

Load Impact Evaluation of PG&E's 2017 SmartRate™ Program

DRMEC Load Impact Workshop

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Presentation Agenda

- Description of PG&E's SmartRate™ Program
- Study Objectives
- Ex-Post Load Impacts
- Ex-Ante Load Impact Forecasts
- Review of Program Performance

PG&E SmartRate™ Program

- Voluntary critical peak pricing program for PG&E's residential customers that overlays lower electric rates on an existing tariff
- Lower electric rates from June 1st through September 30th, except between 2 - 7pm on SmartDays™ where a peak price adder of \$0.60/kWh is in effect
- Designed to help reduce load on the electric grid on days when resources are constrained (9 - 15 possible days)
- Customers receive bill protection during their first summer season.
- SmartRate™ participants may also enroll in PG&E's SmartAC™ program. Nine of the fourteen events in 2017 were called for both programs
- Program began in 2008 with approximately 10,000 participants. In 2017, program had just over 124,000 participants



SmartRate™ Historical Program Performance and Participation

	ENROLLMENT			Number of SmartDay™ Events	PROGRAM IMPACTS (MEGAWATTS)			Total Per Customer Impacts (kW)
	In SmartRate™ Only	In SmartRate™ & SmartAC™	Total		SmartRate™ Only	SmartRate™ & SmartAC™	Aggregated Impacts	
2013	79,842	38,302	118,144	8	20.5	23.7	44.2	0.37
2014	89,061	40,279	129,340	12	18.3	20.4	38.7	0.30
2015	92,288	36,598	128,886	15	19.5	20.0	39.5	0.30
2016	111,389	35,253	146,642	12	14.0	15.8	29.8	0.20
2017	95,126	28,923	124,049	14	13.8	14.3	28.1	0.23

Nexant, Inc., Load Impact Evaluation of Pacific Gas and Electric Company's Residential Time-Based Pricing Programs, Final Reports; 2013 (CALMAC Study ID: PGE0352, April 1, 2014) and 2014 (CALMAC Study ID: PGE0352, April 1, 2015)

Christensen Associates Energy Consulting, Load Impact Evaluation of Pacific Gas and Electric Company's Residential Time-Based Pricing Programs, Volume 1: Ex-Post and Ex-Ante Reports, 2015 (CALMAC Study ID: PGE0371, April 1, 2016) and 2016 (CALMAC Study ID: PGE0393.01, April 1, 2017)

SmartRate, SmartAC, and SmartDay are trademarks of Pacific Gas and Electric Company

Study Objectives

What are the ex-post and ex-ante load impacts for SmartDays™?

- Estimated ex-post load impacts for each event day and typical event day
- Estimated ex-ante load impact for monthly peak days for 2018 – 2028

Why did the Program achieve these results?

- We contextualize load reductions by:
 - key customer segments (e.g., SmartRate™- only / dually enrolled, LCAs), and
 - over time by drawing comparisons to prior evaluation results



Ex-Post Load Impacts

Methodology to Estimate Ex-Post Load Impacts

- Used quasi-experimental design to estimate load impacts using non-event days with similar weather to event days, a matched comparison group, and regression modeling to establish the baseline
 - Used propensity score matching to select both proxy weather days (selected 6) and matched comparison group (5 comparison group customers per participant)
 - Given extremely hot weather conditions in 2017, it was challenging to identify non-event days with similarly hot temperatures for two of the events
 - This information fed into regression models used to develop baselines that best represented the counterfactual
- We estimated load impacts on event days by modeling the predicted baseline informed by comparison group customer loads and non-event proxy day usage, and subtracting SmartRate™ participant loads
- Used a two-way linear fixed-effects regression (LFER) modeling approach



