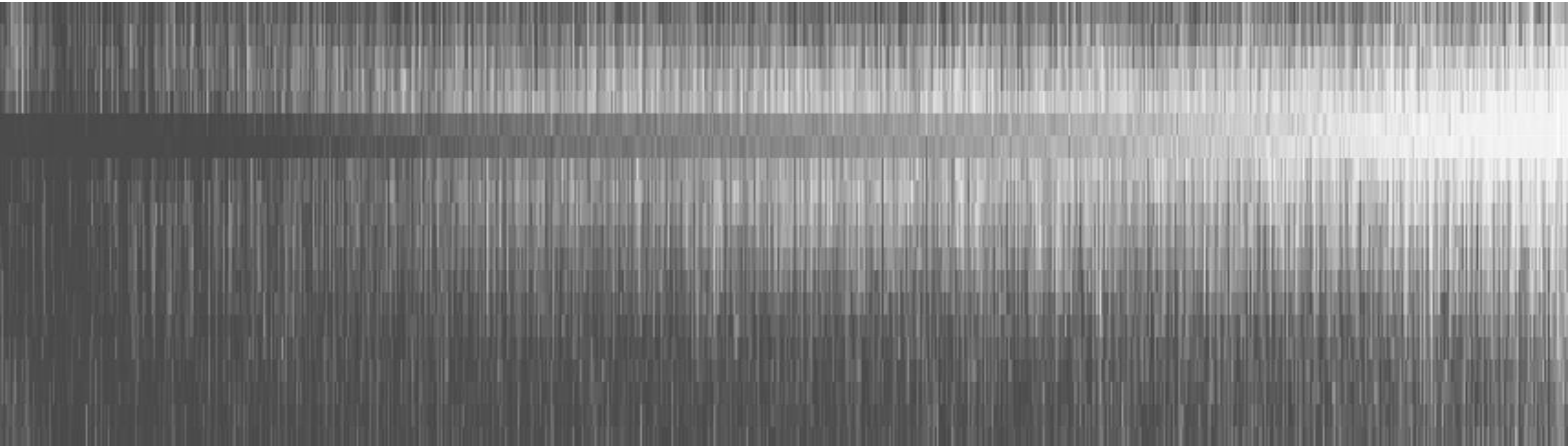
2017 Load Impact Evaluation for Pacific Gas & Electric Company's SmartAC™ Program



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DRMEC workshop
5/4/2018

Program description

- 117,600 customers with direct load control devices that turn off (switches) or curtail (thermostats) Air Conditioning loads when actuated via broadcast control communication
- Active May through October
- “Serial events” called across full territory based on last digit of device serial numbers. This provides randomized controls for event impact evaluation.
- “Sub-LAP events” all customers called within a given sub-LAP area.

2017 serial event schedule

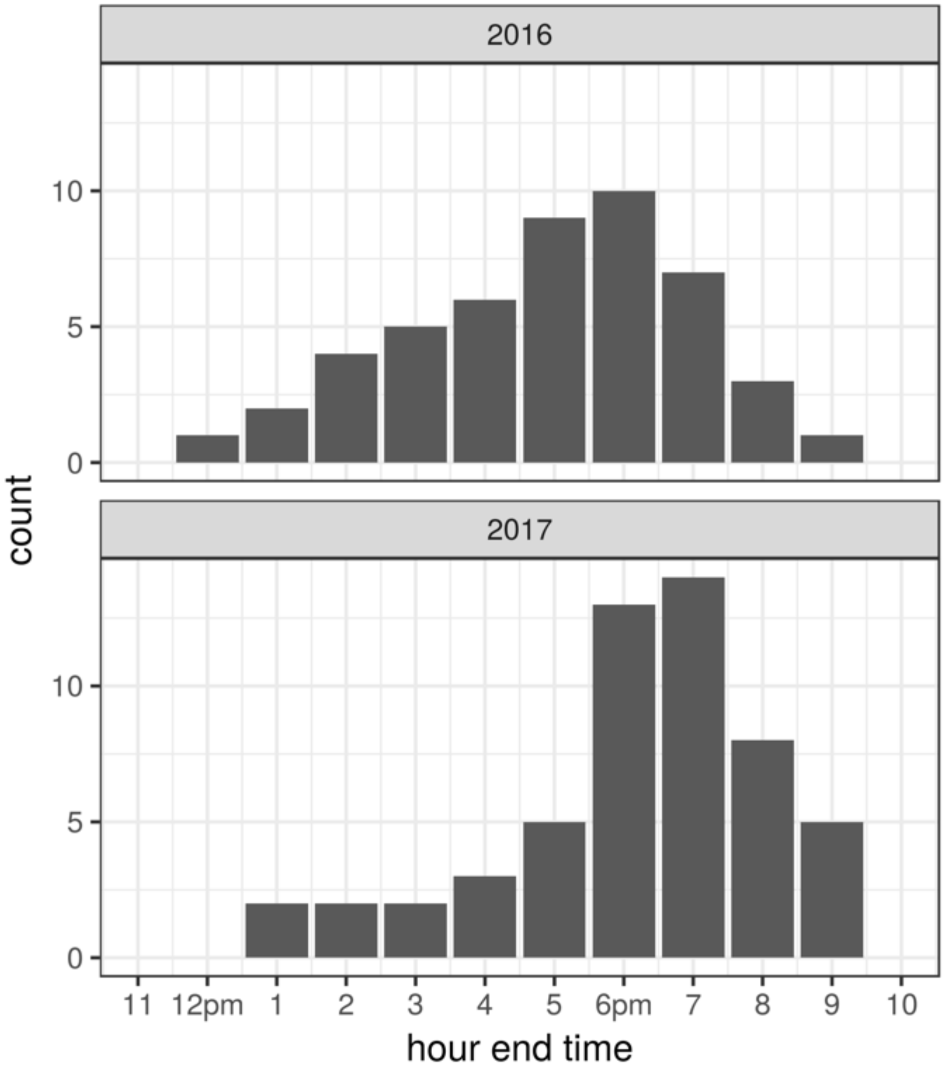
Event type	Date	Smart day?	Group(s) called	Start	End
emergency	5/3/2017	no	0, 1, 2, 3, 4, 5, 6, 7, 8, 9	7 PM	10 PM
serial group	6/19/2017	yes	4, 9	5 PM	7 PM
			7	5 PM	8 PM
			8	6 PM	7 PM
			0	8 PM	9 PM
	6/22/2017	yes	8	6 PM	7 PM
			4	7 PM	8 PM
	7/7/2017	yes	5, 7	4 PM	7 PM
			6, 8	5 PM	6 PM
			4, 9	5 PM	7 PM
			0	7 PM	8 PM
	7/15/2017	no	1	12 PM	3 PM
			0	3 PM	6 PM
			3	6 PM	9 PM

Event type	Date	Smart day?	Group(s) called	Start	End
serial group	7/27/2017	yes	5, 7	3 PM	6 PM
			6, 8	5 PM	6 PM
			4, 9	5 PM	7 PM
	8/1/2017	yes	8	6 PM	7 PM
			1, 4	7 PM	8 PM
			3	8 PM	10 PM
	8/2/2017	yes	4	4 PM	5 PM
			8	5 PM	6 PM
	8/27/2017	no	0	12 PM	3 PM
			3	3 PM	6 PM
			1	6 PM	9 PM
	8/28/2017	yes	4, 9	5 PM	7 PM
			5, 7	5 PM	8 PM
			6, 8	6 PM	7 PM
			1	8 PM	9 PM
	8/31/2017	yes	8	6 PM	7 PM
			4	7 PM	8 PM

