Demand Response Baseline Enhancement 2021 Track Updates

November 16, 2021

Agenda

Time	Item	Speaker
2:00 - 2:15	Welcome & Introductions	ISO
2:15 - 2:30	Background	ISO
2:30 - 2:45	Process and criteria for load adjustment factors outside of min/max caps	Ohm Connect
2:45 - 3:50	Exploring use of a comparison/control group methodology	Recurve
3:50 - 4:00	Final Q&A	ISO

WELCOME & INTRODUCTIONS

BACKGROUND

Background

- Last summer, demand response providers (DRPs) expressed concerns that demand response performance was under-valued
  - Expressed issue affected energy/capacity compensation across ISO (energy compensation), CPUC (QC valuation) and Utilities (DRAM contract evaluation)
- Based on comparisons of historic to intra-day 2020 load on the system, and individual DRP load trends, there was evidence that some demand response performance values may have been limited by available baseline characteristics

In response, CAISO proposed baseline enhancement options to exam impacts highlighted

- Track 1 – Recurve comparison methodology study
- Track 2 – Approved use of load adjustment factors outside of the min/max caps for summer 2021

Background: Track 1 Update

- Study completed on the viability of accessing a control group by all DRPs and use of the Recurve comparison methods.
  - Recurve assessed their comparison group methods in relation to the FERC-approved control group methodology outlined in the CAISO tariff and **found it compliant**
  - Provided CAISO with improved methodology specifications that could be used to enhance control group methodology business practice
  - Demonstrated the use of differential privacy for use in establishing a comparison group
  - Produced a report studying the 2020 summer high heat events under a comparison group method for multiple demand response providers in multiple service territories
- Recurve was unable to directly contrast comparison method values against CAISO settlement of resource performance to dispatch

Background: Track 2 Update

- Four DRPs applied this summer to use alternate (uncapped) load cap adjustment factors (LCAs) between May and October
  - Current adjustment caps:
    - ✓ 10-in-10: 120% up; 80% down
    - ✓ 5-in-10: 140% up; 71% down
- Resources eligible to use alternative LCAs were both PDR and RDRR resources using day-matching baselines (10-in-10, 5-in-10, Day Matching Combined)
- Load trends suggested that historic load used in baselines could have exceeded intra-day load by more than adjustment caps in July, particularly July 9.
  - evidence that alternate LCAs could have helped
- Intra-day load trending higher than historic load was much less pronounced in July 2021 than in August 2021

LOAD ADJUSTMENT FACTORS OUTSIDE OF MIN/MAX CAPS

OhmConnect

Save Energy. Get Paid.

Operational Experience with CAISO's Waiver of the Same-Day Adjustment (SDA) Cap During Summer 2021

November 16 2021

Background on the SDA cap waiver for summer 2021

- After the heat events of summer 2020, OhmConnect and other DRPs informed CAISO that PDR performance (i.e. Demand Response Energy Measurement (DREM)) was frequently and significantly constrained by the 140% upper bound on SDA

- The SDA so often binding at the 140% cap in summer 2020 had several adverse consequences:
  - PDR performance appeared poorer than actually the case (e.g. CAISO Root Cause Analysis)
  - PDRs in CPUC DRAM pilot “underperformed” relative to RA contractual obligations
  - PDRs paid by CAISO market for less energy than actually delivered

- Earlier this year, CAISO approved a waiver that relaxed the upper (and lower) bounds on the SDA for the period May - October 2021
  - OhmConnect requested this waiver for its entire fleet of PDRs

OhmConnect SDA cap waiver metrics for summer 2020 vs 2021

	Summer 2020	Summer 2021
PDR-dispatch hours with calculated SDA > 140%	22%	5%
Change to PDR portfolio performance when SDA unconstrained vs. capped above at 140%*	+169%	+99%
PDR-dispatch hours with calculated SDA < 71%	2%	5%
Change to PDR portfolio performance when SDA unconstrained vs. capped below at 71%**	-57%	-59%

* For subset of May-Oct PDR-dispatch hours with calculated SDA > 140%

** For subset of May-Oct PDR-dispatch hours with calculated SDA < 71%

Takeaways

- Summer 2021 did not exhibit the same extreme heat events as summer 2020
  - Not surprising that, but for the waiver, the SDA cap applicable to OhmConnect's fleet of PDRs would have been binding at 140% less often in 2021 than was the case in 2020
- OhmConnect appreciates the flexibility afforded by the waiver
  - CAISO's waiver request and approval process was simple and well-managed
  - Unconstrained SDA calculations easy to implement on DRP/SC's side
- Recommend preserving the SDA cap waiver as an option for summer 2022 while CAISO Staff and stakeholders continue exploring baseline methodologies that account for effects of extreme weather on residential PDR performance

COMPARISON/CONTROL GROUP METHODOLOGY

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SHAPE THE FUTURE OF ENERGY

FLEXmeter Methods Review

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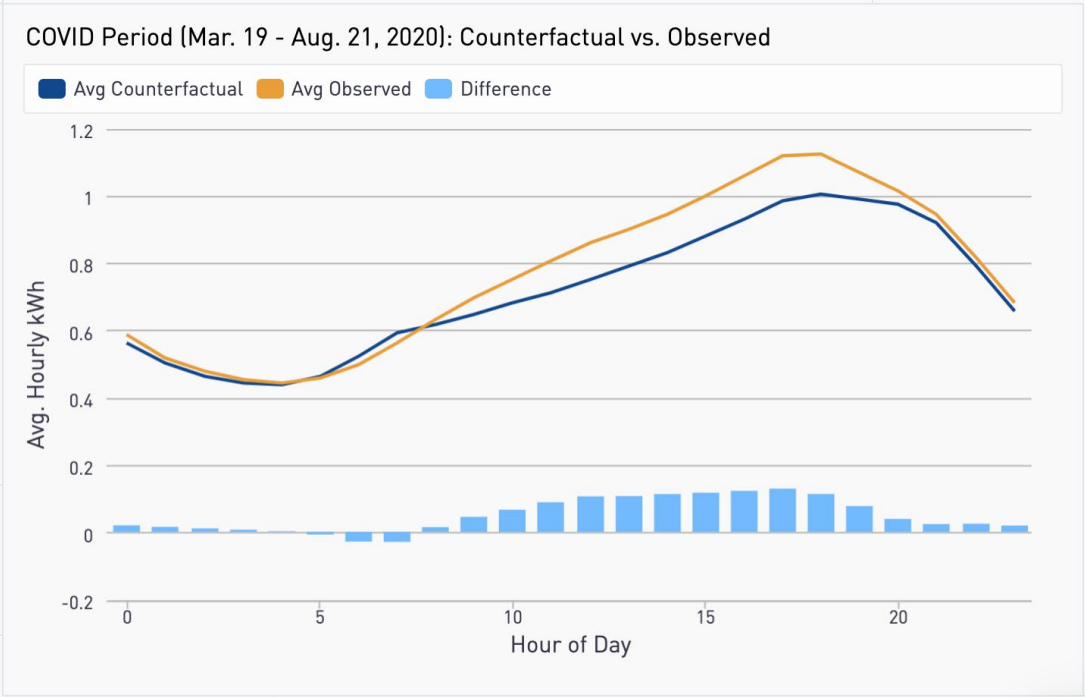
History

COVID-19 altered energy consumption in every area of society and the economy.

Crisis for EE program M&V

Hourly Comparison group method development was critical



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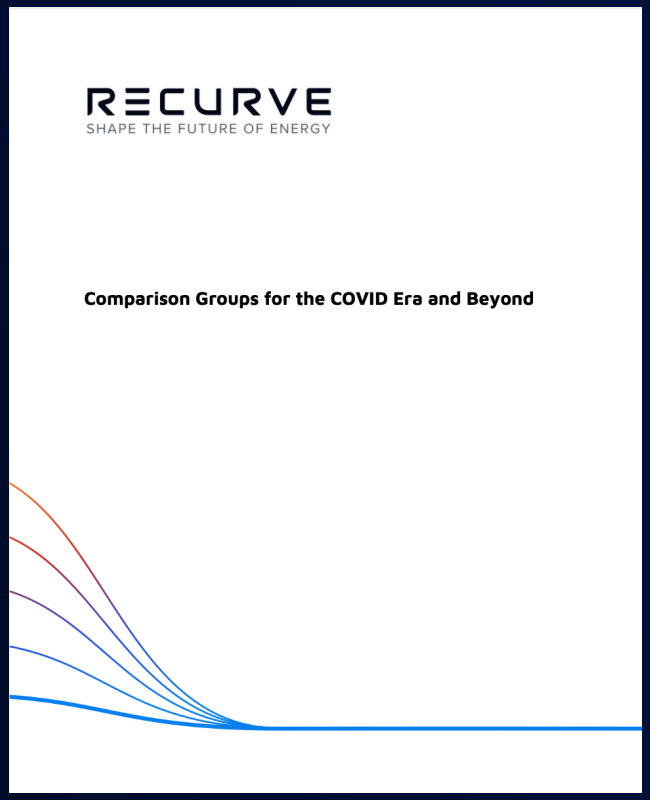
Recurve/DOE Partnership: *Comparison Groups For the COVID Era and Beyond*