Summary of Ex-Post Load Impact Results

- Ex-post aggregate load impact for the typical event day in 2017 is **28.1 MW**
- Average per customer impact in 2017 equaled **0.23 kW**
- On average, over 124,000 customers participated in each of the 14 SmartDays™ events that occurred in 2017
- Dually-enrolled participants account for more than half (51%) of the aggregate program load impacts, but represent under a quarter (23%) of all participants
- Local Capacity Areas (LCAs) with higher temperatures yielded the largest load impacts, as has been the case historically
- We found evidence of behavioral spillover, where program participants habituate load reduction on non-event days



Ex-Post Load Impacts for SmartRate™-only Participants

- Aggregate load impacts for the 2017 summer season were 13.8 MW and per participant impact equaled 0.14 kW

Events	Number Enrolled	Aggregate		Per Customer		% Load Impact	Average Event Temp.
		Reference Load (MW)	Load Impact (MW)	Reference Load (kW)	Load Impact (kW)		
16-Jun-17	98,143	127.5	12.6	1.3	0.13	9.9%	91
19-Jun-17	98,098	177.5	15.5	1.8	0.16	8.7%	99
20-Jun-17	98,063	168.1	14.4	1.7	0.15	8.6%	97
22-Jun-17	98,021	176.1	16.4	1.8	0.17	9.3%	99
23-Jun-17	98,020	154.7	12.4	1.6	0.13	8.0%	94
7-Jul-17	96,861	157.6	14.8	1.6	0.15	9.4%	98
27-Jul-17	93,282	137.7	12.0	1.5	0.13	8.7%	94
31-Jul-17	92,790	137.4	11.9	1.5	0.13	8.7%	93
1-Aug-17	92,500	149.0	13.4	1.6	0.14	9.0%	96
2-Aug-17	92,527	154.1	13.3	1.7	0.14	8.6%	94
28-Aug-17	93,387	167.9	14.9	1.8	0.16	8.9%	99
31-Aug-17	93,381	135.3	12.4	1.4	0.13	9.2%	97
1-Sep-17	93,306	164.9	15.2	1.8	0.16	9.2%	103
2-Sep-17	93,385	182.8	13.5	2.0	0.14	7.4%	105
Average Event Day	95,126	156.5	13.8	1.6	0.14	8.8%	97



Ex-Post Load Impacts for Dually-Enrolled Participants

- Aggregate load impacts for the 2017 summer season were 14.3 MW and per participant impact equaled 0.50 kW

Events	Number Enrolled	Aggregate		Per Customer		% Load Impact	Average Event Temp.
		Reference Load (MW)	Load Impact (MW)	Reference Load (kW)	Load Impact (kW)		
16-Jun-17	30,115	54.4	12.1	1.8	0.40	22.3%	93
19-Jun-17	30,043	81.7	17.9	2.7	0.60	21.9%	102
20-Jun-17	29,974	76.9	16.2	2.6	0.54	21.1%	100
22-Jun-17	29,906	81.0	17.2	2.7	0.58	21.3%	102
23-Jun-17	29,866	69.6	13.7	2.3	0.46	19.7%	96
7-Jul-17	29,544	71.5	15.7	2.4	0.53	21.9%	101
27-Jul-17	28,508	59.8	12.3	2.1	0.43	20.5%	97
31-Jul-17	28,367	59.1	11.5	2.1	0.41	19.5%	95
1-Aug-17	28,300	66.6	14.0	2.4	0.50	21.0%	99
2-Aug-17	28,276	69.9	14.5	2.5	0.51	20.7%	97
28-Aug-17	28,063	74.2	15.1	2.6	0.54	20.4%	103
31-Aug-17	28,012	56.6	10.9	2.0	0.39	19.2%	99
1-Sep-17	27,974	72.0	14.9	2.6	0.53	20.7%	105
2-Sep-17	27,971	80.0	14.8	2.9	0.53	18.5%	106
Average Event Day	28,923	69.5	14.3	2.4	0.50	20.6%	100