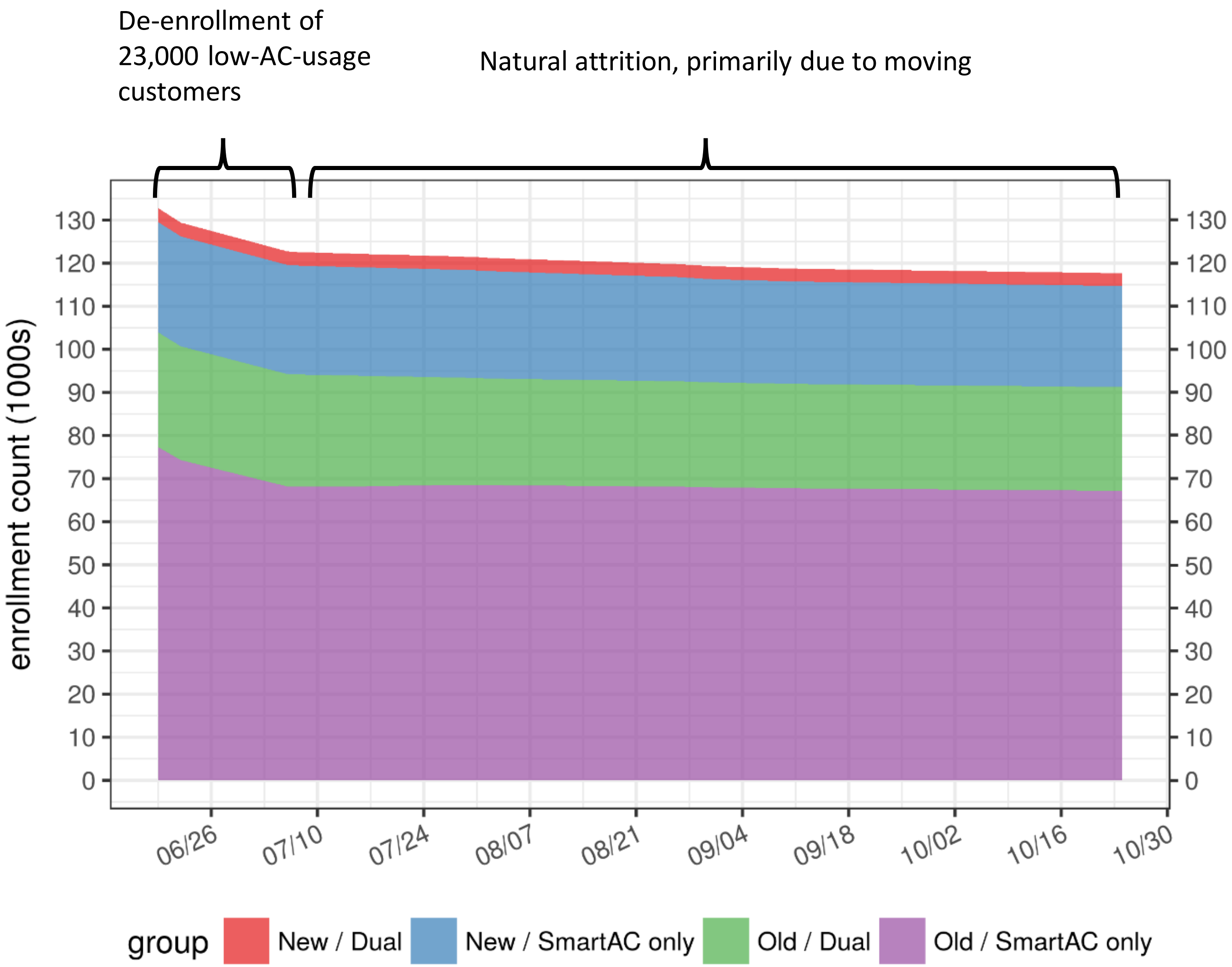
Sub-LAP event schedule

Event type	Date	Smart day?	Group(s) called	Start	End
sub-LAP	7/6/2017	yes	PGF1, PGNP, PGZP	4 PM	7 PM
	7/28/2017	no	PGF1, PGKN, PGNP, PGZP	4 PM	7 PM
	7/31/2017	yes	PGKN, PGNC, PGSI	4 PM	7 PM
	9/11/2017	no	PGP2, PGSB	4 PM	7 PM
	10/24/2017	no	PGP2, PGSB	4 PM	7 PM

2017 Event timing: later in the day



2017 Enrollment changes



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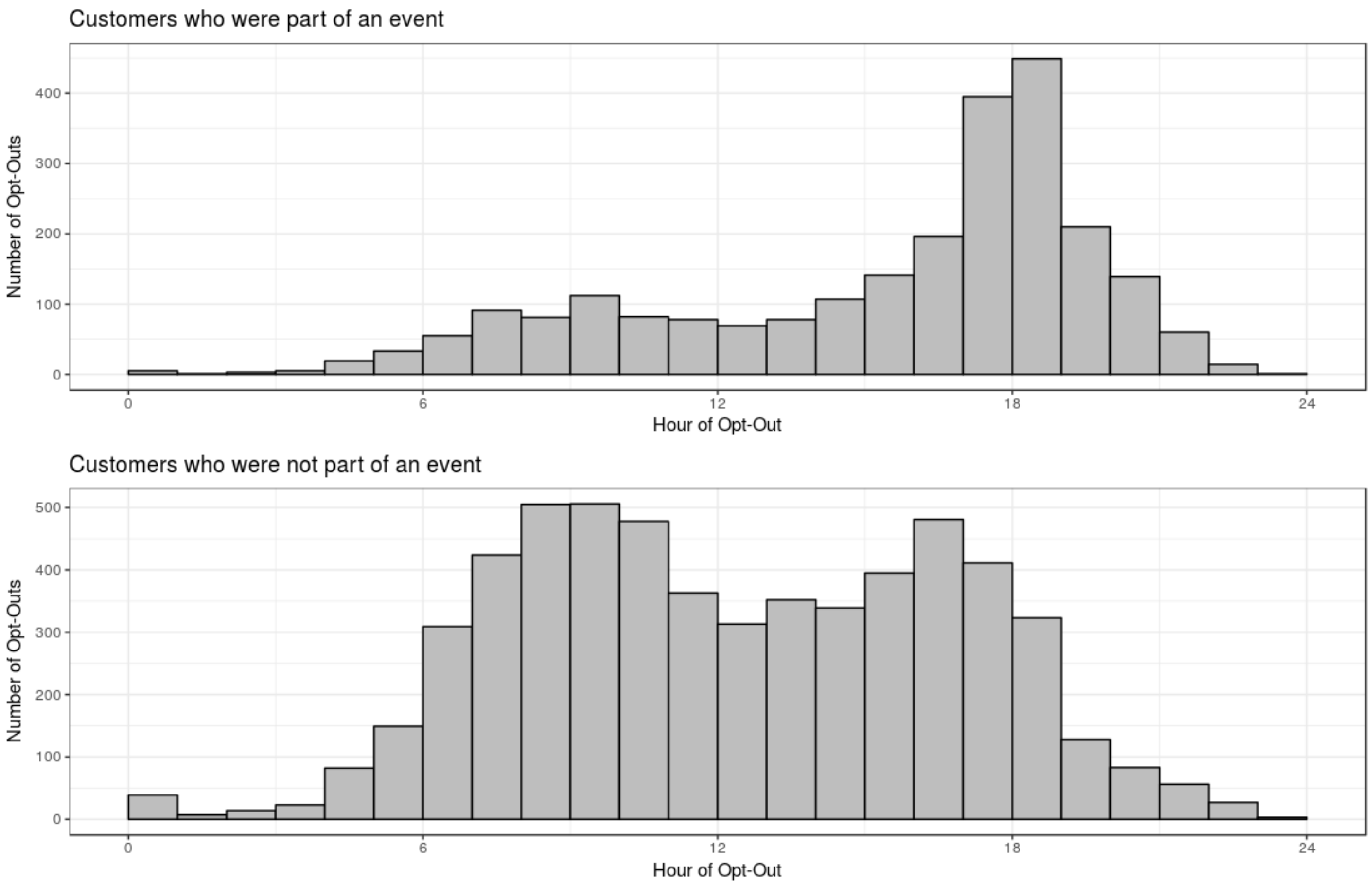
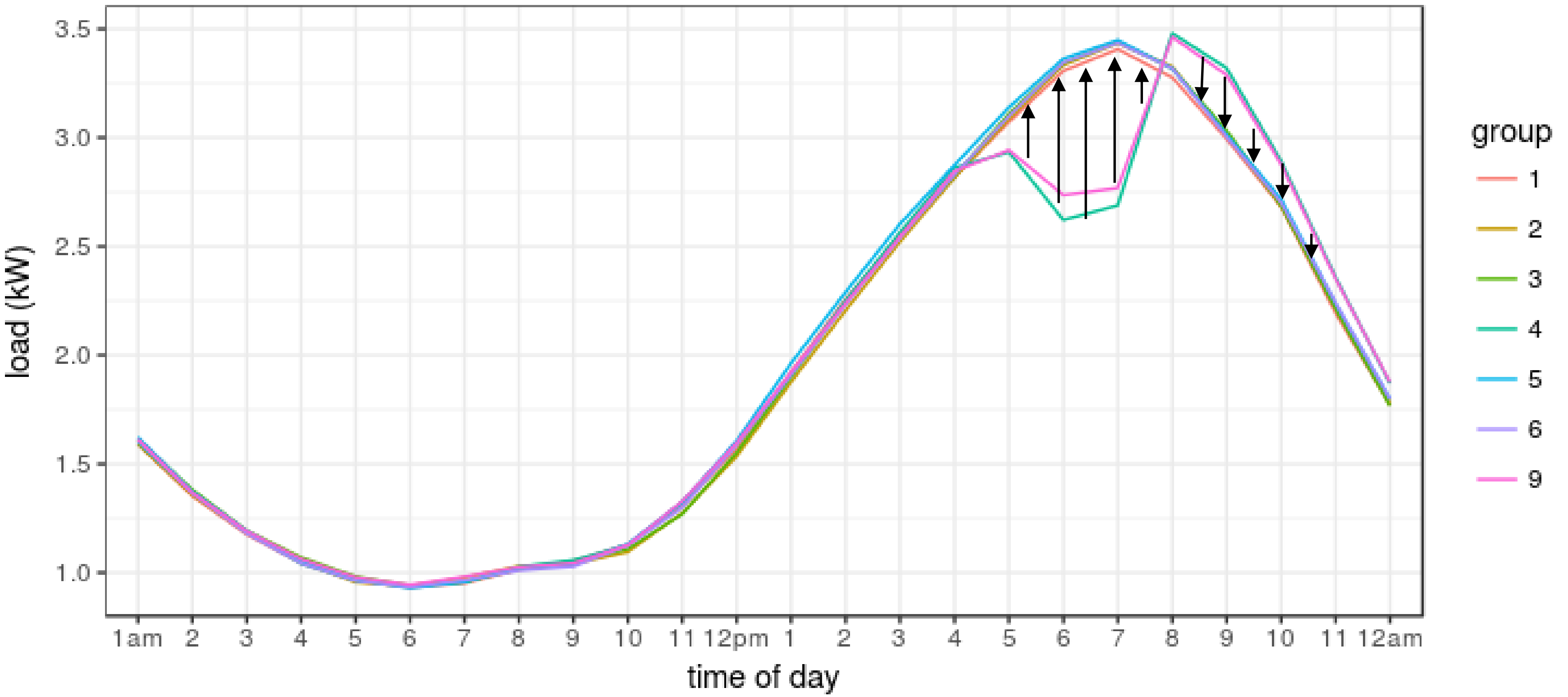
Opt-out timing



