Entering Unchartered Water (Heater Demand Response)

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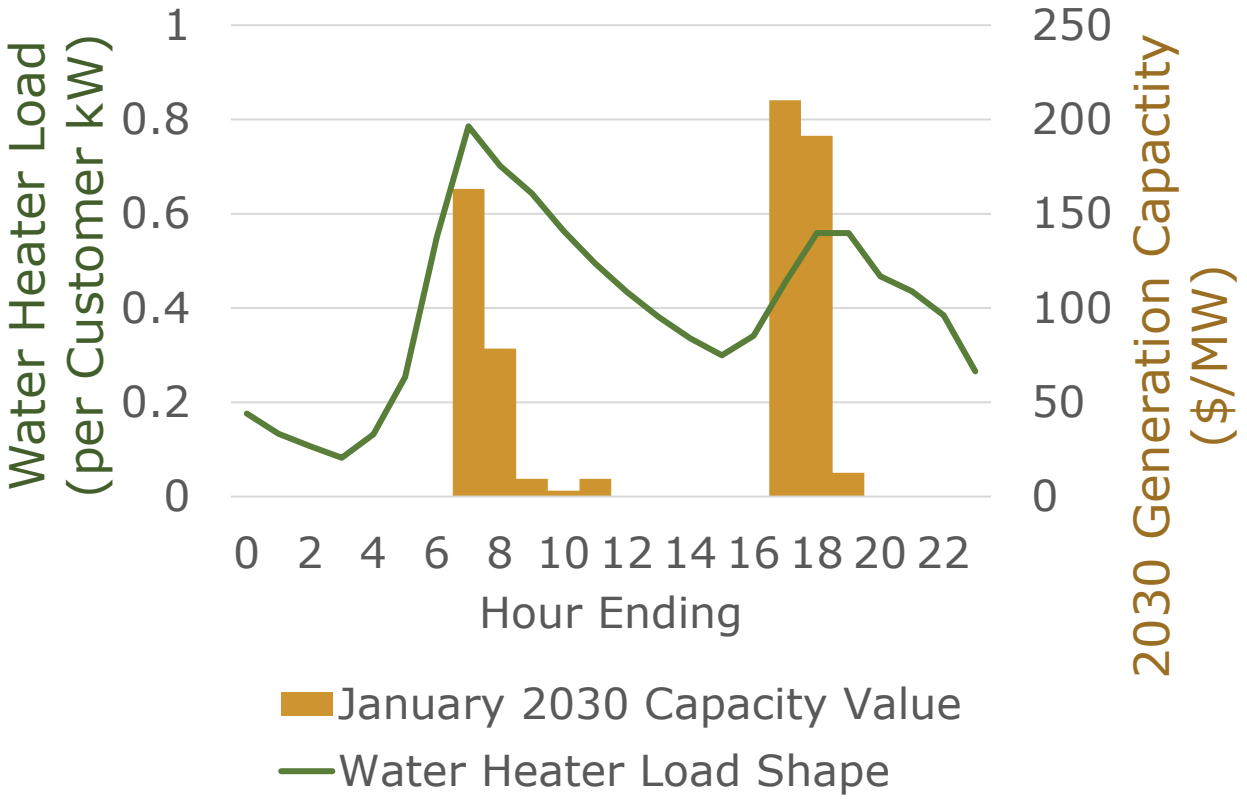
APEX ANALYTICS

Pilot Background

Why Dive into WHDR?

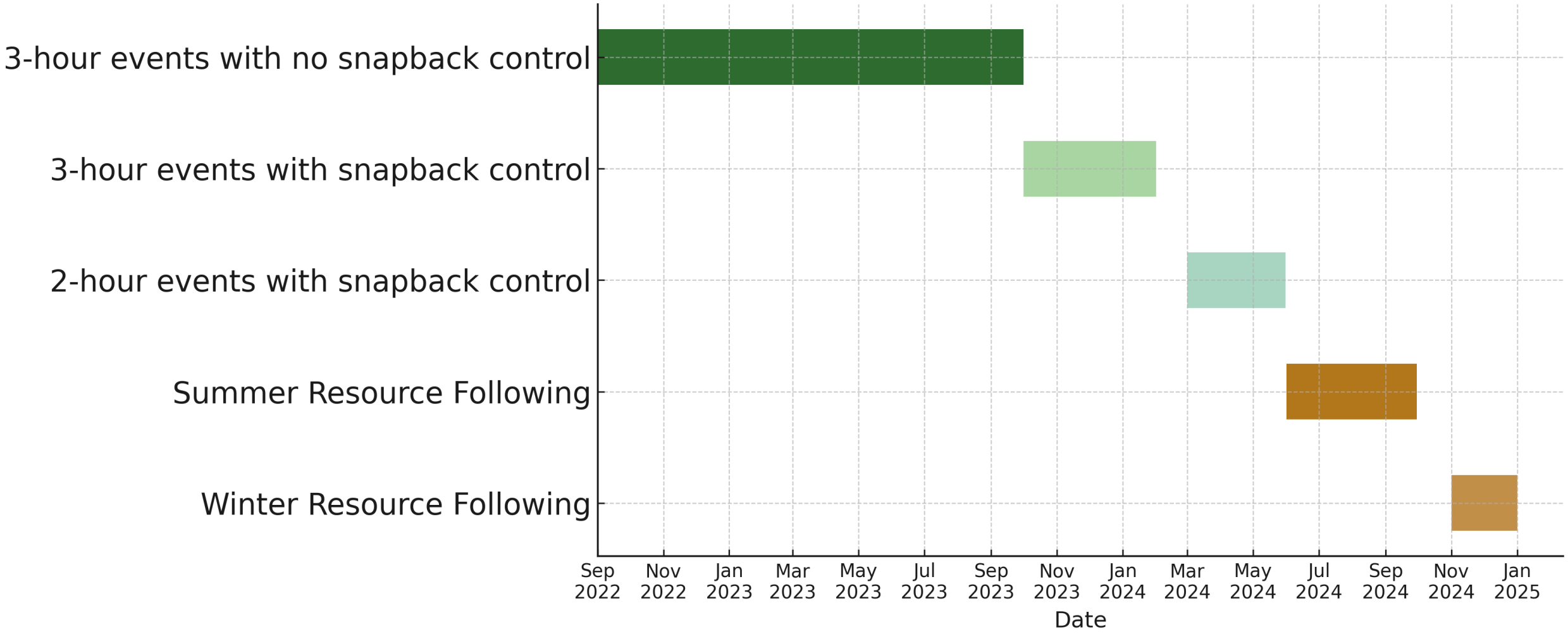
- In the 2020 Integrated Resource Plan, Tacoma Power identified the need for 10 MW of morning and evening load management
- Water Heater load was a great fit:
  - Good match with winter peaks
  - Common in service area
  - Appropriate size for first step



