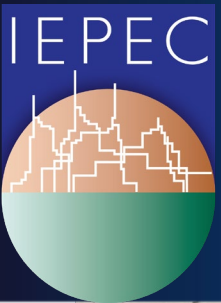


# The Smart Home Data Stream

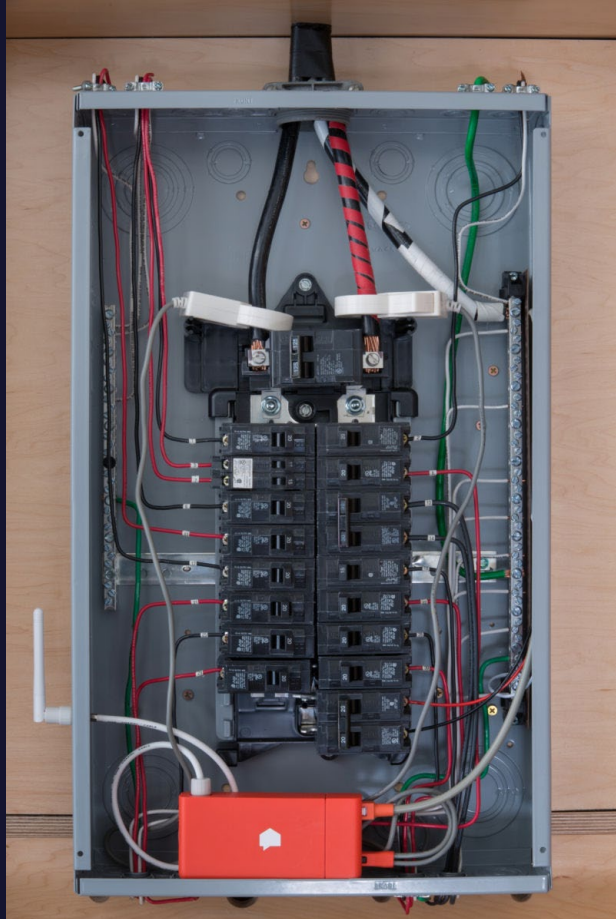
Opportunities and Challenges in Device-Level Energy Monitoring



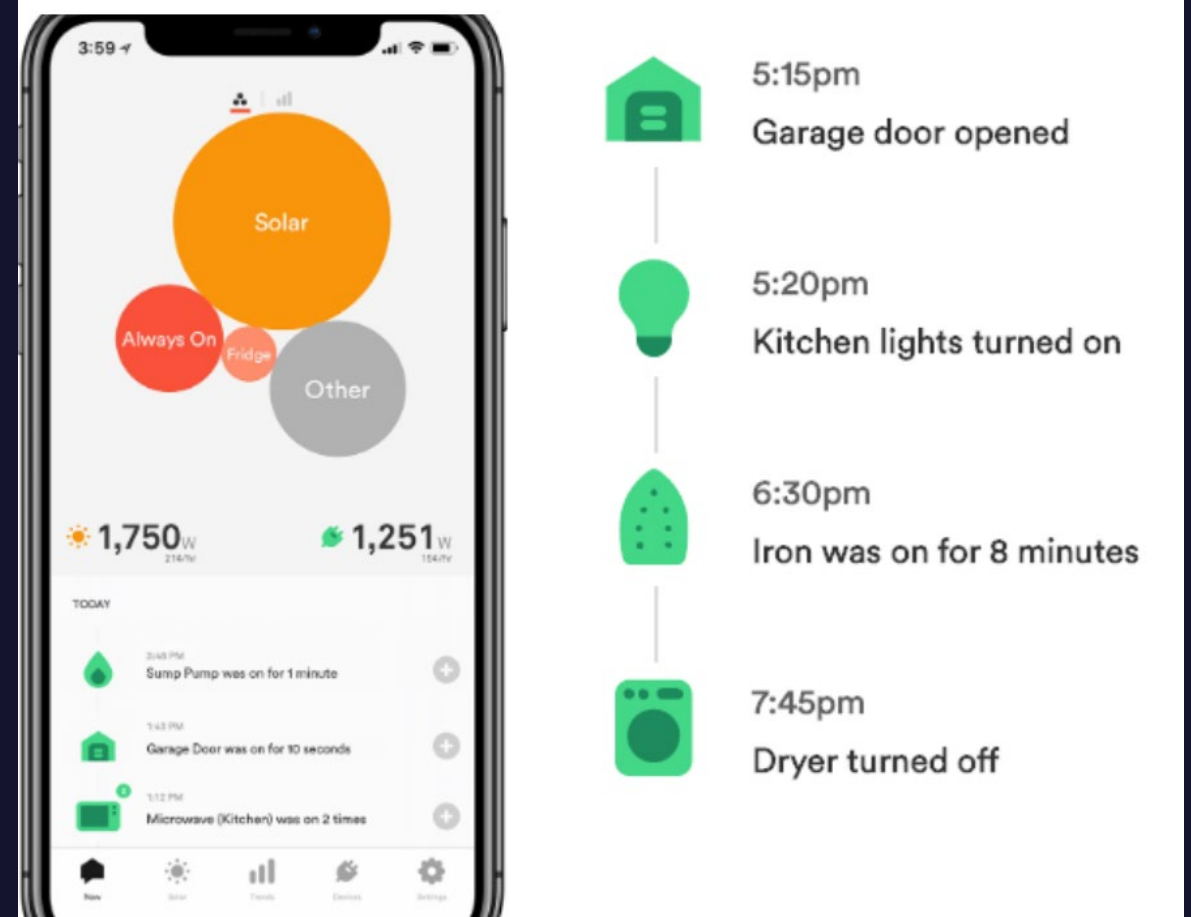
Amalia Hicks, Ph.D.