Resulting Methods:

- **Random Sampling**
- **Advanced Stratified Sampling**
- **Site-based matching**



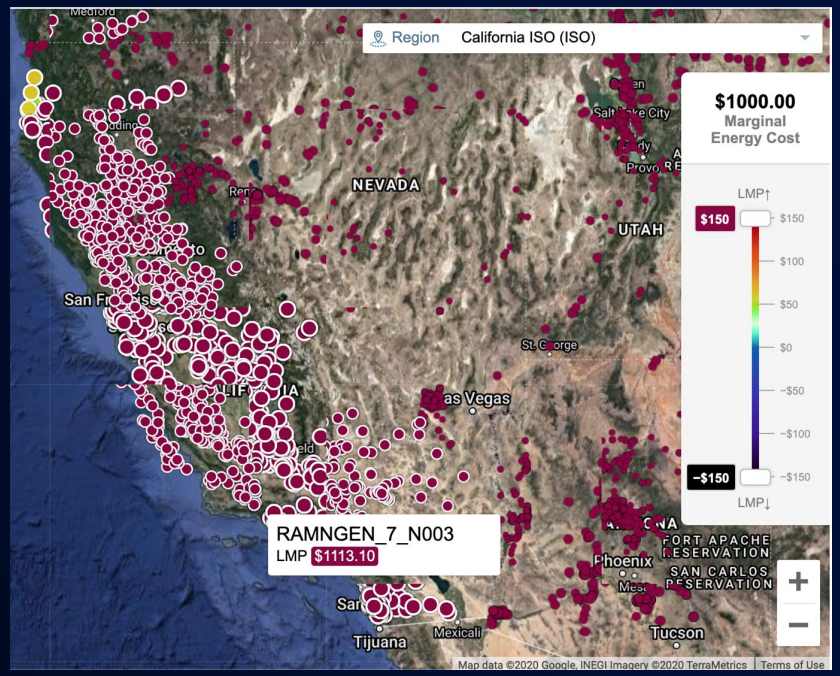
https://groups.recurve.com/methods.html

Test Case: August 14th 2020

- Emergency grid event
- > $1,000/MWh real time prices across the grid
- “All Hands on Deck” DR Events

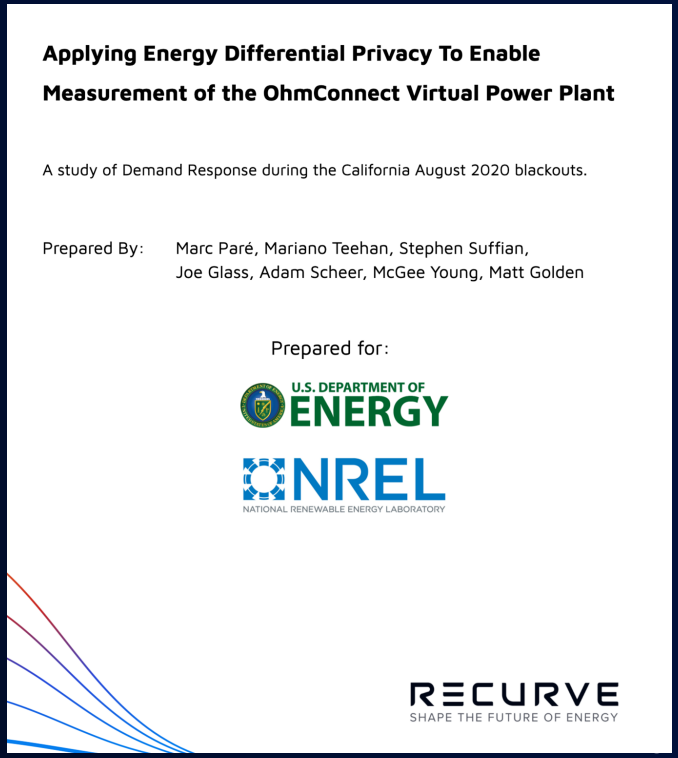
Status Quo DR methods failed to capture DR Event impacts

Aug 14, 7 pm: Demand Spikes



DR Study Origins: MCE / NREL / RECURVE Event Analysis

- Analysis of OhmConnect's response in MCE territory
- DR Event 5 - 8 PM
- Sample of 1,150 MCE Res participants
- Non-participant Comparison group
- GRIDmeter advanced stratified sampling/CalTRACK 2.0 Hourly methods



Applying Energy Differential Privacy To Enable Measurement of the OhmConnect Virtual Power Plant

A study of Demand Response during the California August 2020 blackouts.

Prepared By: Marc Paré, Mariano Teehan, Stephen Suffian, Joe Glass, Adam Scheer, McGee Young, Matt Golden

Prepared for:

U.S. DEPARTMENT OF ENERGY

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

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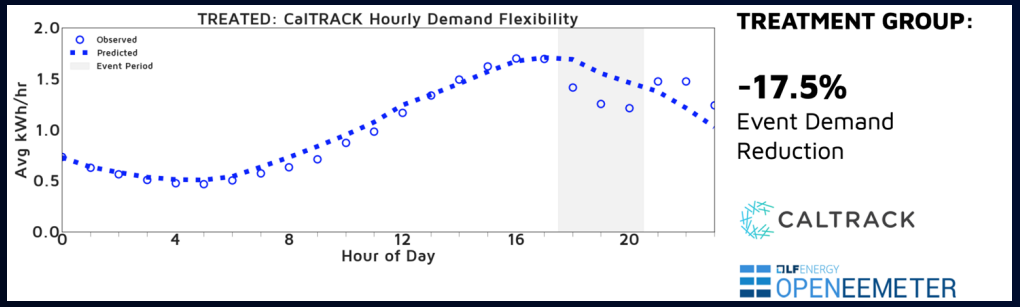
SHAPE THE FUTURE OF ENERGY

OhmConnect/MCE, Aug 14 2020

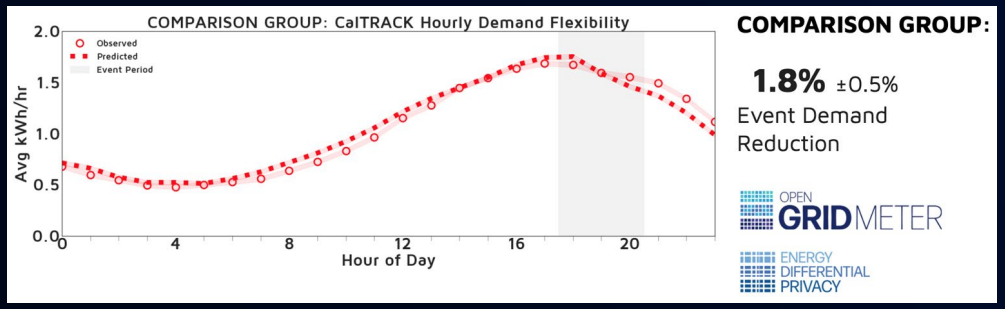


TREATMENT GROUP:

-17.5%
Event Demand Reduction

CALTRACK

LF ENERGY OPENEEMETER

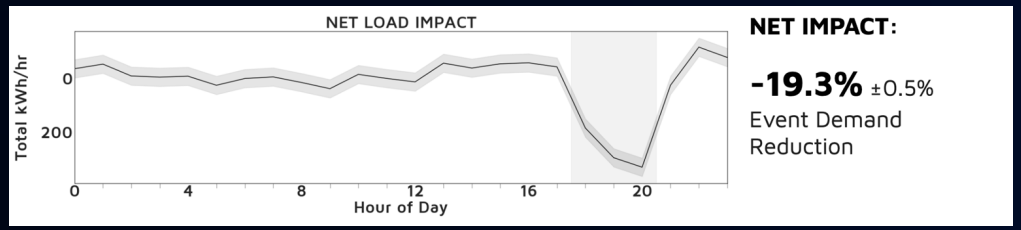


COMPARISON GROUP:

1.8% ±0.5%
Event Demand Reduction

OPEN GRIDMETER

ENERGY DIFFERENTIAL PRIVACY



NET IMPACT:

-19.3% ±0.5%
Event Demand Reduction

Δ Comparison (e.g., COVID Impacts)

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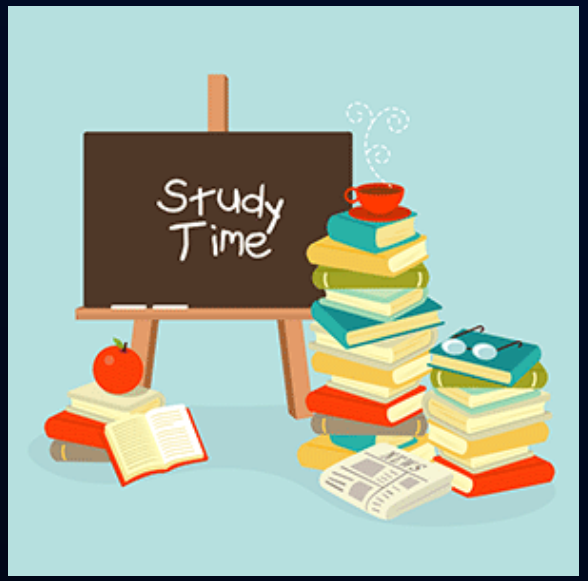
CAISO Key Objectives