Setting Up the Pilot

- Controllers installed on 240 residential single-family water heaters
- Customers enrolled in a Randomized Control Trial (RCT)
  - 120 treatment customers receiving events
  - 120 control customers with controllers but no events

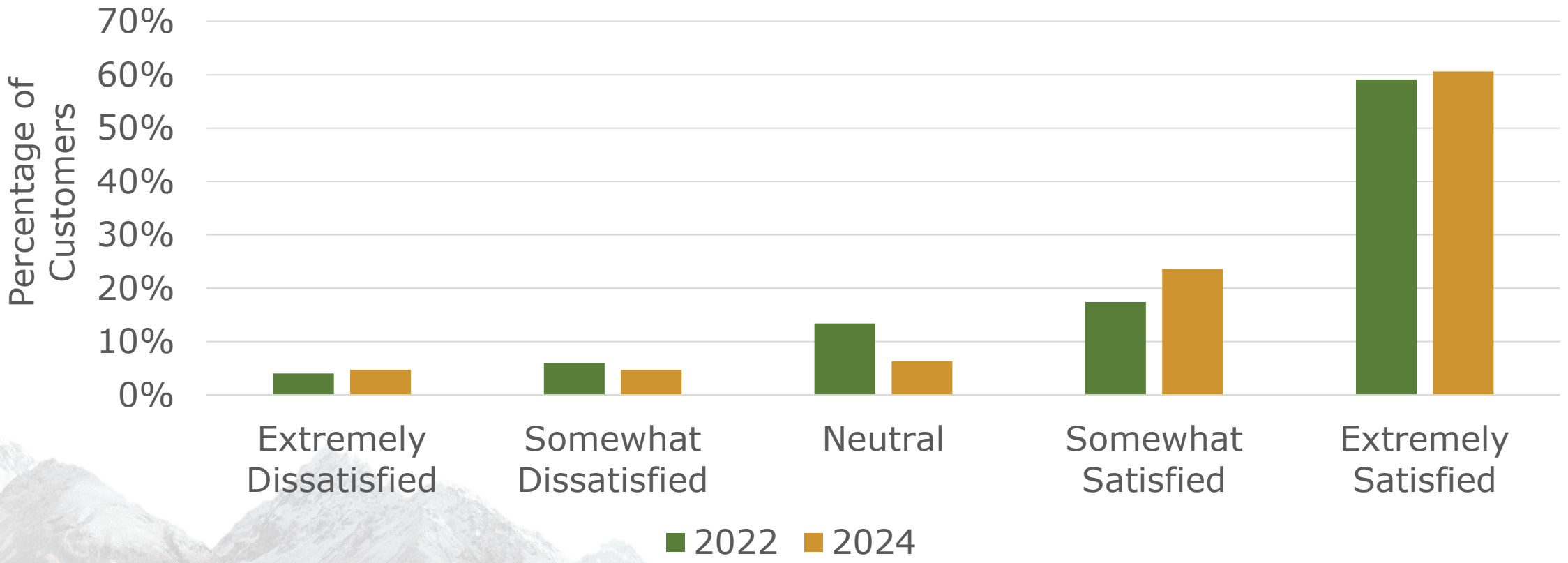
Pilot Phases



Customer Satisfaction

Are customers affected by the WHDR Events?

- Tacoma sent out seasonal surveys to monitor water heater satisfaction
- Minimal change in satisfaction from start of pilot to end of pilot



Implementation Lessons Learned

Successes

- Thousands of events successfully deployed over 2.5 years
- Minimal customer complaints
- Consistent savings found
- Embedded evaluation approach was valuable