# The Technology

## Electric Panel Install



## Customer App



# Pilot Goals



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

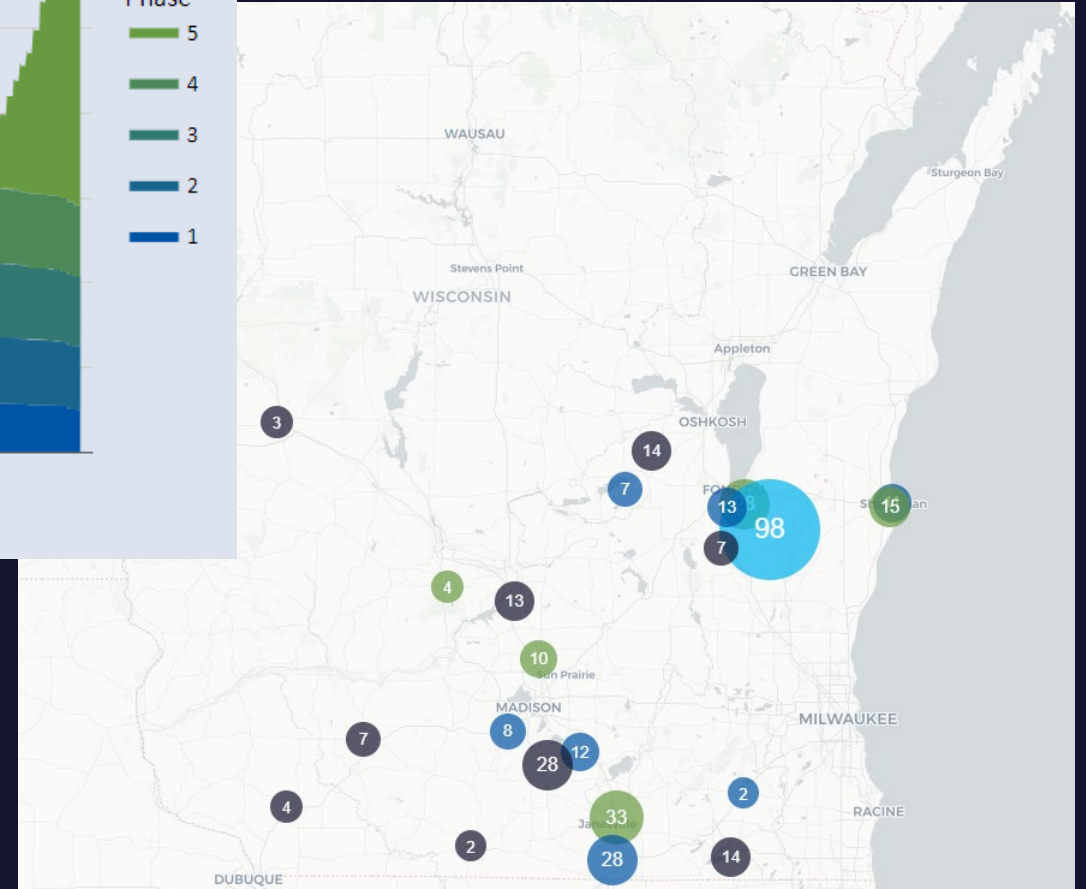
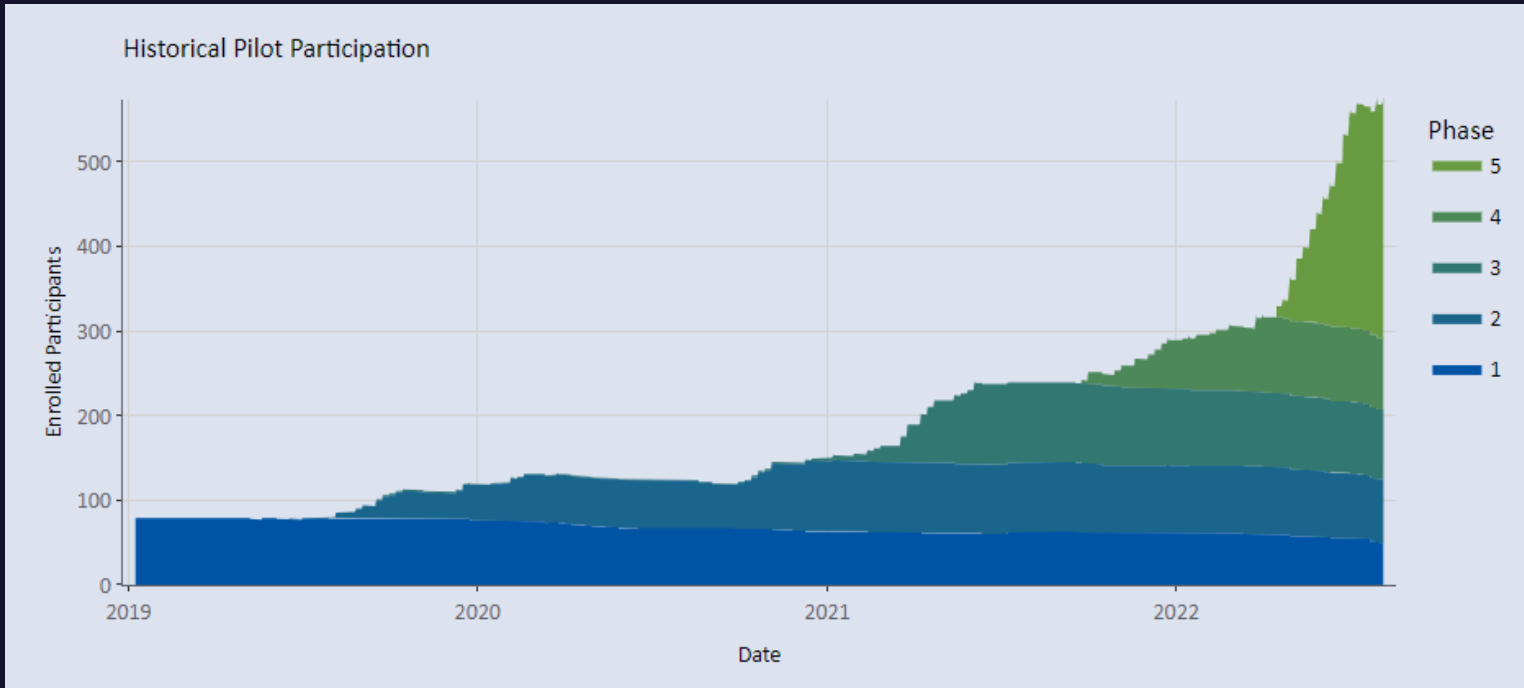