1. ***Understand and operationalize the baseline and comparison group methods in relation to existing guidance and practice***

2. ***Understand barriers to data access and identify a viable path to overcome them***

3. ***Understand the 2020 heat storm events based on the baseline and comparison group methods implemented by Recurve to inform and support decision making***

4. ***Understand impacts of demand response events in 2021 and operationalize methods at scale.***

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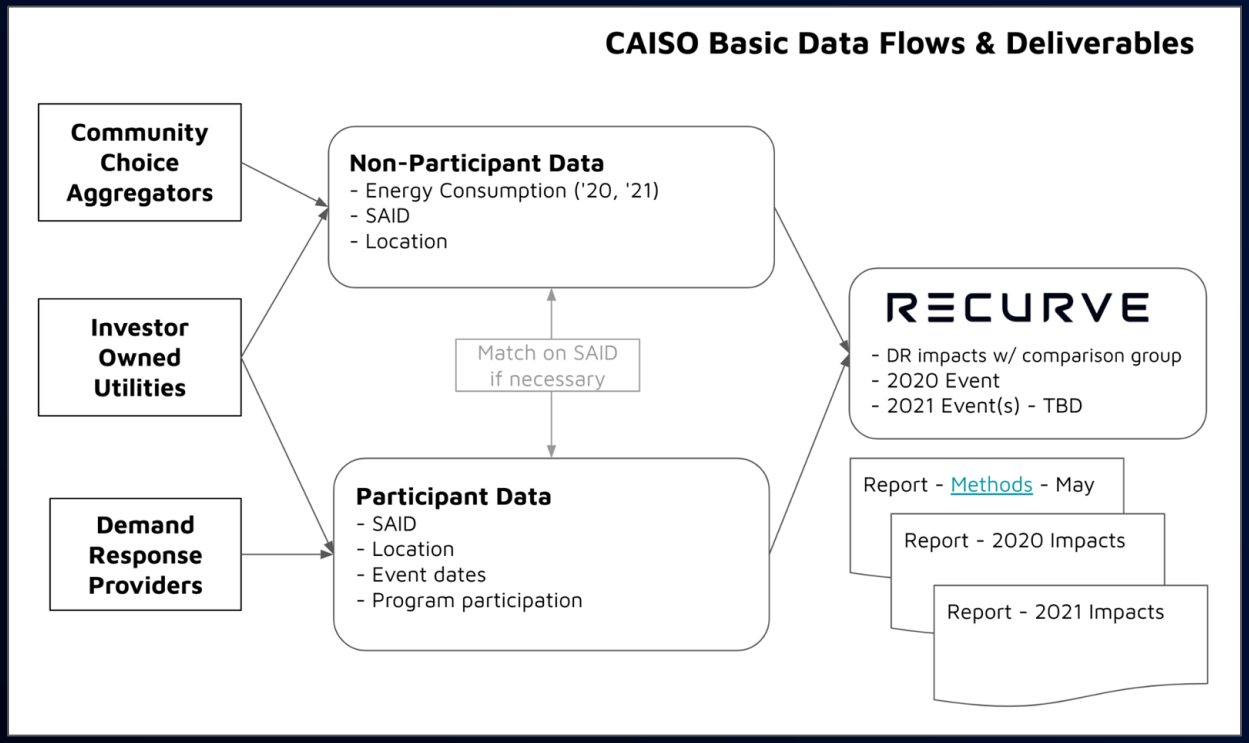
Data Makes the World Go ‘Round



Data Donors

6 DRPs

6+ LSEs

- Res and Non-Res
- 11 Distinct Climate Zones
- Solar and Non-Solar
- Variety of Programs

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FLEXmeter

Foundations

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Methods Overview

FLEXmeter Load Impacts Calculation:

1. Sample matched comparison group
2. Calculate treatment and comparison group hourly load impacts
3. *% Difference of Differences* adjustments
4. Differential privacy to protect non-participant data

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Open-Source, Standardized Methods

Advantages of Open Source

- Full transparency
- Consistency and Verifiability
- Concrete settlement
- Leverage community of experts
- Focus on program, not M&V

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How Do Comparison Groups Work Again?

The “Difference of Differences” Calculation

- **Step 1**: Measure change in consumption for program participants

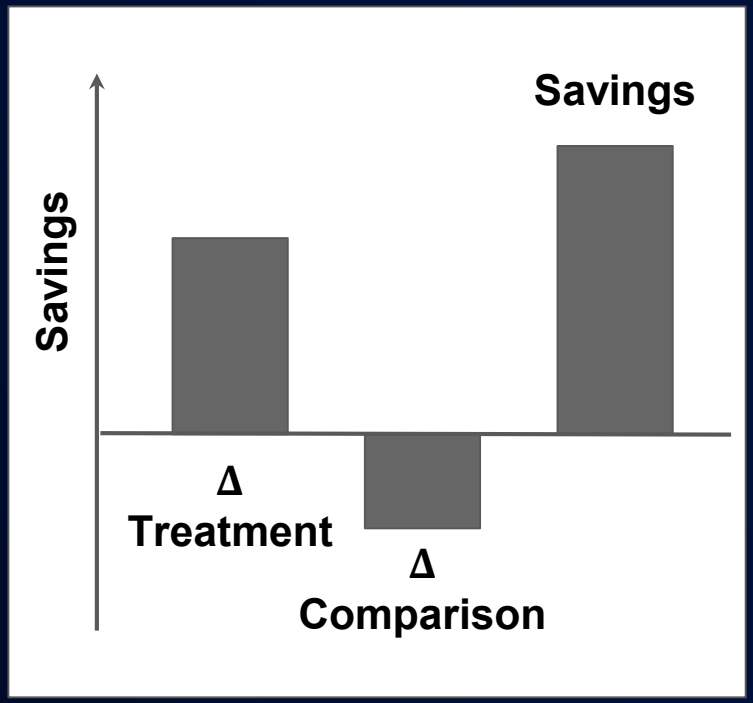
(“*Difference_Treatment*”)

- **Step 2**: Measure change in consumption for selected non-participants

(“*Difference_Comparison*”)

- **Step 3**: Calculate savings as:

Savings = Difference_Treatment - Difference_Comparison



FLEXmeter Comparison Group Selection:

Site Based Matching

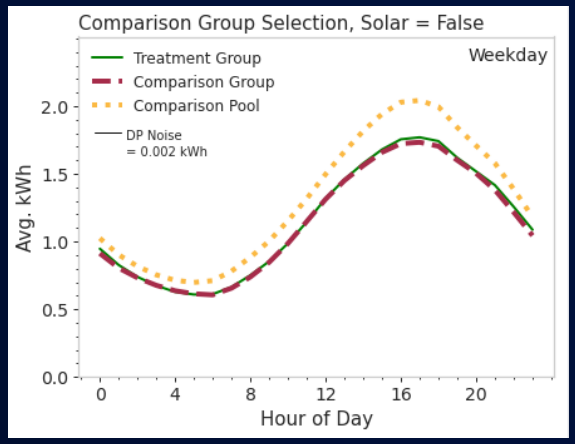
Treatment and comparison customers must share:

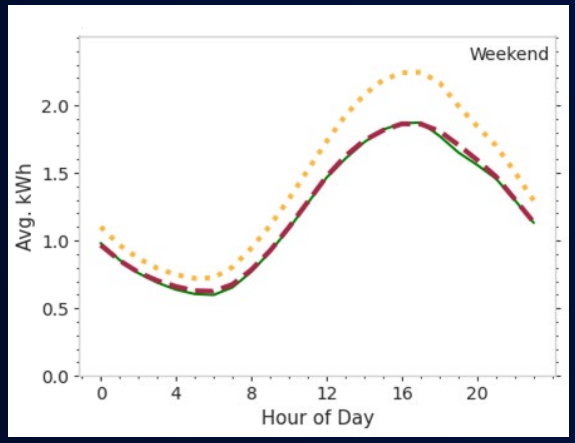
- Sector
- LSE Territory
- Climate Zone
- Solar Status

Basis for equivalence: Avg. weekly load shape

Each participant meter is matched to the most similar non-participant meters

Comparison group: the collection of non-participants that are best matches to individual participants