Lessons Learned

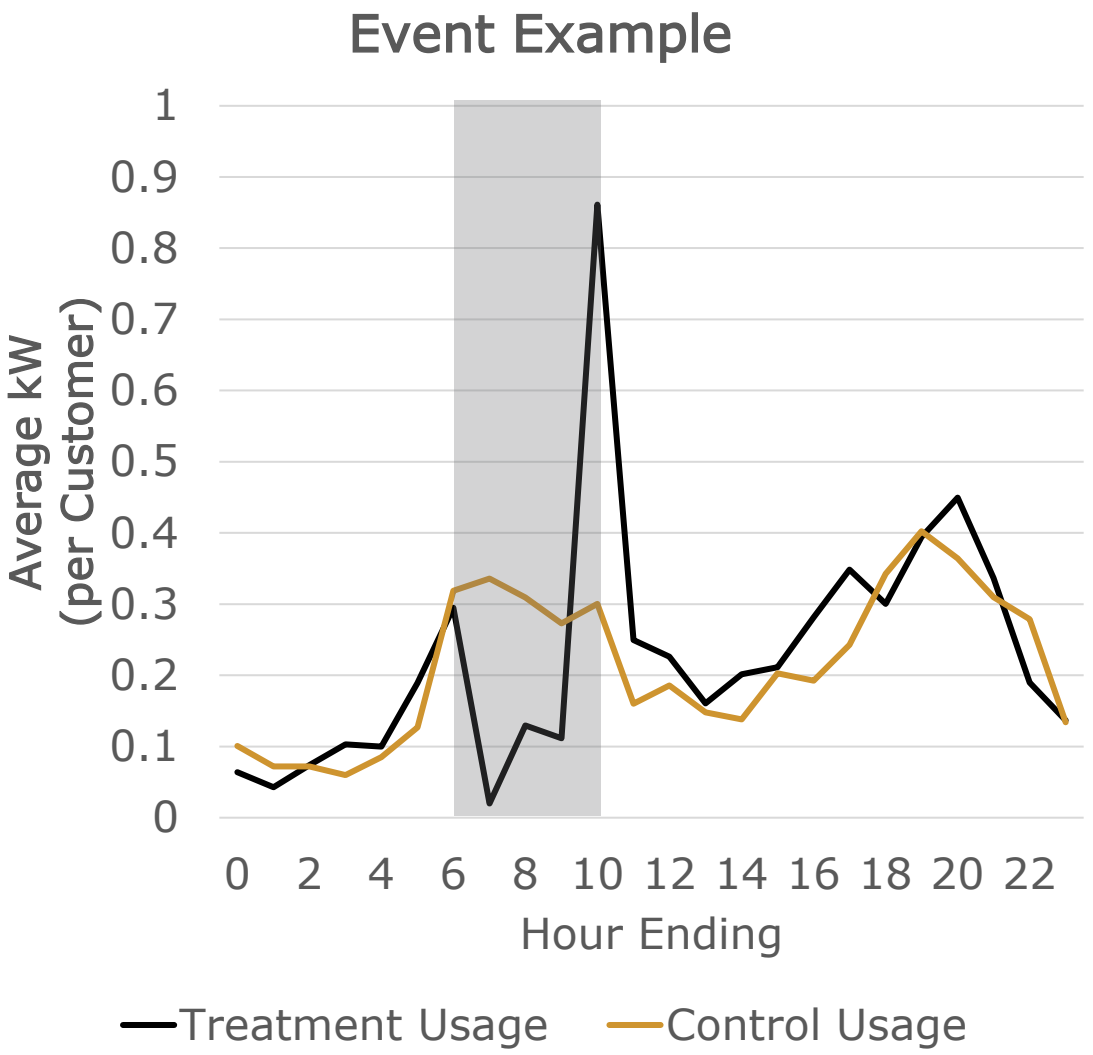
- Hardware is hard
- Innovative testing requires flexibility
- Effects of snapback can be substantial

APEX ANALYTICS

Evaluation Findings

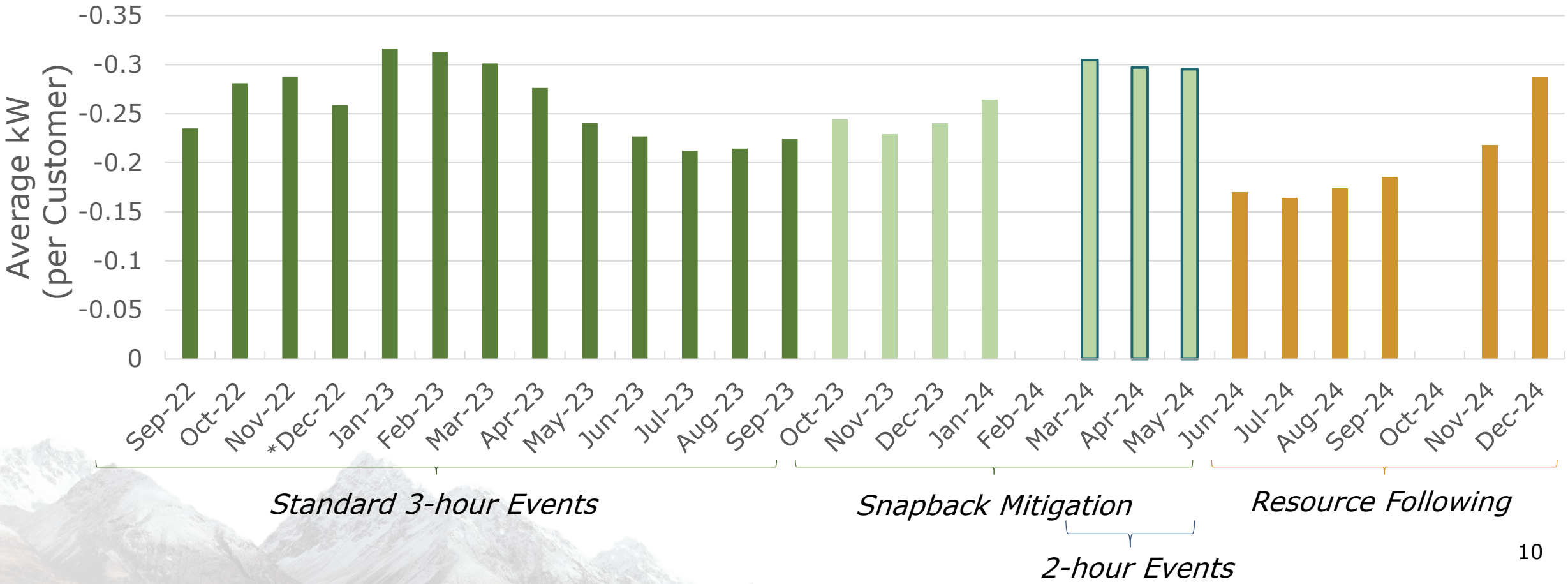
Evaluation Methods

- Embedded Evaluation
  - Evaluation worked in real-time with Tacoma Power
  - Provided impacts and feedback monthly
  - Received 15-minute demand data from controllers and event data
- Leveraged the Randomized Control Trial for savings estimation
  - Regression model to compute hourly treatment impacts before, during, and after each event compared to typical control group usage



Overview of Results

First-Year of Pilot:
- Consistent savings
- Clear seasonality of usage
- Higher usage in winter