Ex-Ante Load Impact Forecasts



Methodology to Estimate Ex-Ante Load Impact Forecasts

- We estimated ex-ante load impacts for 2018 through 2028 for the SmartRate™ program using a linear model and incorporated:
 - PG&E's enrollment projections
 - Previous and current evaluated ex-post impacts for 2016 and 2017
 - We did not use ex-post impacts from 2011-2015 given how distinct these results were compared to 2016 and 2017 estimates. We did not believe they were reliable for forecasting future ex-ante estimates
 - Results from our ex-post models suggest that the correlation between temperature and impacts were markedly different in prior years, leading to a potential overestimate of forecasted results
 - Our comparison of recent ex-post impact results to previous ex-ante load impacts
- Estimated models separately by participant type for each hour of the day



Summary of Ex-Ante Load Impact Forecasts

- Estimated ex-ante load impact forecasts for monthly peak days for 2018 – 2028 based on four weather scenarios (PG&E 1-in-2, PG&E 1-in-10, CAISO 1-in-2, and CAISO 1-in-10)
- We forecast higher load impacts using event window hours (2-7pm) compared to the resource adequacy (RA) window (1-6pm)
- Using the PG&E 1-in-2 weather scenario and RA window of 1 - 6pm, load impact forecast equals 13 MW for August peak day in 2019
- Ex-ante impact forecasts are lower than 2017 ex-post impacts. This stems from:
 - Declining enrollment, particularly in the Greater Bay Area due to CCAs
 - Declining proportion of customers who are dually enrolled

Enrollment Forecasts by LCA for SmartRate™

- Table shows forecasted August enrollment for SmartRate™ and SmartRate™ / SmartAC™ for 2018 and the average across 2019-2028
 - Large decline anticipated in the Greater Bay Area (due to CCAs)
 - Lower projected enrollment leads to lower forecasted ex-ante impacts

LCA	SmartRate™-Only		Dually-Enrolled		Total	
	2018	2019-2028	2018	2019-2028	2018	2019-2028
Greater Bay Area	29,058	3,565	5,280	710	34,338	4,275
Greater Fresno	9,790	9,790	4,066	4,066	13,856	13,856
Humboldt	33	33	0	0	33	33
Kern	3,320	3,320	884	884	4,204	4,204
Northern Coast	1,934	1,934	366	366	2,300	2,300
Other	15,876	15,841	5,222	5,222	21,098	21,064
Sierra	4,968	4,968	2,378	2,378	7,346	7,346
Stockton	4,593	4,593	2,060	2,060	6,653	6,653
Total	69,572	44,044	20,257	15,686	89,829	59,731



Ex-Ante Load Impact Forecast (PG&E 1-in-2, RA Window)

- Portfolio-adjusted impacts (in *bold italicized font*) are lower (approximately 55 to 60% of program impacts) due to removal of SmartAC™ impacts from the impacts of SmartRate™ when both events are called for dually-enrolled participants

Day Type	Program			Portfolio		
	SmartRate™ Only	Dually-enrolled	Total	SmartRate™ Only	Dually-enrolled	Total
January Peak	3.2	2.8	6.0	3.2	2.8	6.0
February Peak	3.2	2.8	6.0	3.2	2.8	6.0
March Peak	3.2	2.8	6.0	3.2	2.8	6.0
April Peak	4.0	3.0	7.0	4.0	3.0	7.0
May Peak	5.0	4.6	9.6	5.0	0.9	5.9
June Peak	6.5	7.0	13.5	6.5	1.4	7.9
July Peak	6.5	7.0	13.5	6.5	1.4	7.9
August Peak	6.3	6.7	13.0	6.3	1.3	7.6
September Peak	5.9	6.0	11.9	5.9	1.2	7.1
October Peak	4.3	3.3	7.6	4.3	0.6	4.9
November Peak	3.2	2.8	6.0	3.2	2.8	6.0
December Peak	3.2	2.8	6.0	3.2	2.8	6.0



