Division 5-34

Request:

Regarding the proposed metric for the Monthly Transmission Peak Demand Reduction Incentive Mechanism:

a. Please describe the weather-normalization methodology to be used for this PIM and provide a numerical example.

b. Please provide the actual monthly peaks for each of the most recent five years in MW, as well as the date and time of the peak.

c. Please provide the weather-normalized monthly peaks for each of the most recent five years.

d. Please provide the reductions in monthly peaks for each of the most recent five years due to energy efficiency, storage, DG, VVO, and Demand Response. Where possible, please provide the reductions separately, by technology.

e. Please explain how "large new electric loads" is defined.

f. Please provide the additions of "large new electric loads" on the system for each of the past five years, as well as the peak demands at the new large load sites that are coincident with monthly or annual peak load.

Response:

a. The Company does not currently weather-normalize monthly peak loads, so it does not yet have a weather-normalization methodology for this performance incentive mechanism. However, the Company expects to use a methodology similar to that used for weather-normalization of annual peaks, described in the Company's response to Division 5-35.

b. Attachment Division 5-34-1 provides the actual monthly peak load for each of the past five years in MW, as well as the date and time of the peak.

c. As discussed in the response to part a., the Company does not currently weather normalize monthly peaks, and therefore cannot provide this information at this time.

Prepared by or under the supervision of: Meghan McGuinness and Timothy R. Roughan

d. The Company does not currently conduct this analysis on monthly peaks. However, the analysis is performance on yearly peaks as described the Company's response to Division 5-35.

e. Any new load would result in an under-valued or under-reported peak load reduction amount. However, tracking all new load is not practical. The Company will determine a method to track as much new load as possible if this performance incentive mechanism is approved.

f. Please see Attachment DIV 5-34-2, which shows, where available, added kW load coincident with monthly system peaks for loads added within the past five years at customers with connected load greater than 1,000 kW, as well as for other spot loads over 1,000 kW.

(This response is identical to the Company's response to Division 1-34 in Docket No. 4780.)

year	month	Monthly_Peak (MW)	Date	Hour-Ending	Comment
2012	1	1,242.6	1/4/2012	18	
2012	2	1,167.4	2/29/2012	19	
2012	3	1,152.8	3/1/2012	19	
2012	4	1,018.4	4/16/2012	15	
2012	5	1,348.4	5/29/2012	17	
2012	6	1,785.5	6/21/2012	17	
2012	7	1,892.2	7/18/2012	15	
2012	8	1,720.5	8/3/2012	16	
2012	9	1,480.3	9/7/2012	16	
2012	10	1,063.3	10/3/2012	20	
2012	11	1,200.9	11/27/2012	18	
2012	12	1,200.0	12/17/2012	18	
2013	1	1,319.7	1/24/2013	19	
2013	2	1,233.4	2/5/2013	19	
2013	3	1,193.0	3/7/2013	19	
2013	4	1,071.4	4/3/2013	20	
2013	5	1,505.8	5/31/2013	17	
2013	6	1,708.9	6/24/2013	17	
2013	7	1,965.4	7/19/2013	15	
2013	8	1,526.3	8/21/2013	17	
2013	9	1,619.5	9/11/2013	17	
2013	10	1,111.1	10/7/2013	19	
2013	11	1,208.1	11/25/2013	18	
2013	12	1,328.5	12/17/2013	18	
2014	1	1,323.0	1/7/2014	19	
2014	2	1,221.1	2/11/2014	19	
2014	3	1,238.7	3/3/2014	19	
2014	4	1,013.2	4/7/2014	20	
2014	5	1,061.3	5/27/2014	14	
2014	6	1,443.2	6/26/2014	14	
2014	7	1,624.6	7/3/2014	16	
2014	8	1,515.0	8/5/2014	17	
2014	9	1,652.9	9/2/2014	16	
2014	10	1,079.7	10/15/2014	20	
2014	11	1,153.4	11/19/2014	18	
2014	12	1,236.3	12/8/2014	18	
2015	1	1,274.7	1/8/2015	18	
2015	2	1,262.1	2/16/2015	19	
2015	3	1,179.3	3/3/2015	19	
2015	4	1,028.6	4/9/2015	20	
2015	5	1,175.6	5/11/2015	15	
2015	6	1,417.1	6/23/2015	17	
2015	7	1,737.6	7/20/2015	15	
2015	8	1,715.4	8/18/2015	15	
2015	9	1,703.4	9/8/2015	16	
2015	10	1,023.6	10/28/2015	19	

year	month	Monthly_Peak (MW)	Date	Hour-Ending	Comment
2015	11	1,098.4	11/30/2015	18	
2015	12	1,112.1	12/8/2015	18	
2016	1	1,219.4	1/19/2016	19	
2016	2	1,222.5	2/15/2016	19	
2016	3	1,080.3	3/4/2016	19	
2016	4	1,069.4	4/4/2016	20	
2016	5	1,262.8	5/31/2016	17	
2016	6	1,336.9	6/29/2016	15	
2016	7	1,712.0	7/26/2016	17	
2016	8	1,802.9	8/12/2016	16	
2016	9	1,640.2	9/9/2016	16	
2016	10	1,043.3	10/19/2016	15	
2016	11	1,102.0	11/21/2016	18	
2016	12	1,238.7	12/15/2016	18	
2017	1	1,218.4	1/9/2017	18	
2017	2	1,110.8	2/10/2017	19	
2017	3	1,096.4	3/15/2017	20	
2017	4	989.8	4/4/2017	20	
2017	5	1,372.1	5/19/2017	16	
2017	6	1,664.2	6/13/2017	16	
2017	7	1,688.2	7/20/2017	16	
2017	8	1,554.0	8/22/2017	16	
2017	9	1,426.8	9/27/2017	17	
2017	10	1,150.7	10/10/2017	14	
2017	11	1,056.2	11/28/2017	18	preliminary
2017	12	1,267.0	12/28/2017	19	preliminary

Customer loads added within the past 5 years at Customers with connected load greater than 1,000 kWs, and other spot loads over 1,000 kWs				Added kW Load coincident with monthly system peaks												
District Code	City/Town	Work Request Number	Notes	1/4/2012	2/29/2012	3/1/2012	4/16/2012	5/29/2012	6/21/2012	7/18/2012	8/3/2012	9/7/2012	10/3/2012	11/27/2012	12/17/2012	1/24/2013	2/5/2013
NE53	BURRILLVILLE	14689576	Active														
NE53	BURRILLVILLE	14689639	Active														
NE53	RIVERSIDE	14987214	Active	320	338	338	482	482	445	483	493	467	390	383	344	376	368
NE56	WARWICK	15583707	Active	946	804	842	1109	1007	1117	1319	1241	1128	697	716	697	835	883
NE53	PROVIDENCE	16324743	Active	2368	3222	3258	3128	2724	2251	4152	3393	4822	4082	3441	2714	3296	3389
NE53	CUMBERLAND	16514684	Active														
NE53	BURRILLVILLE	17790275	no interval data														
NE56	NORTH KINGSTOWN	17828526	Active														
NE56	NORTH KINGSTOWN	18158208	Active														
NE56	EAST GREENWICH	18409402	Active														
NE56	NORTH KINGSTOWN	18680306	Active														
NE53	WOONSOCKET	19077089	Active	2368	3222	3258	3128	2724	2251	4152	3393	4822	4082	3441	2714	3296	3389
NE53	WOONSOCKET	20306539	Active	2368	3222	3258	3128	2724	2251	4152	3393	4822	4082	3441	2714	3296	3389
NE56	NORTH KINGSTOWN	20938512	Active	7186	6152	5992	4497	4668	4732	5478	5720	5092	5813	6704	6818	8438	7693
NE53	EAST PROVIDENCE	21523061	no interval data														
NE53	PROVIDENCE	21595447	Active														
NE56	NORTH KINGSTOWN	22150502	Active	525	529	522	557	624	663	660	560	633	503	551	509	556	536
NE53	PROVIDENCE	22167629	no interval data														

Customer loads added within the past 5 years at Customers with connected load greater than 1,000 kWs, and other spot loads over 1,000 kWs																	
District Code	City/Town	Work Request Number	Notes	3/7/2013	4/3/2013	5/31/2013	6/24/2013	7/19/2013	8/21/2013	9/11/2013	10/7/2013	11/25/2013	12/17/2013	1/7/2014	2/11/2014	3/3/2014	4/7/2014
NE53	BURRILLVILLE	14689576	Active														
NE53	BURRILLVILLE	14689639	Active														
NE53	RIVERSIDE	14987214	Active	365	365	485	468	522	479	511	491	492	515	518	490	479	489
NE56	WARWICK	15583707	Active	851	910	1003	969	1320	958	1157	740	873	909	811	948	915	807
NE53	PROVIDENCE	16324743	Active	2362	3055	2934	3474	1864	3363	5050	4432		2500	2621	3371	3337	2971
NE53	CUMBERLAND	16514684	Active														
NE53	BURRILLVILLE	17790275	no interval data														
NE56	NORTH KINGSTOWN	17828526	Active														
NE56	NORTH KINGSTOWN	18158208	Active														
NE56	EAST GREENWICH	18409402	Active														
NE56	NORTH KINGSTOWN	18680306	Active														
NE53	WOONSOCKET	19077089	Active	2362	3055	2934	3474	1864	3363	5050	4432		2500	2621	3371	3337	2971
NE53	WOONSOCKET	20306539	Active	2362	3055	2934	3474	1864	3363	5050	4432		2500	2621	3371	3337	2971
NE56	NORTH KINGSTOWN	20938512	Active	7317	7008	4561	4834	5399	5168	5201	4889	8135	8164	8512	8787	8653	7040
NE53	EAST PROVIDENCE	21523061	no interval data														
NE53	PROVIDENCE	21595447	Active														
NE56	NORTH KINGSTOWN	22150502	Active	513	419	599	637	632	609	644	483	527	512	489	438	420	350
NE53	PROVIDENCE	22167629	no interval data														

Customer loads added within the past 5 years at Customers with connected load greater than 1,000 kWs, and other spot loads over 1,000 kWs																	
District Code	City/Town	Work Request Number	Notes	5/27/2014	6/26/2014	7/3/2014	8/5/2014	9/2/2014	10/15/2014	11/19/2014	12/8/2014	1/8/2015	2/16/2015	3/3/2015	4/9/2015	5/11/2015	6/23/2015
NE53	BURRILLVILLE	14689576	Active														570
NE53	BURRILLVILLE	14689639	Active														
NE53	RIVERSIDE	14987214	Active	588	567	571	593	608	611						514	640	653
NE56	WARWICK	15583707	Active	1291	1318	938	1103	1215	824		841	854			904	1200	1068
NE53	PROVIDENCE	16324743	Active	2814	3747	3417	3166	4461	4142	3272	3486	2490			3198	3490	3646
NE53	CUMBERLAND	16514684	Active														407
NE53	BURRILLVILLE	17790275	no interval data														
NE56	NORTH KINGSTOWN	17828526	Active												711	1090	1297
NE56	NORTH KINGSTOWN	18158208	Active														
NE56	EAST GREENWICH	18409402	Active														
NE56	NORTH KINGSTOWN	18680306	Active														
NE53	WOONSOCKET	19077089	Active	2814	3747	3417	3166	4461	4142	3272	3486	1126	895	986	770	654	807
NE53	WOONSOCKET	20306539	Active	2814	3747	3417	3166	4461	4142	3272	3486						
NE56	NORTH KINGSTOWN	20938512	Active	6722	6414	5619	5546	5527	5508	9009	8225					645	
NE53	EAST PROVIDENCE	21523061	no interval data														
NE53	PROVIDENCE	21595447	Active														
NE56	NORTH KINGSTOWN	22150502	Active	513	569	601	593	637	328	484	512	492				621	
NE53	PROVIDENCE	22167629	no interval data														

Customer loads added within the past 5 years at Customers with connected load greater than 1,000 kWs, and other spot loads over 1,000 kWs																	
District Code	City/Town	Work Request Number	Notes	7/20/2015	8/18/2015	9/8/2015	10/28/2015	11/30/2015	12/8/2015	1/19/2016	2/15/2016	3/4/2016	4/4/2016	5/31/2016	6/29/2016	7/26/2016	8/12/2016
NE53	BURRILLVILLE	14689576	Active	629	681	758	566	524	618	351	282	496	462	719	791		868
NE53	BURRILLVILLE	14689639	Active			647	614	644	707	655	382	569	573	758	718		625
NE53	RIVERSIDE	14987214	Active	641	684	708	497	504	498	562	560	550	553	659	680	670	674
NE56	WARWICK	15583707	Active	1361	1356	1294		813	858	908	748	783	746	942	1111	1099	1154
NE53	PROVIDENCE	16324743	Active	3827	3746	4902	3438	3162	3377	3359	3290	2481	3022	2942			
NE53	CUMBERLAND	16514684	Active	364	560	5	4	4	4	0	0	0	5	322	548	2	4
NE53	BURRILLVILLE	17790275	no interval data														
NE56	NORTH KINGSTOWN	17828526	Active	1272	1409	1306	954	891	847	689	720	717	654	963	1132	1220	763
NE56	NORTH KINGSTOWN	18158208	Active			80	161	165	176	284	295	211	228	167	179	175	202
NE56	EAST GREENWICH	18409402	Active												783	1067	1094
NE56	NORTH KINGSTOWN	18680306	Active														
NE53	WOONSOCKET	19077089	Active	717	843	833	844	812	804	910	903	939	1046	625	886	751	711
NE53	WOONSOCKET	20306539	Active			982	483	474	480	463	449	454	449	868	917	1013	1183
NE56	NORTH KINGSTOWN	20938512	Active			6000	6452	7266	7757	9769	10026	8538	8120	5837	6166	5310	5902
NE53	EAST PROVIDENCE	21523061	no interval data														
NE53	PROVIDENCE	21595447	Active														
NE56	NORTH KINGSTOWN	22150502	Active				443	413	453	425	499	488	433	614	595	661	609
NE53	PROVIDENCE	22167629	no interval data														

Customer loads added within the past 5 years at Customers with connected load greater than 1,000 kWs, and other spot loads over 1,000 kWs																
District Code	City/Town	Work Request Number	Notes	9/9/2016	10/19/2016	11/21/2016	12/15/2016	1/9/2017	2/10/2017	3/15/2017	4/4/2017	5/19/2017	6/13/2017	7/20/2017	8/22/2017	9/27/2017
NE53	BURRILLVILLE	14689576	Active	879	714	663	602	530		607	638	717	1123	992	719	765
NE53	BURRILLVILLE	14689639	Active	698	671	728	708	717		656	691	746	849	829	873	787
NE53	RIVERSIDE	14987214	Active	655	661	556	576	572		571	530	627	671	650	656	675
NE56	WARWICK	15583707	Active	1009	1213	910	957	936		774	786	1243	1530	1623	1464	1496
NE53	PROVIDENCE	16324743	Active	4769	4025	3332	3227	2485		3283	3487	3792	3716	4181		
NE53	CUMBERLAND	16514684	Active	2	445	6	9	7		1	1	8	276	5	1277	476
NE53	BURRILLVILLE	17790275	no interval data													
NE56	NORTH KINGSTOWN	17828526	Active	855	1122	541	508	682		533	623	906	1031	1079	1277	1163
NE56	NORTH KINGSTOWN	18158208	Active	186	220	313	309	417		339	276	285	255	305	244	286
NE56	EAST GREENWICH	18409402	Active	1060	1013	632	994	1053		605	611	1138	1177	1366	1446	1240
NE56	NORTH KINGSTOWN	18680306	Active	532		456	364	362		297	321	364	405	426	386	412
NE53	WOONSOCKET	19077089	Active	791	694	675	679	686		697	804	808	793	674	661	660
NE53	WOONSOCKET	20306539	Active	1041	835	508	473	491		465	496	881	1025	1008	1035	971
NE56	NORTH KINGSTOWN	20938512	Active	5690	5340	7031	8820	8850	8276	8820	7563	5457	5799	6289	5342	5711
NE53	EAST PROVIDENCE	21523061	no interval data													
NE53	PROVIDENCE	21595447	Active				30	42	72	67	143	48	297	298	258	266
NE56	NORTH KINGSTOWN	22150502	Active	647	631	460	452	515	503	466	455	733	731	771	763	
NE53	PROVIDENCE	22167629	no interval data													