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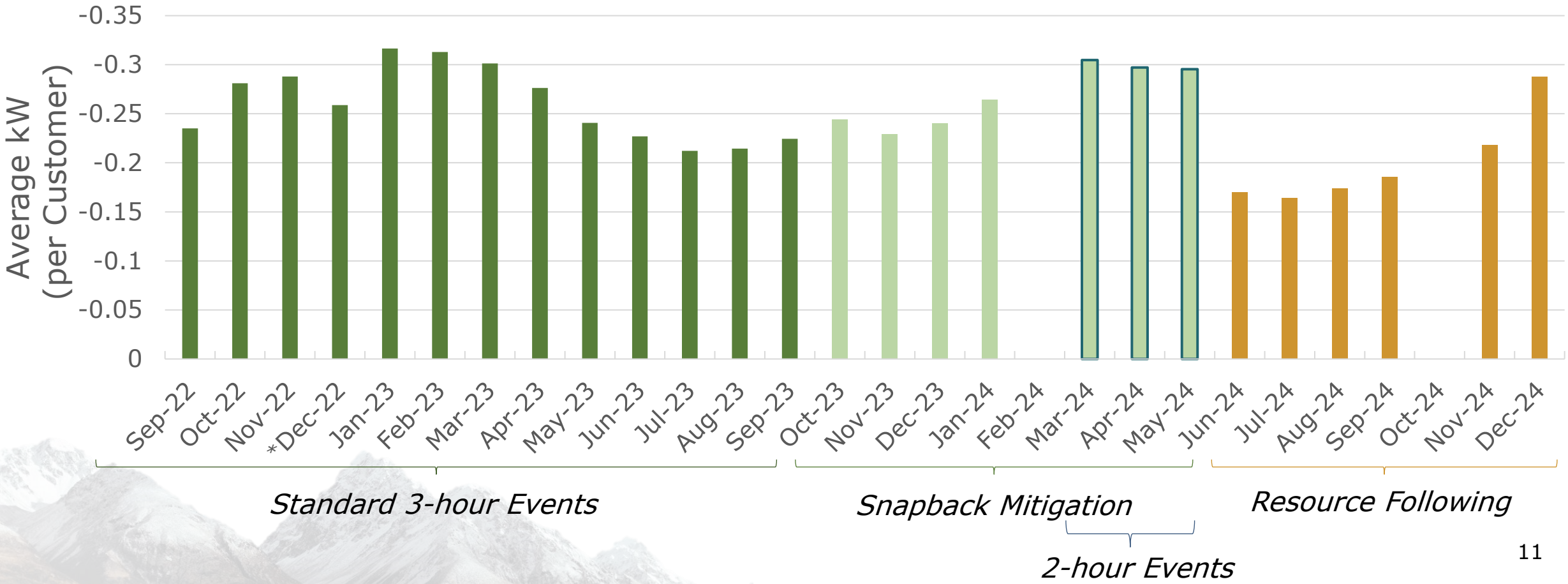

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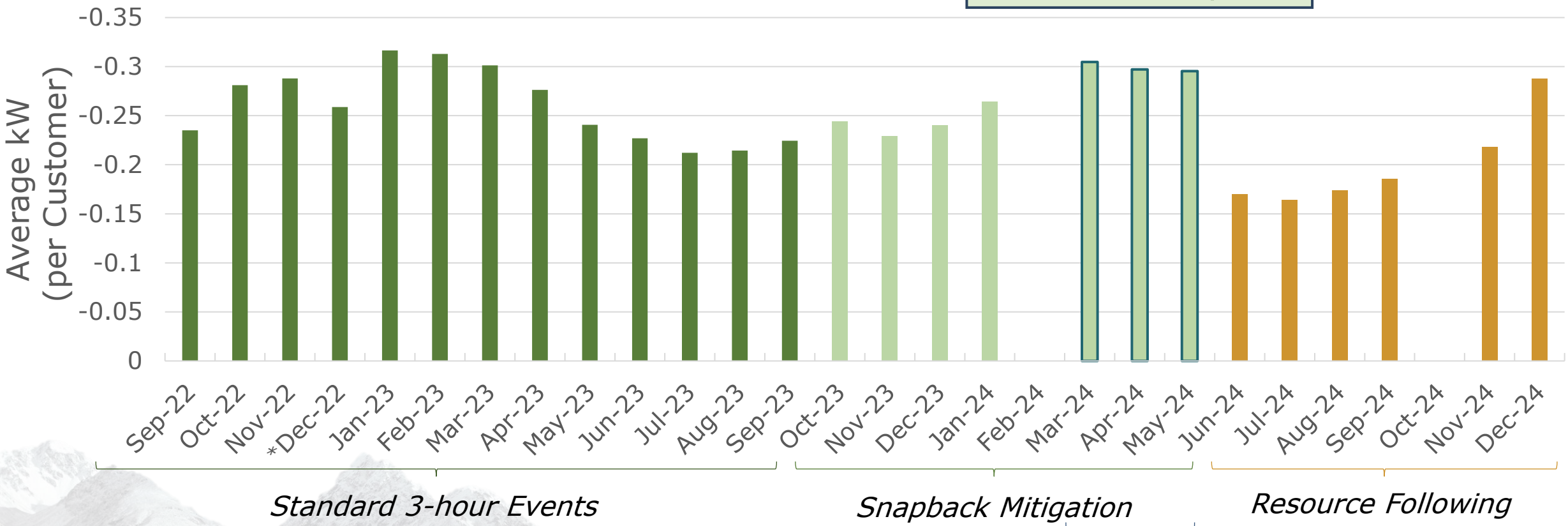
2-hour events: highest, most consistent impacts



