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IEPEC International Energy Program Evaluation Conference

Gas Demand Response

A Pilot Evaluation Using Thermostat Telemetry

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Emily Kremser

Utility Gas DR Programs

Utility	Pilot	Program	Sectors	Mechanism
SoCalGas	2016	2017 - 2019	• Residential	• BYOT
National Grid	2017 - 2020	2019 - present	• Residential • C&I	• C&I Curtailment • BYOT (Res, Small Commercial) • Behavioral
Con Edison	2019 - present	-	• Residential • C&I	• C&I Curtailment • BYOT (Res)
Midwest Utility	2020 - 2022	-	• Residential • Small Commercial	• BYOT

Gas DR Benefits

Defer Infrastructure Investment

Increase System Reliability and Resilience

On capacity constrained distribution nodes, the value of gas DR could be as great as $1,000/ccf-year *(Bode, 2020)*.

Evaluation Challenge

Temporal Resolution Mismatch

Thermostat DR Impacts
Are concentrated in 2-4 hours

Traditional Gas Meters
Record usage at day interval or longer

Need higher resolution data to distinguish impacts in event hours from pre-conditioning and rebound

Evaluation Solution

Two-Stage Estimation Approach

Stage-1
Estimate hourly event impacts in *heating runtime minutes* using thermostat telemetry data

Stage-2
Estimate *therms* per *heating runtime minute* using daily gas meter data and hourly telemetry