Ex-post methodology



- Impacts = average load of non-participant groups 1, 2, 3, 5, 6 minus average load of participant groups 4, 9.

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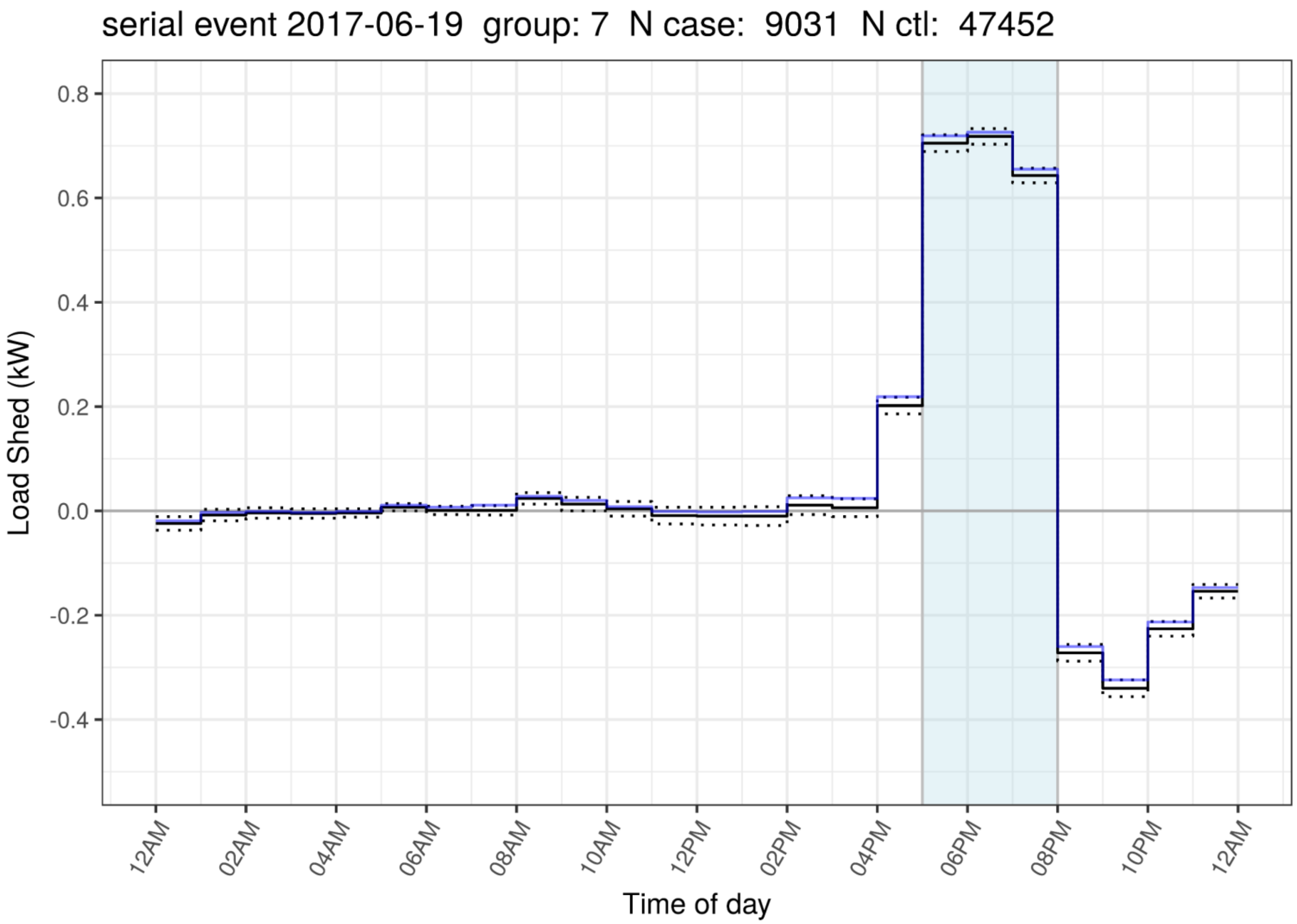
Ex-post: Typical event progression



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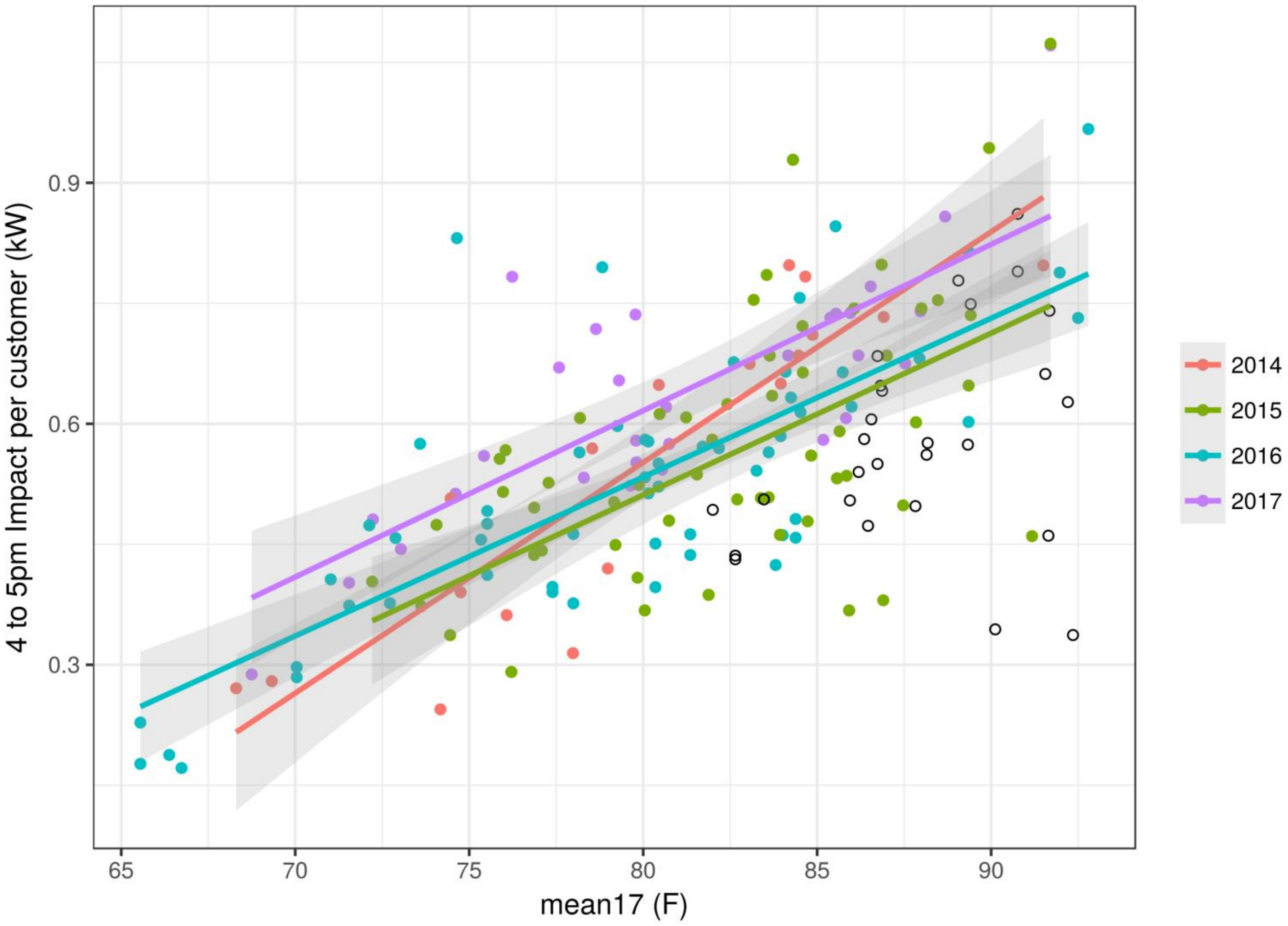
Ex-post: results 2017 vs. 2016