2. Measure behavioral savings obtained through
  - Exposure to appliance-level energy use info
  - Customer messaging (high use alerts, etc.)

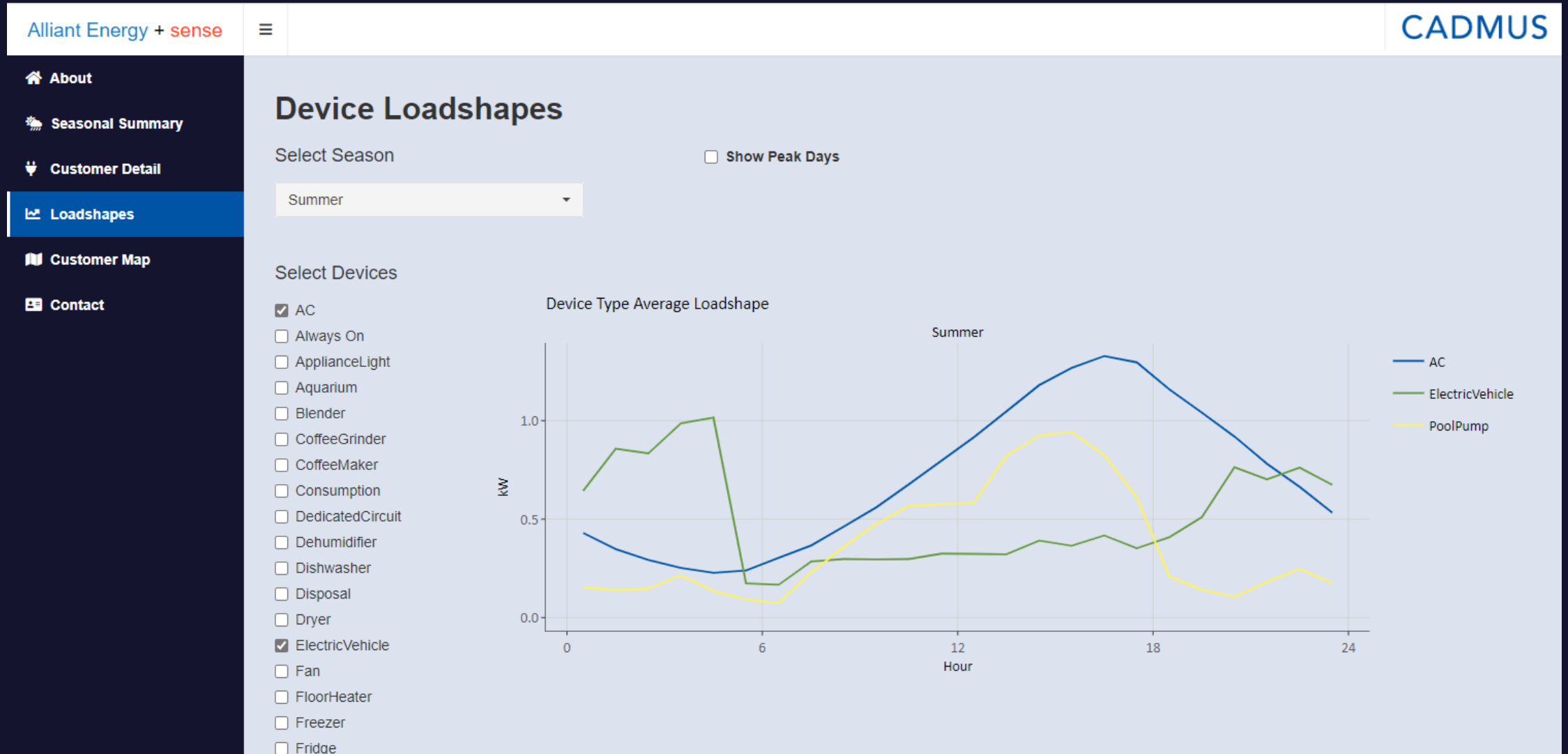


3. Opportunity assessment for demand response

# Participants



# Data Dashboard



# Customer Feedback

## Survey Results



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

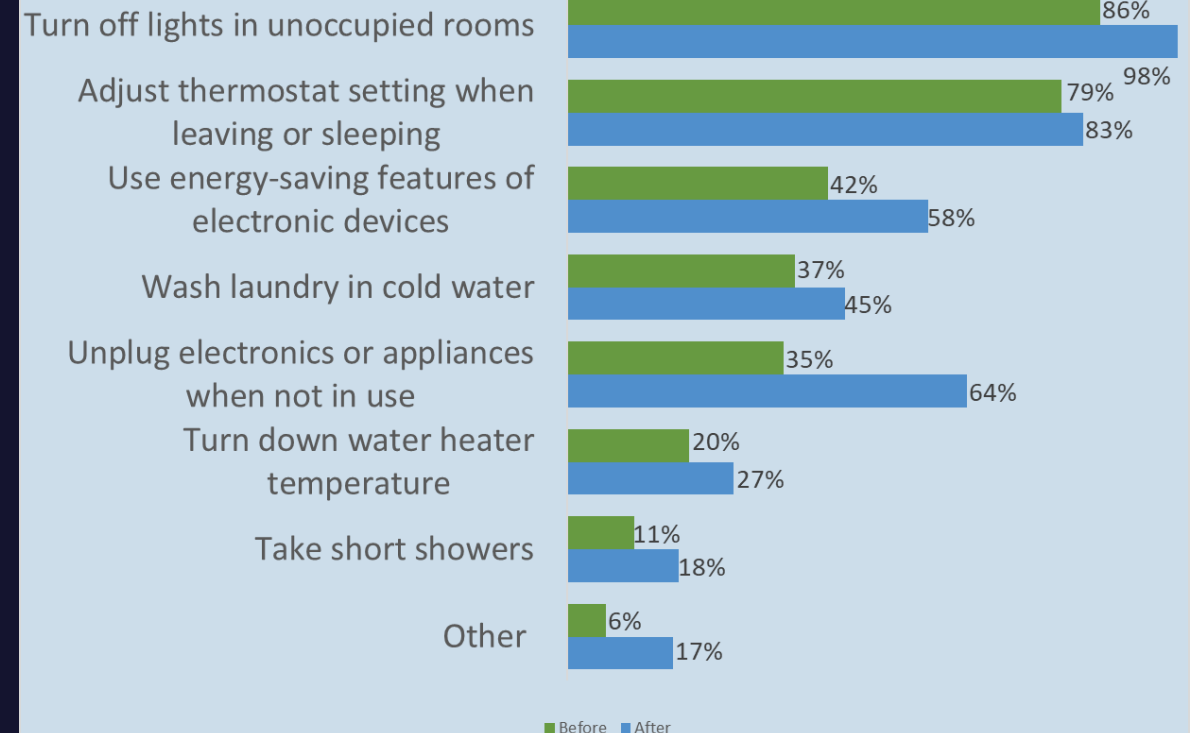