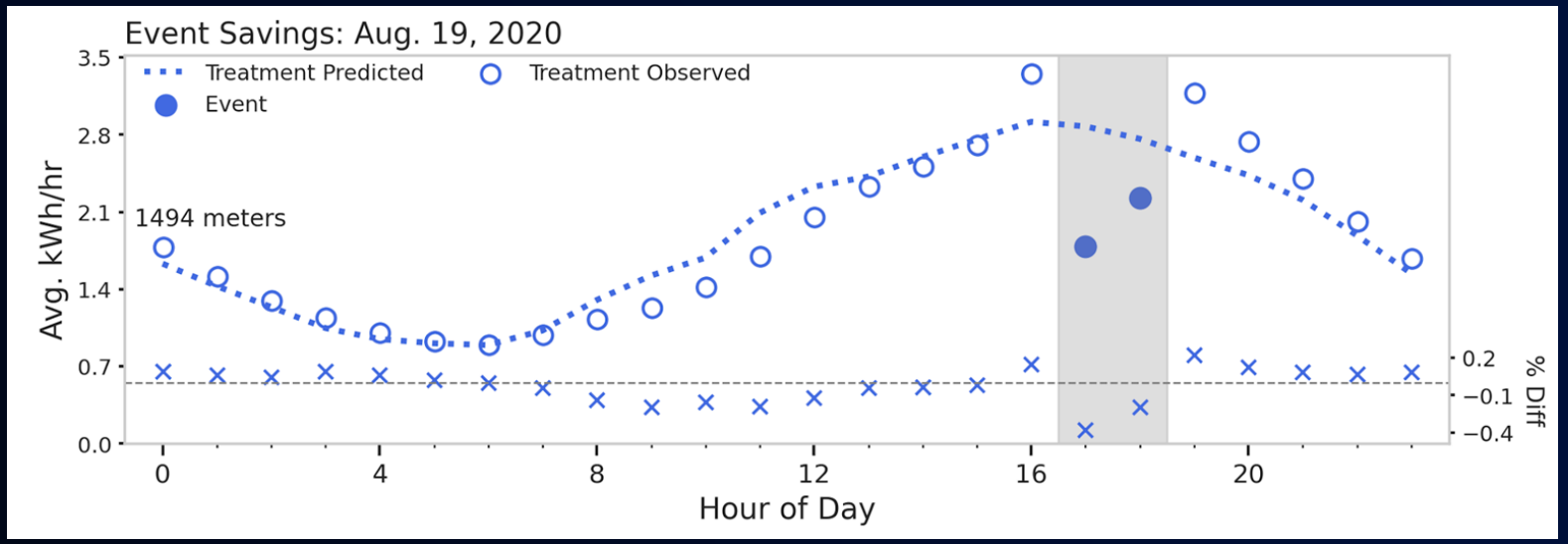




% Diff of Diff Example (DRP B, LSE 2, Aug. 19, 2020)

Step 1. Treatment % Diff

Event % Diff = -28.7%

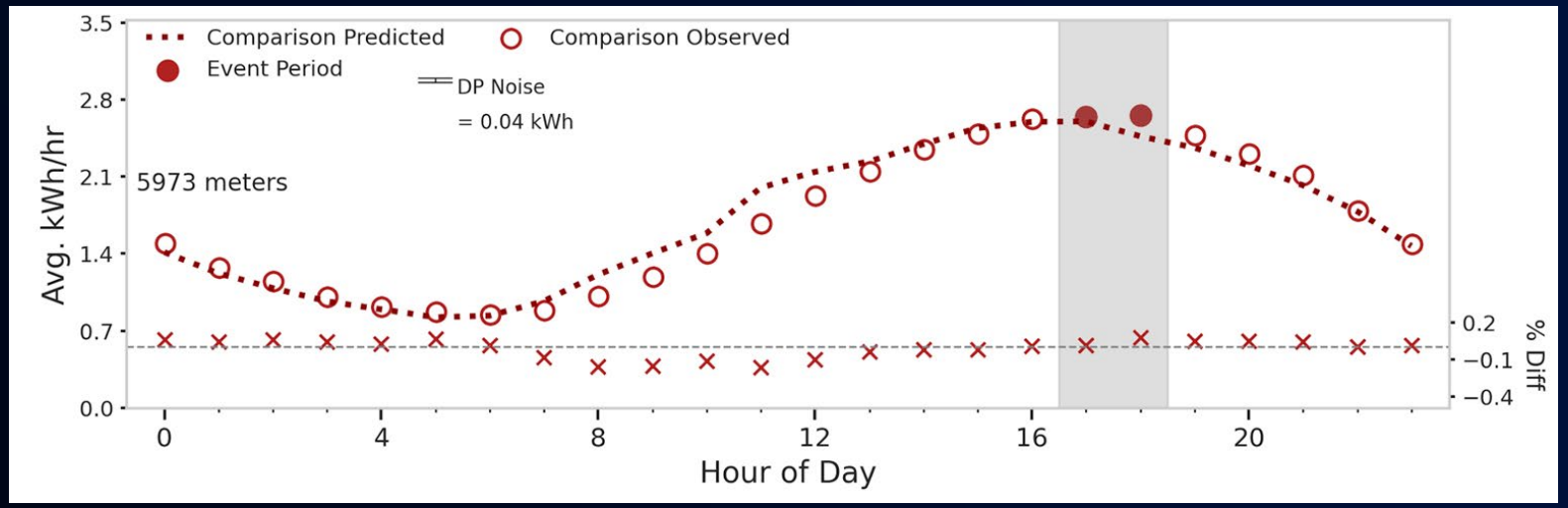


Treatment customers used 28.7% *less* than predicted during event.

% Diff of Diff Example

Step 2. Comparison % Diff

Event % Diff = 5.1%

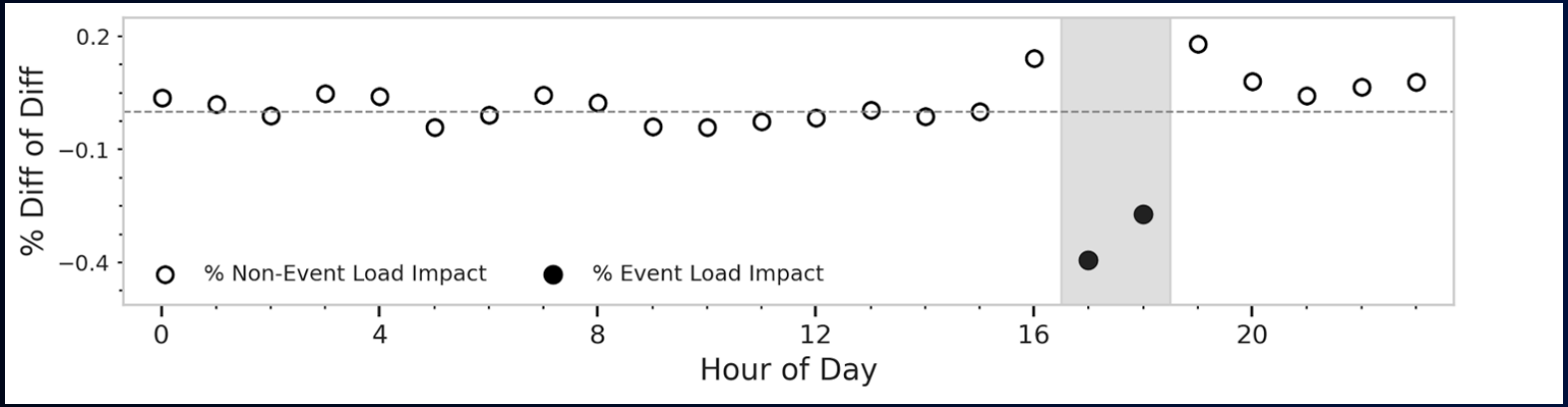


Comparison customers used 5.1% *more* than predicted during event.

% Diff of Diff Example

Step 3. % Diff of Diff

Event % Diff of Diff = -33.8%



Taking the comparison group into account the demand response event had a -28.7% - 5.1% = -33.8% event period load impact.

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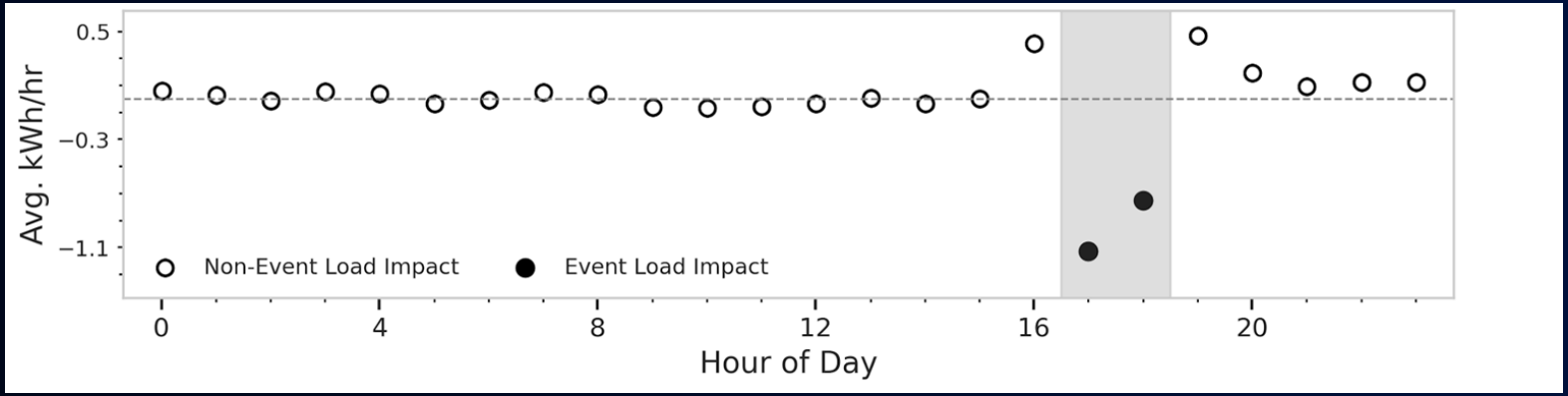
% Diff of Diff Example

Step 4. Total Savings

Avg. Event Load Impact = -0.94 kW



Scaling the % Diff of Diff to predicted participant consumption yields average customer event load impacts of -0.94 kW.

