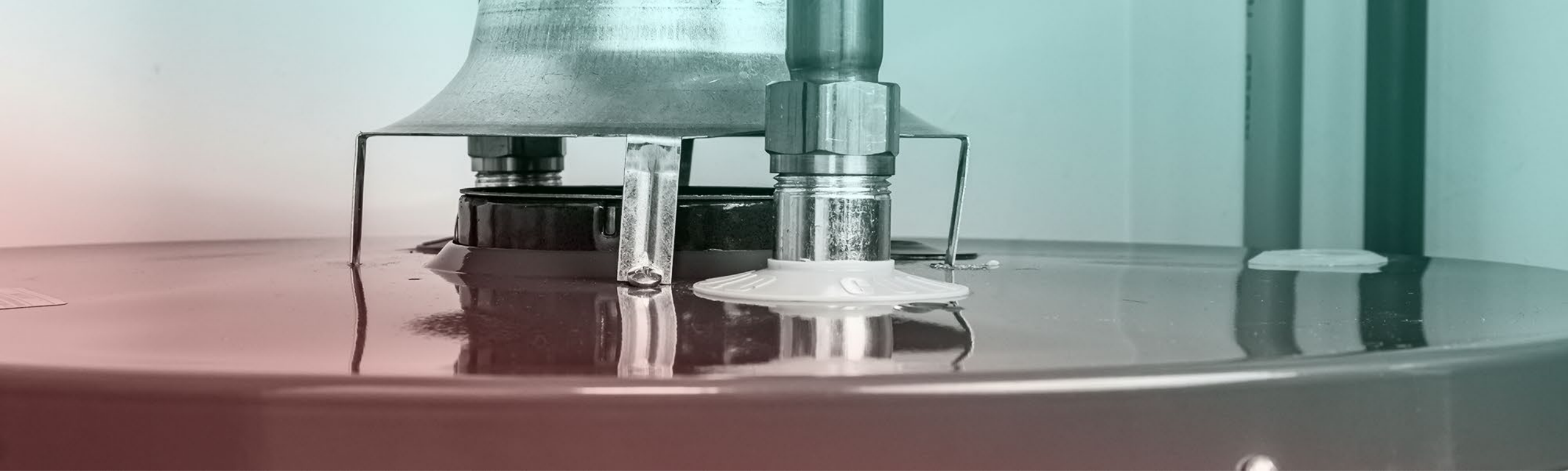


ILLUME



# Water Heater Demand Response:

**Comparing Full Replacement  
and After-Market Controllers**

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# Introduction





# Full-Unit Replacement Pilot

# Pilot Design



## **Recruitment & screening:**

Single family home

5+ year old WH

Wi-Fi

Adequate space to  
install HPWH



## **Installation:**

Professional  
installation from  
electricians

Plumbers

70 Heat Pump

30 Electric  
Resistance



## **DR Events**

5 Winter events

5 Summer events

Post-event surveys

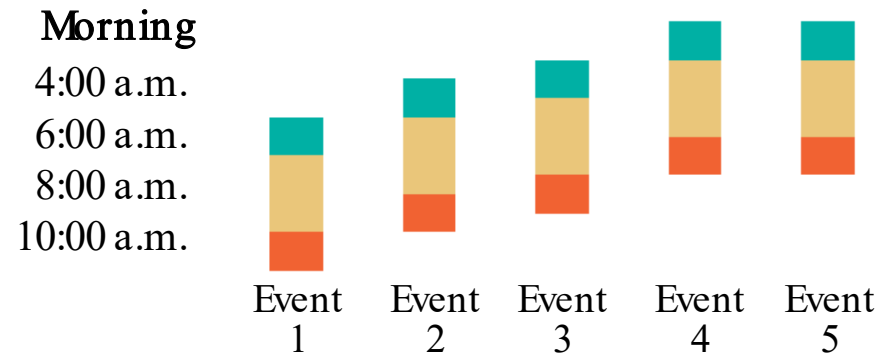


## **Impact analysis**

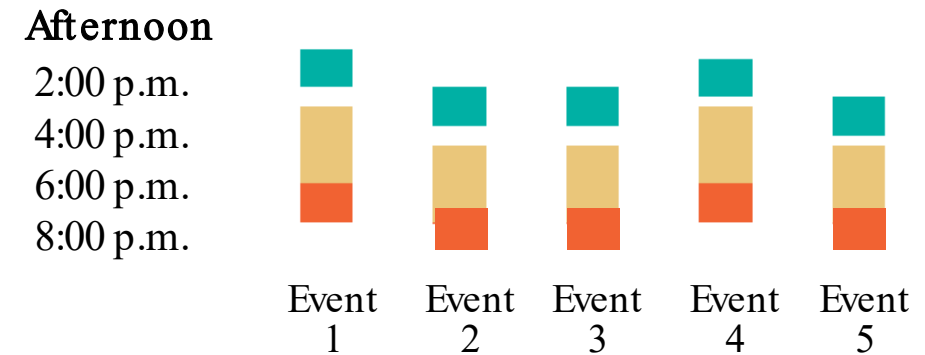
Within subject baseline  
modeling

# Event Strategy

## WINTER



## SUMMER



■ Load Shift   ■ Load Shed   ■ Post-Event





# Lessons Learned → Phase 2 Planning and Results

# COVID Challenges

Phase 2 Pilot delayed:

- Securing installers
- Implementing COVID safety measures
- Robust early response, but then dropped off due to delays





# Eligibility & Connectivity

## Lesson Learned

Space constraints disqualified some interested customers

Connectivity affected demand impacts: 15% had trouble connecting to water heater to Wi-Fi

Connectivity issues may have diminished load shed kW impacts by as much as 25% during the winter and 10% during the summer

## Phase 2 Pilot Approach

After market controllers have fewer space limitations

Testing two communication protocols – Wi-Fi and cell signal

Electric resistance water heaters

## Phase 2 Winter Result

33% receiving Wi-Fi controller had difficulty connecting; 17% receiving controller that uses cell signal had difficulty connecting

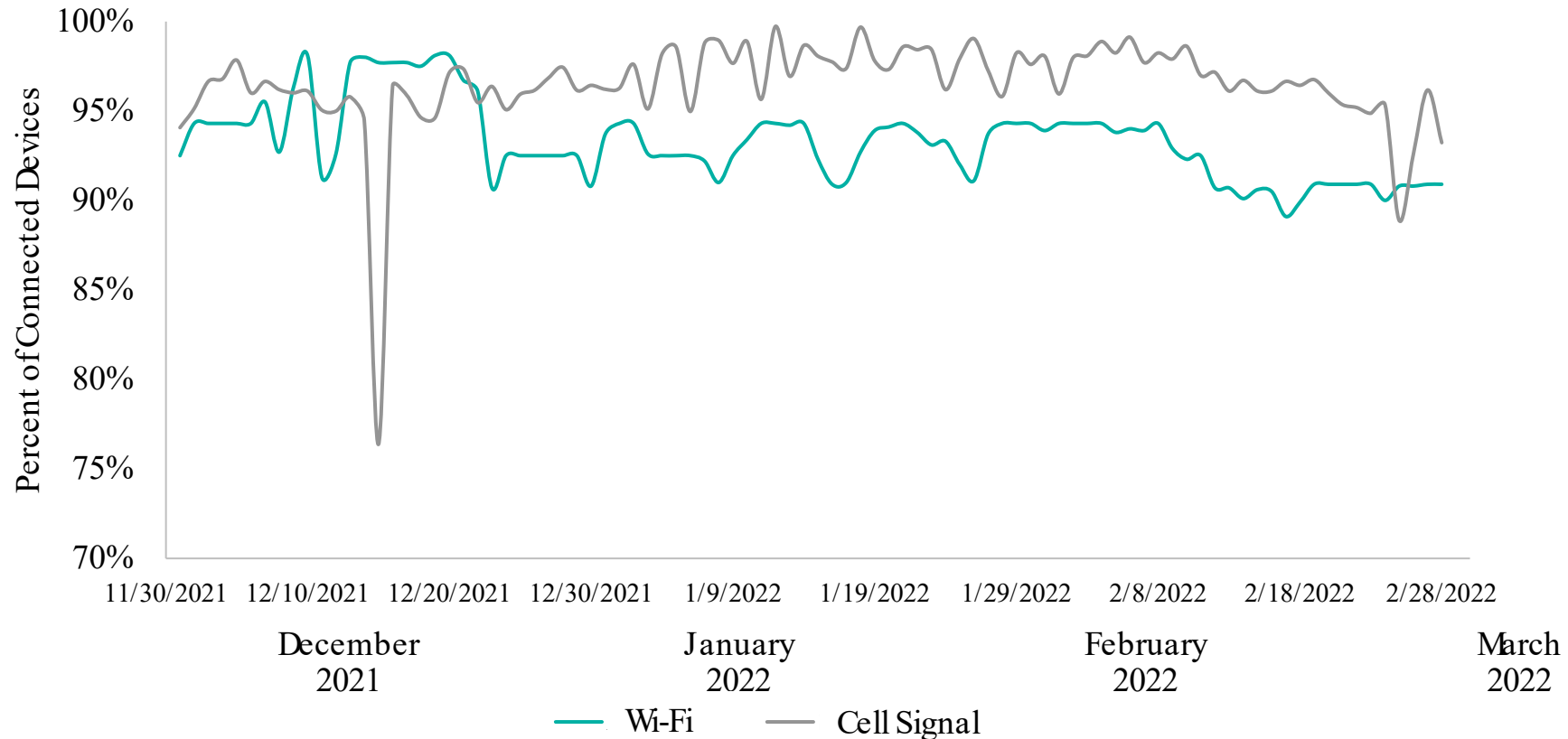
Slight difference by device type in maintaining connection:

Cell signal: 97%

Wi-Fi: 93%

# Phase 2 Winter Connectivity

## Connectivity over the Winter Season



# Cost and Resources

## Lesson Learned

Pilot sponsor invested time and resources:

- Screened prospective participants
- Provided professional installation including electrical and plumbing
- Customers reported installation took 2 to 6 hours to complete

## Phase 2 Pilot Approach

Pilot sponsor:

- Maintained screening process
- Provided professional installation

## Phase 2 Winter Result

Customers report that most installations took 1 visit

- 50% took less than 30 minutes
- 40% took 30 to 60 minutes

# Customer Experience

## Phase 1 Lesson Learned

Participants generally highly satisfied:

- Few issues reported or routines disrupted
- 94% satisfied/ 2% neutral about unit
- Neither advance notice nor pre-heating affected customer experience

## Phase 2 Pilot Approach

Conducted similar number of winter and summer events

Provided advanced notification of planned events

No pre-heating

## Phase 2 Winter Results

Participants highly satisfied:

- Few routines disrupted
- 76% satisfied/21% neutral with the controller
- About 6% reported an issue with hot water availability

# Customer Experience



## Phase 1 Lesson Learned

Customers who received advanced notice did not opt-out prior to the events, but appreciated the notification

Few (<1%) opt-outs, on average

75% would participate again

## Phase 2 Pilot Approach

Provided advanced notification of planned events

## Phase 2 Winter Results

Nearly all survey respondents recall receiving notification

Few (<3%) opt-outs on average

About 6% reported an issue with hot water availability

97% would participate again



# Demand Impacts



# Demand Impacts

## Within Subject Baseline

- Within 2 weeks of matching event day
- Not a holiday or weekend
- Not another event or test day

## Model

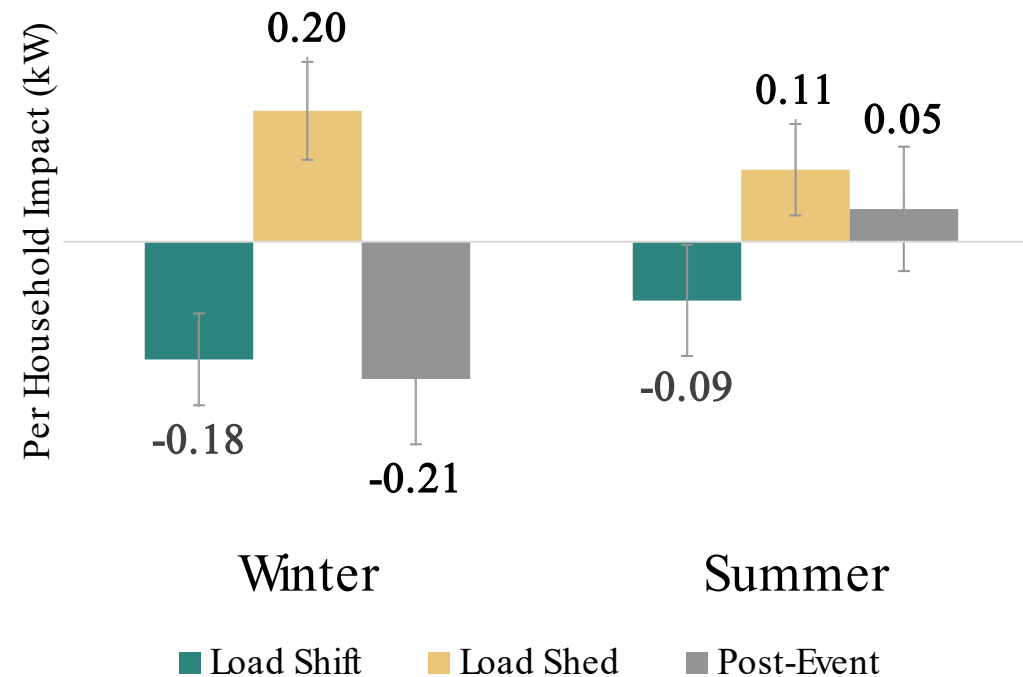
Fixed effects model with:

- Heating Degree Hours
- Cooling Degree Hours
- Load Shift, Load Shed, Post-Shed Hours Flags (Phase 1)
- Load Shed flag (Phase 2)

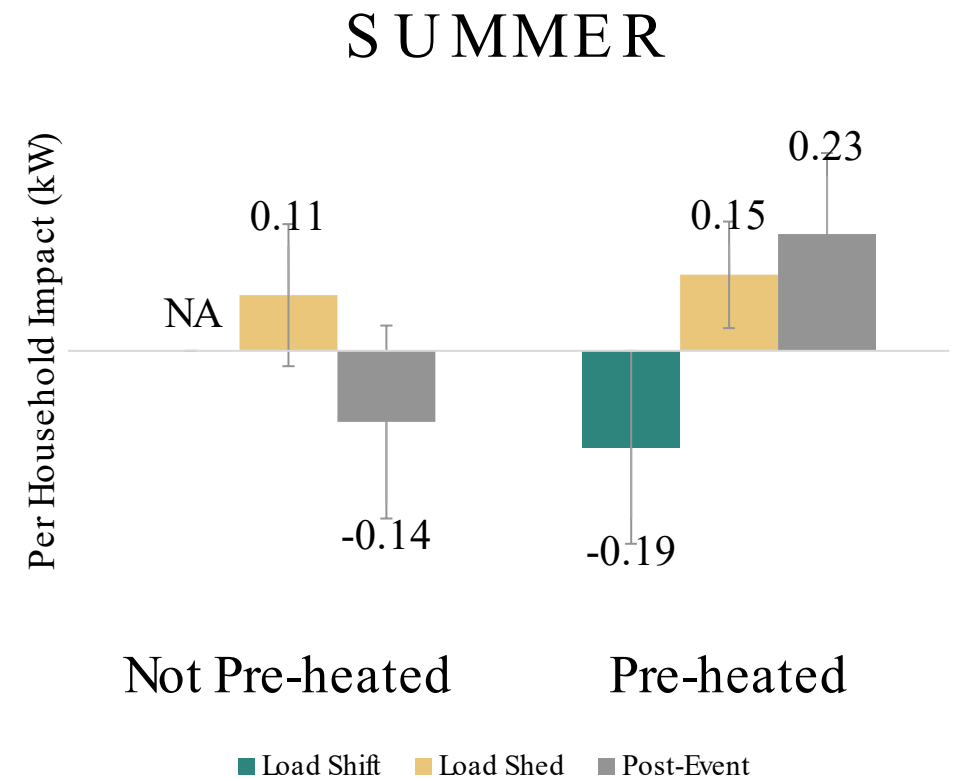
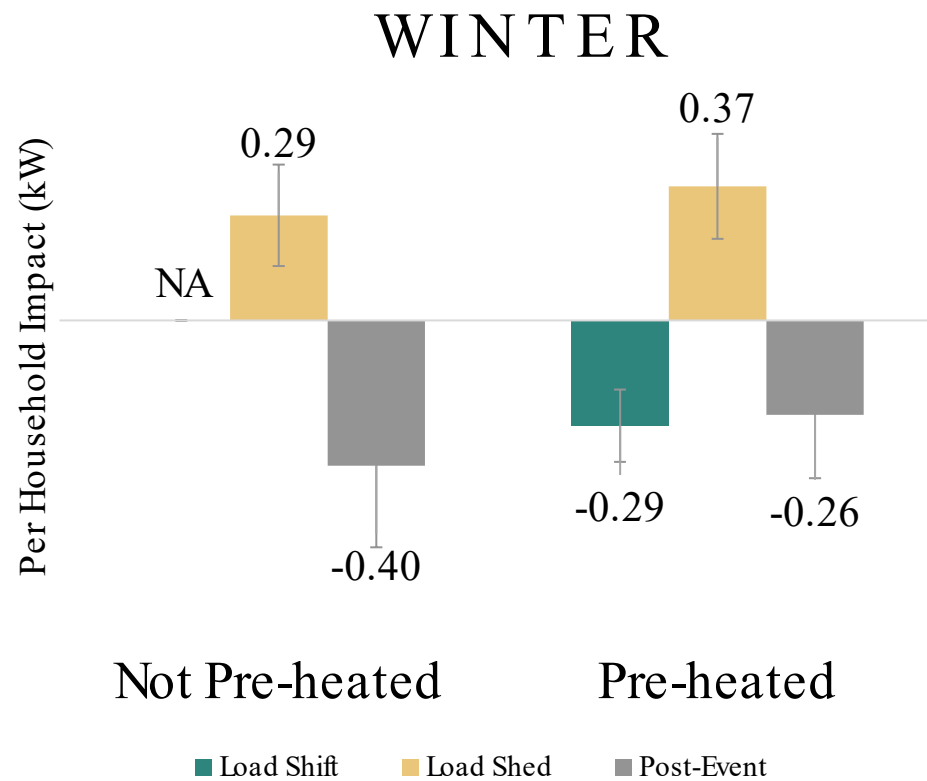