Overview of Results

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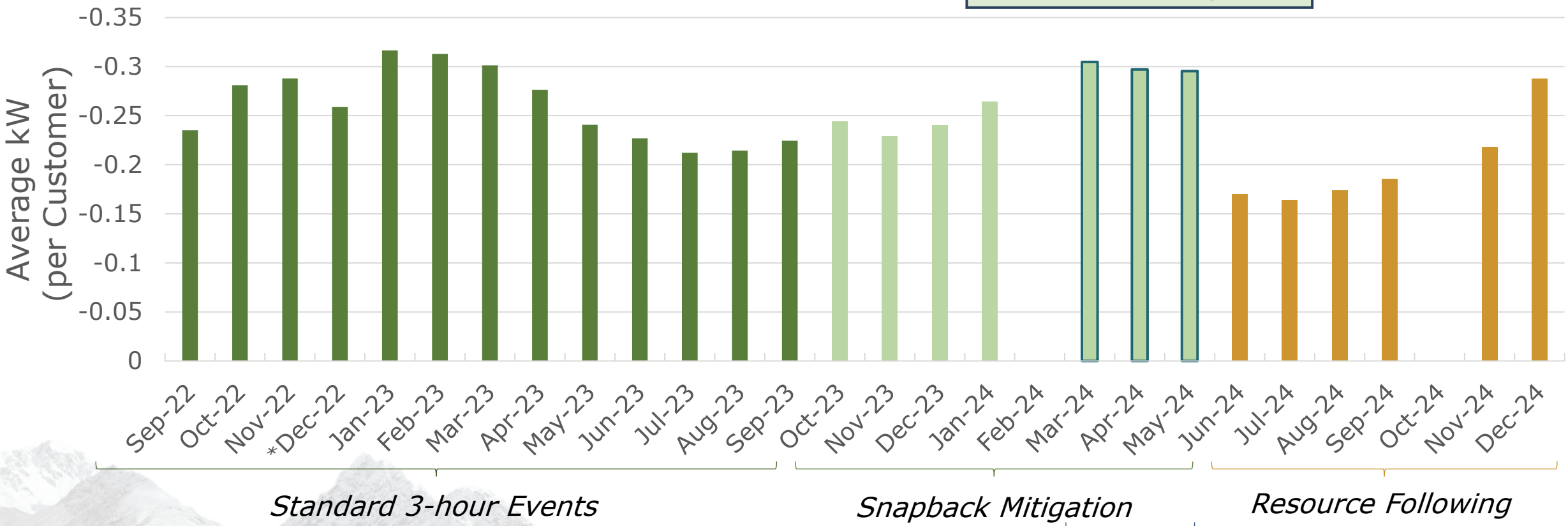
Snapback mitigation efforts were effective