Customer loads added within the past 5 years at Customers with connected load greater than 1,000 kWs, and other spot loads over 1,000 kWs						
District Code	City/Town	Work Request Number	Notes	10/10/2017	11/28/2017	12/28/2017
NE53	BURRILLVILLE	14689576	Active	744	615	366
NE53	BURRILLVILLE	14689639	Active	788	833	682
NE53	RIVERSIDE	14987214	Active	644	548	576
NE56	WARWICK	15583707	Active	1590		829
NE53	PROVIDENCE	16324743	Active		3234	
NE53	CUMBERLAND	16514684	Active	429	1	
NE53	BURRILLVILLE	17790275	no interval data			
NE56	NORTH KINGSTOWN	17828526	Active	683	764	
NE56	NORTH KINGSTOWN	18158208	Active	367	250	
NE56	EAST GREENWICH	18409402	Active	1272	727	
NE56	NORTH KINGSTOWN	18680306	Active	276	223	
NE53	WOONSOCKET	19077089	Active	656	679	700
NE53	WOONSOCKET	20306539	Active		549	536
NE56	NORTH KINGSTOWN	20938512	Active	6698	7360	7321
NE53	EAST PROVIDENCE	21523061	no interval data			
NE53	PROVIDENCE	21595447	Active		261	153
NE56	NORTH KINGSTOWN	22150502	Active	612	622	772
NE53	PROVIDENCE	22167629	no interval data			

Division 5-35

Request:

Regarding the proposed metric for the Forward Capacity Market Peak Demand Reduction:

a. Please describe the weather-normalization methodology to be used for this PIM and provide a numerical example.

b. Please provide the actual annual peak load for each of the past five years in MW, as well as the date and time of the peak.

c. Please provide the weather-normalized annual peak load for each of the past five years.

d. Please provide the reductions in annual peak load from the past five years due to energy efficiency, storage, DG, VVO, and Demand Response. Where possible, please provide the reductions separately, by technology.

Response:

a. For the weather-normalization process, the Company uses a "Daily" regression-based model that includes each of the days in the summer period for the current year. The daily peaks are regressed against a weather variable as well as other categorical variables, including day of the week or holiday. Outliers can also be added, if appropriate. The preference is to use only the current summer's data as input to avoid other extraneous factors, such as year-to-year changes in load, from being introduced. However, this concern is balanced against the need to also have a sufficient range of warm weather to capture weather impacts appropriately. Therefore, in cooler years such as 2017, other prior years are introduced. In those cases, a "dummy" variable is tested that accounts for year to year changes, if any.

   The weather variable is a weighted temperature-humidity index (WTHI) that captures the impacts of multi-day heat waves. The weighting is 70% day of peak, 20% day prior, and 10% two days prior. Before running the model, a normalized value for this weather variable is derived by taking the average of this value at the time of the last 20 summer peak loads on the days of the Company peaks. This becomes the "normal" WTHI. The relevant weather station for the service territory used is Providence.

   The regression model is run and the coefficient on the weather variable becomes the weather adjustment to be made. The form of the adjustment is:

   Adjustment = (WTHI normal – WTHI actual) * WTHI coefficient

This weather adjustment becomes the MWs added to the actual Company peak MWs at the day/time of the peak. In the model runs, only those days above 70 WTHI were used to develop the model for the higher of the weather range since those are the days that the peaks typically occur.

The following is a numerical example based on this past 2017 weather-normalization calculation.

For 2017, the peak occurred on July 20 and was 1,688.2 MW. The actual WTHI on that day was 81.65. The weather-normal value was 82.22. The WTHI weather coefficient based on the daily model was 61.53. Thus, for summer 2017, the weather-normalized (w/n) peak was:

w/n peak = Actual Peak + [(WTHI normal – WTHI actual) * WTHI coefficient]

w/n peak = 1,688.2 + [(82.22 - 81.65) * 61.53]

w/n peak = 1,688.2 + [0.57 * 61.53]

w/n peak = 1,688.2 + 35.07

w/n peak = 1,727.3 MW

The full model for 2017 based on the daily model summarized above was:

WTHI_max:	61.53	WTHI coeff used in numerical example
year 2013:	58.51	year 2013 added to model because 2017 was a cooler than normal summer
Saturday:	-130.97	weekend day
Sunday:	-127.96	weekend day
July 4, 2013:	-178.27	holiday
July 4, 2017:	-184.37	holiday
June 1, 2013:	-163.07	outlier
June 2, 2013:	-200.29	outlier
Intercept:	-3,308.52	intercept of regression model

The Company wishes to make a correction to Schedule PST – 1, Chapter 9, Page 8 (Bates Page 169 of PST Book 1), which did not correctly describe the methodology detailed above. The Company wrote, "To control for weather variations, the Company proposes to normalize the peak for the average weather for the past 10 annual peak days." Instead,

the sentence should read, "To control for weather variations, the Company proposes to normalize the peak for the average weather for the past 20 annual peak days."

b. Attachment DIV 5-35-1 provides the actual annual peak load for each of the past five years in MW, as well as the date and time of the peak.

c. Attachment DIV 5-35-1 provides the weather-normalized annual peak load for each of the past five years.

d. Attachment DIV 5-35-2 provides the reductions in annual peak load from the past five years due to energy efficiency, distributed generation (photovoltaic), and demand response. The Company does not have data on peak load reductions due to storage and Volt/VAR optimization (VVO) over this timeframe.

(This response is identical to the Company's response to Division 1-35 in Docket No. 4780.)

Year	Peak MW (actual)	Peak MW (weather-normal)	Date	Hour-ending
2013	1,965.4	1,965.4	7/19/2013	15
2014	1,652.9	1,652.9	9/2/2014	16
2015	1,737.6	1,737.6	7/20/2015	15
2016	1,802.9	1,802.9	8/12/2016	16
2017	1,688.2	1,688.2	7/20/2017	16

CUMULATIVE DER REDUCTIONS (MW)

Year	EE Reduction	PV Reduction	Demand Response
2013	148	2	12
2014	187	4	0
2015	220	5	0
2016	250	7	0
2017	279	16	0

Division 5-35 CORRECTED

Request:

Regarding the proposed metric for the Forward Capacity Market Peak Demand Reduction:

a. Please describe the weather-normalization methodology to be used for this PIM and provide a numerical example.

b. Please provide the actual annual peak load for each of the past five years in MW, as well as the date and time of the peak.

c. Please provide the weather-normalized annual peak load for each of the past five years.

d. Please provide the reductions in annual peak load from the past five years due to energy efficiency, storage, DG, VVO, and Demand Response. Where possible, please provide the reductions separately, by technology.

Response:

a. For the weather-normalization process the Company uses a "Daily" regression based model that includes each of the days in the summer period for the current year. The daily peaks are regressed against a weather variable as well as other categorical variables including day of the week or holiday. Outliers can also be added if appropriate. The preference is to use only the current summer's data as input in order to avoid other extraneous factors such as year-to-year changes in load from being introduced. However, this concern is balanced against the need to also have a sufficient range of warm weather to capture weather impacts appropriately. Therefore, in cooler years such as 2017, other prior years are introduced. In those cases, a 'dummy' variable is tested that accounts for year to year changes, if any.

The weather variable is a weighted temperature-humidity index (WTHI) that captures the impacts of multi-day heat waves. The weighting is 70% day of peak, 20% day prior and 10% two days prior. Before running the model, a normalized value for this weather variable is derived by taking the average of this value at the time of the last 20 summer peak loads on the days of the Company peaks. This becomes the 'normal' WTHI. The relevant weather station for the service territory used is Providence.

The regression model is run and the coefficient on the weather variable becomes the weather adjustment to be made. The form of the adjustment is:

Adjustment = (WTHI normal – WTHI actual) * WTHI coefficient

This weather adjustment becomes the MWs added to the actual Company peak MWs at the day / time of the peak. In the model runs, only those days above 70 WTHI were used to develop the model for the higher of the weather range since those are the days that the peaks typically occur.

The following is a numerical example based on this past 2017 weather-normalization calculation. For 2017, the peak occurred on July 20th and was 1,688.2 MW. The actual WTHI on that day was 81.65. The weather-normal value was 82.22. The WTHI weather coefficient based on the daily model was 61.53. Thus, for summer 2017, the weather-normalized (w/n) peak was:

w/n peak = Actual Peak + [(WTHI normal – WTHI actual) * WTHI coefficient]

w/n peak = 1,688.2 + [(82.22 - 81.65) * 61.53]

w/n peak = 1,688.2 + [0.57 * 61.53]

w/n peak = 1,688.2 + 35.07

w/n peak = 1,727.3 MW

The full model for 2017 based on the daily model summarized above was:

WTHI_max:	61.53	WTHI coeff used in numerical example
year 2013:	58.51	year 2013 added to model b/c 2017 cooler than normal summer
Saturday:	-130.97	weekend day
Sunday:	-127.96	weekend day
July 4, 2013:	-178.27	holiday
July 4, 2017:	-184.37	holiday
June 1, 2013:	-163.07	outlier
June 2, 2013:	-200.29	outlier
Intercept:	-3,308.52	intercept of regression model

The Company wishes to make a correction to Schedule PST – 1 Chapter 9, page 8, which did not correctly describe the methodology detailed above. The Company wrote, "To control for weather variations, the Company proposes to normalize the peak for the average weather for the past 10 annual peak days." Instead, the sentence should read, "To control for weather variations, the Company proposes to normalize the peak for the average weather for the past 20 annual peak days."

b. Attachment DIV 5-35-1 provides the actual annual peak load for each of the past five years in MW, as well as the date and time of the peak.

c. Attachment DIV 5-35-1 provides the weather-normalized annual peak load for each of the past five years.

In this Corrected response, the Company wishes to correct the weather-normalized annual peak load values that were included in subpart (c), Attachment DIV 5-35-1. Attachment DIV 5-35-1 CORRECTED provides the corrected weather-normalized annual peak loads for the past five years.

d. Attachment DIV 5-35-2 provides the reductions in annual peak load from the past five years due to energy efficiency, DG (PV) and Demand Response. The Company does not have data on peak load reductions due to storage and VVO over this timeframe.

(As corrected, this response is identical to the Company's response to Division 1-35 in Docket No. 4780.)

year	Peak MW (actual)	Peak MW (weather-normal)	Date	Hour-ending
2013	1,965.4	1,817.4	7/19/2013	15
2014	1,652.9	1,810.5	9/2/2014	16
2015	1,737.6	1,850.5	7/20/2015	15
2016	1,802.9	1,777.9	8/12/2016	16
2017	1,688.2	1,723.3	7/20/2017	16

CUMULATIVE DER REDUCTIONS (MW)

Year	EE Reduction	PV Reduction	Demand Response
2013	148	2	12
2014	187	4	0
2015	220	5	0
2016	250	7	0
2017	279	16	0

Division 5-36

Request:

Refer to Workpaper 9.4 – Incentive Benefits, page 2 of 5. Please provide the calculations used to derive the annual capacity benefits from the peak targets (in MW) in as a machine-readable Excel file.

Response:

Attachment DIV 5-36-1 and Attachment DIV 5-36-2 provide machine-readable Excel versions of Workpaper 9.4 – Incentive Benefits, Pages 1 and 2, respectively. Attachment DIV 5-36-1 is included with Attachment DIV 5-36-2 so that the inputs and assumptions included in the calculation are transparent.

(This response is identical to the Company's response to Division 1-36 in Docket No. 4780.)

Benefits and Savings Comparisons for PIMs

Key Inputs and Assumptions	**Source/Notes**	**Values**								
Discount Rate:	Company WACC	0.075								
Value of a Basis Point:	Revenue Requirements Calculations									
			2019	2020	2021					
			$ 59,493	$ 60,526	$ 63,602					
RNS Transmission Rate	RNS rate 6/1/17-5/31 2018, assumed for 2019-2021	110.35	kW-yr							
		9.20	kW-month							
Avoided Unit Cost of Electric Capacity	AESC 2015 Update - Appendix B	Below	$/MW-yr							

2018	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
$ -	$ -	$ -	$ -	$ 151,748	$ 145,443	$ 154,497	$ 173,685

FCM Savings and Value of Incentive Comparision

FCM Peak Tarkets (MW reduced, year over year)

Targets	2019	2020	2021	Basis Points
	22	18	19	6
	29	26	26	12
	38	31	31	18

FCM Peak Targets expressed as MW reductions relative to Company forecast including EE and solar impacts
Note: these values were used for calculating FCM benefits

Targets	2019	2020	2021
	7	13	25
	13	27	46
	22	42	65

Annual Capacity Benefits	**2018**	**2019**	**2020**	**2021**	**2022**	**NPV**
Min	0	0	0	0	$ 3,724,200	$ 2,594,124
Target	0	0	0	0	$ 6,914,005	$ 4,816,010
Max	0	0	0	0	$ 9,908,105	$ 6,901,576

Annual Value of Incentive at Target Levels

	2018	**2019**	**2020**	**2021**	**2022**	**NPV**
Min	0	$ 356,961	$ 363,159	$ 381,613		$ 886,970
Target	0	$ 713,921	$ 726,317	$ 763,227		$ 1,773,940
Max	0	$ 1,070,882	$ 1,089,476	$ 1,144,840		$ 2,660,910

Present Value of 2021 Incentive

2018	**2019**	**2020**	**2021**	**2022**	**NPV**
0	0	0	$ 381,613		$ 285,752
0	0	0	$ 763,227		$ 571,505
0	0	0	$ 1,144,840		$ 857,257

Division 5-37

Request:

Regarding the EV Off-Peak Charging Rebate Participation incentive mechanism:

a. Please explain how off-peak EV charging will be measured. Will an advanced meter be required, or will the Company rely on a different technology?

b. If the Company will rely on a different technology to measure off-peak charging, please describe the technology, the cost of the technology, and who will bear the cost of purchasing and installing the technology.

c. Please explain how target participation levels will be developed. Will the target participation level be based on a percentage of EV sales in Rhode Island, or some other metric?

Response:

a. The Company is considering several alternatives to advanced meters for obtaining data on a vehicle's off-peak charging load, including but not limited to: WiFi-connected home chargers/electric vehicle supply equipement, WiFi-connected circuit monitoring devices, measurement devices that capture data from the vehicle's onboard diagnostics port, or obtaining charging data from automakers collected via existing electric vehicle on-board telematics. As the Company moves forward with an advanced metering deployment over time, the Company would explore the possibility of disaggregating electric vehicle charging load from an advanced meter.

b. The Company is seeking a low-cost solution that will provide the best value to the customer and the Company. As the Company has not yet determined the method it will use, the Company does not know the cost of the solution. For the purposes of the Pilot, the Company expects to bear all or most of the cost of the solution.

c. The Company's annual participation target is provided in Table 9-4 of Schedule PST-1, Chapter 9-Performance (Bates Page 171 of PST Book 1), shown below for ease of reference.

Table 9-4: EV Off-Peak Rebate Participation Targets and Basis Points

Number of participants				
	2019	2020	2021	Basis Points
Minimum	80	188	400	2
Target	100	250	500	2.5
Maximum	120	300	600	3

The target is not based on a percentage of electric vehicle sales in Rhode Island, but was set by the Company to obtain a meaningful sample of the State's electric vehicle drivers while managing the overall cost of the program. The proportion of electric vehicle drivers participating in the Pilot will depend on electric vehicle sales; 500 vehicles would represent approximately 12 percent of the 2021 forecast of 4,225 vehicles provided by the Company in Workpaper 9.3 (Bates Page 3 of PST Book 3), a copy of which is provided as Attachment DIV 5-42-1).