Use Stage-2 estimates to convert runtime impacts into therms

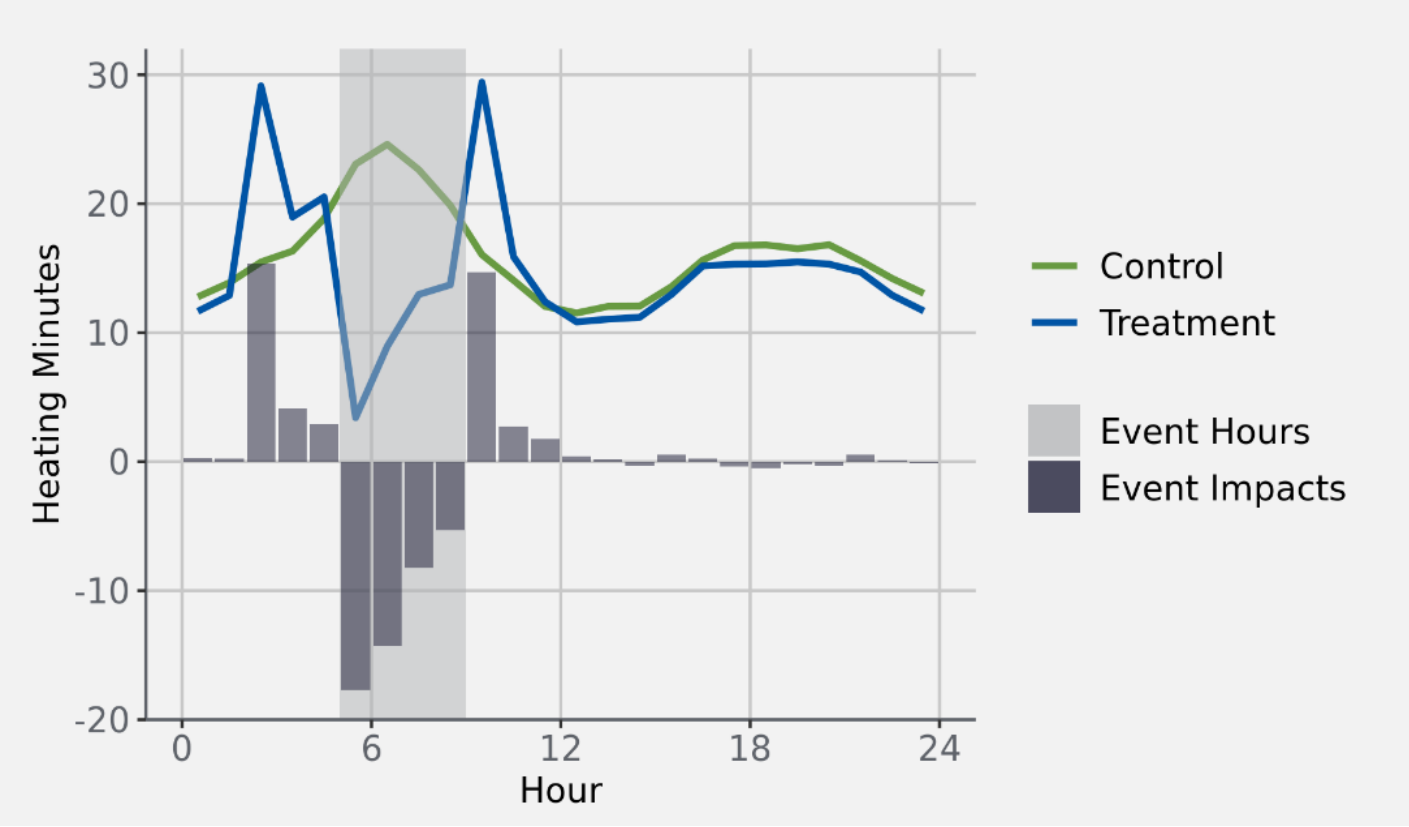
Estimation Stage-1 Methodology

Residential	• RCT design • Event re-randomization within each thermostat brand • Diff-in-diff regression with controls for differences in time-of-day and Heating Degree Hour (HDH) effects

Small Commercial	• Small population, no control group
	• Individual customer baseline model selection
	  • min(RMSE)
	• Tested a range of models including variables for hour, week, day-of-week, HDH and HDH buildup (with varying temperature thresholds)
	  • E.g., $Heat\_min = \beta*Hour + \beta*Hour*HDH50 + \epsilon$

Estimation Stage-1 Results

Difference-in-differences regression with randomized assignment (RCT)



Events target heating during morning peak (5-9 a.m.)

Heating during event period reduced by ~50% (Res.) and ~34% (Small Commercial)

Spikes in heating due to pre-conditioning and post-event rebound offset most of the event demand reduction

Estimation Stage-2 Methodology

Methodology	• Aggregate hourly heating data to day interval • Merge with gas usage (by account/premise) • Estimate average cf per heating minute • $cf = \alpha + \beta * heat\_min + \epsilon$
Limitation	• Approach not feasible without customer level thermostat telemetry that can be linked to consumption data