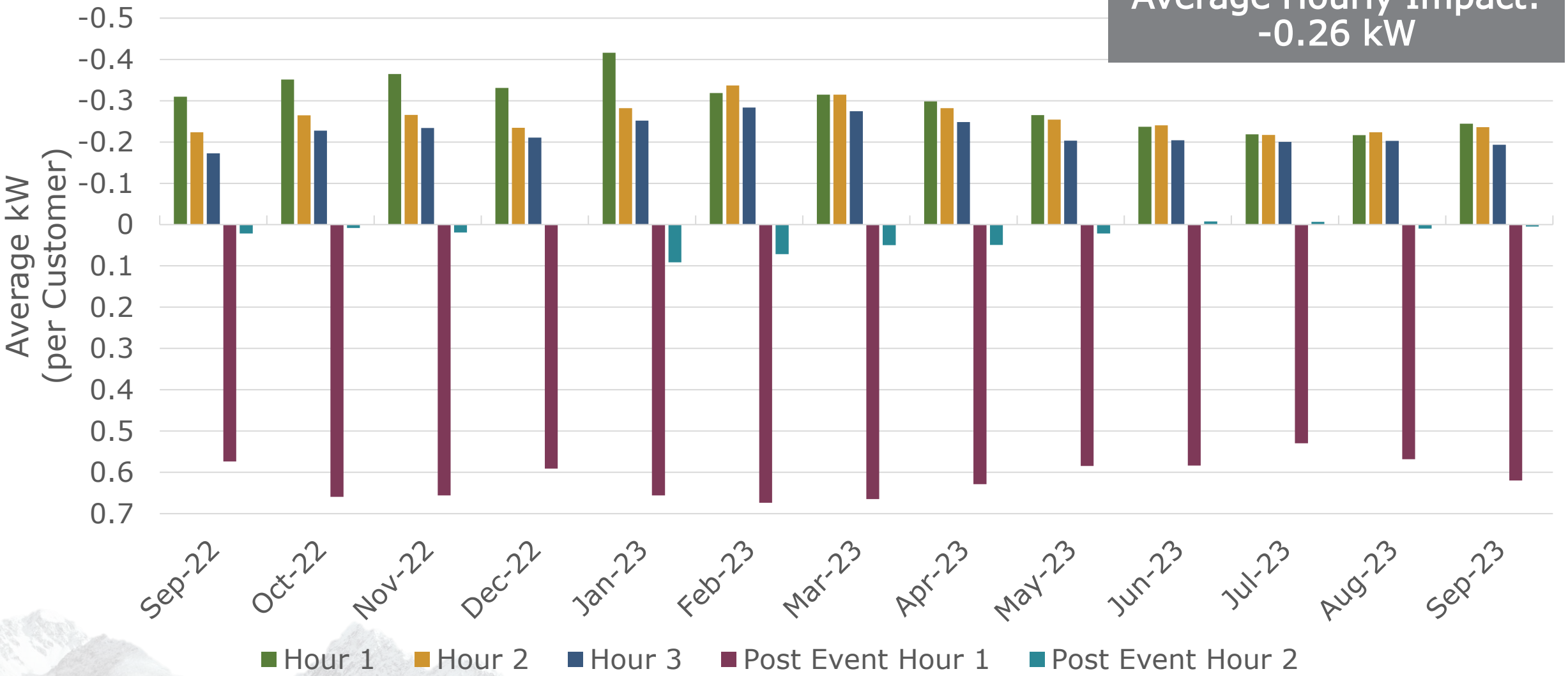
Resource Following: lower impacts

2-hour events: highest, most consistent impacts



Diving Deeper – First-Year of Impacts

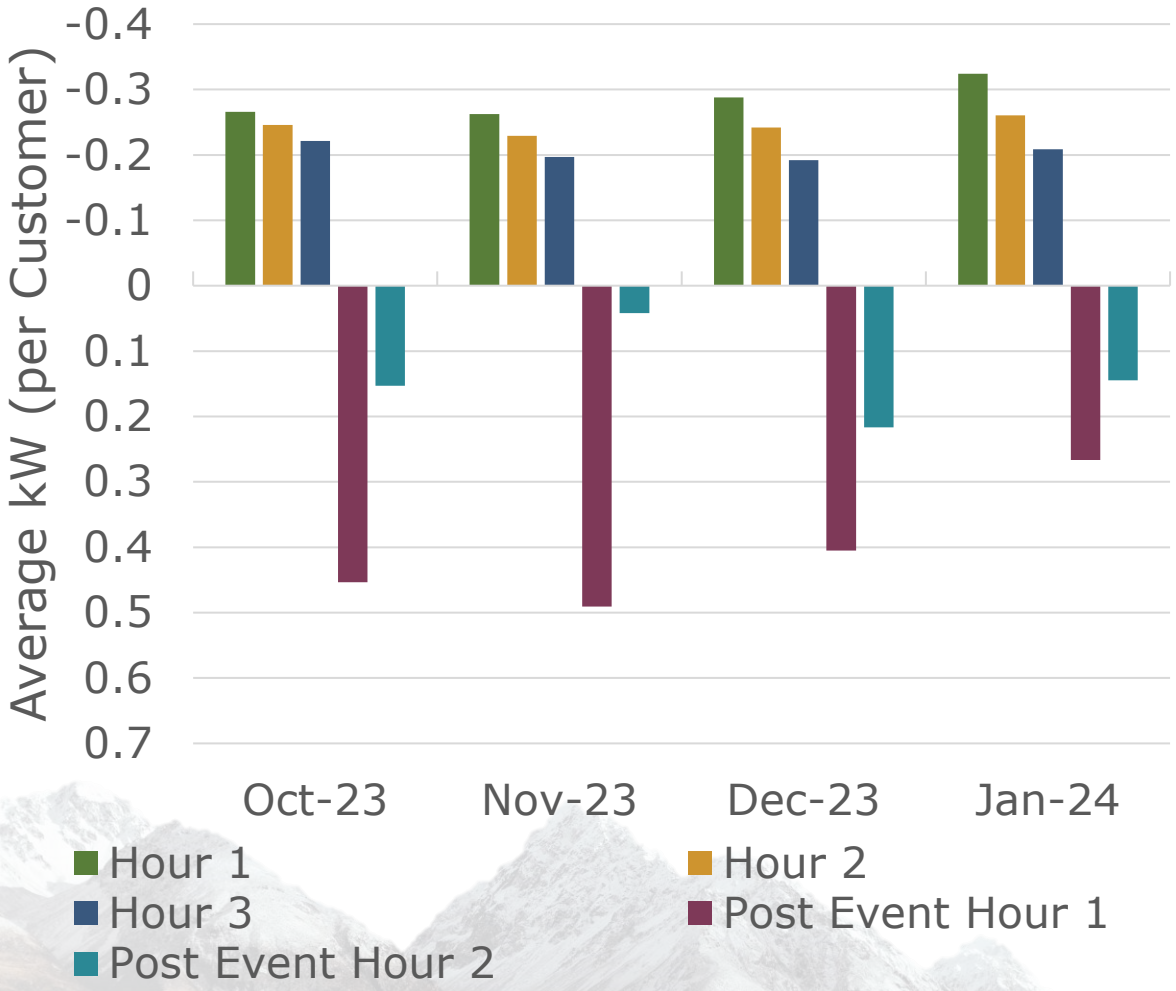
Average Hourly Impact: -0.26 kW