For the purposes of earning an incentive, the minimum target allows the Company to start to earn an incentive when it approaches 80 percent of the target participation level for the year; the maximum allows earnings to increase for participation up to 120 percent of the participation target if the Company find implementation efficiencies that enable enrollment beyond funded target levels.

(This response is identical to the Company's response to Division 1-37 in Docket No. 4780.)

Division 5-38

Request:

Regarding DG-Friendly Substation Transformers:

a. Please describe the conditions under which ground fault detection is needed to integrate DG.

b. Please identify the number of substation transformers that currently experience the conditions described in (a).

c. Please identify the number of substation transformers that are projected to experience the conditions described in (a), and when such conditions are expected to first occur.

d. Please provide the number of substation transformers that already have ground fault detection (3V0) installed and are capable of readily accommodating distributed generation.

e. Please provide the number of substation transformers that were installed with ground fault detection (3V0) each year for the past five years.

f. For each substation, please provide the number and capacity (MW) of DG installations, and identify whether the substation already has ground fault detection installed, or when installation is planned.

Response:

a. The addition of distributed generation (DG) to distribution feeders can result in the flow of power in the reverse direction on feeders and, at times, the substation transformer, effectively turning a station transformer (designed to step transmission voltage down to distribution voltage for serving load) into a generation step-up transformer pushing excess power onto the transmission system. Protection of a transmission side ground fault overvoltage on power transformer equipment from any source on the secondary side is a National Grid standard practice. With certain transformer connection types and certain fault conditions, the distributed generation cannot "see" the fault and can remain islanded for a short period of time contributing to overvoltage conditions. To protect against ground faults with secondary source connections, zero sequence overvoltage (3V0) protection equipment is required.

b. As a result of aggregated DG, 3V0 protection is required, has been installed, or is in the process of being installed at seven substations.

c. Twelve substations have been identified with in-queue DG applications projected to result in the potential for reverse power flow. The condition requiring the protection scheme is the aggregated connection of the in-queue DG creates the potential for conditions described in part a. Since the decision on whether an in-queue DG installation proceeds, as well as the quantity, capacity, location, and type of new DG applications are out of the Company's control, the timing of the condition is difficult to predict. However, the Company expects that aggregated DG interconnections will mean that 3V0 protection is required on these twelve substations within two to six years.

d. Six substations have ground fault sensing and are capable of readily accommodating distributed generation.

e. Over the past five years, one substation transformer was installed with ground fault detection (Chase Hill, 2017).

f. Attachment DIV 5-38 shows the capacity of DG installations, ground fault detection details, and when 3V0 installation is planned.

Substation	DG kWs	Notes	Subpart	Projected 3V0 in-service Date
Chopmist	33969	3V0/protection installed or in progress	b	T1, T3 - existing, T2 - TBD
Coventry	7417	3V0/protection installed or in progress	b	2018
Dexter	12818	3V0/protection installed or in progress	b	2020
Kenyon	12064	3V0/protection installed or in progress	b	2018
Kilvert St	9838	3V0/protection installed or in progress	b	T2 - 2018, T1 - 2020
West Cranston	17023	3V0/protection installed or in progress	b	2019
Wood River	34205	3V0/protection installed or in progress	b	2019
Hopkins Hill	9311	3V0 proposed or pending	c	2020
Lafayette	2228	3V0 proposed or pending	c	2023
Nasonville	7803	3V0 proposed or pending	c	TBD
Old Baptist Road	3251	3V0 proposed or pending	c	T2 - 2018, T1 - 2020
Peacedale	4819	3V0 proposed or pending	c	2021
Point Street	5397	3V0 proposed or pending	c	2022
Pontiac	938	3V0 proposed or pending	c	2021
Quonset	7200	3V0 proposed or pending	c	2022
Riverside	3187	3V0 proposed or pending	c	2023
Staples	7157	3V0 proposed or pending	c	2021
Tiverton	7539	3V0 proposed or pending	c	2019
Warwick Mall	756	3V0 proposed or pending	c	2023
Davisville	14838	Existing ground fault sensing	d	existing
Drumrock	21321	Existing ground fault sensing	d	existing
Johnston	29914	Existing ground fault sensing	d	existing
Kent County	8025	Existing ground fault sensing	d	existing
West Kingston	6880	Existing ground fault sensing	d	existing
Woonsocket	7640	Existing ground fault sensing	d	existing
Chase Hill	3506	Completed new substation (3V0/protection included)	e	existing
Admiral Street (12kV)	NA	Pending new/rebuild (3V0/protection to be included)		2025
Anthony	673			TBD
Auburn (12kV)	NA	Pending new/rebuild (3V0/protection to be included)		2028
Bonnet	104			TBD
Bristol	477			TBD
Central Falls	7			TBD
Centredale	51			TBD
Clarke Street	157			TBD
Clarkson Street	523			TBD
Division St	1903			TBD
Dyer Street	122			TBD
East George St	57			TBD
East Providence	NA	Pending new/rebuild (3V0/protection to be included)		2022
Eldred	290			TBD
Elmwood	180			TBD
Farnum	60			TBD
Farnum Pike	2695			TBD
Gate Two	567			TBD
Harrison	105			TBD
Highland Park	260			TBD
Hope	643			TBD
Hospital	49			TBD
Hunt River	129			TBD
Jepson	30807	Pending new/rebuild (3V0/protection to be included)		2021
Kingston	72			TBD
Knightsville	55			TBD
Langworthy Corner	166			TBD
Lincoln Avenue	321			TBD
Lippitt Hill	273			TBD

Substation	DG kWs	Notes	Subpart	Projected 3V0 in-service Date
Manton	132			TBD
Merton	7			TBD
Natick	67			TBD
New London Ave	NA	Pending new/rebuild (3V0/protection to be included)		2018
Newport	NA	Pending new/rebuild (3V0/protection to be included)		2020
Pawtucket 1	1643			TBD
Pawtucket 2	20			TBD
Putnam Pike	2851			TBD
Shun Pike	NA			TBD
Southeast (13kV)	NA	Pending new/rebuild (3V0/protection to be included)		2022
Tiogue Ave	44			TBD
Tower Hill	4888			2018
Valley	1151			TBD
Wakefield	380			TBD
Wampanoag	2485			TBD
Warren	941			TBD
Warwick	218			TBD
Washington	4358			TBD
West Greenville	108			TBD
West Howard	24			TBD
Westerly	291			TBD

Division 5-39

Request:

Regarding the Company's Connected Solutions program:

a. Please provide the average annual number of residential customers participating in the Connected Solutions program for each of the last five years.

b. For each high energy demand event over the last five years, please provide the MW reductions attributed to the Connected Solutions program.

c. Please provide the average kW reduction per high energy demand event per residential customer attributed to the Connected Solutions program.

d. Please provide the program costs by major cost category, exclusive of customer incentives, for each of the past five years.

Response:

a. The Company has run residential demand response programs in 2016 and 2017. In 2016, there were 333 participants, and in 2017 there were 930 participants.

b. The estimated MW curtailment for each residential demand response event is shown below. Please note that, for evaluation purposes in 2017, the population of thermostats was divided into treatment groups and control groups. The effect is that only half of the populations of thermostats were called for curtailment during any single event during 2017.

Date of Demand Response Event	Curtailment (MW)
7/6/2016	0.04
7/7/2016	0.04
7/8/2016	0.04
7/12/2016	0.05
7/13/2016	0.05
7/14/2016	0.05
7/15/2016	0.05
7/18/2016	0.05
7/22/2016	0.06
7/25/2016	0.06

Prepared by or under the supervision of: Meghan McGuinness and Timothy R. Roughan

Date of Demand Response Event	Curtailment (MW)
7/26/2016	0.06
7/27/2016	0.06
8/8/2016	0.08
8/10/2016	0.08
8/11/2016	0.08
8/12/2016	0.08
8/15/2016	0.08
8/16/2016	0.08
8/17/2016	0.08
8/18/2016	0.08
8/19/2016	0.08
8/24/2016	0.08
8/26/2016	0.08
8/29/2016	0.09
8/31/2016	0.09
9/6/2016	0.09
9/8/2016	0.09
9/14/2016	0.10
9/19/2016	0.10
9/20/2016	0.10
9/22/2016	0.11
9/23/2016	0.11
7/12/2017	0.18
7/17/2017	0.23
7/18/2017	0.23
7/20/2017	0.24
7/21/2017	0.24
7/31/2017	0.25
8/1/2017	0.25
8/16/2017	0.26
8/21/2017	0.27
8/22/2017	0.27
9/25/2017	0.27

c. The average kW reduction per residential customer is evaluated to be 0.5 kW per event.

d. Program costs, exclusive of customer incentives, are shown below.

Major Cost Category	2016	2017
Program Planning and Administration, Marketing, and Evaluation	$46,772	$128,584
Sales, Technical Assistance, and Training	$25,444	$119,146
	$72,216	$247,729

(This response is identical to the Company's response to Division 1-39 in Docket No. 4780.)

Division 5-39 CORRECTED

Request:

Regarding the Company's Connected Solutions program:

a. Please provide the average annual number of residential customers participating in the Connected Solutions program for each of the last five years.

b. For each high energy demand event over the last five years, please provide the MW reductions attributed to the Connected Solutions program.

c. Please provide the average kW reduction per high energy demand event per residential customer attributed to the Connected Solutions program.

d. Please provide the program costs by major cost category, exclusive of customer incentives, for each of the past five years.

Corrected Response:

a. The Company has run residential demand response programs in 2016 and 2017. In 2016, there were 333 participants, and in 2017 there were 930 participants.

b. The estimated MW curtailment for each residential demand response event is shown below. Please note that, for evaluation purposes in 2017, the population of thermostats was divided into treatment groups and control groups. The effect is that only half of the populations of thermostats were called for curtailment during any single event during 2017.

Date of Demand Response Event	Curtailment (MW)
7/6/2016	0.04
7/7/2016	0.04
7/8/2016	0.04
7/12/2016	0.05
7/13/2016	0.05
7/14/2016	0.05
7/15/2016	0.05
7/18/2016	0.05

Prepared by or under the supervision of: Meghan McGuinness and Timothy R. Roughan

Date of Demand Response Event	Curtailment (MW)
7/22/2016	0.06
7/25/2016	0.06
7/26/2016	0.06
7/27/2016	0.06
8/8/2016	0.08
8/10/2016	0.08
8/11/2016	0.08
8/12/2016	0.08
8/15/2016	0.08
8/16/2016	0.08
8/17/2016	0.08
8/18/2016	0.08
8/19/2016	0.08
8/24/2016	0.08
8/26/2016	0.08
8/29/2016	0.09
8/31/2016	0.09
9/6/2016	0.09
9/8/2016	0.09
9/14/2016	0.10
9/19/2016	0.10
9/20/2016	0.10
9/22/2016	0.11
9/23/2016	0.11
7/12/2017	0.18
7/17/2017	0.23
7/18/2017	0.23
7/20/2017	0.24
7/21/2017	0.24
7/31/2017	0.25
8/1/2017	0.25
8/16/2017	0.26
8/21/2017	0.27

Date of Demand Response Event	Curtailment (MW)
8/22/2017	0.27
9/25/2017	0.27

c. The average kW reduction per residential customer is evaluated to be 0.5 kW per event.

d. Program costs, exclusive of customer incentives, are shown below.

Major Cost Category	2016	2017
Program Planning and Administration, Marketing, and Evaluation	$46,772	$128,584
Sales, Technical Assistance, and Training	$25,444	$119,146
	$72,216	$247,729

In this corrected response, the Company wishes to correct its response to Division 5-39, part d. above. The corrected program costs, exclusive of customer incentives, are shown below.

Major Cost Category	2016	2017
Program Administration, Marketing, and Evaluation	$98,564	$304,916
Sales, Technical Assistance, and Training	$9,226	$96,183
	$107,790	$401,099

(This response is identical to the Company's response to Division 1-39 (CORRECTED) in Docket No. 4780.)

Division 5-40

Request:

Regarding the Company's C&I demand response programs:

a. Please describe each of the Company's C&I demand response programs.

b. Please provide the average annual number of commercial and industrial customers, separately, participating in the Company's C&I demand response programs.

c. Please provide the historical MW capacity enrolled in the Company's C&I demand response programs.

d. Please provide the historical MW reductions achieved via the Company's C&I demand response programs.

e. Please provide the program costs by major cost category, exclusive of customer incentives, for each of the past five years.

f. Are demand reductions attributable to this program included in the Company's baseline forecast of peak demand?

Response:

The Company has one demand response program for commercial and industrial (C&I) customers; the program opened and ran for the first time in summer of 2017. The responses provided below are based on that single year of results for the program.

a. The Company's demand response program for C&I customers aims to help customers reduce their energy use when the grid is at peak demand.

The Company and its vendors help customers to identify strategies and technologies that will help customers to reduce their energy use at peak times. Through a competitive request for proposal (RFP) process, the Company has selected three approved curtailment service providers to guide customers through this process. Through another competitive RFP process, the Company has procured a demand response management system to identify when the grid will be at peak, notify vendors and customers of peak events, and measure each customer's reduction in energy use during demand response events.

The program is set up to run in June, July, August, and September of each program year. The Company may call demand response events on any weekday (except holidays)

between the hours of 2:00 PM to 5:00 PM. On average, three to five demand response events will be called every year. The Company will not call more than seven events in a single year.

Customers and vendors receive incentives paid for via the energy efficiency program budget based on their performance. The vendors and customers split the incentive amounts based on negotiations between the customers in the vendor. However, historically customers have always received the majority of the incentives paid.

b. 32 customers were enrolled in the C&I Demand Response program for 2017. The breakdown of C&I customers is as follows:

Segment	# of Customers
Industrial	8
Grocery	6
Retail	5
School	5
Hotel	2
Municipal	2
Commercial	2
Restaurant	1
Hospital	1
Total	**32**

c. A total of 6.7 MW of capacity was enrolled in the C&I demand response program in 2017. Please see the table below for the breakout of curtailment commitments by industry segment.

Segment	# of Customers	Curtailment Commitment (kW)
Industrial	8	3,430
Grocery	6	240
Retail	5	430
School	5	1,400
Hotel	2	125
Municipal	2	275
Commercial	2	400
Restaurant	1	75
Hospital	1	300
Total	**32**	**6,675**

Prepared by or under the supervision of: Meghan McGuinness and Timothy R. Roughan

d. During the 2017 program year, customers curtailed an average of 10.6 MW per demand response event.

e. 2017 program costs by major cost category are as follows:

Major Cost Category	Amount Spent in 2017
Program Planning and Administration/Marketing/Evaluation	$12,750
Sales Technical Assistant Training (STAT)	$97,060
	$109,810

f. The demand reductions attributable to this program are not included in the Company's baseline forecast of peak demand as 2017 was the first program year, and the program is still in a demonstration phase.

(This response is identical to the Company's response to Division 1-40 in Docket No. 4780.)

Division 5-41

Request:

Regarding the Company's ground source heat pump and equipment incentives being offered under the Electric Heat Initiative:

a. Please provide the annual number of customers, by rate schedule, that have used the Company's ground source heat pump and equipment incentives for the past five years;

b. Please provide the annual CO2 reductions attributed to the ground source heat pump and equipment incentives for the past five years.

c. Please provide the average per customer CO2 reductions, by customer class, attributed to the ground source heat pump and equipment incentives for the past five years.

d. Are demand reductions attributable to these programs included in the Company's baseline forecast of peak demand?

Response:

The Electric Heat Initiative described in Chapter Six of the Company's PST Plan (Bates Pages 120-135 of PST Book 1) is a new program for consideration under Docket No. 4780. The Company does not currently offer ground source heat pump and equipment incentives and has not offered them within the last five years.