Review of Program Performance



Comparison of 2017 Ex-Post to 2018 Ex-Ante

- A comparison of 2017 ex-post load impacts for the typical event day to 2018 ex-ante load impact forecasts for the August peak day using PG&E 1-in-2 weather and event hours of 2-7pm shows:
 - Decline in number of enrolled participants (enrollment in CCAs)
 - Decline in aggregate load impacts
 - Lower average event day temperature, particularly for SmartRate™-only

Enrollment Type	2017 Typical Event Day/2018 August Peak	Enrolled	Aggregate		Per Participant		% Load Impact	Average Event Temp.
			Reference Load (MW)	Load Impact (MW)	Reference Load (kW)	Load Impact (kW)		
SmartRate™-only	2017 Ex Post	95,126	156.5	14.0	1.64	0.14	8.9%	97.1
	2018 Ex Ante	69,572	118.7	10.2	1.70	0.15	8.6%	91.6
Dually-enrolled	2017 Ex Post	28,923	69.5	14.3	2.40	0.50	20.6%	99.7
	2018 Ex Ante	20,257	48.2	9.70	2.38	0.50	20.2%	98.3

Note: Impacts above were based on event window hours of 2-7pm. Ex ante impacts are typically provided for the RA window, which runs from 1-6pm.



Conclusions and Recommendations

- PG&E expects the declining impacts from SmartRate™ to continue due to:
 - Customers joining CCAs
 - Declining proportion of customers who are dually-enrolled
 - Declining proportion of customers who enrolled before 2014 as newer customers contribute smaller per participant impacts
- We recommend PG&E:
 - Incorporate results from the multi-level modeling analysis conducted to identify existing customers and target future customers who can contribute to load impacts
 - Consider a process evaluation to gather data from participants to gauge their understanding of SmartRate™, what changes in electric consumption they make during SmartDay™ event hours to reduce load, and whether they are satisfied with their experience with the Program

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Appendix of Additional Ex-Post Results

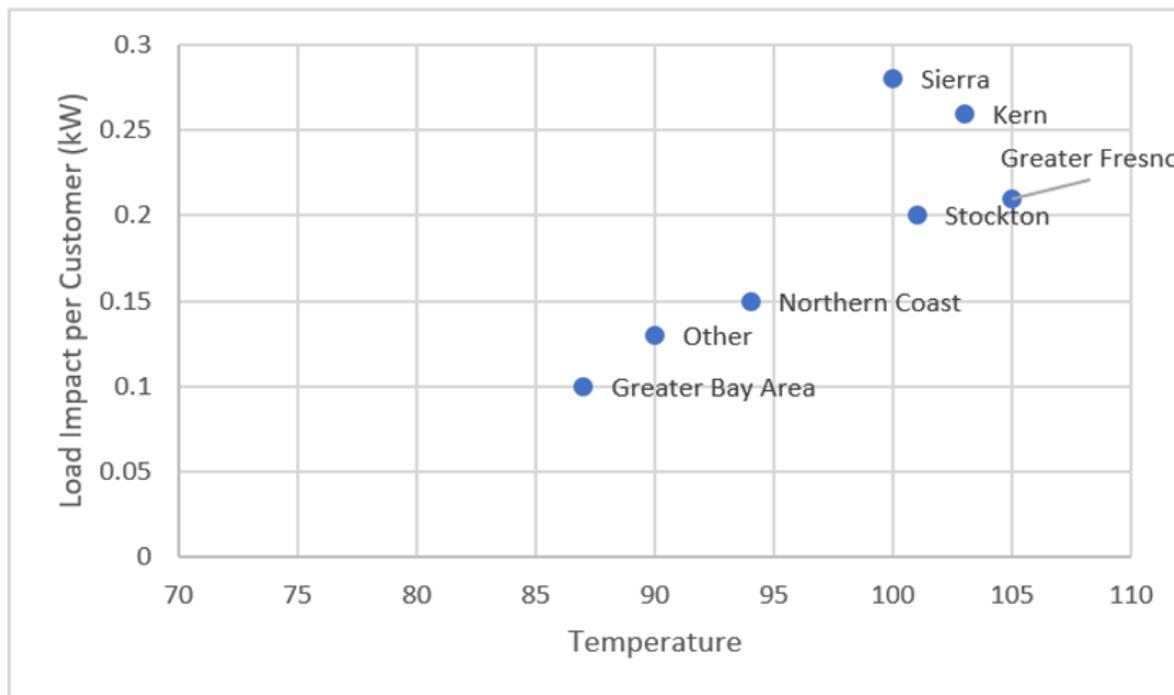
Average Event-Hour Ex-Post Load Impacts by LCA, SmartRate™-only