60% of homeowners changed their energy-saving behavior after participating in the program



30% of respondents sought out additional energy saving opportunities

## Energy Saving Behaviors



# Energy Savings Potential

## Savings Opportunities

Opportunities to replace inefficient appliances

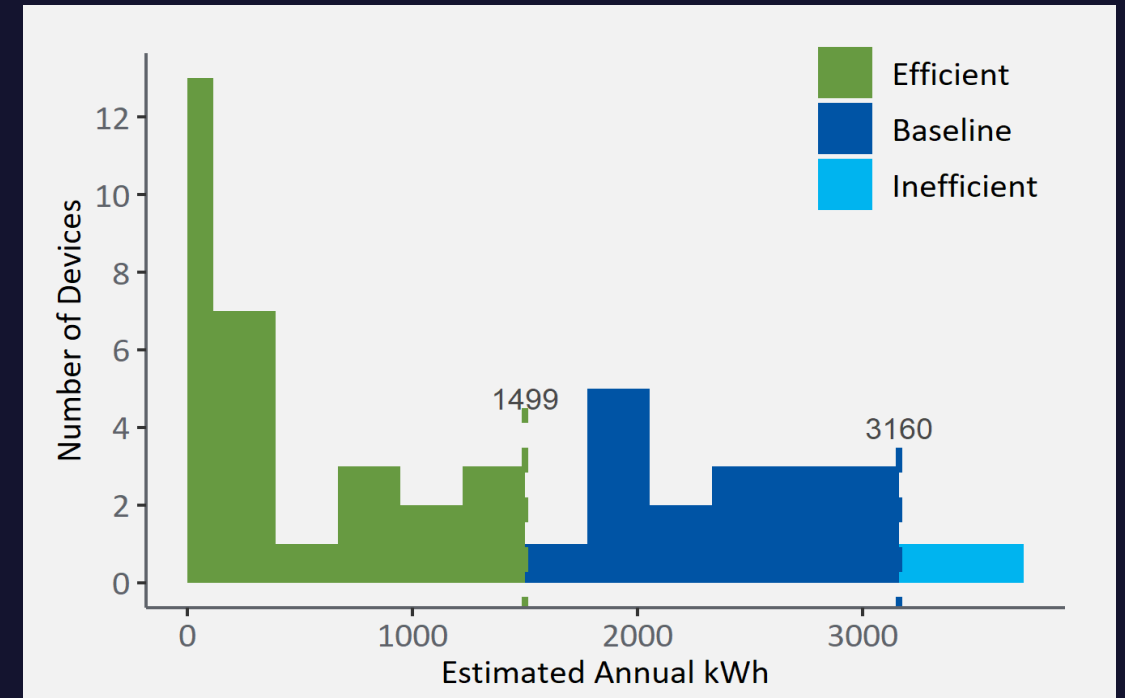
- Electric Dryers
- Refrigerators
- Water Heaters