(This response is identical to the Company's response to Division 1-41 in Docket No. 4780.)

Prepared by or under the supervision of: Mackay Miller

Division 5-42

Request:

Regarding Electric Vehicles:

a. Please provide the data and calculations used to derive the 2018 – 2021 forecasts for EV registrations in Workpaper 9.3 – Electric Vehicle Targets in machine-readable format.

b. Has the Company or its consultants developed any other forecasts of EV Sales Growth? If yes, please provide such forecasts.

Response:

a. Attachment DIV 5-42-1 provides a machine readable version of Workpaper 9.3, and includes the calculations and data used to derive the 2018-2021 forecasts for EV registrations in the Company's service territory. Attachment DIV 5-42-2 contains the data from the Energy Information Administration's 2017 Annual Energy Outlook that the Company used to calculate the assumed growth rates in electric vehicle sales. These calculations are included in Attachment DIV 5-42-1.

b. Attachment DIV 5-42-3 provides an Excel file of the electric vehicle growth scenarios for Rhode Island constructed by the Company's Electric Forecasting group.

(This response is identical to the Company's response to Division 1-42 in Docket No. 4780.)

Prepared by or under the supervision of: Carlos Nouel

Electric Vehicles Target Calculation

Registered EVs in Company's RI Territory -- Summary of Polk Data as of 10/31/17

Row Labels	2010	2011	2012	2013	2014	2015	2016	2017 YTD	2018	2019	2020	2021
BEV(PEV)				32	41	117	193	293				
HEV(PHEV)				178	182	413	538	733				
HV(NP_HEV)				8669	9070	10425	10985	11613				
Grand Total				8879	9293	10955	11716	12639				
Cumulative EV Registrations with Projections Based on AEO 2017 EV Sales Growth for New England									*Forecast*			
BEV				32	41	117	193	293	463	706	1,049	1,537
PHEV				178	182	413	538	733	1,041	1,448	1,983	2,688
Total Ev				210	223	530	731	1026	1,505	2,153	3,032	4,225
Annual New BEV Registrations					9	76	76	100				
Annual New PHEV Registrations					4	231	125	195				
Annual New EV Registrations Total					13	307	201	295	*479*	*648*	*879*	*1,193*

Annual New Registrations

	Actual			*Forecast (includes annualized YTD number for 2017)*			
BEVs - Incremental	2015	2016	**2017**	**2018**	**2019**	**2020**	**2021**
Actuals and Forecast	76	76	120	170	242	344	488

	Actual			*Forecast (includes annualized YTD number for 2017)*			
PHEVs - Incremental	2015	2016	**2017**	**2018**	**2019**	**2020**	**2021**
Actuals and Forecast	231	125	234	308	406	535	705

Growth Assumptions Based on AEO 2017	
(CAGR of EV Sales, New England, 2017-2021)	
BEV	0.419903375
PHEV	0.317319663
Total	0.367908739

New registrations target based adjustment of forecast (includes forecast)

	2019	**2020**	**2021**	
Min	778	1,055	1,432	120% of forecast prediction
Target	908	1,230	1,670	140% of forecast prediction
Max	1,167	1,582	2,148	180% of forecast prediction

Incremental Annual New Registrations (above forecast)

	2019	**2020**	**2021**	
Min	130	176	239	120% of forecast prediction
Target	259	352	477	140% of forecast prediction
Max	519	703	954	180% of forecast prediction

Light-Duty Vehicle Sales by Technology Type

https://www.eia.gov/outlooks/aeo/data/browser/#/?id=48-AEO2017&region=1-1&cases=ref2017

Source: U.S. Energy Information Administration

	units	2017	2018	2019	2020	2021
New Car Sales						
Conventional Cars						
Gasoline ICE Vehicles	thousands	245.3124	223.2413	215.6049	212.4081	210.0028
TDI Diesel ICE	thousands	0.403223	0.710639	1.017644	1.570167	1.990506
Total Conventional Cars	thousands	245.7156	223.9519	216.6226	213.9783	211.9933
Alternative-Fuel Cars						
Ethanol-Flex Fuel ICE	thousands	9.514113	7.789683	7.540799	7.614345	7.716037
100 Mile Electric Vehicle	thousands	1.094409	1.303109	1.978409	2.561116	3.247332
200 Mile Electric Vehicle	thousands	2.539362	2.791365	4.916884	8.17848	12.14679
Plug-in 10 Gasoline Hybrid	thousands	2.104098	3.300079	3.636943	4.28946	5.635622
Plug-in 40 Gasoline Hybrid	thousands	1.646258	4.40154	5.045798	6.273098	7.514267
Electric-Diesel Hybrid	thousands		0.001902	0.005944	0.011678	0.076873
Electric-Gasoline Hybrid	thousands	13.6175	20.98451	19.41527	20.31549	21.98807
Natural Gas ICE	thousands	1.391074	1.71979	1.800127	1.860192	1.957308
Natural Gas Bi-fuel	thousands	0.631805	0.60987	0.600014	0.605743	0.624864
Propane ICE	thousands	0.055894	0.053772	0.052171	0.052782	0.054229
Propane Bi-fuel	thousands	0.103563	0.099738	0.097747	0.098992	0.102187
Fuel Cell Gasoline	thousands					
Fuel Cell Methanol	thousands					
Fuel Cell Hydrogen	thousands	0.121787	0.265925	0.563699	0.892304	1.254311
Total Alternative Cars	thousands	32.81986	43.32129	45.6538	52.75368	62.31789
Percent Alternative Car Sales	percent	11.78301	16.20862	17.40675	19.77778	22.71796
Total New Car Sales	thousands	278.5355	267.2732	262.2764	266.732	274.3112
New Light Truck Sales						
Conventional Light Trucks						
Gasoline ICE Vehicles	thousands	359.5293	362.2998	342.729	333.5076	331.23
TDI Diesel ICE	thousands	7.811819	7.589931	9.152342	9.673575	10.57613
Total Conventional Light Trucks	thousands	367.3411	369.8897	351.8813	343.1812	341.8062

	units	2017	2018	2019	2020	2021
Alternative-Fuel Light Trucks						
Ethanol-Flex Fuel ICE	thousands	86.46133	87.50911	83.4101	81.68643	81.81944
100 Mile Electric Vehicle	thousands	0.512036	0.430872	0.78186	1.186205	1.651247
200 Mile Electric Vehicle	thousands	0.365282	0.267344	0.567071	0.908739	1.291141
Plug-in 10 Gasoline Hybrid	thousands	0.837852	0.885082	1.032687	1.220441	1.416842
Plug-in 40 Gasoline Hybrid	thousands	0.600115	0.55019	0.69904	0.863288	1.057247
Electric-Diesel Hybrid	thousands		0.007744	0.017467	0.033397	0.053351
Electric-Gasoline Hybrid	thousands	1.626752	2.533567	2.555374	2.629725	2.743826
Natural Gas ICE	thousands	1.3688	1.744764	1.815617	1.864552	1.953911
Natural Gas Bi-fuel	thousands	0.813302	0.824459	0.787703	0.76754	0.771034
Propane ICE	thousands	0.44714	0.447117	0.428271	0.414801	0.416111
Propane Bi-fuel	thousands	2.133735	2.184631	2.09107	2.012971	2.029492
Fuel Cell Gasoline	thousands					
Fuel Cell Methanol	thousands					
Fuel Cell Hydrogen	thousands	0.121773	0.265906	0.563667	0.892229	1.254212
Total Alternative Light Trucks	thousands	95.28812	97.6508	94.74993	94.48032	96.45785
Percent Alternative Light Truck S	percent	20.59708	20.88606	21.21435	21.58753	22.00907
Total New Light Truck Sales	thousands	462.6292	467.5405	446.6313	437.6615	438.264
Percent Total Alternative Sales	percent	17.28469	19.18474	19.80564	20.90224	22.28196
EPACT Legislative Alternative Sa	thousands	10.64861	10.56436	11.20802	12.52693	14.40896
ZEVP Legislative Alternative Sale	thousands					
Total Sales	48-AEO2017.58.					
Conventional Gasoline	thousands	604.8417	585.5411	558.3339	545.9157	541.2328
TDI Diesel	thousands	8.215042	8.30057	10.16999	11.24374	12.56664
Flex-Fuel	thousands	95.97545	95.2988	90.95091	89.30077	89.53548
Electric	thousands	4.51109	4.792689	8.244225	12.83454	18.33651
Plug-in Electric Hybrid	thousands	5.188322	9.136891	10.41447	12.64629	15.62398
Electric Hybrid	thousands	15.24425	23.52773	21.99405	22.99029	24.86212
Gaseous (Propane and Natural G	thousands	6.945313	7.684141	7.67272	7.677574	7.909138
Fuel Cell	thousands	0.24356	0.53183	1.127366	1.784533	2.508523
Total Vehicles Sales	thousands	741.1647	734.8137	708.9077	704.3935	712.5752
Conventional Gasoline Microhyb	thousands	35.92984	38.64515	48.41894	57.77042	80.54247
TDI Diesel Microhybrids	thousands	0.418091	0.477066	0.723614	1.031093	1.670921
Total Alternative-Fueled Vehicle	thousands	172.2529	187.9178	198.9927	216.2482	251.8849
Total Incremental Sales in New England						
BEV		4511.089	4792.69	8244.224	12834.54	18336.51
PHEV		5188.322	9136.891	10414.47	12646.29	15623.98
Total		9699.411	13929.58	18658.69	25480.83	33960.48

RI Excerpt from
National Grid Electric Vehicle Scenarios
Electric Forecasting & Analysis

Published November 2015; updated January 2017

Over the longer-term, the forecast results may be adjusted for the penetration of plug-in electric vehicles (PEVs). National Grid has developed estimates for several scenarios covering a mix of different levels of future adoption of PEVs. These scenarios generally range low to higher levels of adoption. These scenarios include:

- **Annual Energy Outlook (AEO) Low:** This scenario uses information from the Department of Energy's 2015 AEO report to determine a scenario for PEVs in National Grid's share of the state's in which its service territory spans. The "low" scenario is selected as AEO "Reference" case.
- **Annual Energy Outlook (AEO) High:** This scenario similarly uses information from 2015 AEO report. For the "high" scenario, the AEO "High Oil (price)" case was used. While this case is not a high PEV case per se, it does have the highest penetration of PEVs versus the other AEO cases.
- **Percent of New Registrations:** This scenario uses the historical adoption rate of "non plug-in hybrid electric vehicles" (NPHEVs) as a proxy for how the plug-in electric vehicle adoption might behave. This scenario is determined as a function of new PEV registrations each year as a percent of all new vehicle registrations. NPHEVs have been in the market for over ten years and have a record of adoption over that time frame. This scenario assumes that PEVs, which have not until recently begun to be widely adopted in the marketplace, may behave similarly to that of NPHEVs.
- **Zero Emissions Vehicles (ZEVs) target:** This scenario assumes that PEV adoption meets the ZEV targets by the year 2025. National Grid is assumed to garner a share of those goals as a function of its current share of PEVs in its service territory as a percent PEVs in the entire state. Current levels of PEVs are ramped up between now and the year 2025 to achieve those shares.

 # OF VEHICLES

STATE	ELEC_TYPE	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
AEO Reference Case		9	109	187	412	570	797	1,016	1,318	1,717	2,201	2,823	3,555	4,339	5,190	6,091
AEO High Oil Case		9	109	187	412	570	797	1,057	1,421	1,922	2,538	3,357	4,312	5,304	6,352	7,473
Percent of Registrations		9	109	187	412	570	797	1,304	2,055	3,115	4,035	4,967	5,777	6,580	7,437	8,320
ZEV Case		9	109	187	412	570	797	1,304	2,055	4,436	9,177	15,217	21,986	29,412	36,982	44,685
	BEV	1	10	29	82	133	214	250	290	350	421	508	607	720	845	970
	PHEV	8	99	158	330	437	583	766	1,028	1,367	1,780	2,314	2,948	3,619	4,345	5,121
	All EV	9	109	187	412	570	**797**	1,016	1,318	1,717	2,201	**2,823**	3,555	4,339	5,190	6,091
AEO High Oil Case																
	BEV	1	10	29	82	133	214	259	311	387	473	572	683	803	929	1,059
	PHEV	8	99	158	330	437	583	798	1,110	1,535	2,066	2,785	3,629	4,500	5,423	6,414
	All EV	9	109	187	412	570	797	1,057	1,421	1,922	2,538	3,357	4,312	5,304	6,352	7,473
Percent of Registrations																
	BEV	1	10	29	82	133	214	279	389	547	752	963	1,157	1,344	1,516	1,687
	PHEV	8	99	158	330	437	583	1,026	1,666	2,567	3,283	4,004	4,619	5,236	5,921	6,633
	All EV	9	109	187	412	570	797	1,304	2,055	3,115	4,035	4,967	5,777	6,580	7,437	8,320
ZEV Case																
	BEV	1	10	29	82	133	214	279	389	738	1,435	2,325	3,323	4,409	5,492	6,588
	PHEV	8	99	158	330	437	583	1,026	1,666	3,697	7,742	12,892	18,663	25,003	31,491	38,096
	All EV	9	109	187	412	570	797	1,304	2,055	4,436	9,177	15,217	21,986	29,412	36,982	44,685

STATE	ELEC_TYPE	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
RHODE ISLAND	HV(NP_HEV)	879	1,158	1,240	1,116	901	931									
RHODE ISLAND	BEV(PEV)	-	20	34	52	56	95	65	111	353	703	896	1,025	1,127	1,143	1,161
RHODE ISLAND	HEV(PHEV)	9	132	150	91	77	166	446	646	2,047	4,076	5,199	5,948	6,540	6,629	6,734
	PEV/PHEV	9	152	184	143	133	261	511	757	2,400	4,779	6,095	6,973	7,667	7,772	7,895
		9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
NEW, net of End of Life Replacements																
RHODE ISLAND	HV(NP_HEV)	879	1,158	1,054	773	152	25									
RHODE ISLAND	BEV(PEV)	-	20	34	51	52	95	65	111	352	702	896	1,005	1,093	1,091	1,105
RHODE ISLAND	HEV(PHEV)	9	132	150	91	77	166	446	646	2,047	4,076	5,190	5,816	6,390	6,538	6,657
	PEV/PHEV	9	152	184	142	129	261	511	757	2,399	4,778	6,086	6,821	7,483	7,629	7,762
End of Life	10															
RI Moodys (New)		41,551	44,559	47,283	50,036	52,298	49,600	48,531	47,520	47,993	47,786	48,763	49,810	51,114	51,811	52,633
	HV(NP_HEV)	2.1%	2.6%	2.6%	2.2%	1.7%	0	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%
	BEV(PEV)	0.0%	0.0%	0.1%	0.1%	0.1%	0	0.1%	0.2%	0.7%	1.5%	1.8%	2.1%	2.2%	2.2%	2.2%
	HEV(PHEV)	0.0%	0.3%	0.3%	0.2%	0.1%	0	0.9%	1.4%	4.3%	8.5%	10.7%	11.9%	12.8%	12.8%	12.8%
	PEV/PHEV	0.0%	0.3%	0.4%	0.3%	0.3%	0	1.1%	1.6%	**5.0%**	**10.0%**	**12.5%**	**14.0%**	**15.0%**	**15.0%**	**15.0%**