- Aggregate ex-post impacts are largest for Greater Bay Area, which has the highest enrollment, followed by Other, which has the next highest enrollment

LCA	Number Enrolled	Aggregate		Per Customer		% Load Impact	Average Event Temp.
		Reference Load (MW)	Load Impact (MW)	Reference Load (kW)	Load Impact (kW)		
Greater Bay	46,992	48.0	4.7	1.0	0.10	9.9%	87
Greater Fresno	9,478	26.9	2.0	2.8	0.21	7.3%	105
Humboldt							
Kern	3,328	9.5	0.9	2.9	0.26	9.0%	103
Northern Coast	1,920	2.6	0.3	1.3	0.15	11.3%	94
Other	20,701	37.4	2.7	1.8	0.13	7.3%	90
Sierra	8,225	20.7	2.3	2.5	0.28	11.0%	100
Stockton	4,482	11.4	0.9	2.5	0.20	8.0%	101
All	95,170	156.5	13.8	1.6	0.14	8.8%	97

Ex-Post Load Impacts by LCA and Temperature, SmartRate™-only

- LCAs with higher per participant impacts are those in warmer climate zones, such as Sierra, Kern, Greater Fresno, and Stockton
- We see the same trend for dually enrolled per participant impacts plotted against temperature by LCA



Average Event-Hour Ex-Post Load Impacts by LCA, Dually Enrolled

- Similar to SmartRate™-only impacts, aggregate ex-post impacts are largest for Greater Bay Area, which has the highest enrollment
- Per participant impacts are generally higher for dually-enrolled participants compared to SmartRate™-only participants