		2016		2017	
All LCAs together	**Average reduction per cust. (5-6 pm)**	**0.55 kW**	**21%**	**0.65 kW**	**21%**
	Range of reduction per cust. (5-6 pm)	0.28-0.71 kW	15% - 23%	0.53 -0.76 kW	19% - 23%
By LCA	Greater Bay Area	0.46	21%	0.65	23%
	Greater Fresno	0.61	19%	0.59	17%
	Humboldt	0.73	27%	Not reported due to small sample	
	Kern	0.73	22%	0.79	23%
	Northern Coast	0.37	20%	0.53	19%
	Other	0.58	20%	0.68	21%
	Sierra	0.59	20%	0.70	21%
	Stockton	0.65	22%	0.66	19%

Note: Several other factors besides LCA can also affect per customers impacts (e.g., SF v MF, CARE, multiple AC units, NEM, etc.). These effects are described in Error! Reference source not found. and Error! Reference source not found.. Humboldt data is not reported due to the small number of participants in 2017 (de-enrollments and new geographic assignments associated with updated LCAs reduced it from 722 participants in 2016 to 2).

Ex post: comparison to prior years



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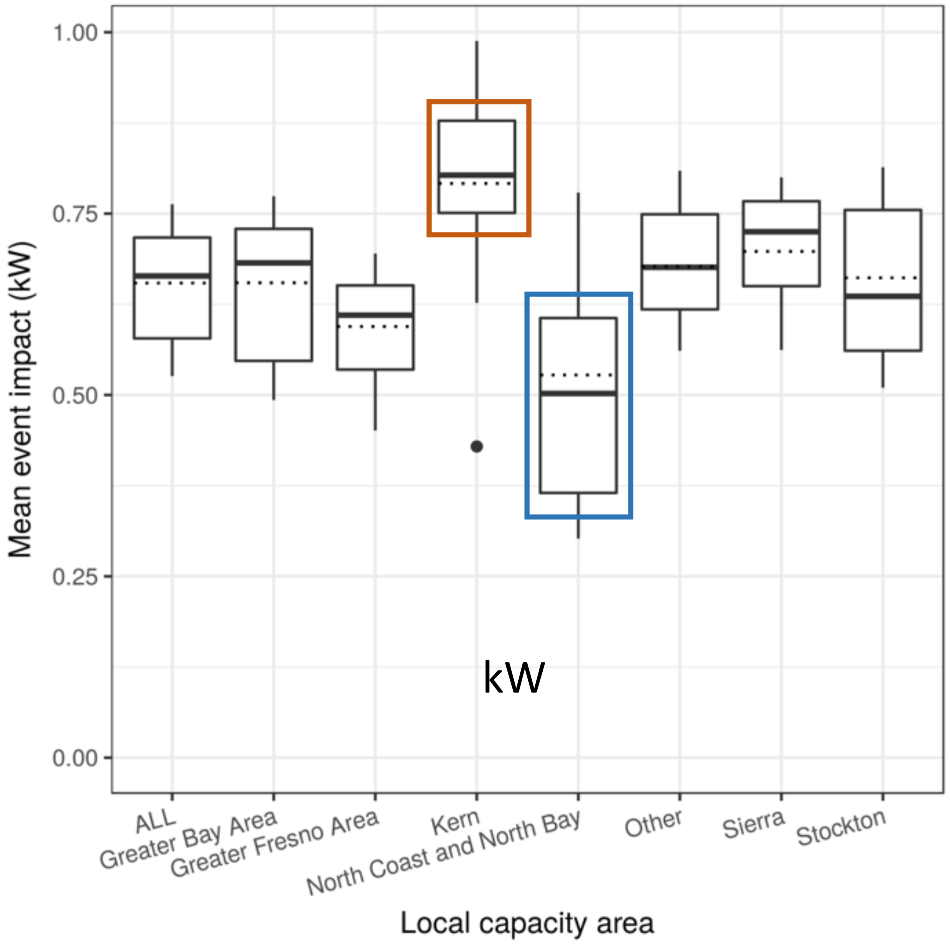
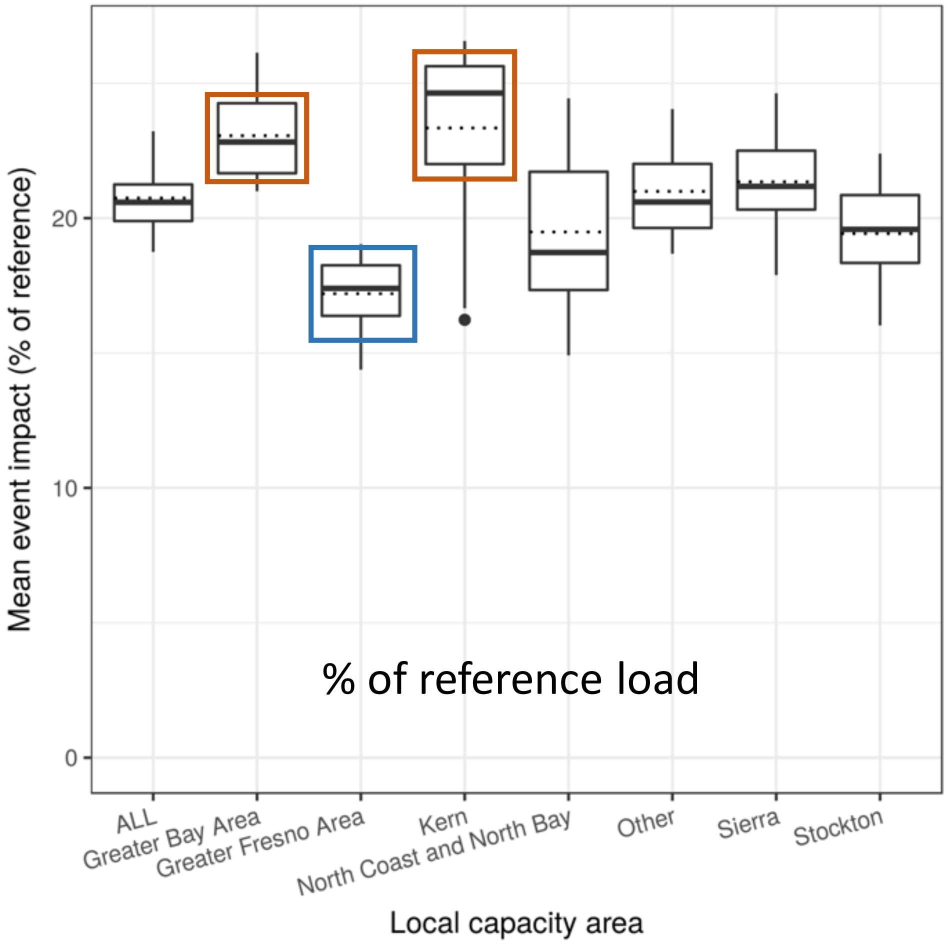
Ex post: impacts by LCA – in kW and % of reference