STATE	ELEC_TYPE	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
RHODE ISLAND	HV(NP_HEV)	1,158	1,240	1,116	901	931									
RHODE ISLAND	BEV(PEV)	20	34	52	56	95	65	111	160	207	212	216	222	225	229
RHODE ISLAND	HEV(PHEV)	132	150	91	77	166	446	646	908	721	736	752	771	782	794
	PEV/PHEV	152	184	143	133	261	511	757	1,068	929	948	968	993	1,007	1,023
		10	11	12	13	14	15	16	17	18	19	20	21	22	23
NEW, net of End of Life Replacements															
RHODE ISLAND	HV(NP_HEV)	1,158	1,054	773	152	25									
RHODE ISLAND	BEV(PEV)	20	34	51	52	95	65	111	159	206	212	196	188	173	173
RHODE ISLAND	HEV(PHEV)	132	150	91	77	166	446	646	908	721	727	620	621	691	717
	PEV/PHEV	152	184	142	129	261	511	757	1,067	928	939	816	809	864	890
End of Life	10														
RI Moodys (New)		44,559	47,283	50,036	52,298	49,600	48,531	47,520	47,993	47,786	48,763	49,810	51,114	51,811	52,633
	HV(NP_HEV)	2.6%	2.6%	2.2%	1.7%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%
	BEV(PEV)	0.0%	0.1%	0.1%	0.1%	0.2%	0.13%	0.2%	0.3%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%
	HEV(PHEV)	0.3%	0.3%	0.2%	0.1%	0.3%	0.92%	1.4%	1.9%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%
	PEV/PHEV	0.3%	0.4%	0.3%	0.3%	0.5%	1.1%	1.6%	2.2%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%

VIO ALL (# Cars)	ELEC_TYPE	2011	2012	2013	2014	2015	2016
RI	HV(NP_HEV)	6,985	7,879	8,591	9,886	10,635	11,129
RI	BEV(PEV)	1	11	29	83	133	216
RI	HEV(PHEV)	8	100	158	333	441	586
	PEV/PHEV	9	111	187	416	574	802

VIO NGRID Zips (# Cars)	ELEC_TYPE	2011	2012	2013	2014	2015	2016
RI	HV(NP_HEV)	6,953	7,841	8,553	9,845	10,590	11,093
RI	BEV(PEV)	1	10	29	82	133	214
RI	HEV(PHEV)	8	99	158	330	437	583
	PEV/PHEV	9	109	187	412	570	797

NGRID Zips % of State (# Cars)	ELEC_TYPE	2011	2012	2013	2014	2015	2016	Last 10 yr avg	Last 5	Last 3
NGRID RI % of ALL	HV(NP_HEV)	100%	100%	100%	100%	100%	100%	100%	100%	100%
NGRID RI % of ALL	BEV(PEV)	100%	91%	100%	99%	100%	99%	99%	98%	99%
	HEV(PHEV)	100%	99%	100%	99%	99%	99%	#DIV/0!	99%	99%
	PEV/PHEV	100%	98%	100%	99%	99%	99%	100%	99%	**99%**

ZERO EMISSIONS VEHICLE TARGETS (ZEV)

State Goals for ZEVs	# cars by 2025	NG Share	NG Share # cars by 2025
RI	45,000	99%	44,751
	45,000	99%	44,751

ZERO EMISSIONS VEHICLE TARGETS (ZEV) *

State Goals for ZEVs	# cars by 2025
RI	45,000
	45,000

* assumed cars on the road by target year

STATE	ELEC_TYPE	2011	2012	2013	2014	2015	2016
RHODE ISLAND	HV(NP_HEV)	879	1,158	1,240	1,116	901	931
RHODE ISLAND	BEV(PEV)		20	34	52	56	95
RHODE ISLAND	HEV(PHEV)	9	132	150	91	77	166

STATE	ELEC_TYPE	2011	2012	2013	2014	2015	2016
RI	HV(NP_HEV)	6,953	7,841	8,553	9,845	10590	11093
RI	BEV(PEV)	1	10	29	82	133	214
RI	HEV(PHEV)	8	99	158	330	437	583

STATE	ELEC_TYPE	2011	2012	2013	2014	2015	2016
RI	HV(NP_HEV)	6,985	7,879	8,591	9,886	10635	11129
RI	BEV(PEV)	1	11	29	83	133	216
RI	HEV(PHEV)	8	100	158	333	441	586

US (stock)	**AEO 2016**											
RAW	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	
Alternative-Fuel Cars (millions)												
100 mile PEV	0.20	0.23	0.27	0.32	0.38	0.46	0.56	0.66	0.79	0.93	1.06	
200 mile PEV	0.10	0.14	0.23	0.32	0.49	0.73	1.05	1.46	1.95	2.51	3.16	
PHEV - 10	0.14	0.20	0.26	0.33	0.43	0.54	0.68	0.86	1.05	1.26	1.47	
PHEV - 40	0.11	0.17	0.23	0.32	0.44	0.59	0.78	1.01	1.24	1.49	1.77	
PHEV (both)	0.25	0.37	0.48	0.65	0.87	1.13	1.46	1.87	2.29	2.75	3.24	
PHEV-10	54%	53%	54%	51%	49%	48%	47%	46%	46%	46%	46%	**48%**
PHEV-40	46%	47%	46%	49%	51%	52%	53%	54%	54%	54%	54%	**52%**
Annual Growths												**avg since 2016**
100 mile PEV		18%	17%	16%	21%	20%	21%	19%	19%	17%	15%	**18%**
200 mile PEV		50%	60%	42%	51%	50%	44%	39%	34%	29%	26%	**42%**
PHEV - 10		45%	32%	29%	28%	26%	27%	26%	22%	20%	17%	**27%**
PHEV - 40		52%	31%	41%	38%	35%	32%	29%	23%	20%	18%	**32%**
PHEV (both)		48%	31%	34%	33%	30%	30%	27%	23%	20%	18%	**30%**

US (stock)	**AEO 2016**											
RAW	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	
Alternative-Fuel Cars (millions)												
100 mile PEV	0.20	0.23	0.28	0.34	0.42	0.52	0.63	0.75	0.88	1.02	1.16	
200 mile PEV	0.10	0.14	0.23	0.37	0.62	0.97	1.43	2.01	2.67	3.45	4.34	
PHEV - 10	0.14	0.20	0.27	0.34	0.43	0.55	0.70	0.89	1.07	1.27	1.48	
PHEV - 40	0.11	0.17	0.24	0.36	0.54	0.76	1.06	1.41	1.77	2.16	2.58	
PHEV (both)	0.25	0.37	0.50	0.70	0.97	1.31	1.76	2.30	2.85	3.43	4.06	
PHEV-10	54%	53%	53%	49%	45%	42%	40%	39%	38%	37%	36%	**43%**
PHEV-40	46%	47%	47%	51%	55%	58%	60%	61%	62%	63%	64%	**57%**
Annual Growths												**avg since 2016**
100 mile PEV		18%	21%	20%	25%	22%	21%	19%	18%	16%	14%	**19%**
200 mile PEV		50%	65%	58%	68%	56%	47%	40%	33%	29%	26%	**47%**
PHEV - 10		45%	35%	28%	28%	26%	28%	26%	21%	18%	17%	**27%**
PHEV - 40		52%	39%	51%	48%	42%	39%	33%	26%	22%	19%	**37%**
PHEV (both)		48%	37%	39%	38%	35%	35%	30%	24%	21%	18%	**33%**

Mnemonic:	FREG.US	FREG.NY	FREG.MA	FREG.RI
Description:	New Vehicle Registr	New Vehicle Registr	New Vehicle Registr	New Vehicle Registrations: Total,
Source:	R.L. Polk & Co.; Moc	The Polk Company; I	The Polk Company; I	The Polk Company; Moody's Ana
Native Frequency:	QUARTERLY	QUARTERLY	QUARTERLY	QUARTERLY
Geography:	United States	New York	Massachusetts	Rhode Island
Dec-2000	17,423,720.7	909,069.5	397,087.3	60,620.5
Dec-2001	17,344,755.9	883,600.9	392,350.7	58,276.9
Dec-2002	16,713,248.7	922,186.1	370,982.6	60,041.4
Dec-2003	16,527,628.4	917,680.6	389,857.5	60,823.1
Dec-2004	16,786,777.4	906,530.0	382,103.3	60,926.9
Dec-2005	16,569,503.3	855,625.6	367,517.9	58,712.8
Dec-2006	16,497,443.5	846,401.7	343,710.4	55,197.5
Dec-2007	15,967,153.9	869,799.7	330,700.4	53,169.7
Dec-2008	13,049,087.0	788,275.6	284,371.9	43,061.0
Dec-2009	10,228,635.0	677,725.4	246,267.3	36,736.7
Dec-2010	11,389,659.1	748,018.4	268,569.4	38,915.8
Dec-2011	12,642,996.8	797,731.1	288,594.8	41,551.2
Dec-2012	14,334,886.4	872,844.5	310,343.0	44,558.5
Dec-2013	15,387,919.0	929,514.4	332,762.3	47,283.0
Dec-2014	16,337,621.6	964,638.1	356,123.8	50,035.5
Dec-2015	17,186,947.2	1,013,112.6	375,254.1	52,298.2
Dec-2016	17,250,701.7	1,045,625.5	363,710.4	49,600.2
Dec-2017	17,219,439.8	1,050,835.5	373,805.3	48,530.9
Dec-2018	16,980,861.8	1,043,503.3	376,567.0	47,520.3
Dec-2019	16,525,233.9	1,020,008.0	369,534.2	47,993.1
Dec-2020	16,213,193.1	1,003,863.0	364,258.6	47,785.6
Dec-2021	16,271,973.4	1,007,289.0	365,957.0	48,763.0
Dec-2022	16,465,371.0	1,019,169.0	371,160.8	49,809.9
Dec-2023	16,730,695.4	1,041,129.8	379,855.8	51,114.0
Dec-2024	16,938,740.5	1,053,582.5	384,646.6	51,810.6
Dec-2025	17,086,463.8	1,067,315.8	388,614.1	52,632.8
Dec-2026	17,228,747.4	1,077,906.5	392,041.7	53,241.0
Dec-2027	17,291,928.4	1,083,449.3	393,441.2	54,360.6
Dec-2028	17,340,769.7	1,093,932.0	395,397.8	55,016.5
Dec-2029	17,344,935.9	1,094,830.8	395,878.1	55,300.0
Dec-2030	17,290,433.4	1,094,768.3	395,706.7	54,796.7
Dec-2031	17,260,532.2	1,100,823.5	398,122.1	55,379.4
Dec-2032	17,269,936.2	1,102,635.0	398,781.2	55,664.6
Dec-2033	17,300,324.8	1,105,405.5	399,725.8	55,735.9
Dec-2034	17,415,503.5	1,112,197.5	402,474.4	56,175.7
Dec-2035	17,600,987.8	1,120,287.0	406,208.1	56,117.6

Mnemonic	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Mnemonic	December-11	December-12	December-13	December-14	December-15	December-16	December-17	December-18	December-19	December-20	December-21	December-22	December-23	December-24	December-25
FREG.US	12,642,997	14,334,886	15,387,919	16,337,622	17,186,947	17,250,702	17,219,440	16,980,862	16,525,234	16,213,193	16,271,973	16,465,371	16,730,695	16,938,740	17,086,464
FREG.NY	797,731	872,845	929,514	964,638	1,013,113	1,045,626	1,050,836	1,043,503	1,020,008	1,003,863	1,007,289	1,019,169	1,041,130	1,053,583	1,067,316
FREG.MA	288,595	310,343	332,762	356,124	375,254	363,710	373,805	376,567	369,534	364,259	365,957	371,161	379,856	384,647	388,614
FREG.RI	41,551	44,559	47,283	50,036	52,298	49,600	48,531	47,520	47,993	47,786	48,763	49,810	51,114	51,811	52,633

Division 5-43

Request:

Regarding behind-the-meter storage:

a. Please provide the total MWs of behind-the-meter storage currently installed in National Grid's Rhode Island service territory, by customer class.

b. Please provide the annual incremental MW of installed behind-the-meter storage for the past five years.

c. Please describe how the Company is informed of, and tracks, behind-the-meter storage.

d. Please discuss whether the Company will be rewarded for any additional behind-the-meter storage installed, or only incremental to a baseline forecast of naturally-occurring storage installations.

Response:

a. The Company has not provided any authorizations to connect customer-owned behind-the-meter electric storage.

b. The Company has not provided any authorizations to connect customer-owned behind-the-meter electric storage.

c. The Company tracks storage applications through the interconnection application process, per tariff guidelines. Additionally, the Company is in the process of developing a supplemental information request for prospective battery storage customers and plans on collecting the information during the application review process.

d. The Company proposes to earn a behind-the-meter storage incentive only for customer-owned storage applications that are incremental to a baseline forecast of storage applications that the Company expects to be submitted without influence by the Company.

(This response is identical to the Company's response to Division 1-43 in Docket No. 4780.)

Prepared by or under the supervision of: Carlos Nouel

Division 5-44

Request:

Regarding Company-owned storage as described on Schedule PST-1, Chapter 9, page 13:

a. Please identify whether the Company owns any storage that is not "used to support peak reduction or provide other system benefits."

b. Please provide the total MW and MWh of Company-owned storage currently installed.

c. Please provide the annual incremental MW and MWh of Company-owned storage for the past five years.

d. Please provide a list of all planned Company-owned storage projects, including the site, size (in MW and MWh), and expected installation date.

Response:

a. The Company does not currently own any storage.

b. The Company does not currently own any storage.

c. The Company does not currently own any storage.

d. The Company does not currently own any storage and has none proposed apart from those in this proceeding.

(This response is identical to the Company's response to Division 1-44 in Docket No. 4780.)

Prepared by or under the supervision of: Carlos Nouel

Division 5-45

Request:

Refer to page 175 of the Power Sector Transformation Panel (Book 1 of 3). Please provide examples of customer insights from internal customer research, knowledge gained from Company experience with pilot projects, and industry best practices that will be used in the proposed customer engagement plan under the AMF Customer Engagement and Deployment incentive mechanism.

Response:

Regarding internal customer research, please see Attachment DIV 5-45-1 (National Grid, *Value Proposition Research: A Study of 3 Energy Solutions Areas*, 2017) for the Company's existing customer value proposition research, which is an example that will help inform the proposed AMF customer engagement plan. In addition, please see Schedule PST-1, Chapter 4 – AMF, Section 3.1 of the Power Sector Transformation (PST) Plan (Bates Page 77 of PST Book 1), where the Company highlights the diverse and evolving customer expectations and needs identified for a modern grid customer experience. As noted on Schedule PST-1, Chapter 9 - Performance of the PST Plan (Bates Page 175 of PST Book), the Company will conduct customer awareness surveys both pre- and post-deployment to better inform customer outreach efforts and measure the impact of customer engagement. Lastly, as noted on Schedule PST-1, Chapter 4-AMF of the PST Plan (Bates Page 91 of PST Book), the Company will also conduct messaging and satisfaction studies throughout the deployment period, offering valuable updates and refreshes to continuously improve the customer experience.

Regarding experience with pilot projects, please see Schedule PST-1, Chapter 4-AMF, Section 5.1 of the PST Plan (Bates Page 86 of PST Book 1), where the Company details the lessons learned from its ongoing Smart Energy Solutions AMF pilot in Worcester, Massachusetts. Examples of important insights offered from this pilot that will be utilized in the proposed AMF customer engagement plan include items such as the viability of an opt-out program design strategy, availability, and utilization of a customer-centric energy management portal, and the provision to customers of personalized information and simplified communication channels. A copy of the final customer evaluation report for the Company's Smart Energy Solutions AMF pilot in Worcester, Massachusetts is provided with this response as Attachment DIV 5-45-2.

Over the course of the Smart Energy Solutions AMF pilot, the Company completed numerous customer surveys that provide further experience, knowledge, and input for the Company's proposed AMF customer engagement plan. A list of these customer surveys is provided below, as well as the month and year of their respective implementation within the Smart Energy

Solutions AMF pilot. Copies of these customer surveys (and their respective findings) are provided as Attachment DIV 5-45-3 through Attachment DIV 5-45-23.