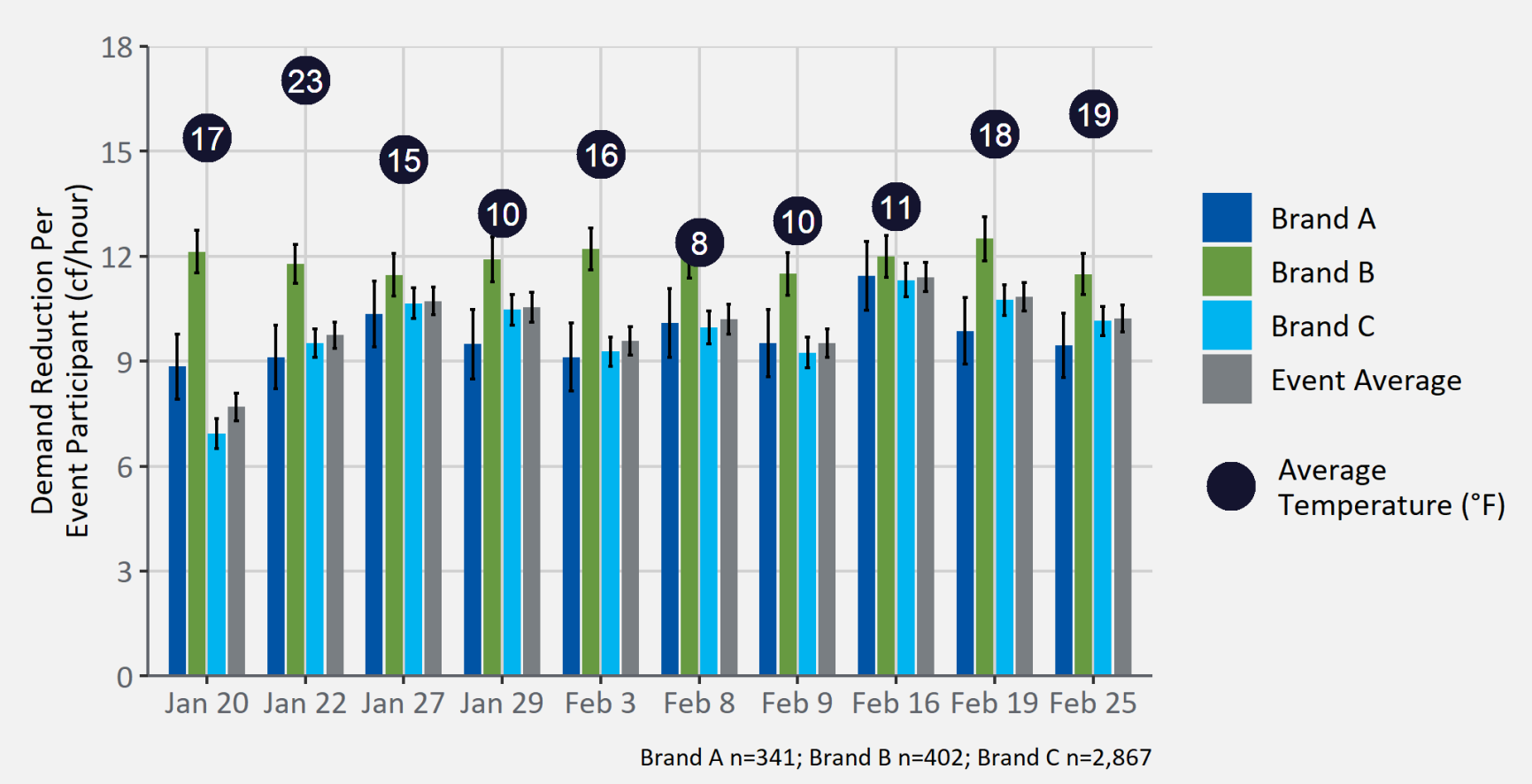
Estimation Stage-2 Results

Residential	• Results consistent across thermostat brands
Small Commercial	• Disaggregated results by gas usage segment
Limitation	• Incomplete data on customer heating equipment prevented further segmentation (e.g., furnace vs boiler)

Residential	cf per Heating Min.
	0.95

Small Commercial	Median Daily Gas Usage (cf)	cf per Heating Min.
	< 25	0.91
	25 - 49	1.14
	50 - 99	1.68
	100 - 199	3.23
	200 - 299	4.60
	> 300	6.08