Diving Deeper – Snapback Testing

Average Hourly Impact: -0.24 kW

3-hour Events with Snapback Control



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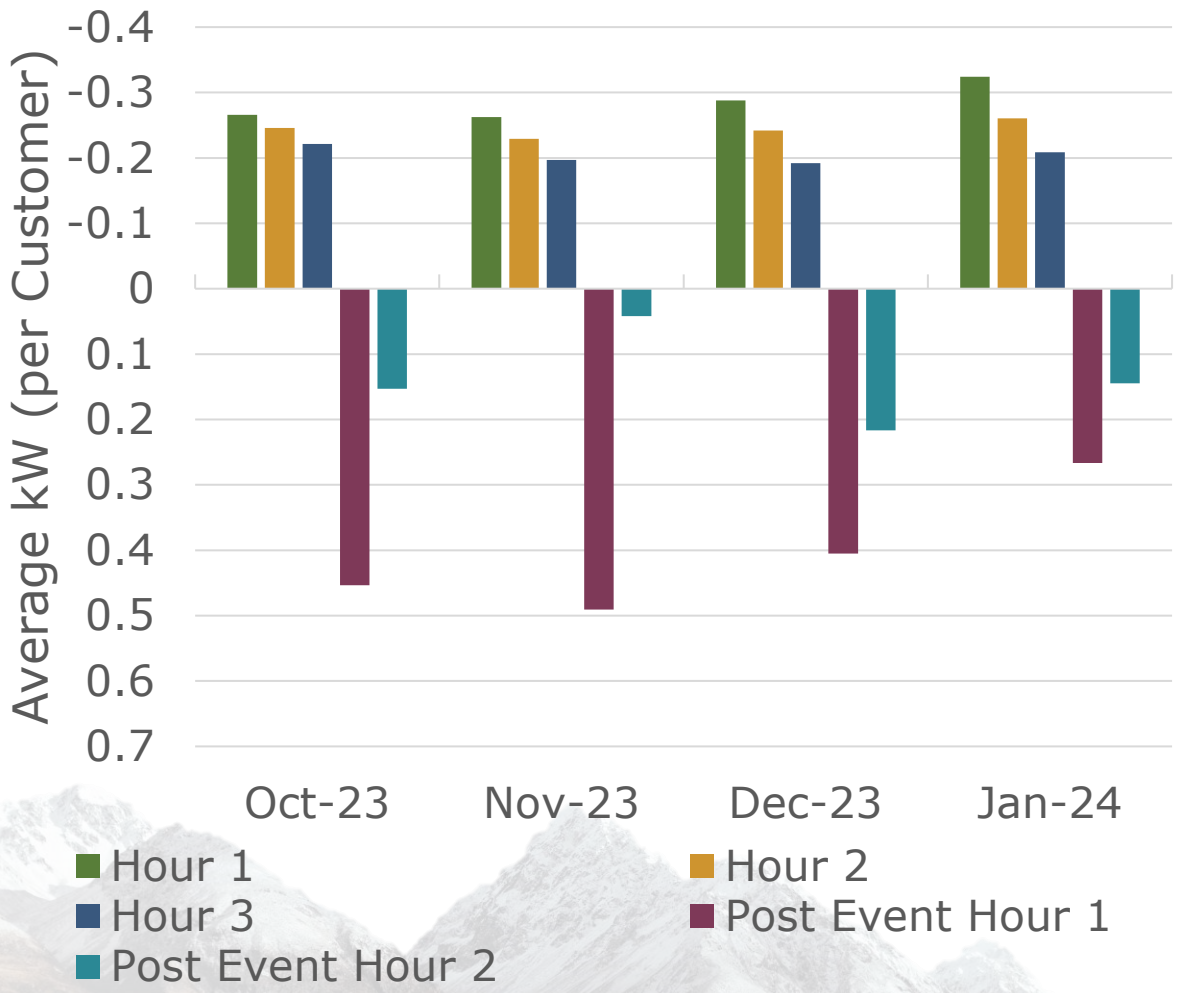
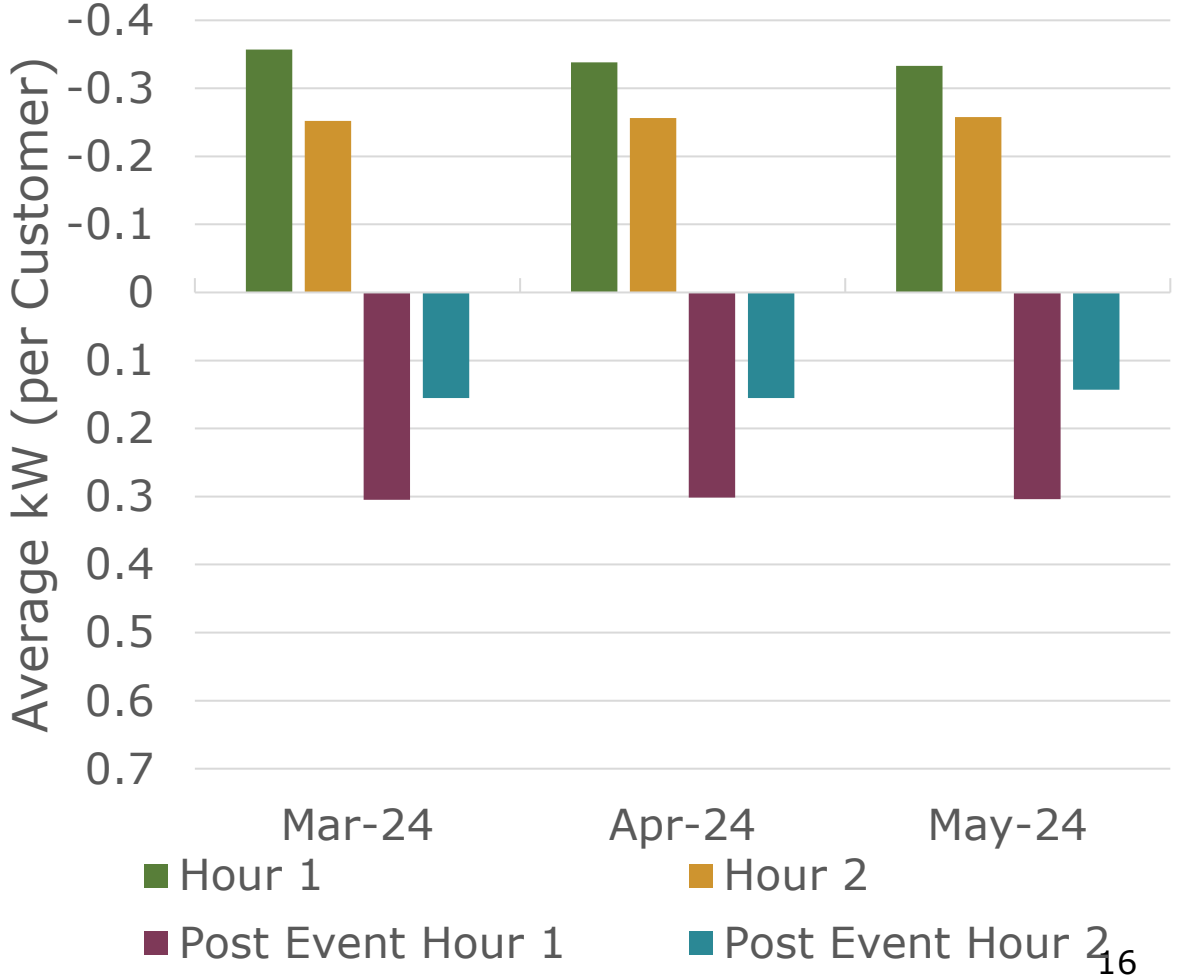