1. Meter Decline Survey, November 2013 (Attachment DIV 5-45-3 and Attachment DIV 5-45-4);
2. Pre-Pilot Survey, February 2014 (Attachment DIV 5-45-5, Attachment DIV 5-45-6, and Attachment DIV 5-45-7);
3. Post Installation Survey, April 2014-March 2015 (Attachment DIV 5-45-8 and Attachment DIV 5-45-9);
4. Post Event Surveys; June-July 2015 (Attachment DIV 5-45-10, Attachment DIV 5-45-11, Attachment DIV 5-45-12), July-August 2016 (Attachment DIV 5-45-15, Attachment DIV 5-45-16, and Attachment DIV 5-45-17);
5. End of Summer Survey, September 2015 (Attachment DIV 5-45-13 and Attachment DIV 5-45-14);
6. End of Pilot Survey, October 2016 (Attachment DIV 5-45-18 and Attachment DIV 5-45-19);
7. Opt Out & Drop Out Survey, November 2015 (Attachment DIV 5-45-20 and Attachment DIV 5-45-21); and
8. Opt Out & Drop Out Survey, October 2016 (Attachment DIV 5-45-22 and Attachment DIV 5-45-23).

Lastly, the Company participates in various industry groups, such as the Smart Energy Consumer Collaborative, that are heavily comprised of peer utilities and associated vendor partners that have already undertaken AMF deployment and other smart energy programs. The Company intends to gather learnings and best practices from those deployments and programs to help augment its proposed AMF Customer Engagement plan.

(This response is identical to the Company's response to Division 1-45 in Docket No. 4780.)

Prepared by or under the supervision of: John Leana

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2017 Value Proposition Research – A Study Of 3 Energy Solution Areas

Total All Regions

Grid Modernization

Distributed Generation & Storage

Alternative Fuel Vehicles

Russell Research
February, 2017

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Background & Objectives

- **Following up on its 2014 research, National Grid wanted to update its understanding of customer awareness of, interest in, and other opinions related to 3 value-added Energy Solution Areas:**
  - **Grid Modernization (GM)**
  - **Distributed Generation & Storage (DG&S)**
  - **Alternative Fuel Vehicles (AFV)**
- **Within each Energy Solution Area, NG wanted to revisit what its customers need and value for home, business, and/or transportation. Specifically, NG wanted to:**
  - See current needs and values **relative to each other**…
  - And **in combination with each other**;
  - And to reassess **table stakes values** for each Solution Area.
- **This report focuses on the Total from All NG Regions, though it must be noted that in the New York Region, GM and DG&S surveys were conducted only in Upstate while AFV surveys were conducted in both Upstate and Downstate NY (and totaled together as one NY Region in this report).**

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Survey Method, Sample Sizes & Timing

- **Surveys were conducted Online in January 2017, with respondents drawn from lists of NG Residential and Commercial Customers provided by National Grid. Following are the specific samples evaluating each Solution area:**

	Sample Size			
Grand Total All Cells	**3,379**			
	Grid Mod	**DG&S**	**AFV**	
Total Each Cell	**1084**	**1031**	**1264**	
Total Commercial	**146**	**118**	**121**	
Upstate NY	68	56	37	Commercial Regions Not Quota'd Or Weighted And Thus Are Representative Of Commercial Customer Base
Massachusetts	63	45	44	
Rhode Island	15	17	13	
Downstate NY	0	0	27	
Total Residential	938	913	1143	
Upstate NY	304	303	234	Residential Regions Were Quota'd & Weighted To Be Representative Of Residential Customer Base
Massachusetts	307	299	302	
Rhode Island	327	311	303	
Downstate NY	0	0	304	

- **In all cells, respondents were qualified as age 18+ with no industry conflicts. In the Grid Mod and DG&S cells, respondents had to at least contribute to energy-related decisions for their home/business. In the AFV cell, they had to own/lease a vehicle or plan to in the next 3 years and, if Commercial, had to be involved in vehicle purchase decisions for their company.**
- **Commercial respondents tend to be smaller businesses, with about 90% in each cell having 100 or fewer employees (median ~5-6 employees). The median number of years in business is about 22 years and over half own their building.**

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Learning & How It Will Be Used

- **The report that follows shows comparative data across the 3 Solution Areas as well as findings within each Area. For each Solution Area, data are shown in Total and by Residential vs. Commercial. There were few notable differences in results by Energy Type (Gas v. Electric) and Region and those are highlighted here. In addition, NY and MA are reported separately.**

- **Findings from this research will be used by New Energy Solutions to:**
  - Inform NG's strategy to create greater customer value in the 3 Solution Areas;
  - Help determine which "innovative solutions" the company should prioritize for development now and in the future;
  - And…used in the Innovative Solutions Development process, which will screen potential solutions against what is learned here about customer needs and values.
  - Additional applications of findings may include informing Product Marketing's messaging to customers as they market current and future innovative solutions to customers, and use in rate cases and regulatory filings.

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Comparing The 3 Energy Solution Concepts In All Regions

Grid Modernization

Distributed Generation & Storage

Alternative Fuel Vehicles

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The 3 Solution Area Concepts

(As Survey Respondents Saw Them, But With No Headlines As Below)

Grid Modernization (GRID MOD)

There are a range of possible solutions to the energy challenges we face. One solution area is referred to as Modernizing The Electric Grid. This involves a system of technologies that will update our energy infrastructure to be more reliable, resilient, and efficient. Some of these technologies will be visible to customers while others will be deployed on the electric grid. Some examples of technologies that may be available to customers in the course of Modernizing The Electric Grid include:

- **Smartphone applications you can use to control electricity use in your (home/business)**
- **Thermostats that can be remotely controlled depending on electric grid conditions**
- **Appliances and equipment that will run when it is most cost-effective to do so**
- **Expanded energy pricing options and tools to help you decide when it's most cost-effective to use electricity**

Distributed Generation & Storage (DG&S)

There are a range of possible solutions to the energy challenges we face. One solution area is focused on Making Your (Home's) (Business') Own Electricity. New technology brings us ways to generate energy like electricity on a small scale – such as, at your (home) (place of business). This technology is intended to make the electricity you use more reliable, resilient, and environmentally-friendly. Some examples of the technology that can be used to Make Your (Home's) (Business') Own Electricity include:

- **Solar panels, that make electricity from the sun**
- **Micro wind turbines--propellers small enough to put on a home or building—that make electricity from wind**
- **Combined heat and power, or co-generation units, that efficiently make electricity and heat for your (home) (business) using natural gas from the gas utility company**
- **Fuel cells, a small unit that efficiently generates electricity and heat for your (home)(business) through a chemical reaction with little or no environmental emissions**

Alternative Fuel Vehicles (AFV)

There is a range of potential solutions to the energy challenges we face. One possible solution is development and usage of Alternative Fuel Vehicles. Here, we're talking about HIGHWAY-CAPABLE cars, trucks, vans, or buses and NOT non-highway vehicles such as golf carts or other low-speed vehicles; nor are we talking about hybrid gasoline and battery vehicles that do not plug into an electrical source.

There are currently two major types of highway-capable Alternative Fuel Vehicles – "plug-in electric vehicles" and "natural gas vehicles".

- **Plug-in electric vehicles are cars, trucks, vans, or buses which run on electricity and which are re-charged with electricity after being plugged in for a sufficient amount of time to an electric source or outlet.**
- **Natural gas vehicles are cars, trucks, vans, or buses which run on natural gas, with the vehicle's fuel tank re-filled as needed with natural gas.**
- **Again, we are NOT talking about hybrid vehicles that do not plug into an electrical source.**

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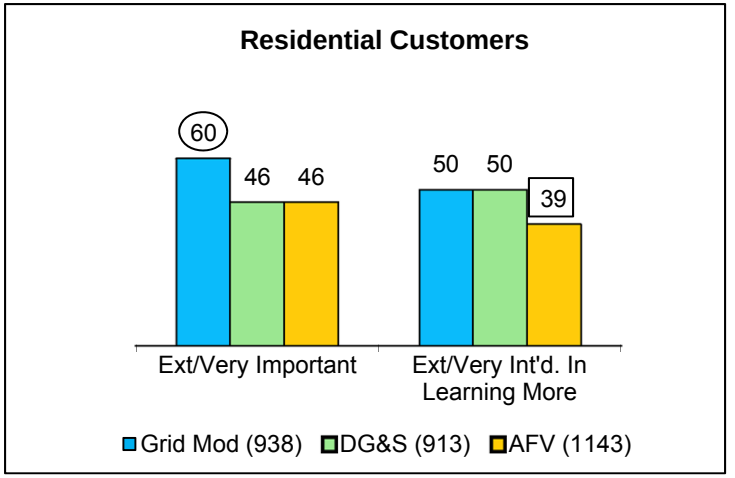
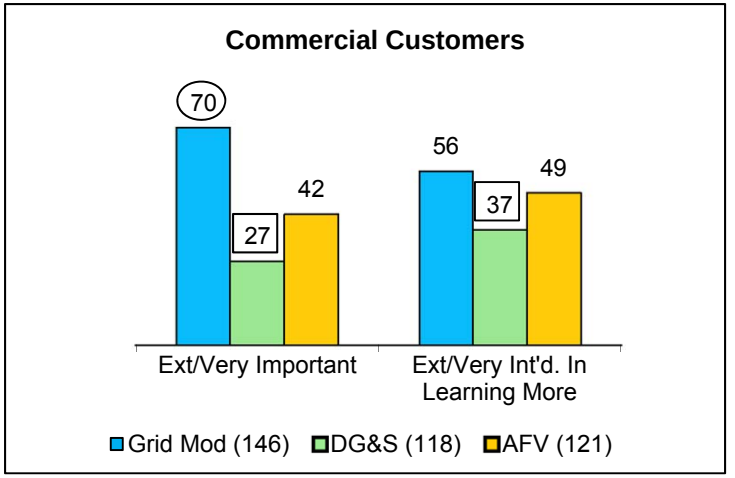
Reaction To Solution Areas Based On Name Only

- Before seeing the full idea of each Solution Area as expressed in its concept, respondents saw just its name and were asked to rate the importance of the solution area as well as their interest in learning more about it.

- Both Residential Customers and Commercial Customers considered Grid Modernization significantly more **IMPORTANT** than the other two Solution Areas.

- Grid Modernization also generated at least directionally more **INTEREST** among Commercial Customers than did the other Solutions Areas. However, Residential Customers had about equal INTEREST in learning more about both Grid Mod and DG&S.





NOTE: Throughout the report, the following graphical statistical notation is used:

Indicates data significantly higher than all other comparative data (95% confidence level).

Indicates data significantly lower than all other comparative data (95% confidence level).

Q9 How important to you is the topic of (TOPIC)?
Q10 And how interested are you in learning more about (TOPIC)?

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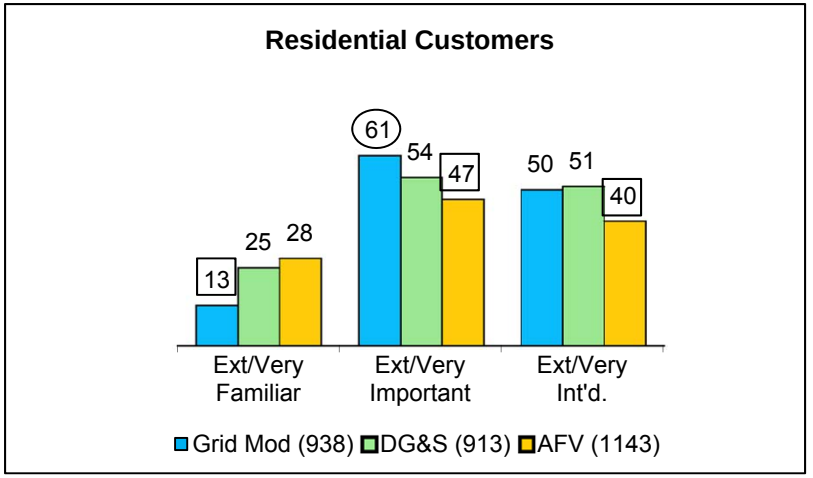
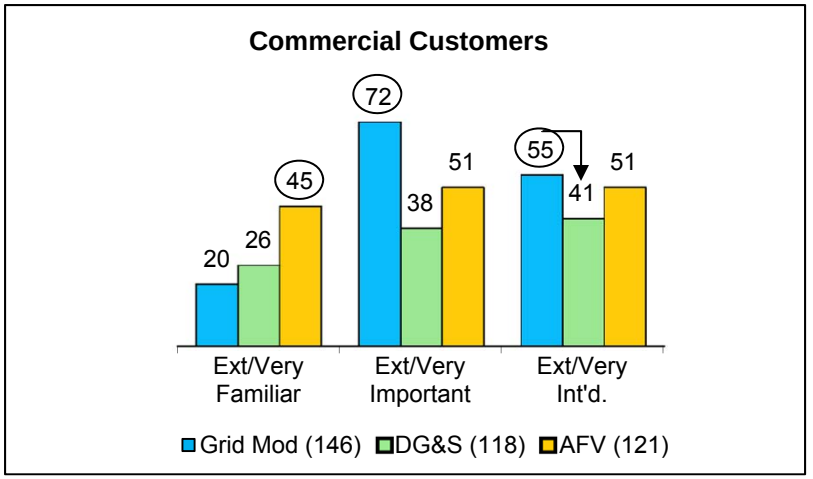
Reaction After Reading Full Solution Area Concept

- After reading a detailed description of the Solution Area covered in their sample/cell, Residential and Commercial Customers each had highest **FAMILIARITY** with **AFV**, followed by **DG&S**, with Grid Modernization significantly lower than the other two Areas.

- In the **IMPORTANCE** rating, however, **Grid Modernization** was clearly considered more IMPORTANT than either of the other two Solution Areas – and was considered more important by both Residential and Commercial Customers.

- **Grid Modernization** was also ahead of the other two Solutions Areas in terms of generating **INTEREST** in learning more among Commercial Customers. **Grid Mod and DG&S** were about equal among Residential Customers.





Q12 How familiar were you with (TOPIC) before the survey today?
Q13 Based on the description you read, how important to you is (TOPIC)?
Q14 And how interested are you in learning more about (TOPIC)?

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Reaction After Concept – By Key Segments

- There was a limited number of differences in these or other survey measures across segments.

RESIDENTIAL BY REGION	Grid Mod			DG&S			AFV			
	UNY	MA	RI	UNY	MA	RI	UNY	DNY	MA	RI
Total Per Region	(304)	(307)	(327)	(303)	(299)	(311)	(234)	(304)	(302)	(303)
% Ext/Very IMPORTANT	55	62	69	45	45	51	43	48	46	43
% Ext/Very INTERESTED To Learn More	47	51	57	50	47	55	36	41	42	36

COMMERCIAL BY REGION	Grid Mod			DG&S			AFV			
	UNY	MA	RI	UNY	MA	RI	UNY	DNY	MA	RI
Total Per Region	(68)	(63)	(15)	(56)	(45)	(17)	(37)	(27)	(44)	(13)
% Ext/Very IMPORTANT	68	73	-	23	27	-	38	63	34	-
% Ext/Very INTERESTED To Learn More	56	54	-	38	31	-	41	70	45	-

BY ENERGY TYPE	Grid Mod		DG&S		AFV	
	GAS	ELECTRIC	GAS	ELECTRIC	GAS	ELECTRIC
Total Per Region	(236)	(1077)	(218)	(1021)	(863)	(768)
% Ext/Very IMPORTANT	69	61	40	43	48	41
% Ext/Very INTERESTED To Learn More	55	51	45	48	43	37

Red = Caution: Base Too Small For Analysis & Statistical Testing

Q9 How important to you is the topic of (TOPIC)?
Q10 And how interested are you in learning more about (TOPIC)?

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Customer Needs & Values And Other Topics For Each Of The 3 Solution Areas

Grid Modernization

Distributed Generation & Storage

Alternative Fuel Vehicles

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Grid Modernization:

Customer Needs & Values And Other Topics

GRID MOD

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GRID MOD

Stated Importance Of Value Propositions

- After exposure to the **Grid Modernization** concept shown earlier here, we asked NG Customers to tell us what they need and value within the context of Grid Modernization.