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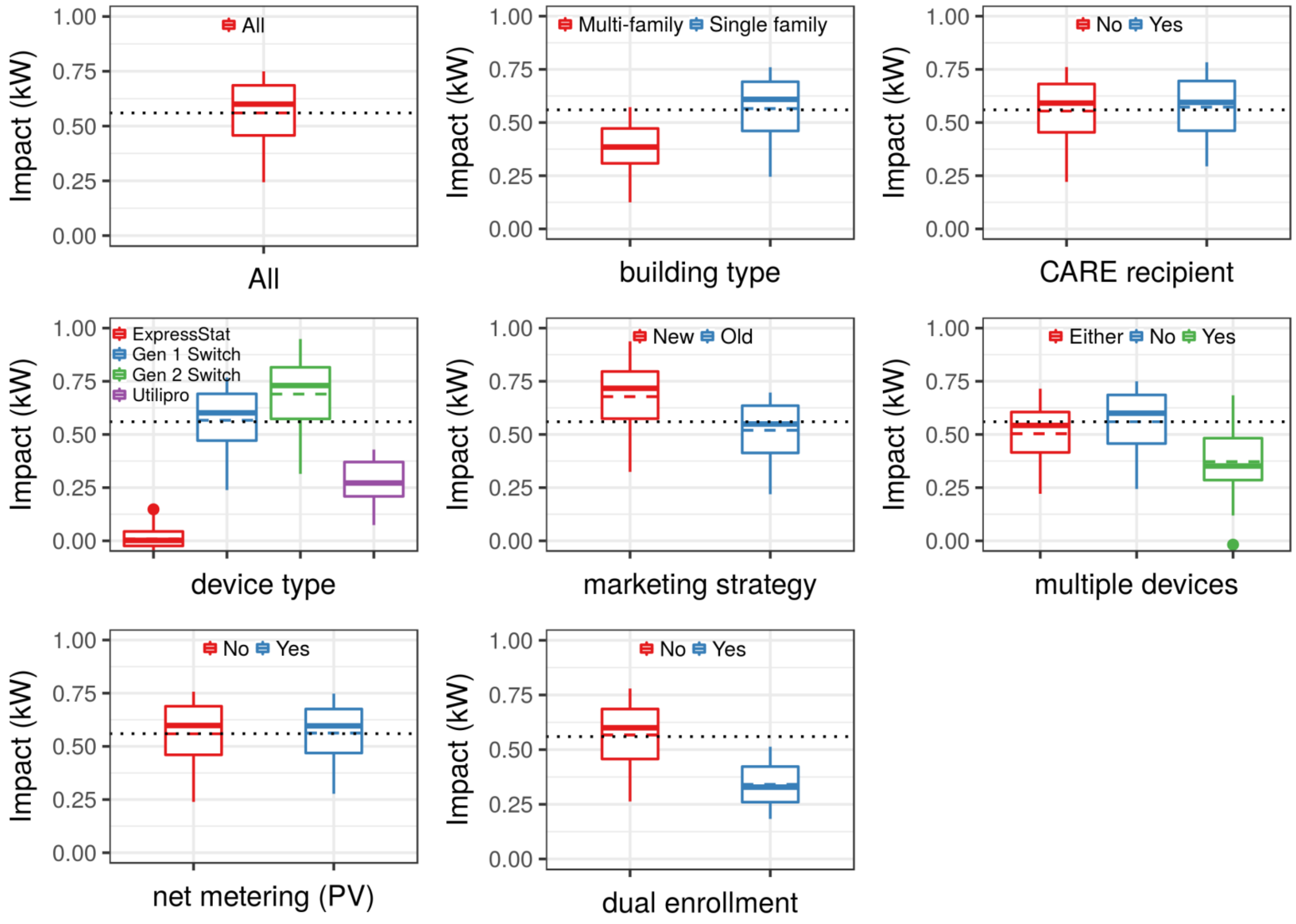
Ex-post: Factors that influence impacts



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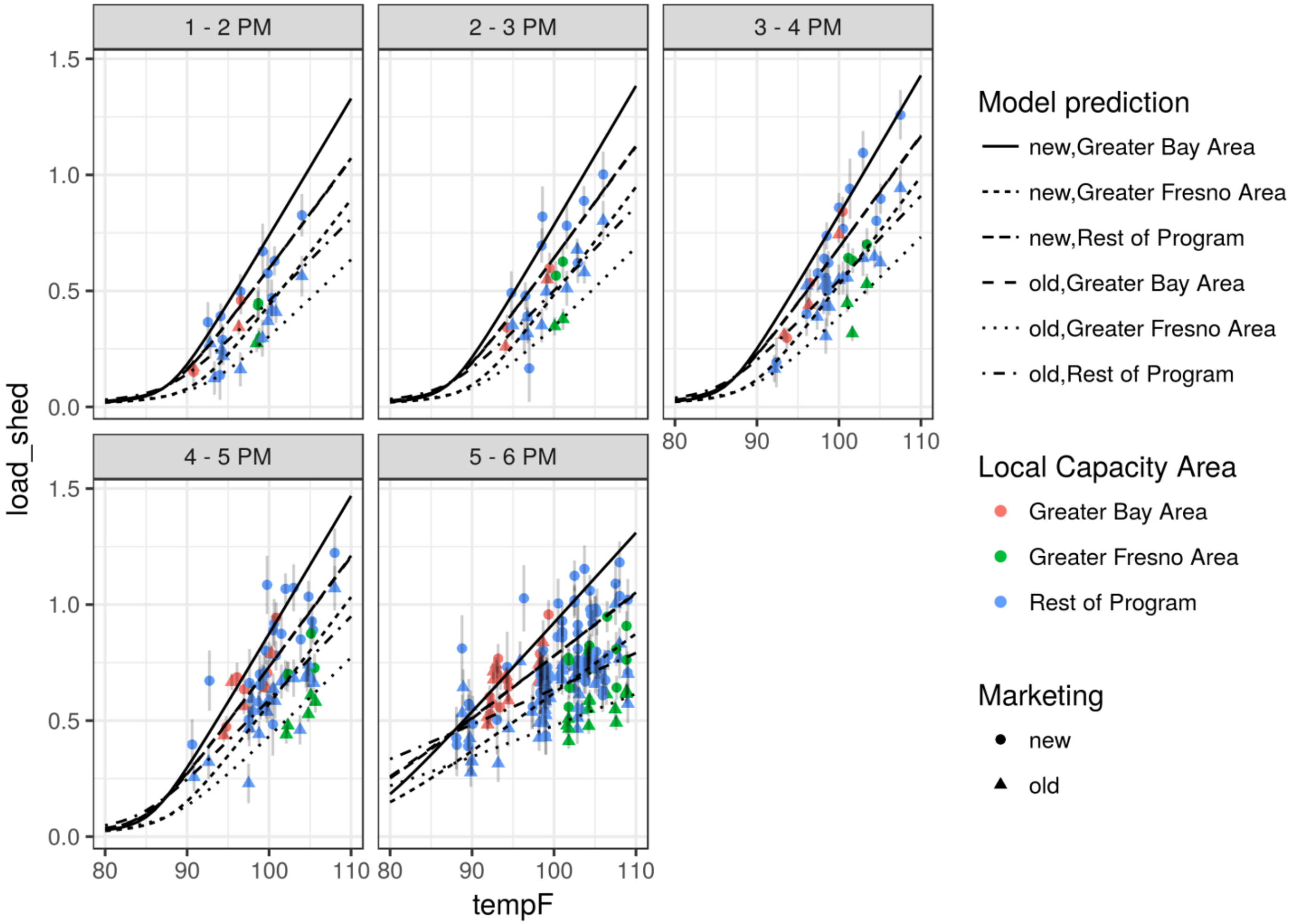
Ex-ante methodology