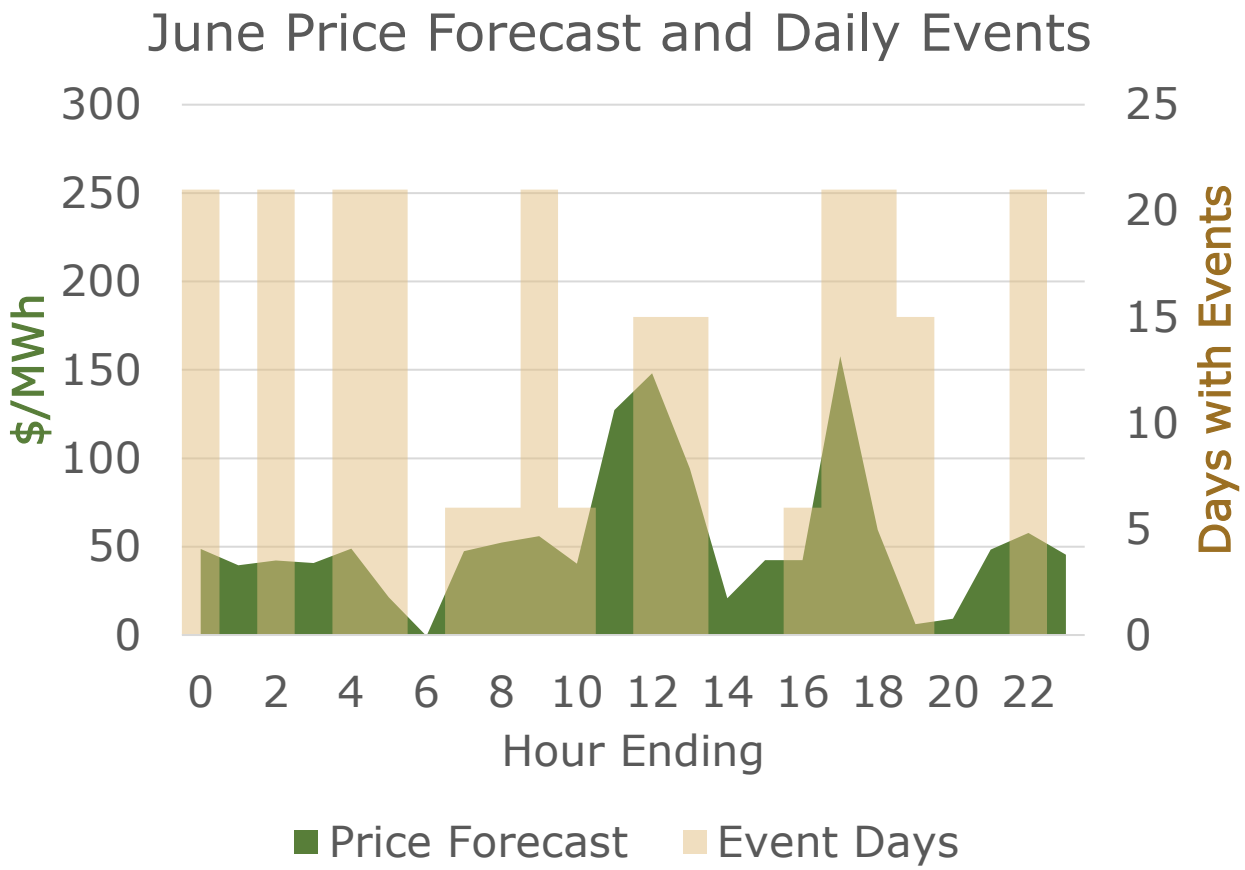
Average Hourly Impact: -0.30 kW

2-hour Events with Snapback Control



Diving Deeper – Resource Following Testing

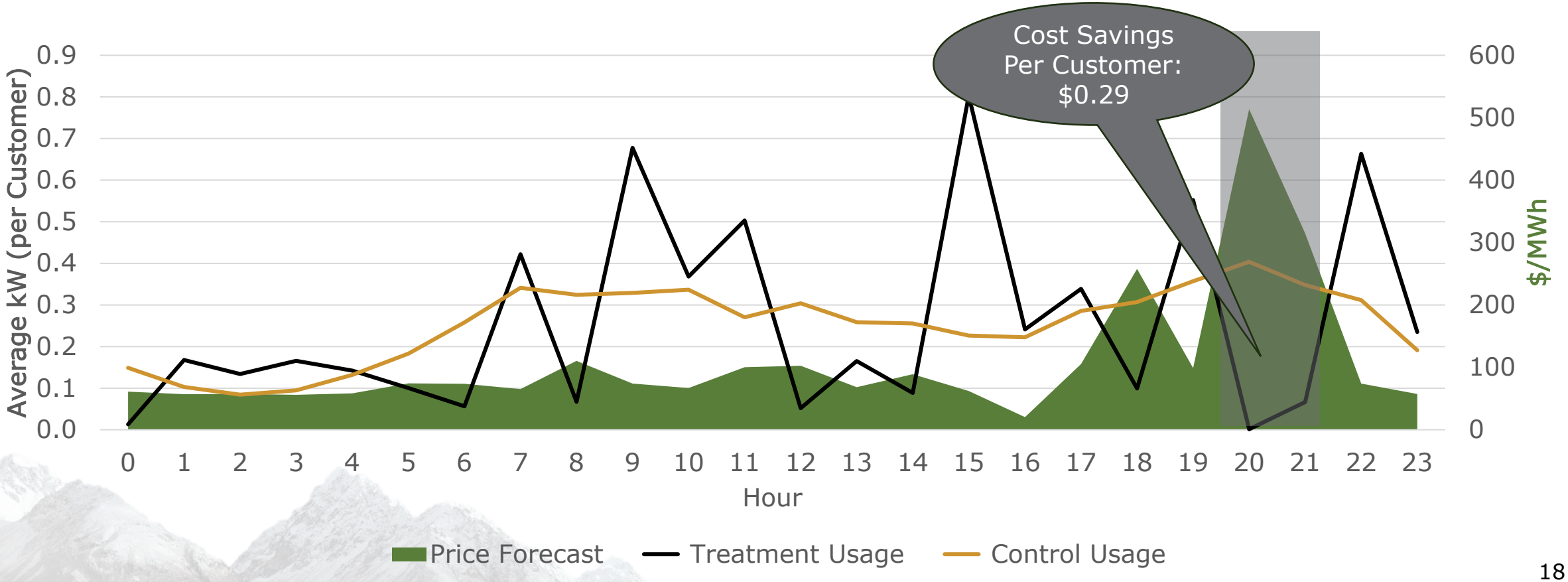
- Events designed to reduce costs not just demand
  - Daily price forecasts used to generate 1-hour events during any hour of the day
- Average of 200 Events Per Month
  - Summer Impact: -0.17 kW
  - Winter Impact: -0.25 kW



Evaluation Approach: Cost Savings

What cost savings can the utility achieve by timing events with high price forecasts?

*Hourly Cost Savings = Hourly kW Impact [difference in differences of hourly treatment and control usage] * Hourly Price Forecast*



Evaluation Lessons Learned

- WHDR average event impacts of Tacoma service-territory is around -0.26kW
- Snapback mitigation efforts successfully reduced effects of first-hour snapback
- 2-hour events showed highest average savings
- Best opportunity for utility cost savings was evening events lined up with high price hours

Thank You

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