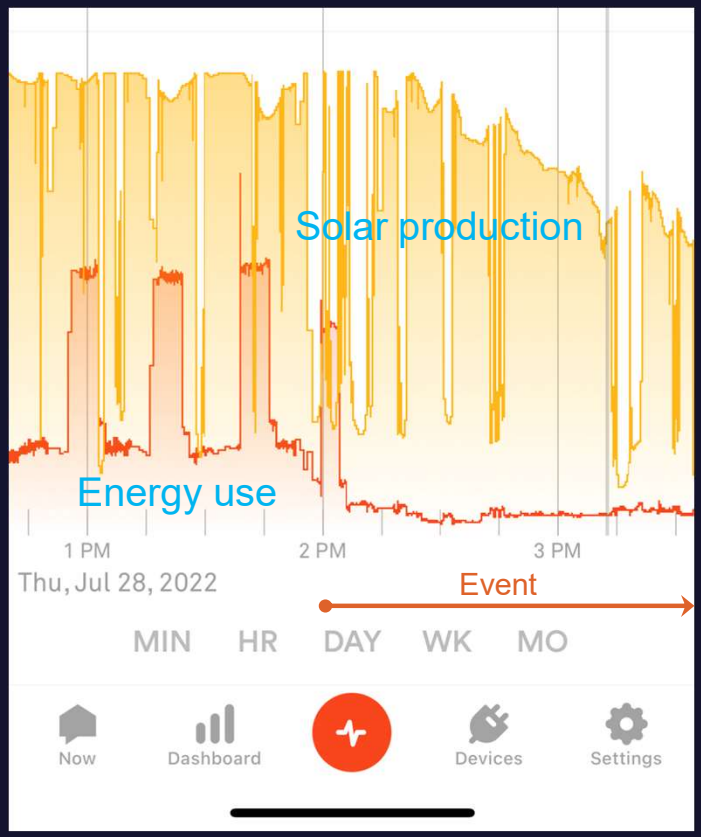
Device-Specific Feedback



Hicks House Test Run

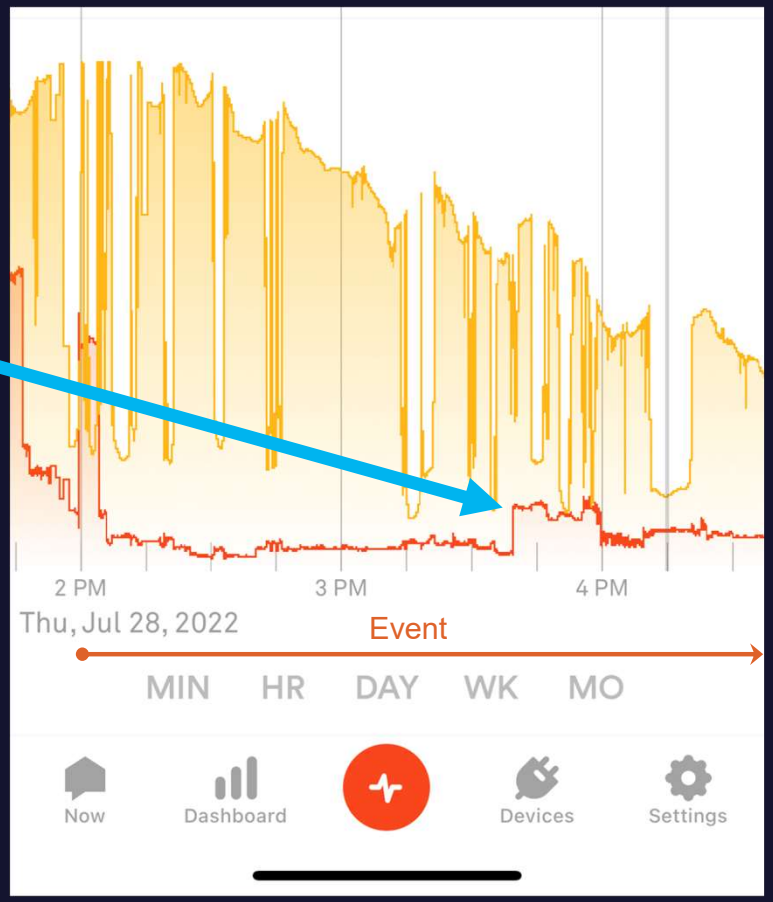
Reduced Loads

- AC
- Pool Pump
- Beer Fridge
- Lights
- Cell phones
- Laptops
- Xbox
- TVs



Non-Energy Benefits

Sneaky 6th grader watching TV during event



Lessons Learned

Recruitment

- Obtain estimate of distance between WiFi router and electric panel
- Ensure participant has smartphone

Installation

- Test signal strength at panel
- Have signal extenders on hand
- Collect large equipment/appliance data while on site
- Connect participant to app immediately, before technician leaves home

Troubleshooting

Some fraction of monitors will require reboot, revisit

Device Identification

Multiple devices of the same type may actually be the same device in different modes of operation

Summary

Home disaggregation technology delivers opportunities in several areas of interest

- Customer engagement
- Behavioral and resource acquisition energy savings
- Demand response initiatives

Customer survey results positive

- Over half adjusted their behavior and/or sought out new energy saving opportunities

Significant savings and load shifting potential

- “Always on” load, incandescent lighting, inefficient equipment (dryers, water heaters)
- Behavioral savings (1-2%)
- Identification of devices contributing to peak coincident load (e.g., dryers)
- Provides instantaneous customer feedback and enhanced engagement during called events

CADMUS

Thank You / Questions

Amalia Hicks, Ph.D.

Principal

Email: amalia.hicks@cadmusgroup.com

Office: 608.807.4023

Mobile: 720.771.5245