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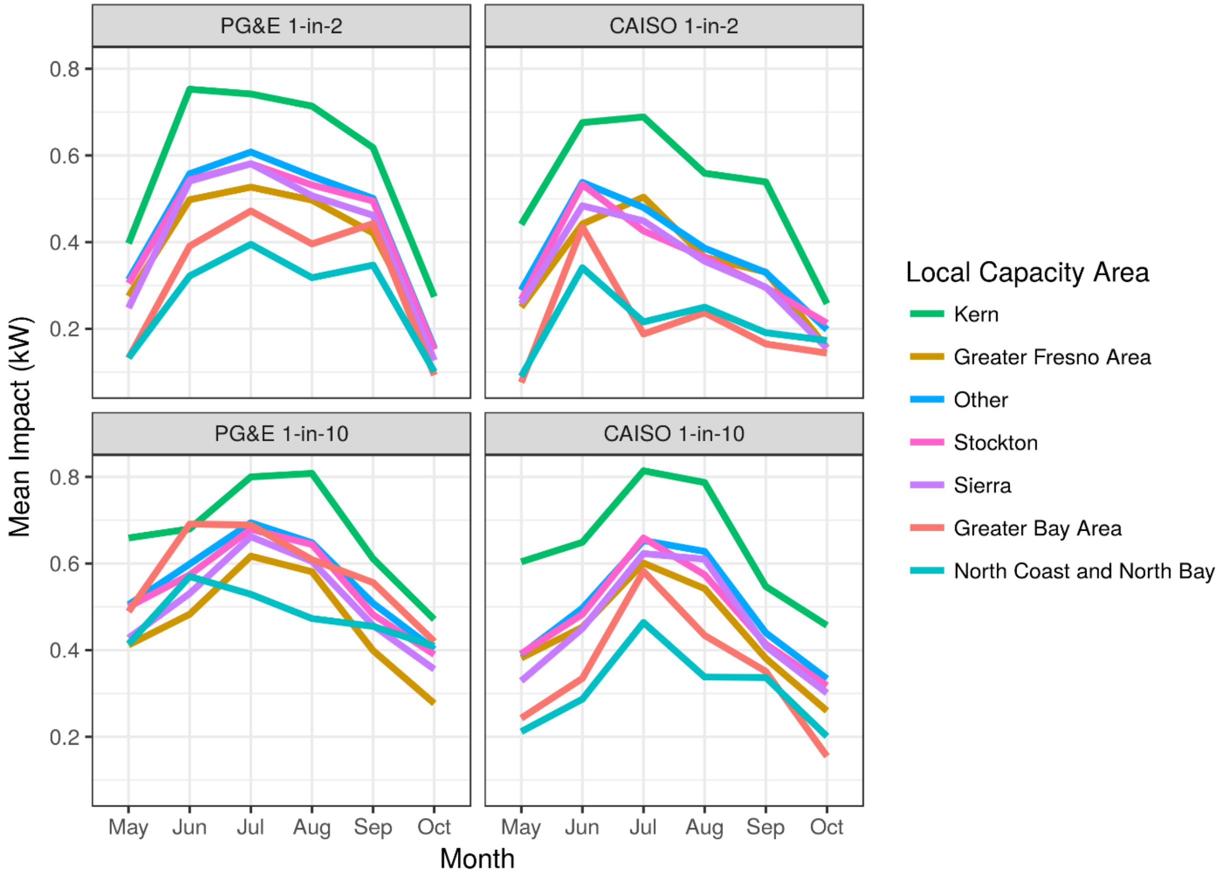
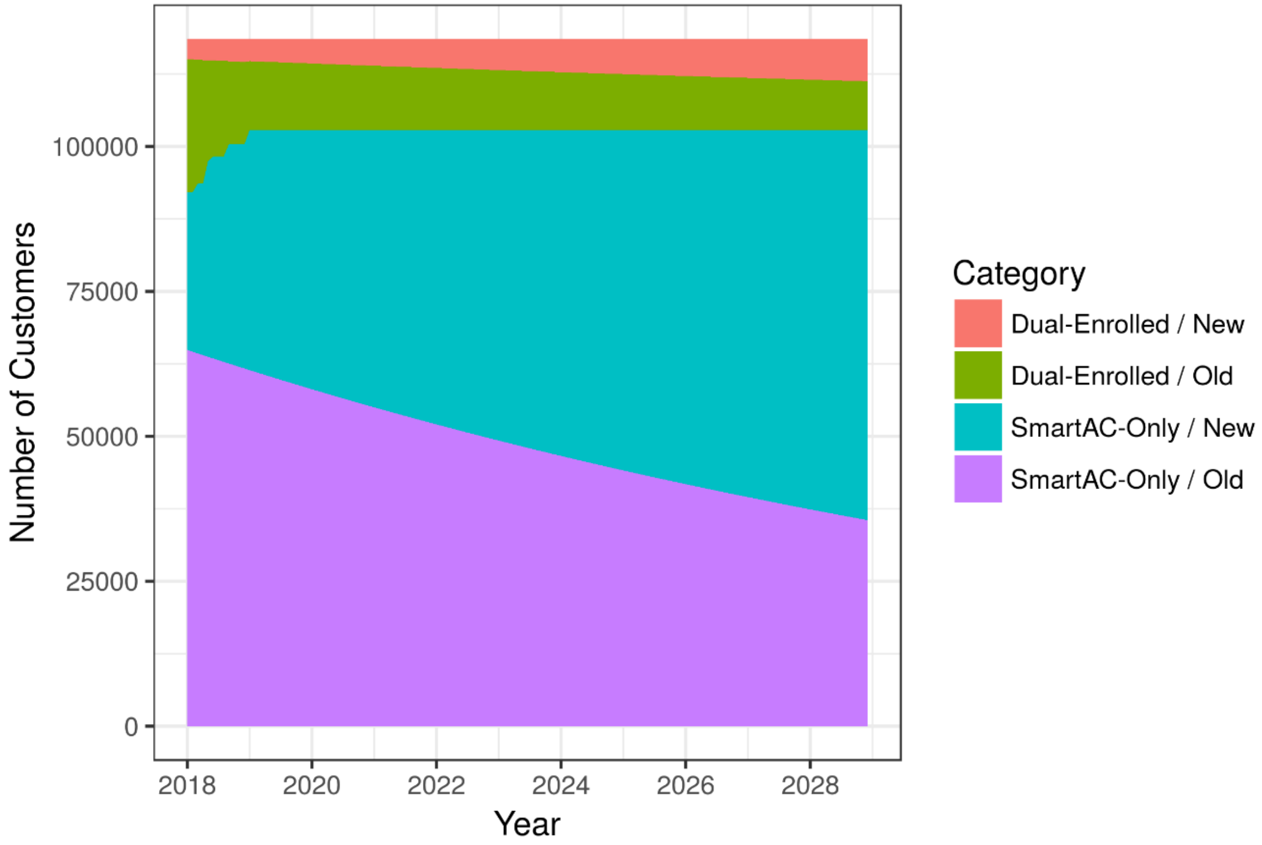
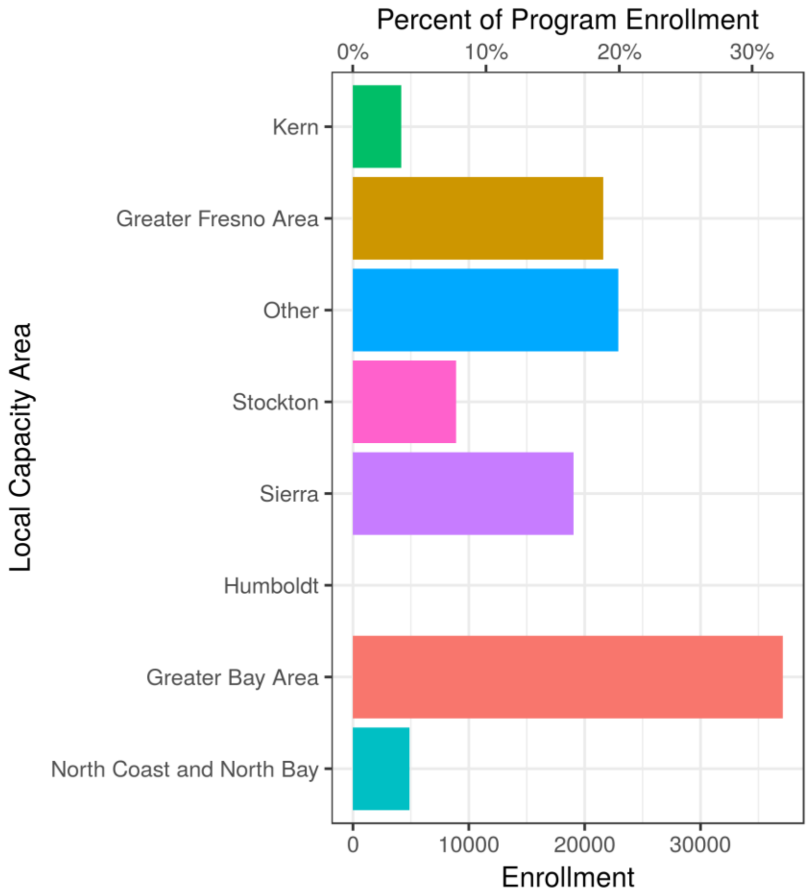
Ex-ante: per-customer results