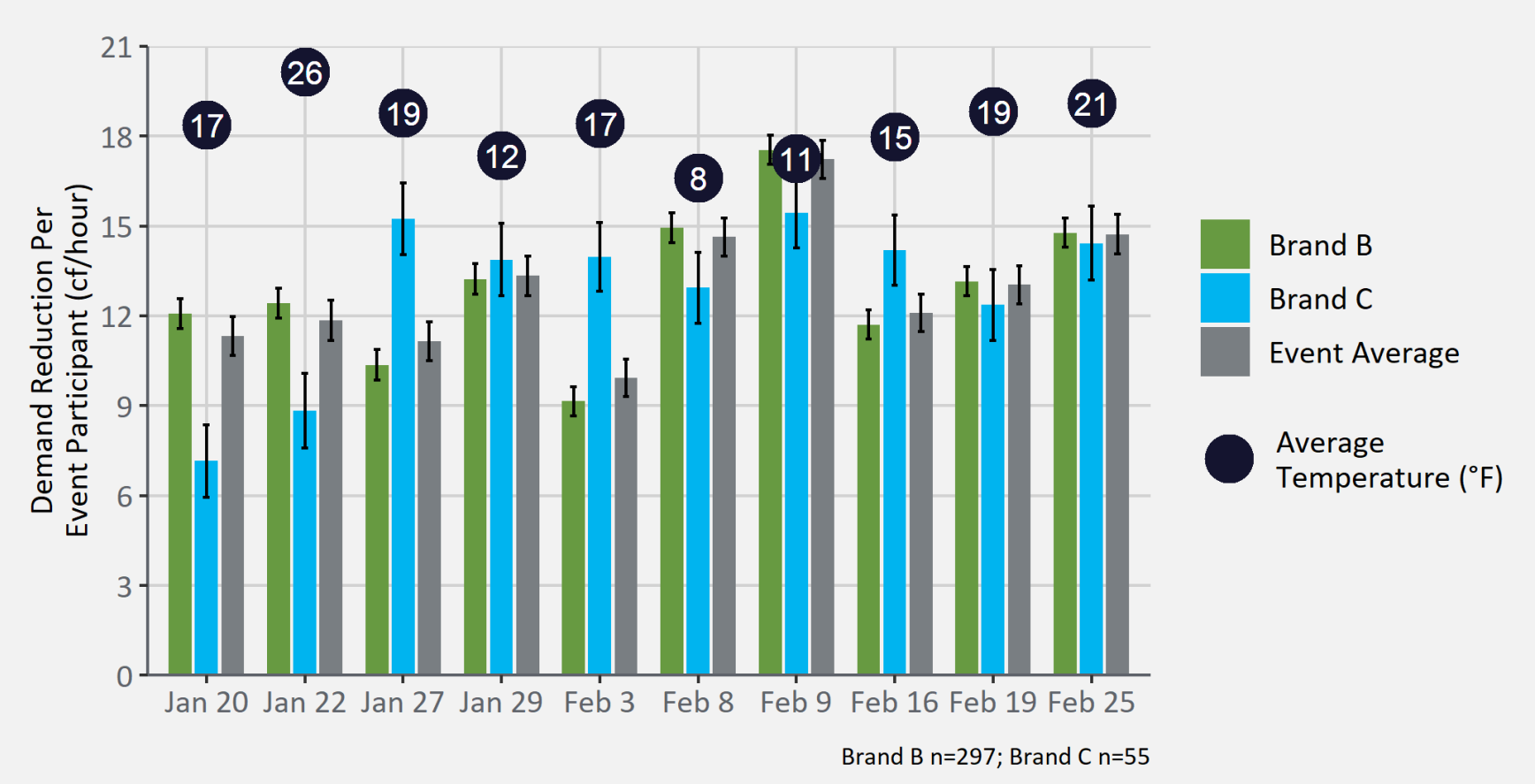
Event Results - Residential



Impacts were relatively consistent across events and conditions

No apparent loss of performance under cold conditions including February 2021 polar vortex events (8-11 degrees)

Event Results - SMB



Impacts were relatively consistent across events and conditions

No apparent loss of performance under cold conditions including February 2021 polar vortex events (8-11 degrees)

Conclusions

Impacts	• Gas DR can deliver significant reductions in customer gas demand during 4-hour targeted events • Reductions are offset by increases during pre/post-event hours
Methodology	• Limitations of daily interval gas meters can be overcome using thermostat telemetry to measure hourly program impacts
Big Picture	• Gas DR may deliver large benefits on constrained distribution nodes • Additional research is needed to determine whether thermostat gas DR can address capacity constraints and provide resilience and reliability benefits cost-effectively • Regional context is a key consideration

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Thank You / Q&A