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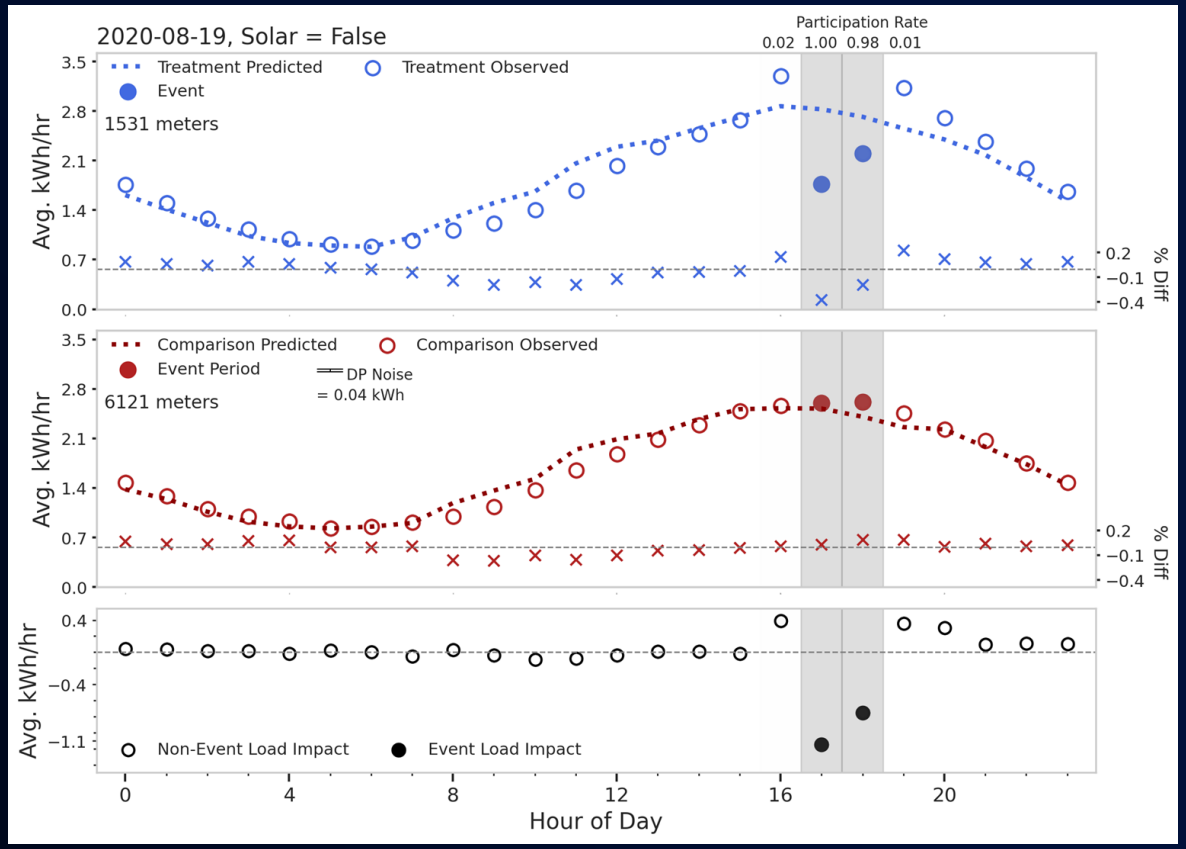
Bringing it All Together



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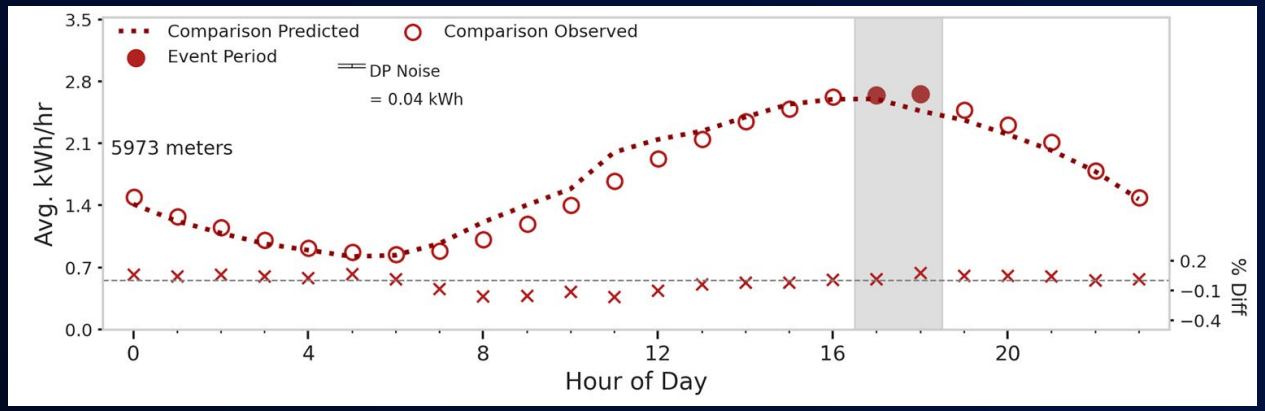
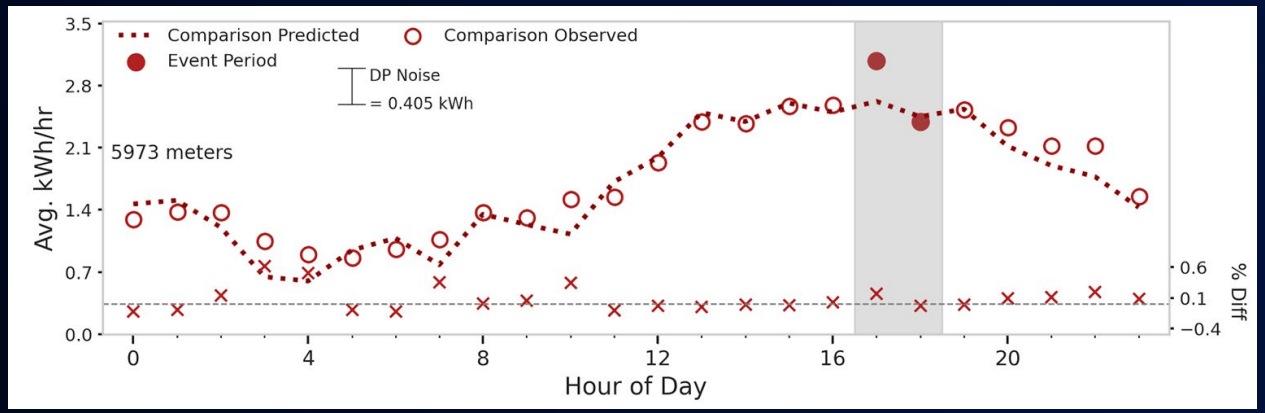
Differential Privacy

- Calibrated noise addition
- Masks the presence of individuals in datasets
- Much stronger protection than traditional aggregation methods





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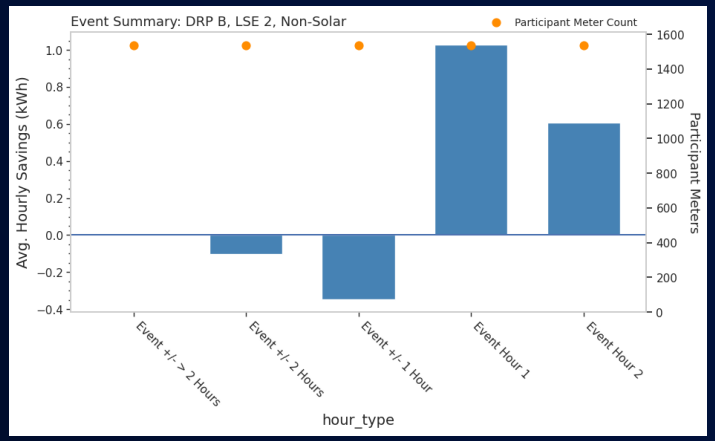
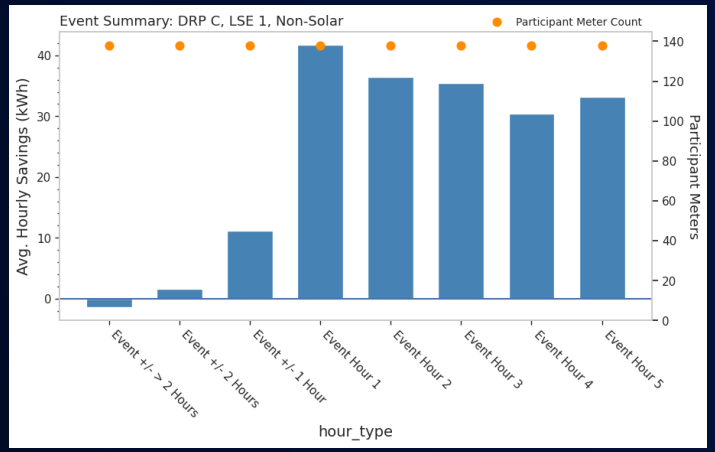
Event Day: Comprehensive Results

FLEXmeter enables measurement of load impacts <u>all hours of the day</u>.