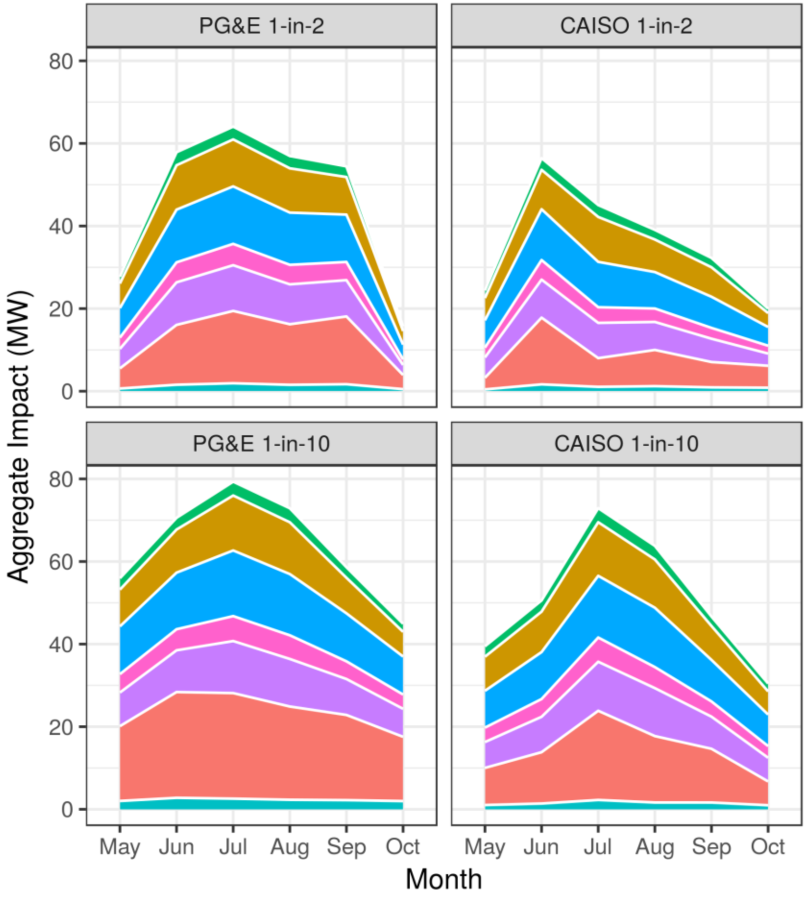


Enrollment forecast

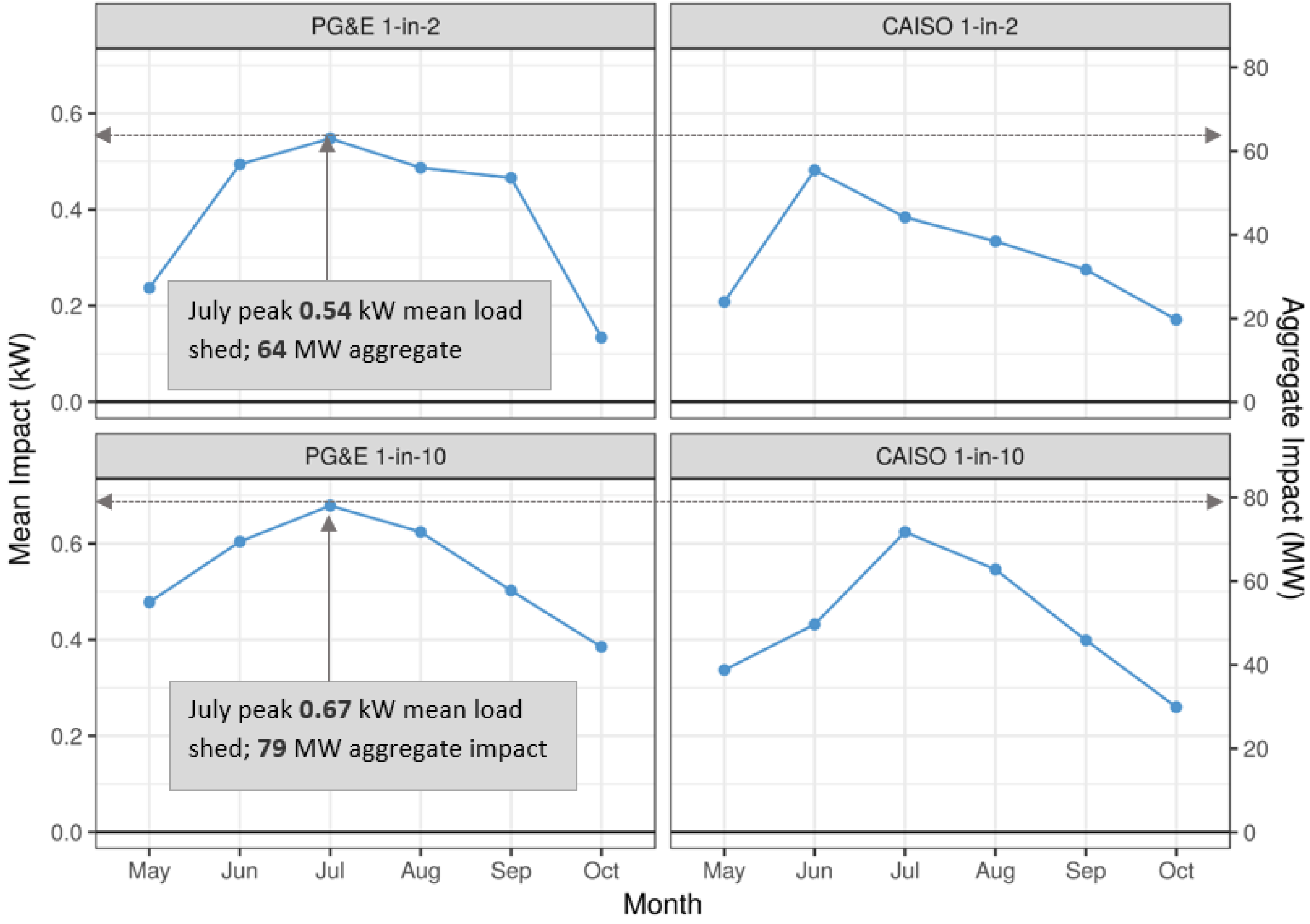


Ex-ante: LCA breakdown





Ex-ante: aggregate results



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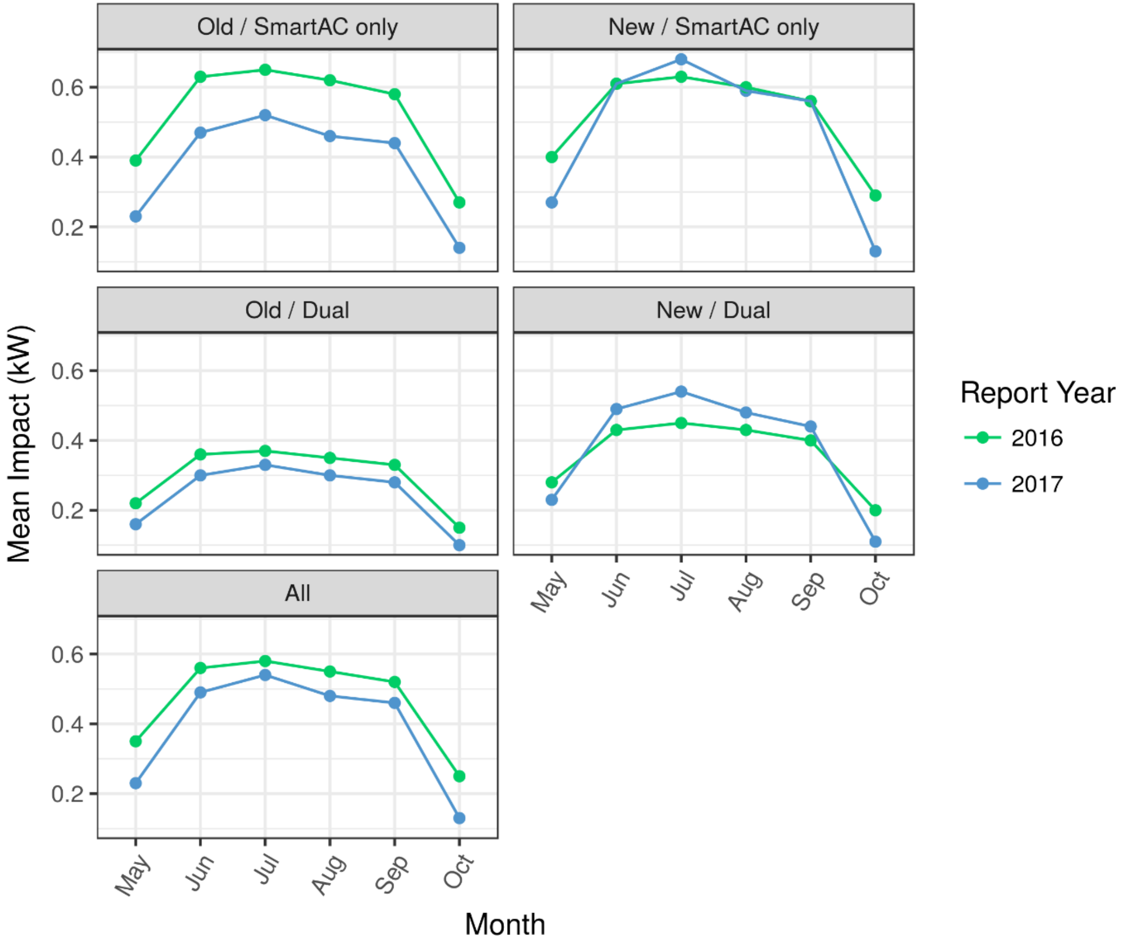
2017 ex ante forecast over time