# Phase 1: Winter and Summer Impacts

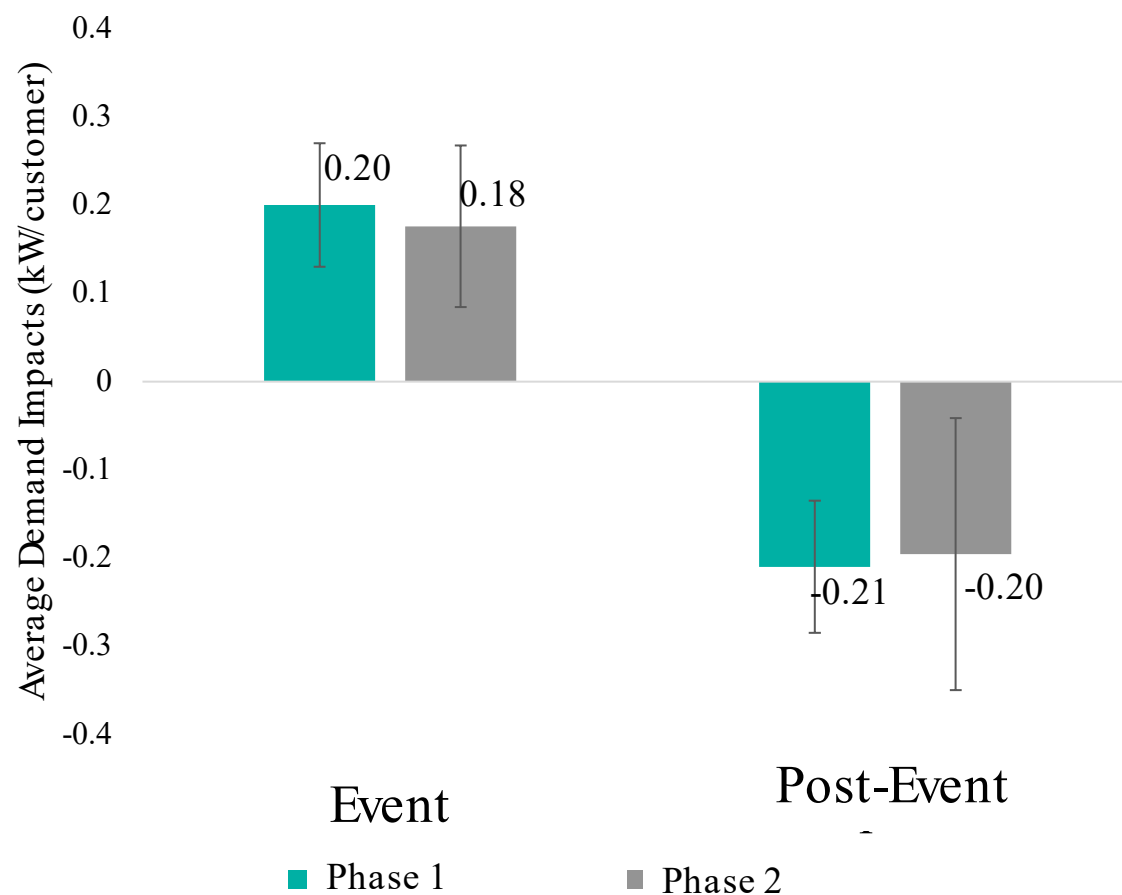


# Phase 1: Pre-Heating Impacts



# Water Heater DR Pilot Impact Comparison

Phase 1 and Phase 2 Comparison:  
Winter Impacts



# Next Steps



# Conclusions



1. Using lessons learned in one pilot to inform design of the next pays off.
2. Water heater demand reductions are small but pilots had high customer satisfaction.
3. Connectivity continues to be an issue with Wi-Fi and cell networks.
4. Controllers show promise as a more cost-effective option to enable water heater demand response, but is this model scalable? How can utilities interest customers in adding a controller to an appliance they don't think about much.



# Contact



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