- Total savings determined (both event and non-event)
- Can directly monitor “takeback”

DRP	Sector	Total Event Savings (MWh)	Total Non-Event Savings (MWh)	Total Savings (MWh)
A	Res	20.4	-21.3	-0.9
B	Res	17.4	-5.9	11.5
D	Res	114.5	-23.3	91.2
C	Non-Res	85	2.0	87
D	Non-Res	116.4	-87.2	29.2





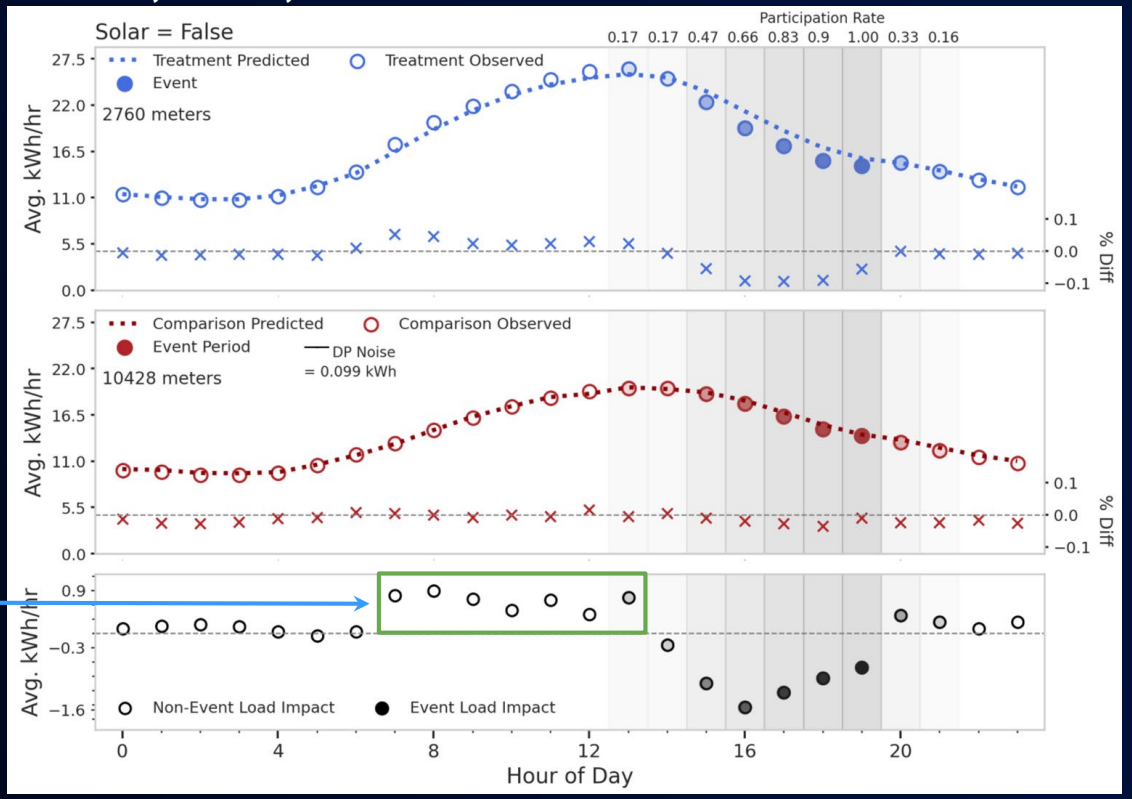
Takeback and 10 of 10 Baselines with SDA

For most (but not all) programs Recurve observes takeback.

Takeback can bias baselines with Same Day Adjustments

Strong takeback during non-event hours

DRP D, LSE 1, Non-Res



Summary Results

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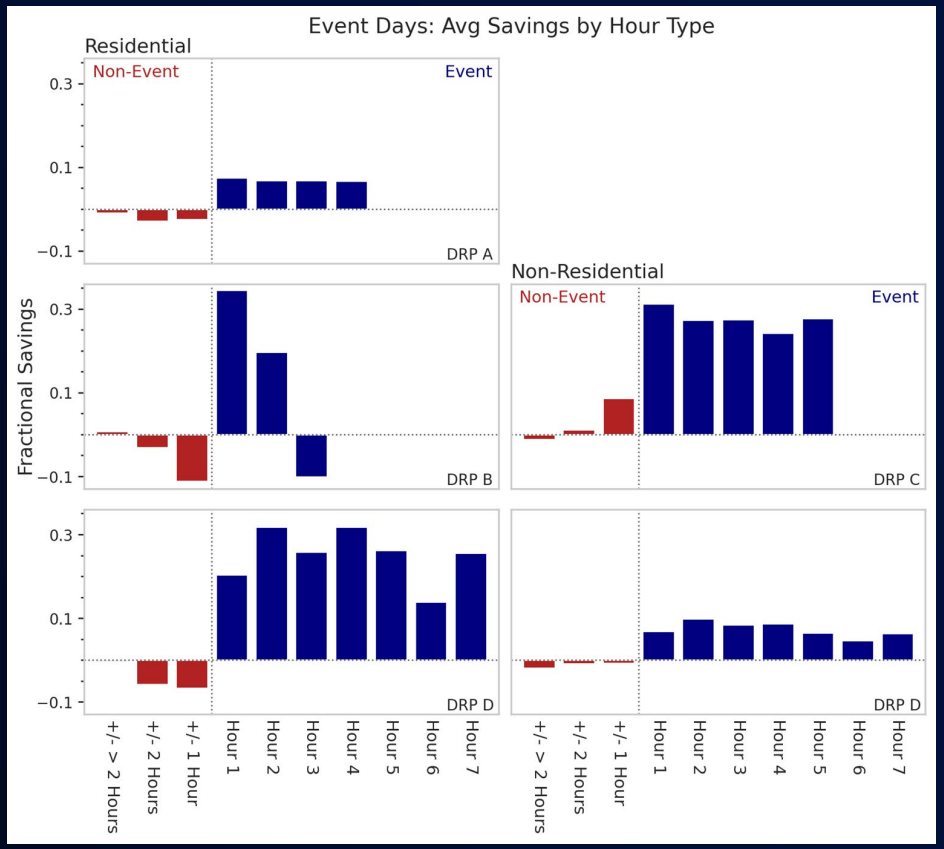
FLEXmeter Summary Results

DRP	Sector	Events Measured	Unique Participants	Avg. Event Hours	Avg. kW Savings	% Savings
A	Res	14	13,793	3.6	0.14	6.9%
B	Res	7	2,773	2.1	0.78	26.8%
D	Res	6	5,073	7.0	0.78	26.1%
C	Non-Res	5	138	5.0	36	27%
D	Non-Res	6	2,759	7.0	1.51	7.9%

Wide variety of programs, territories and results, and...

Apples to apples comparisons across the board



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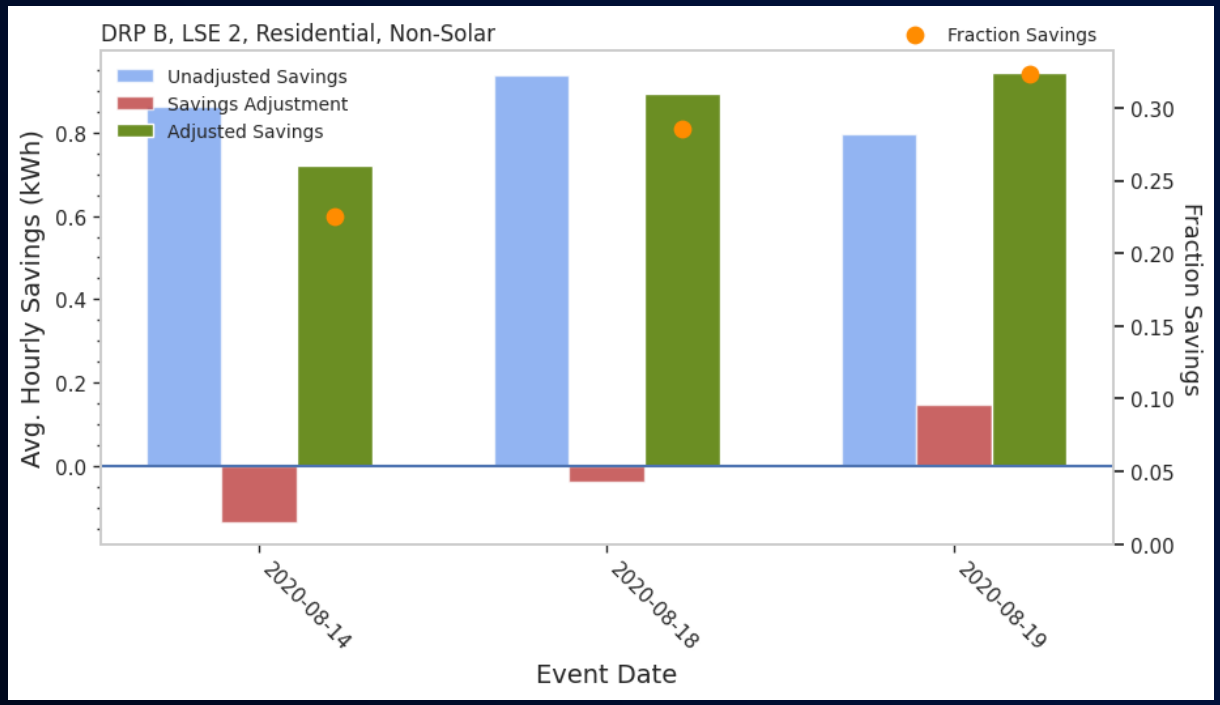
FLEXmeter Summary Results Example for DRP B LSE 2

Analogous results available for all DRP/LSE combinations studied.