- To get a clearer sense of Values, we approached this in two ways. First, we captured **Stated Importance** by having Customers rate a list of 20 Value Propositions one-by-one (rotated) using a 1-10 agreement rating scale. As shown to the right in a summary of high agreement (8-9-10 ratings), there are some Values that rise to the top in each Customer segment and most of these relate to Choice and being Informed.

Stated Importance Ratings (% T3B, 8-9-10 On 1-10 Agreement Scale)	Residential	Commercial
Total Per Segment	(938)	(146)
CHOICE: I Want To Choose How/When I Use Energy	**66**	**50**
INFORMED: Want To See How Much Apps/Equip Use Impacts Bill	**64**	**58**
ENVIRO: Community Needs To More Green Power On Grid	**60**	**56**
CONTROL: "Hands-On" When It Comes To Controlling Energy Use	**58**	**51**
INFORMED: Want More Transparency How Usage Impacts Bill	**56**	**54**
CHOICE: Want Price Options So Bill Accu Reflects My Usage	**55**	**47**
RELIABILITY: Would Turn Up Thermostat To Help Prevent Outage	54	50
COST: Want Oppty To Save By Using Power When CPU Lower	54	46
CHOICE: Want Variety Of Solutions To Help Me Manage Usage	53	46
CONTROL: I Want To Better Control How And When I Use Power	53	45
COST: Concerned Cost Reliable Grid, Which Community Pays For	48	45
CONVENIENCE: Want To Conveniently Manage Use w/New Tech	45	40
COST: Will Change Habits To Save $$, Even If Less Convenient	44	38
INFORMED: Personalized Energy-Saving Recos Based On Usage	44	39
INFORMED: Want Real-Time Advice From Energy Co.On Wise Use	40	37
RELIABILITY: Will Contrib To Reliable Grid To Prevent Outages	37	37
INFORMED: Want Trusted Advisor To Inform On Energy Use Mgmt.	28	27
CONVENIENCE: Want To Better Mge Usage, But Lack Time & Know	20	23
CONVENIENCE: Trade Ctrl To Save, e.g., Allow Remote Thermo Ctrl	18	18
RELIABILITY: Wld Pay More If $$s Went To Tech To Reduce Outages	14	14

Q15 Following are some statements about (CELL CONCEPT). Please use the slider to indicate the extent to which you agree or disagree with each statement as it relates to your (home) (business).

Yellow indicates leaders within each Customer segment.

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GRID MOD

Comparative Importance Of Value Propositions

- Later, we had Customers react to the 20 Grid Mod Value Propositions on a direct **Comparative Importance** basis using the Max Diff test/analytical technique.
  - Max Diff calculates importance for a longer list of attributes by showing respondents sub-sets of all of the attributes and asking them to choose the one they agree with most and the one they disagree with most.
- As with the other Solutions Areas, we found more discrimination in results from the Max Diff work than from the Stated Importance ratings, though most of the leaders in Stated were also among the leaders in Comparative. In addition, the top Values (in yellow to the right) were mostly the same in both Customer segments and related mainly to being Choice, Informed, and Control.

Q21 On each of the next screens, you will see a short list of statements about (CELL CONCEPT) as it relates to your (home) (business). From each list, please choose the one statement that you AGREE with Most and then choose the one statement that you DISAGREE with Most.

Comparative Importance Ratings (% Of Comparisons In Which Each Value Statement Had Higher Agreement Than Others)	Residential	Commercial
Total Per Segment	(938)	(146)
INFORMED: Want To See How Much Apps/Equip Use Impacts Bill	**75.6**	**72.6**
CHOICE: Want Variety Of Solutions To Help Me Manage Usage	**72.5**	**70.6**
INFORMED: Want More Transparency How Usage Impacts Bill	**71.7**	**69.0**
COST: Want Oppty To Save By Using Power When CPU Lower	**69.5**	**55.0**
CHOICE: Want Price Options So Bill Accu Reflects My Usage	**68.8**	**63.3**
CHOICE: I Want To Choose How/When I Use Energy	**68.5**	**64.6**
CONTROL: I Want To Better Control How And When I Use Power	**66.9**	**61.2**
CONTROL: "Hands-On" When Comes To Controlling Energy Use	**60.3**	**56.2**
ENVIRO: Community Needs To Put More Green Power On Grid	56.9	55.4
COST: Will Change Habits To Save $$, Even If Less Convenient	56.2	44.3
RELIABILITY: Would Turn Up Thermostat To Help Prevent Outage	56.1	56.8
CONVENIENCE: Want To Conveniently Manage Use w/New Tech	53.4	56.5
INFORMED: Personalized Energy-Saving Recos Based On Usage	49.6	52.4
COST: Concerned Cost Reliable Grid, Which Community Pays For	46.9	52.1
INFORMED: Want Real-Time Advice From Energy Co.On Wise Use	42.4	47.9
CONVENIENCE: Want To Better Mge Usage, But Lack Time & Know	29.8	39.3
RELIABILITY: Will Contrib To Reliable Grid To Prevent Outages	29.4	32.1
INFORMED: Want Trusted Advisor To Inform On Energy Use Mgmt.	22.8	31.9
CONVENIENCE: Trade Ctrl To Save, e.g., Allow Remote Thermo Ctrl	20.0	24.6
RELIABILITY: Wld Pay More If $$s Went To Tech To Reduce Outages	14.9	17.7

Yellow indicates leaders within each Customer segment.

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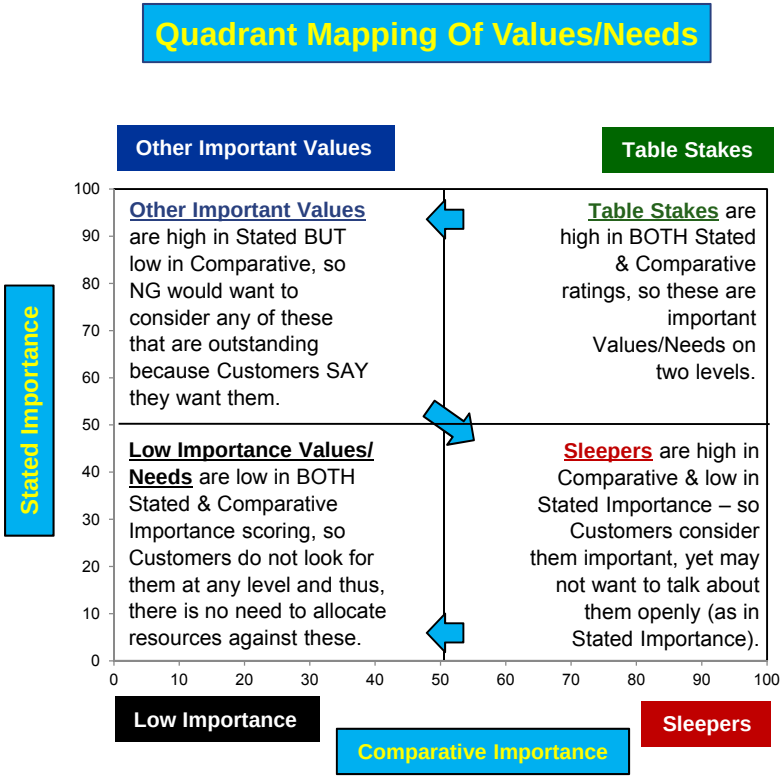
GRID MOD

Hierarchy Of Values & Identifying Table Stakes

- To assess the **relative importance of the 20 Grid Mod-related Value Propositions** and to **identify the Table Stakes** among them, we plotted the two Importance scores (Stated Importance ratings and Comparative Importance Max Diff scores) in a Quadrant Map.

- To the right is a guide to the thinking behind use of these data and mapping and how they can be used to both establish a hierarchy of importance and to identify Table Stakes.



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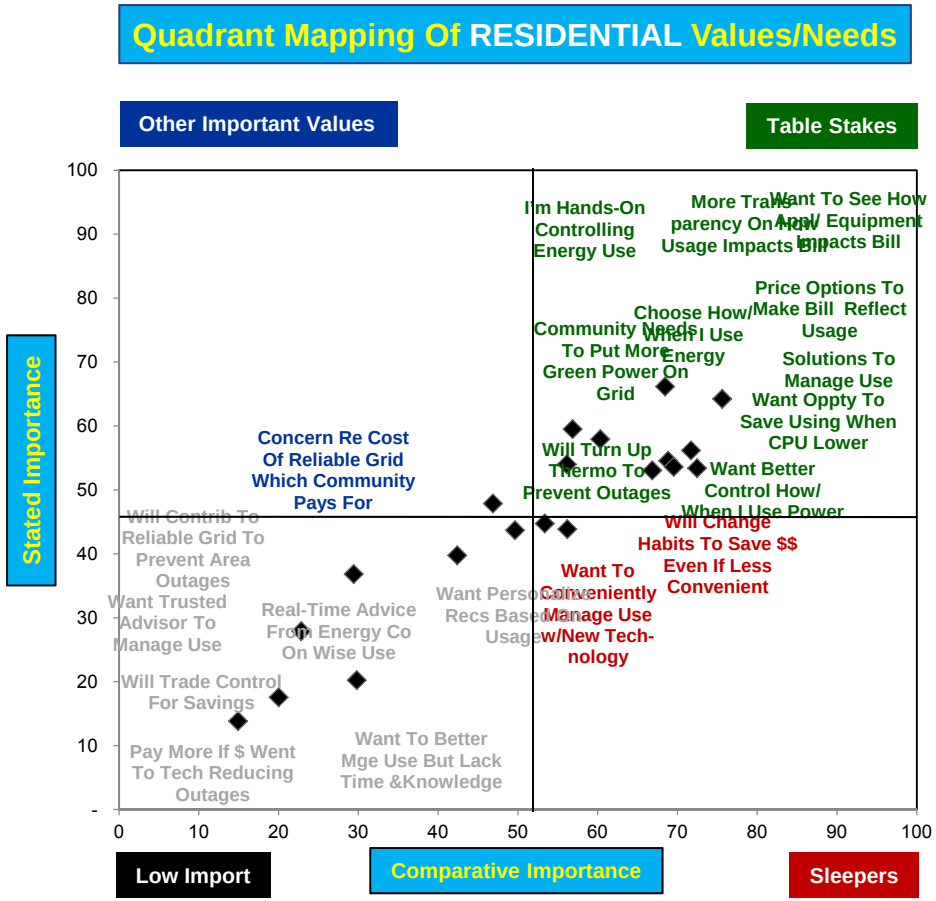
GRID MOD

Values & Table Stakes (Cont'd.)

- Quadrant Mapping showed that **Residential** Table Stakes were related to being Informed, Choice and Control:
  1. Want To See How Much Appliances/Equipment Use Impacts Bill (INFORMED)
  2. Want Variety Of Solutions To Help Me Manage Energy Usage (CHOICE)
  3. Would Like More Transparency Into Usage As It Impacts My Bill (INFORMED)
  4. Want Price Options Making Bill Accurately Reflect My Usage (CHOICE)
  5. Want Opportunity To Save By Using Power When CPU Is Lower (COST)
  6. Want To Better Control How/When I Use Power (CONTROL)
  7. Want To Choose How/When I Use Energy (CHOICE)
  8. I'm Hands-On When It Comes To Controlling Energy Use (CONTROL)
  9. Community Needs To Put More Green Power On Grid (ENVIRO)
  10. Willing To Turn Up Thermostat To Help Prevent Outages (RELIABILITY)



- But note the Convenience Sleeper –
  1. Want To Conveniently Manage Use With New Technology (CONVENIENCE)

Q15 Use the slider to indicate the extent to which you agree or disagree with each statement as it relates to your (home) (business).
Q21 Pease choose the one statement that you AGREE with Most and then choose the one statement that you DISAGREE with Most.

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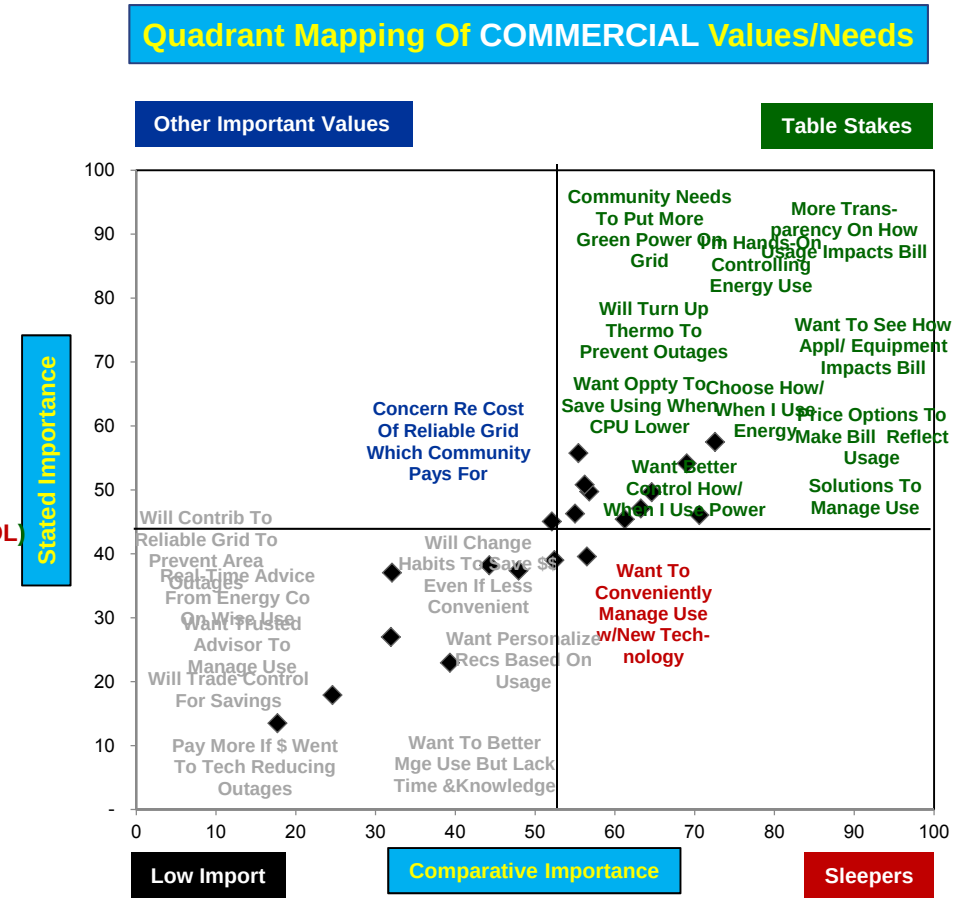
Values & Table Stakes (Cont'd.)

- Meanwhile, Table Stakes **among Commercial Customers** also centered around Choice, Informed, and Control.

1. Want To See How Much Appliances/ Equipment Use Impacts Bill (INFORMED)
2. Would Like More Transparency Into Usage As It Impacts My Bill (INFORMED)
3. Want To Choose How/When I Use Energy (CHOICE)
4. Want Price Options Making Bill Accurately Reflect My Usage (CHOICE)
5. I'm Hands-On When It Comes To Controlling Energy Use (CONTROL)
6. Want To Better Control How/When I Use Power (CONTROL)
7. Community Needs To Put More Green Power On Grid (ENVIRO)
8. Want Opportunity To Save By Using Power When CPU Is Lower (COST)
9. Want Variety Of Solutions To Help Me Manage Energy Usage (CHOICE)
10. Willing To Turn Up Thermostat To Help Prevent Outages (RELIABILITY)

- Plus there was the same Sleeper –

1. Want To Conveniently Manage Use With New Technology (CONVENIENCE)



Q15 Use the slider to indicate the extent to which you agree or disagree with each statement as it relates to your (home) (business).
Q21 Pease choose the one statement that you AGREE with Most and then choose the one statement that you DISAGREE with Most.