“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

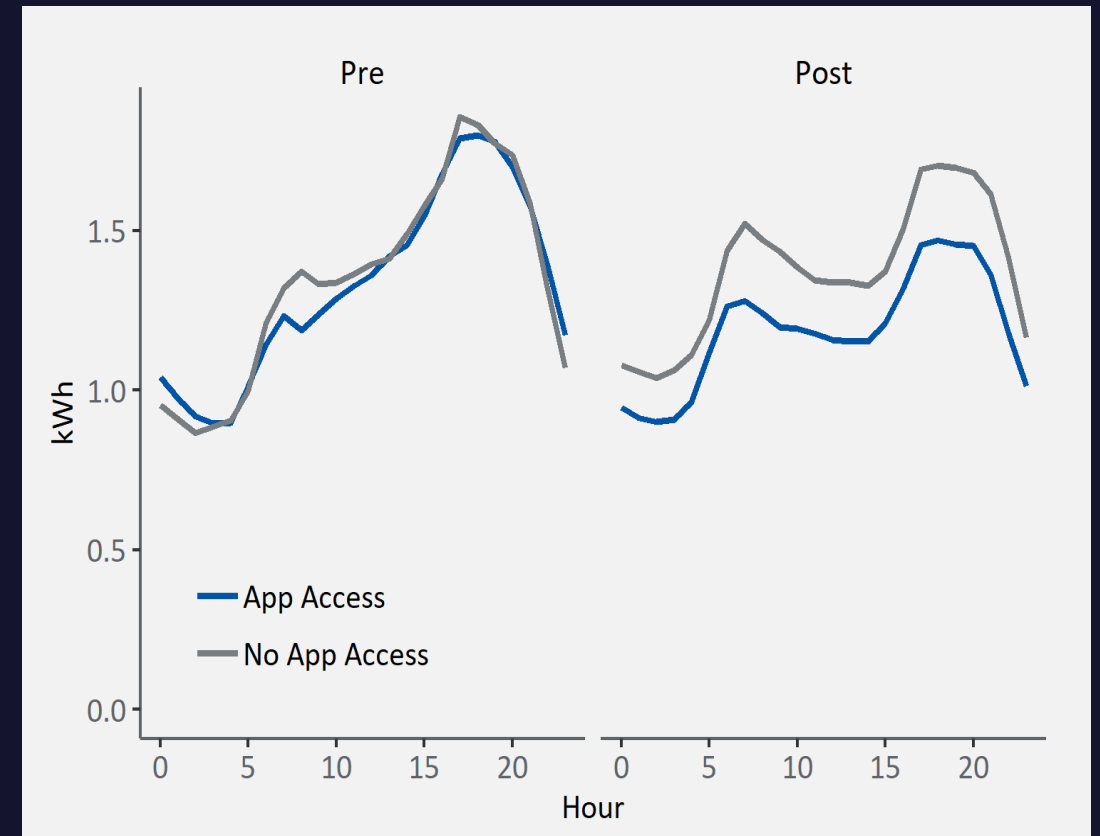
## Behavioral Savings

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!

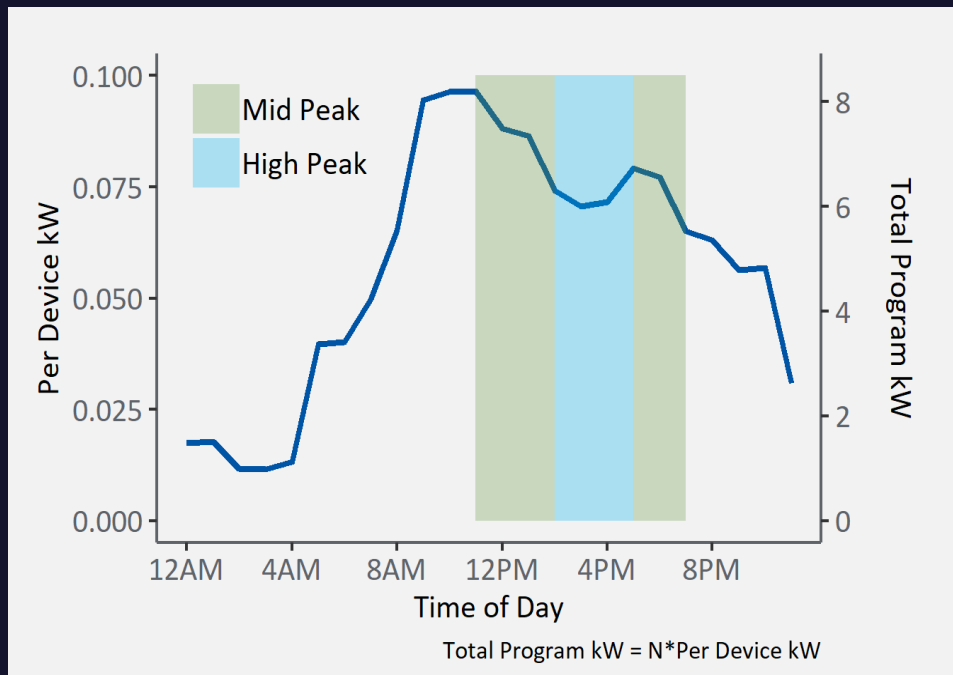
Phase	N	Annual Per Participant Savings (kWh) <sup>1</sup>	90% Confidence Interval (kWh)	Percent Savings	Annual Pilot Savings (MWh)
Phase 1	89	387.6	±733.3	3.3%	34.5
Phase 2	90	752.9	±485.3	7.6%	67.8
Phase 3	79	289.9	±461.4	3.2%	22.9
Phase 4	78	322.3	±682.6	3.4%	25.1
All Phases Combined	336	454.2	±296.5	4.5%	152.6
<sup>1</sup> Based on 2022 savings estimates					