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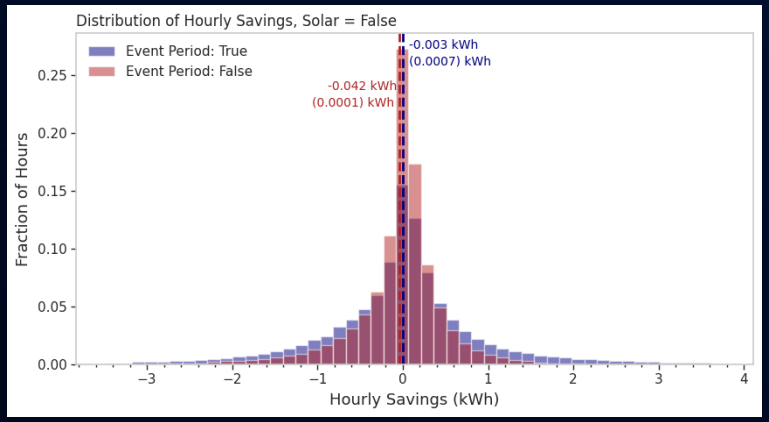
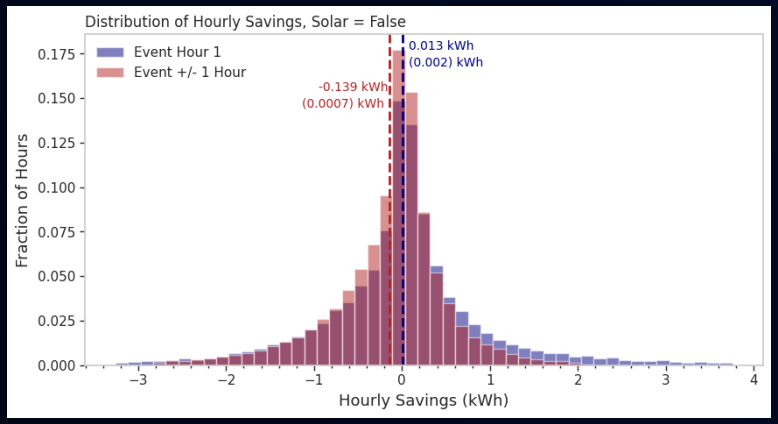
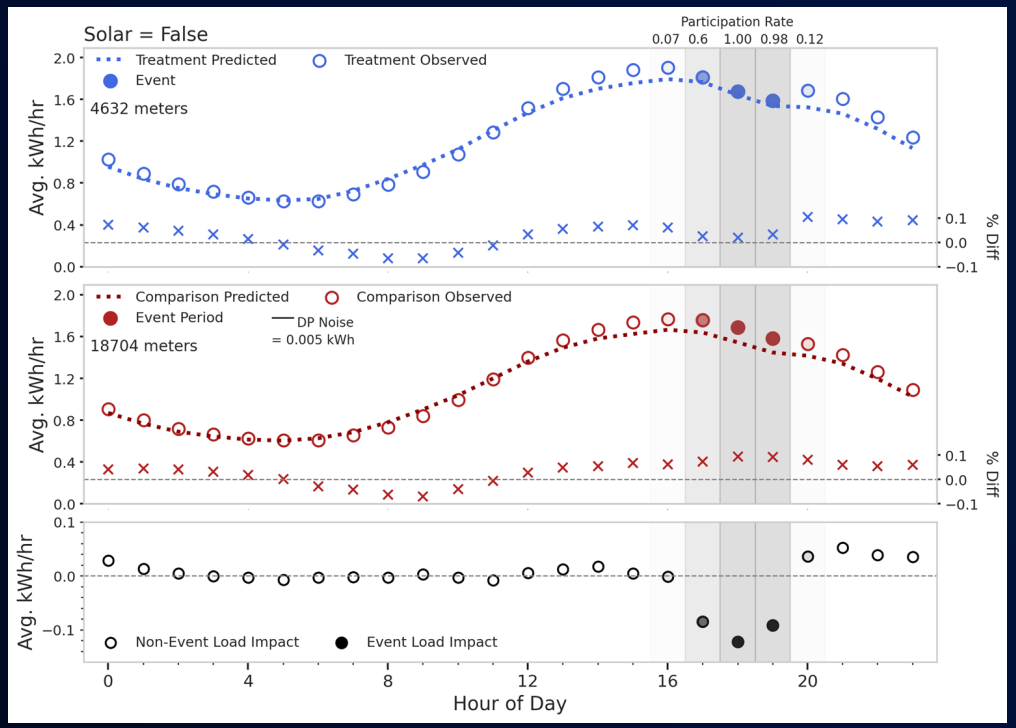
Importance of Comparison Groups: DRP A LSE 3







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Methods Appendix

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Diff-of-Diff: A (Slightly) Deeper Dive

The “Difference of Differences” Calculation

- **Step 1**: Create baseline period model for treatment group and project that model as a counterfactual into the reporting period (*Counterfactual_Treatment*)
- **Step 2**: Create baseline period model for comparison group and project forward as a counterfactual (*Counterfactual_Comparison*)
- **Step 3**: Calculate savings via % Diff of Diff computation as:

Savings = *Counterfactual_Treatment* x

[(Counterfactual_Treatment - Observed_Treatment) / Counterfactual_Treatment

- (*Counterfactual_Comparison - Observed_Comparison*) / *Counterfactual_Comparison]*

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A Note on Difference of Differences Adjustment

Recommendation:

The Difference of Differences adjustment should be made on a percentage basis.

Why?

To neutralize error on account of imperfect matching/differences in magnitude of consumption

	Treatment Group	Comparison Group
Avg. Annual MWh Baseline	100	150
Avg. Annual MWh Reporting	90	138
Difference	10	12
Savings	**-2**	
% Difference	10%	8%
Savings	**2**	

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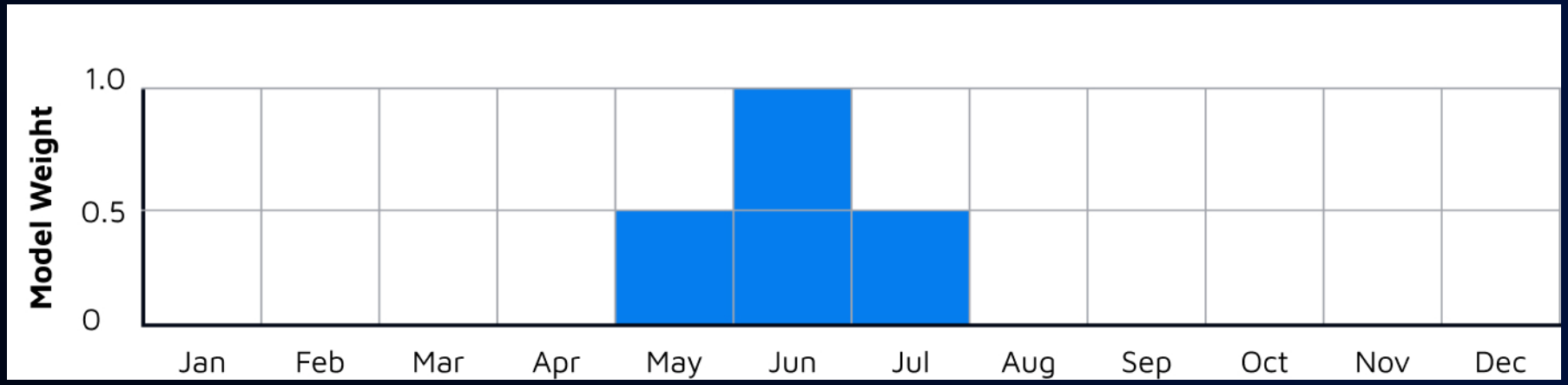
How do Hourly CalTRACK Methods work?

1) Pick your reporting period month



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How do Hourly Methods work?