LCA	2018 (1-6pm; PG&E; Aug. 1-in-2)			2019 (1-6pm; PG&E; Aug. 1-in-2)			2028 (1-6pm; PG&E; Aug. 1-in-2)		
	Enrollment	Per Customer (kW)	Aggregate (MW)	Enrollment	Per Customer (kW)	Aggregate (MW)	Enrollment	Per Customer (kW)	Aggregate (MW)
Greater Bay Area	37083	0.40	14.8	37083	0.42	15.7	37083	0.43	16.1
Greater Fresno	21589	0.50	10.8	21589	0.51	11.0	21589	0.55	11.9
Kern	4187	0.72	3.0	4187	0.72	3.0	4187	0.75	3.1
Northern Coast	4872	0.32	1.6	4872	0.32	1.6	4872	0.34	1.6
Other	22888	0.56	12.8	22888	0.56	12.9	22888	0.59	13.6
Sierra	19045	0.51	9.7	19045	0.51	9.8	19045	0.54	10.3
Stockton	8897	0.54	4.8	8897	0.54	4.8	8897	0.58	5.1
Total	**118563**	**0.48**	**57.4**	**118563**	**0.50**	**58.7**	**118563**	**0.52**	**61.8**

Ex ante for 2018: 2016 vs. 2017 evaluations

2016	2017
Assumed low AC users slated for de-enrollment had been contributing zero savings	Data shows low AC users had been contributing savings
"Old Marketing" customers predicted to have systematically higher savings	"Old Marketing" customers improved after de-enrollments, but do not reach parity or exceed "New Marketing"
Used ex-post data from early program years (2012-2014) that was systematically higher than recent performance	Used only 2017 data
Enrollment forecast: 131k customers *(this is not shown in the per-customer impact to the right, but is the multiplier that determines the aggregate impact)*	Enrollment forecast: 118k customers



Ex-post vs. 2 prior ex-ante year 1-in-2

	2017 ex post (4-6pm Aug. 27)			2017 ex ante (1-6pm; PG&E; Aug. 1-in-2)			2016 ex ante (1-6pm; PG&E; Aug. 1-in-2)		
LCA	**Enrollment**	**Per Customer (kW)**	**Aggregate (MW)**	**Enrollment**	**Per Customer (kW)**	**Aggregate (MW)**	**Enrollment**	**Per Customer (kW)**	**Aggregate (MW)**
Greater Bay Area	37,547	0.73	27.3	37,083	0.40	14.8	40,756	0.47	19.0
Greater Fresno	22,461	0.62	14.0	21,589	0.50	10.8	16,634	0.66	11.0
Kern	6,493	1.03	6.7	4,187	0.72	3.0	8,324	0.67	5.6
Northern Coast	5,126	0.73	3.7	4,872	0.32	1.6	7,601	0.45	3.4
Other	20,110	0.71	14.4	22,888	0.56	12.8	29,069	0.60	17.4
Sierra	19,190	0.71	13.6	19,045	0.51	9.7	14,543	0.52	7.5
Stockton	8,819	0.76	6.7	8,897	0.54	4.8	13,654	0.60	8.2
Total	**119,748**	**0.72**	**85.9**	**118,563**	**0.48**	**57.4**	**131,327**	**0.55**	**72.3**

1-in-2 conditions are substantially cooler than event days and the 2017 ex ante model is more sensitive to temperature than previous years. This means that ex post for actual events comes in significantly higher than ex ante for the same month.

Recommendations and conclusions

Program recommendation	Continue	Explore	Description
Target high users	✓		Target homes with higher reference loads and more potential to save on hot days.
Upgrade hardware	✓		Upgrading hardware, or at least using the newer 2-way AMI switches for new participants, is expected to continue to increase the average impacts per participant.
Prepare to dispatch and evaluate sub-LAP events over a range of conditions	✓		The plan for market integrated events for program year 2018 and beyond will dispatch devices at the sub-LAP level in the service of grid balancing. This will happen over a wider range of operating conditions, including in cooler weather and off-peak timing, and without randomized controls.
Adopt a value-driven framework for customer retention		✓	PG&E should assess the value of load impacts versus the cost of continuing to include legacy customers in the program. If there are low operating costs, encourage legacy customers to stick with the program.
Explore satisfaction of opt-outers to help with targeting		✓	If customers become dissatisfied if they participate in several multi-hour events in a year and therefore drop out of the program or stop participating in events, it will limit the effectiveness of the program and complicate the ability to predict the load shed in late-season events.

Questions and Discussion

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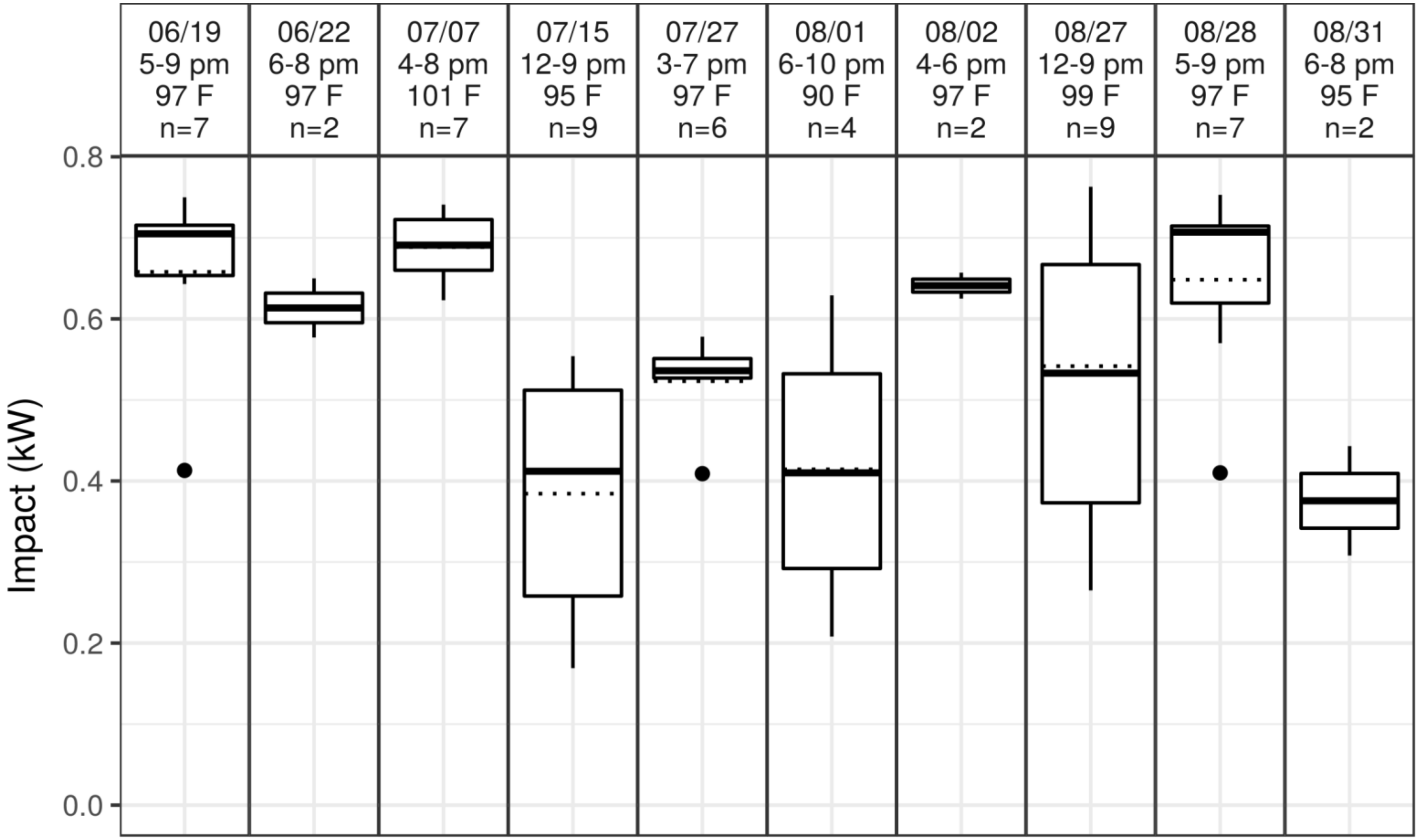
Ex-post: results by event date



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Ex ante: influences on aggregate predictions