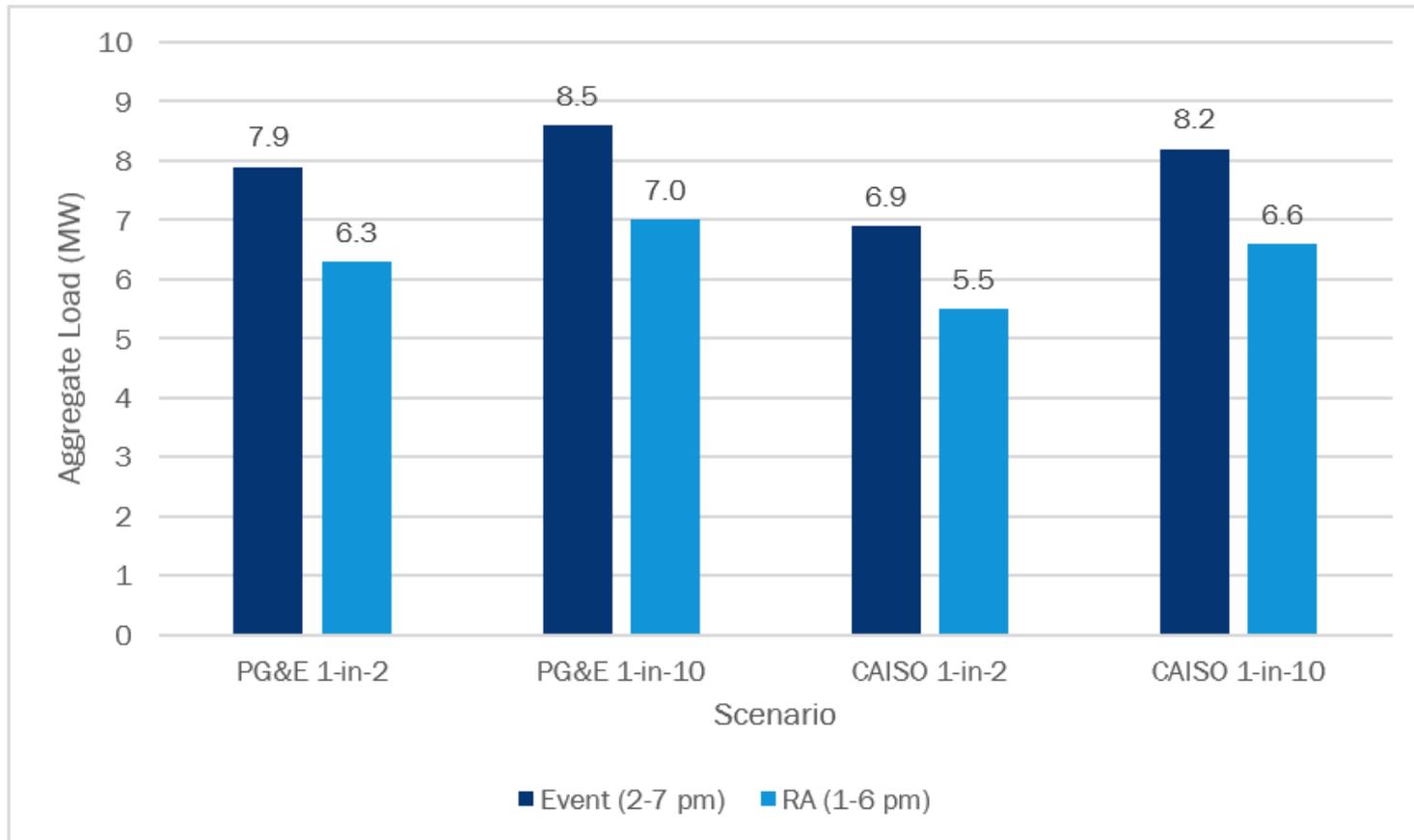
LCA	Number Enrolled	Aggregate		Per Customer		% Load Impact	Average Event Temp.
		Reference Load (MW)	Load Impact (MW)	Reference Load (kW)	Load Impact (kW)		
Greater Bay	10,317	19.1	4.0	1.9	0.39	20.9%	93
Greater Fresno	4,338	13.0	2.3	3.0	0.53	17.8%	104
Humboldt	-	NA	NA	NA	NA	NA	NA
Kern	961	2.9	0.5	3.0	0.54	17.9%	103
Northern Coast	400	0.7	0.2	1.9	0.38	20.2%	95
Other	5,776	14.6	2.9	2.5	0.51	20.0%	101
Sierra	4,921	13.0	3.2	2.6	0.64	24.3%	100
Stockton	2,211	6.1	1.3	2.7	0.57	20.8%	101
All	28,923	69.5	14.34	2.41	0.50	20.6%	100



Appendix of Additional Ex-Ante Results

Ex-Ante Load Impact Forecasts by Weather Scenario and Event/RA Windows, August Peak Day in 2019, SmartRate™-only

- Event window impacts are larger than RA window impacts projected for future years as seen in the example for August peak day in 2019 below



Ex-Ante Load Impact Forecasts by Weather Scenario and Event/RA Windows, August Peak Day in 2019, Dually Enrolled

- Projected impacts for dually enrolled customers are generally larger than for SmartRate™-only customers for all weather scenarios