1) Pick your reporting period month
2) Select your hour of the week

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
1	25	49	73	97	121	145
2	26	50	74	98	122	146
3	27	51	75	99	123	147
4	28	52	76	100	124	148
5	29	53	77	101	125	149
6	30	54	78	102	126	150
7	31	55	79	103	127	151
8	32	56	80	104	128	152
9	33	57	81	105	129	153
10	34	58	82	106	130	154
11	35	59	83	107	131	155
12	36	60	84	108	132	156
13	37	61	85	109	133	157
14	38	62	**86**	110	134	158
15	39	63	87	111	135	159
16	40	64	88	112	136	160
17	41	65	89	113	137	161
18	42	66	90	114	138	162
19	43	67	91	115	139	163
20	44	68	92	116	140	164
21	45	69	93	117	141	165
22	46	70	94	118	142	166
23	47	71	95	119	143	167
24	48	72	96	120	144	168

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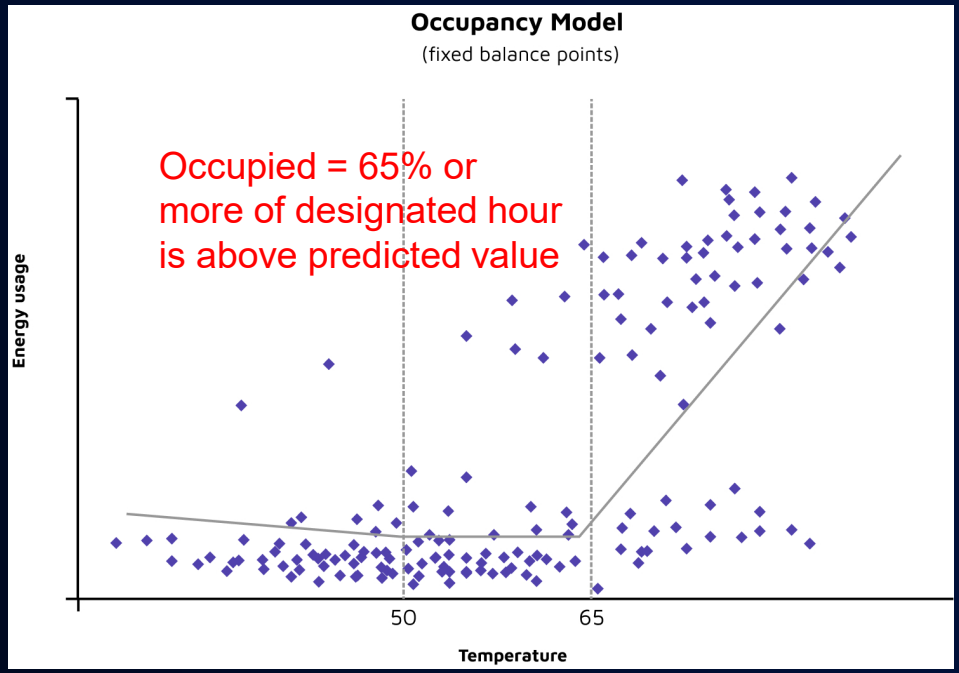
How do Hourly Methods work?

1) Pick your reporting period month
2) Select your hour of the week
3) Figure out “occupancy”



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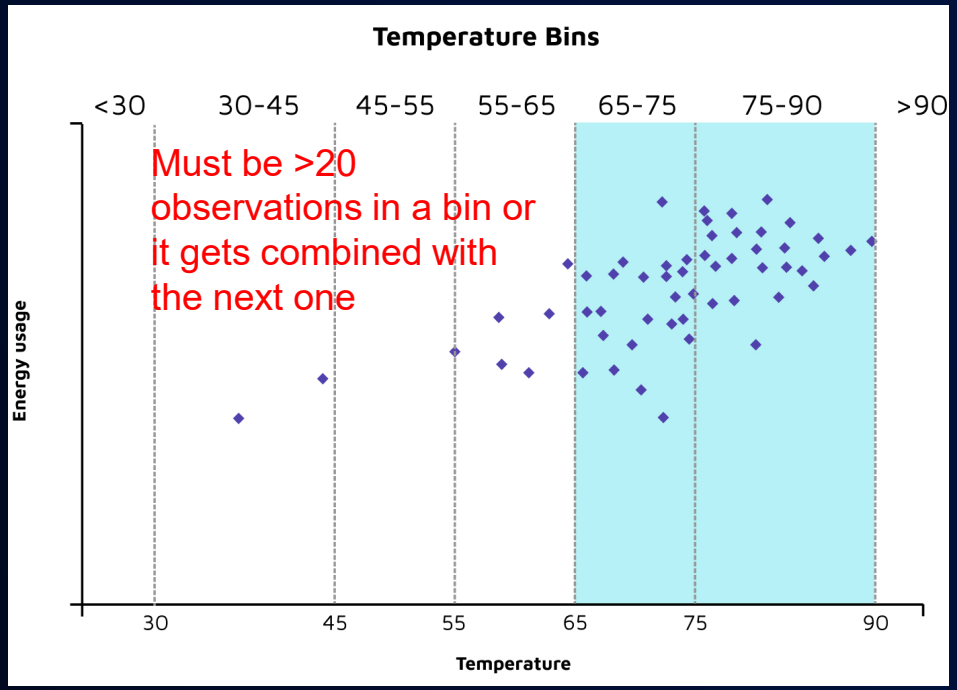
How do Hourly CalTRACK Methods work?

1) Pick your reporting period month
2) Select your hour of the week
3) Figure out “occupancy”
4) Create temperature bins



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How do Hourly CalTRACK Methods work?

1) Pick your reporting period month
2) Select your hour of the week
3) Figure out “occupancy”
4) Create temperature bins
5) Convert to a temperature matrix

Bin:	<30	30-45	45-55	55-65	65-75	75-90	>90
T_p	$T_{1,p}$	$T_{2,p}$	$T_{3,p}$	$T_{4,p}$	$T_{5,p}$	$T_{6,p}$	$T_{7,p}$
20	20	0	0	0	0	0	0
40	30	10	0	0	0	0	0
50	30	15	5	0	0	0	0
60	30	15	10	5	0	0	0
70	30	15	10	10	5	0	0
80	30	15	10	10	10	5	0
100	30	15	10	10	10	15	10

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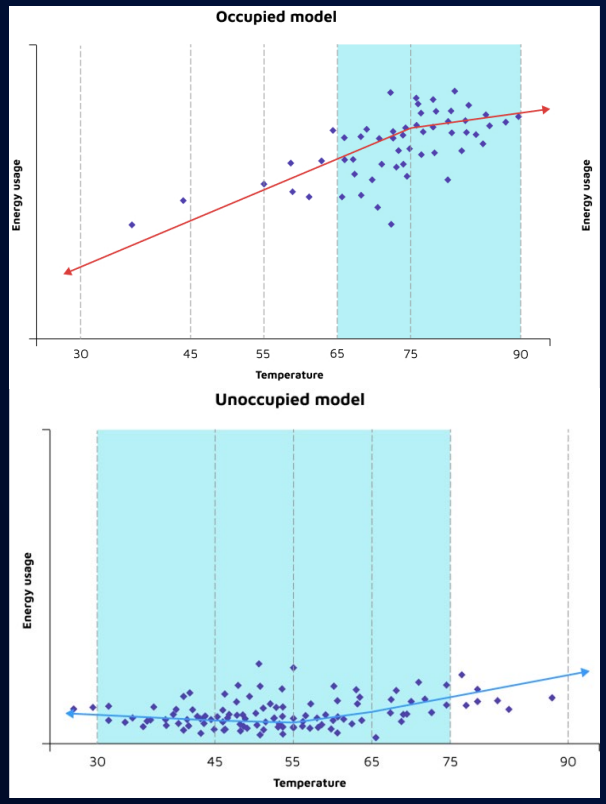
How do Hourly CalTRACK Methods work?

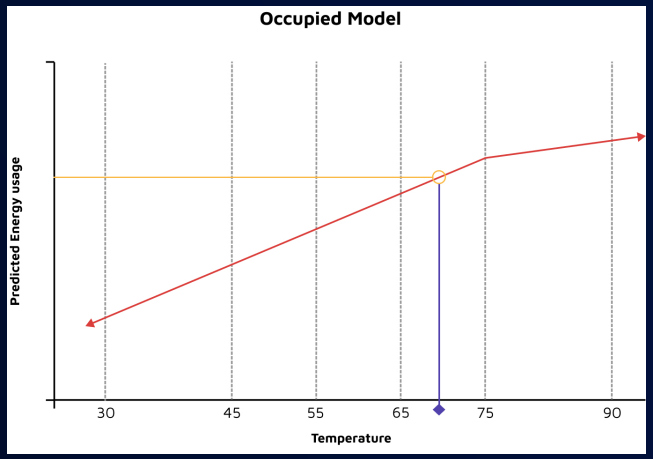
1) Pick your reporting period month
2) Select your hour of the week
3) Figure out “occupancy”
4) Create temperature bins
5) Convert to a temperature matrix
6) Fit a WLS regression model to each occupancy state



RECURVE

How do Hourly CalTRACK Methods work?

1) Pick your reporting period month
2) Select your hour of the week
3) Figure out “occupancy”
4) Create temperature bins
5) Convert to a temperature matrix
6) Fit a WLS regression model to each occupancy state
7) Calculate counterfactual for each hour of the month/year
    a) Effects of occupancy + effects of time of week + effects of temperature = predicted consumption



RECURVE

FINAL Q&A

Final Q&A

- Stakeholder written comments on today's discussion are encouraged, and may be sent to isostakeholderaffairs@caiso.com