# Load Shifting Potential

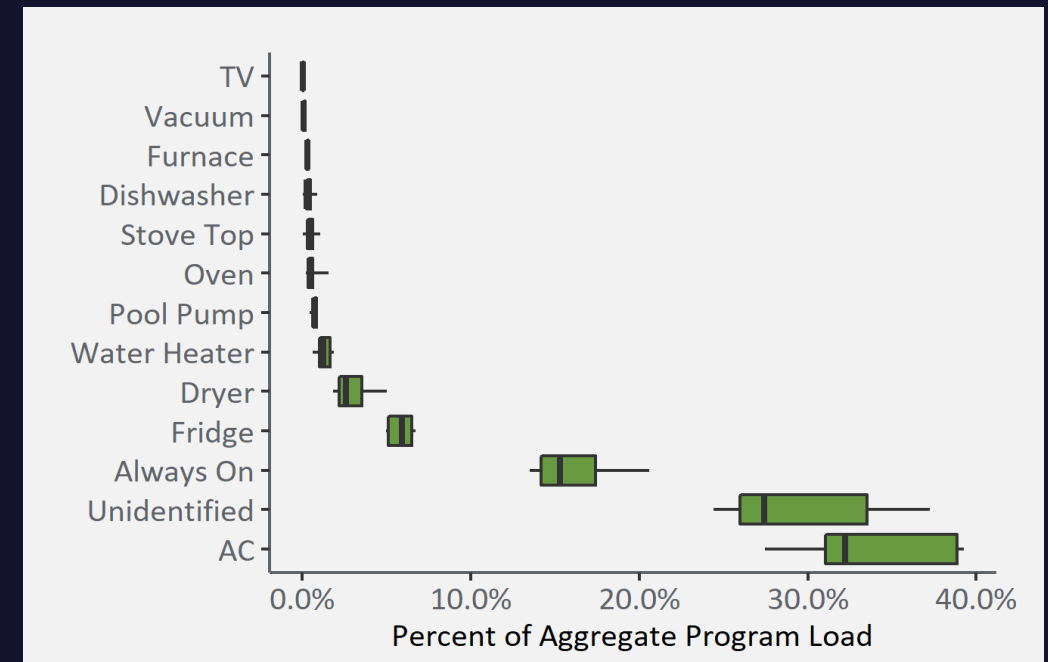
## Best opportunities for demand reduction

- 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 16<sup>th</sup>



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

**You earned a reward by saving energy.  
Nice Work!**



You used less energy than you've typically used on similar days, so you qualify to earn rewards. You earned 4 prize drawing entries because you saved 4 kWh. After September 31st, your entries will be included in a drawing for a chance to win prizes that include a pair of tickets to a Green Bay Packers game or one of three \$200 visa cards.

### High Demand Devices

During the event, the following devices used the most energy:

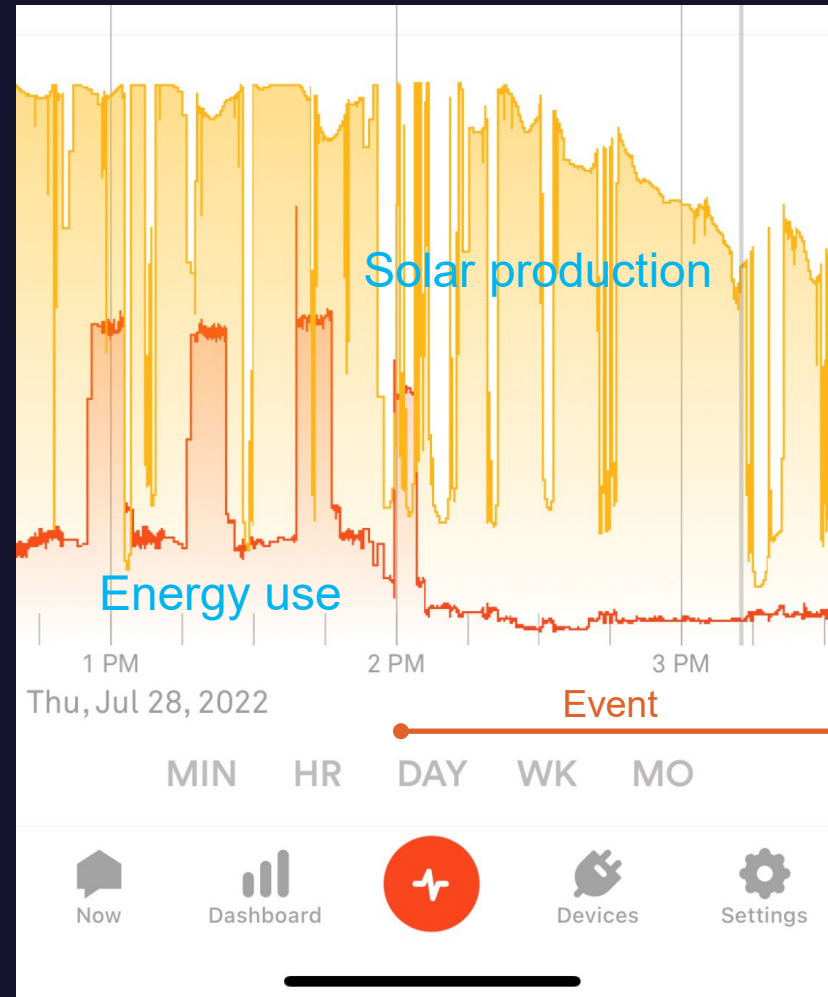


During future events, check your Sense monitor to see which devices are using the most electricity and power down unnecessary items to earn rewards.

# Hicks House Test Run

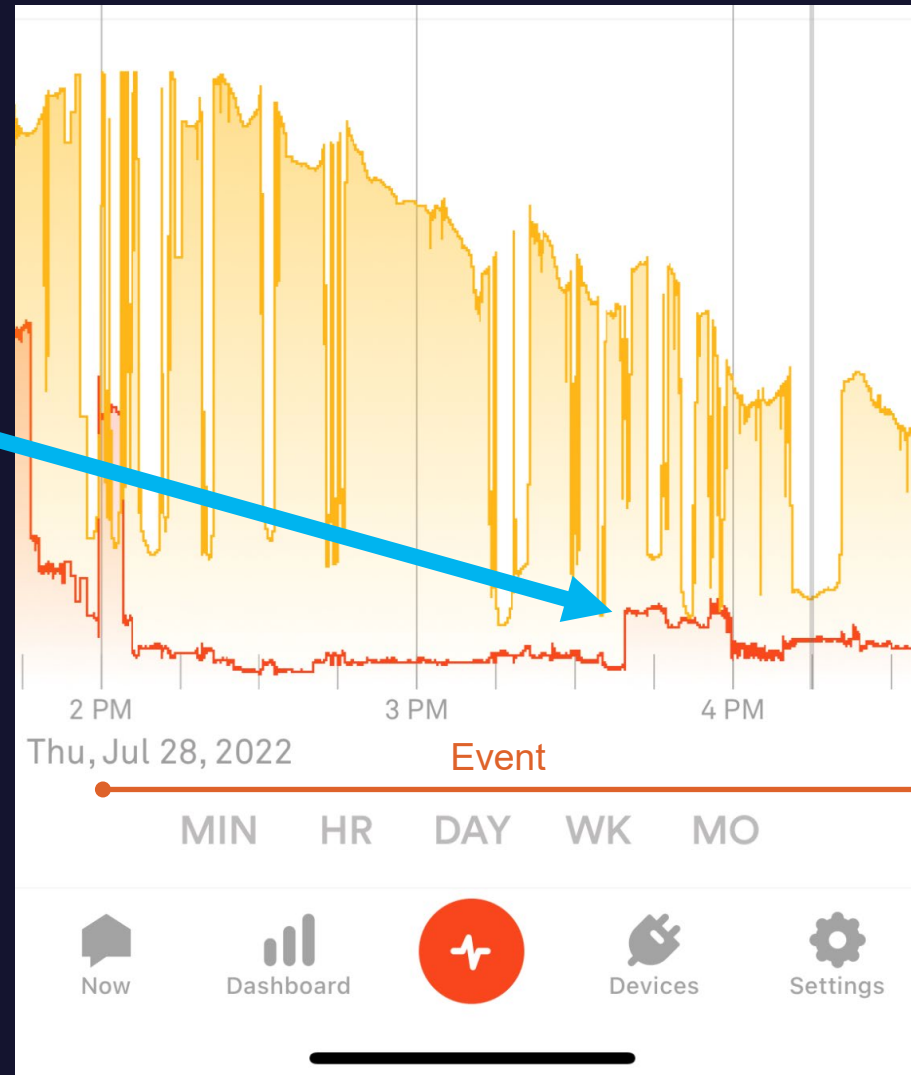
## Reduced Loads

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



# Non-Energy Benefits

Sneaky 6<sup>th</sup> 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

## Thank You / Questions



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