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Top Combinations Of Value Propositions

- Analysis to this point has focused on identifying the top Value Propositions. Another objective of the research was to **identify Top Combinations of Value Propositions**. We addressed this objective using TURF Analysis…
  - **TURF = Total Unduplicated Reach & Frequency.** This analytical technique looks for the net, non-duplicative, gain in appeal of adding different Values together in combination.
- The TURF work here showed that the **top combination of TWO Values** was very similar among Residential and Commercial Customers, and that all items within each top pairing were among the Table Stakes identified in the Quad Mapping earlier.

Top Combinations Of TWO Values (% From TURF Analysis Of Max Diff Scores)	Resi-dential	Com-mercial
TOP RESIDENTIAL COMBINATIONS	(938) Rank	(146) Rank
INFORMED: See How Much App/Equip Use Impacts Bill ENVIRO: Community Needs To Put More Green On Grid	50.2 #1	42.4 #1
CONTROL: Hands-On When It Comes To Control'ng Use INFORMED: See How Much App/Equip Use Impacts Bill	44.6 #2	37.7 #2
CHOICE: I Want To Choose How/When I Use Energy INFORMED: See How Much App/Equip Use Impacts Bill	43.7 #3	37.4 #7
TOP COMMERCIAL COMBINATIONS	(938) Rank	(146) Rank
INFORMED: See How Much App/Equip Use Impacts Bill ENVIRO: Community Needs To Put More Green On Grid	50.2 #1	42.4 #1
CONTROL: Hands-On When It Comes To Control'ng Use INFORMED: See How Much App/Equip Use Impacts Bill	44.6 #2	37.7 #2
CHOICE: I Want To Choose How/When I Use Energy ENVIRO: Community Needs To Put More Green On Grid	40.3 #6	37.4 #3

Total Possible Combinations = 190

Yellow highlighting indicates this combination is among the leaders in both Customer segments.

Q21 On each of the next screens, you will see a short list of statements about (CELL CONCEPT) as it relates to your (home) (business). From each list, please choose the one statement that you AGREE with Most and then choose the one statement that you DISAGREE with Most.

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Top Combinations Of Value Propositions

- We found that there was substantial gain in reach of about 10-15 points in moving from combinations of 2 Value Propositions to **combinations of THREE**, but less gain in then moving on to combos of 4 or 5 (which are also difficult to address in a single Solution area).

- When moving from combinations of 2 to 3, we find that two of the top combinations are identical between Residential and Commercial Customer segments – with each including the same Informed, Environmental, and Control values.

Q21 On each of the next screens, you will see a short list of statements about (CELL CONCEPT) as it relates to your (home) (business). From each list, please choose the one statement that you AGREE with Most and then choose the one statement that you DISAGREE with Most.

Top Combinations Of THREE Values (% From TURF Analysis Of Max Diff Scores)	Resi-dential	Com-mercial
TOP RESIDENTIAL COMBINATIONS	(938) Rank	(146) Rank
INFORMED: See How Much App/Equip Use Impacts Bill CONTROL: Hands-On When It Comes To Control'ng Use ENVIRO: Community Needs To Put More Green On Grid	61.1 #1	52.9 #1
ENVIRO: Community Needs To Put More Green On Grid INFORMED: See How Much App/Equip Use Impacts Bill COST: Want Oppty To Save By Using When CPU Lower	60.0 #2	46.3 #11
CHOICE: I Want To Choose How/When I Use Energy INFORMED: See How Much App/Equip Use Impacts Bill ENVIRO: Community Needs To Put More Green On Grid	59.4 #3	51.1 #2
TOP COMMERCIAL COMBINATIONS	(938) Rank	(146) Rank
INFORMED: See How Much App/Equip Use Impacts Bill CONTROL: Hands-On When It Comes To Control'ng Use ENVIRO: Community Needs To Put More Green On Grid	61.1 #1	52.9 #1
CHOICE: I Want To Choose How/When I Use Energy INFORMED: See How Much App/Equip Use Impacts Bill ENVIRO: Community Needs To Put More Green On Grid	59.4 #3	51.1 #2
COST: Concerned Cost Reliable Grid, Commty Pays For INFORMED: See How Much App/Equip Use Impacts Bill ENVIRO: Community Needs To Put More Green On Grid	54.0 #9	50.4 #3

Total Possible Combinations = 1,140

Yellow highlighting indicates this combination is among the leaders in both Customer segments.

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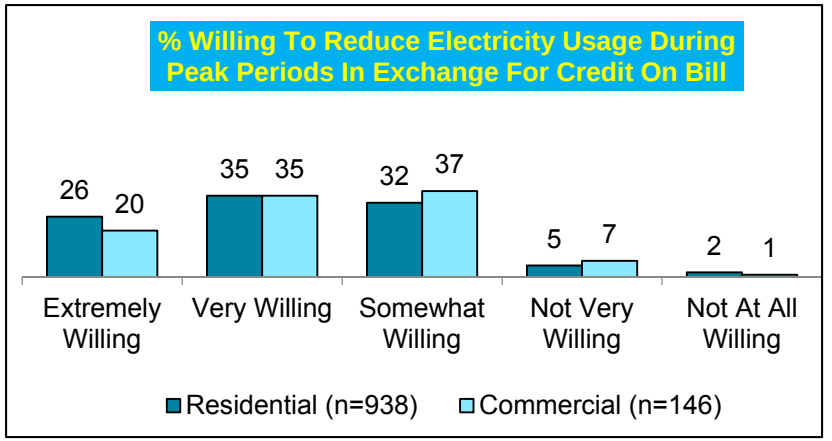
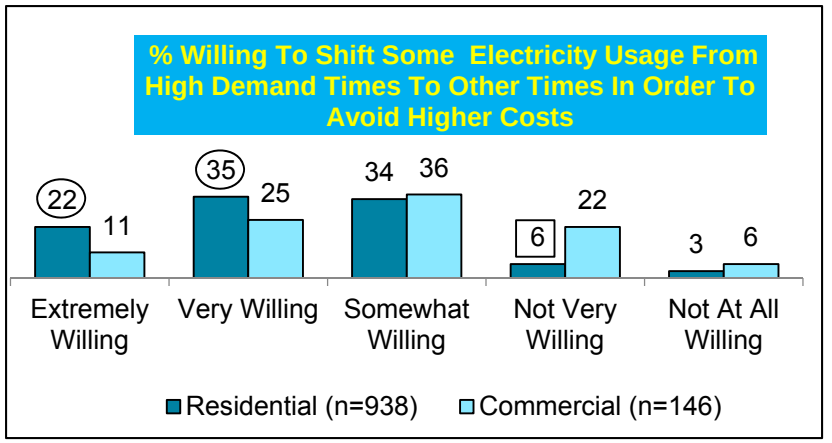
Other Topics: Peak Events & Reduced Usage

- In other topics related to Grid Mod, we found very high willingness to **Reduce Electricity Usage During Peak Periods In Exchange For A Credit On The Bill** – with ~20%+ of each Customer segment being Extremely Willing and 55-61% Extremely or Very Willing.

- We also found high willingness to **Shift Some Electricity Usage From High Demand Times To Other Times In Order To Avoid Higher Costs** – but MAINLY just among Residential Customers (57% of whom were Extremely or Very Willing). Willingness to do this was much lower among Commercial Customers (at only 36% Extremely/Very Willing).





Q17 How willing would you be to reduce your (household) (business) electricity usage for a period of the peak time in exchange for a credit on your bill?

Q19 How willing would you be to shift some of your (household) (business) electricity usage from high demand daytime hours to other times of the day in order to avoid higher costs?

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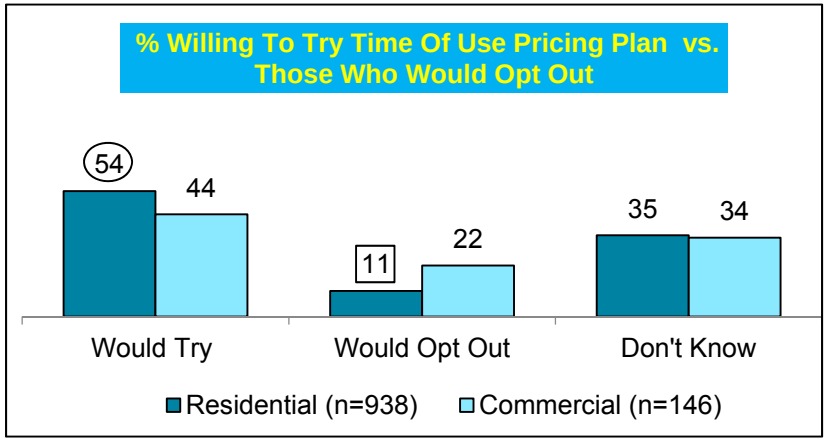
Other Topics: Auto Enroll In Time Of Use Pricing

- Asked if they would **Try A Time Of Use Pricing Plan if their utility company automatically enrolled them in it**, a majority of Residential Customers (54%) said they would and only 11% would opt out (with the rest uncertain). Willingness to try was lower among Commercial Customers.

- **Main reasons for NOT being willing to try a Time Of Use Pricing Plan** showed that Customer resistance to a plan like this centered around not wanting to be automatically enrolled in anything (Residential) and not being able to change energy needs (Commercial).



% Reasons For Opting Out Of Automatically Enrollment In Time Of Use Pricing Plan	Residential	Commercial
Total **Who Would Opt Out** Per Segment	(104)	(32)
Don't want to automatically enrolled in anything/forced to	21	6
Need to use energy when we need it/can't change needs	7	17
Not interested/happy with way things are	7	5
Don't want big brother watching me	7	--

Q20a If your utility company automatically enrolled you in a new "time of use" pricing plan that is designed to help customers save money from a shift in usage, would you be willing to try the new pricing plan knowing that you could opt out at any time?

Q20b Why would you chose to opt out of being automatically enrolled in a time of use pricing plan?

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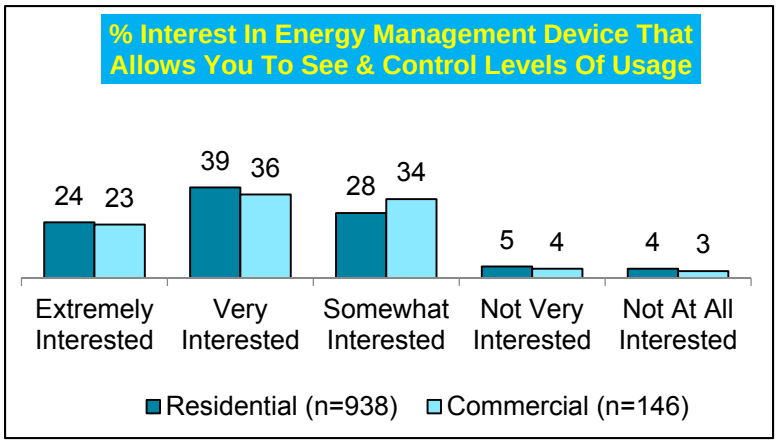
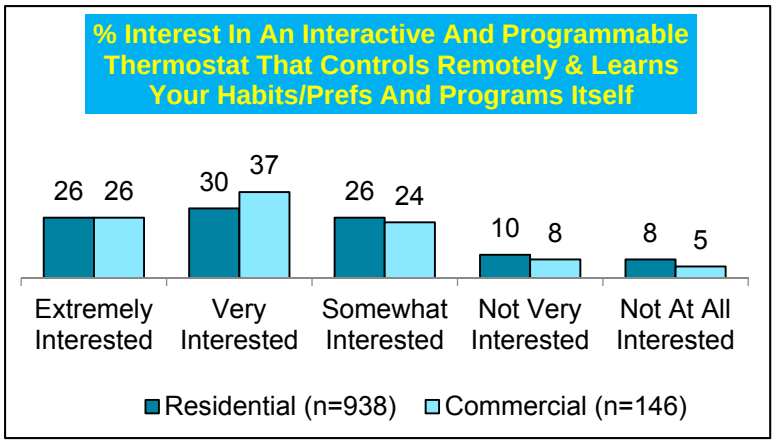
Other Topics: Energy Management Devices

- There was strong interest in **An Energy Management Device That Allows You To See And Control Levels Of Usage** – with 63% of Residential and 59% of Commercial Customers being Extremely or Very Interested in this idea.
- Over half of each Customer segment also showed strong interest in an **Interactive and Programmable Thermostat** that controls remotely and programs itself based upon usage patterns.





Q23 How interested would you be in an energy management device that allows you to see and control the levels of energy usage (in your home) (for your business)?

Q25 How interested would you be in an interactive and programmable thermostat for your (home) (business) that has the following features? > You can control the temperature and on/off time remotely; > It learns your habits and preferences and can program itself accordingly

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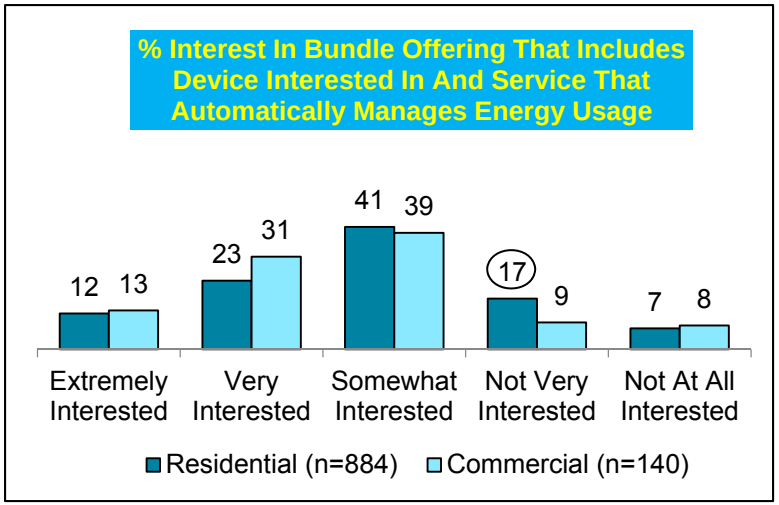
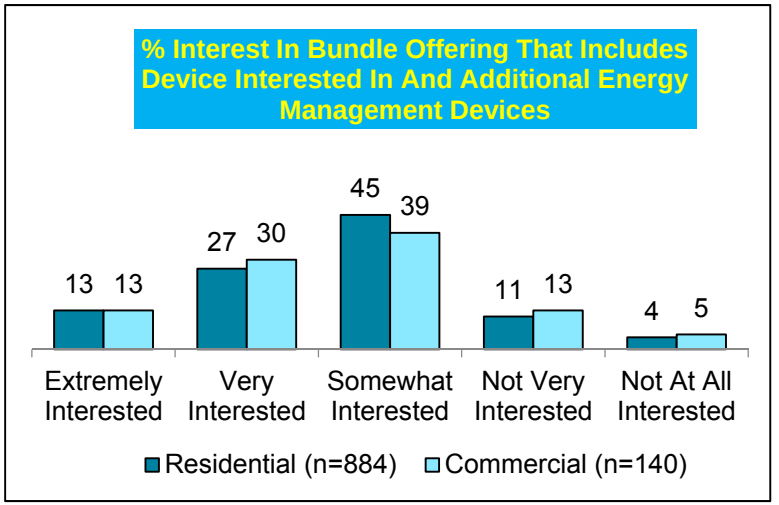
Other Topics: Bundle Interest With Device

- There was moderate interest in **A Bundle That Includes An Energy Management/Interactive Device & Automatic Peak Usage Management Service** – with 35% of Residential and 44% of Commercial being Extremely or Very Interested in this idea.
- There was also moderate interest in **A Bundle Of Different Energy Management Devices** (without Automatic Peak Usage Service) – with about 40% of Residential and 43% of Commercial Customers being Extremely/Very Interested in it.





Q25a You mentioned that you are interested in energy management devices and/or smart interactive thermostats. Sometimes companies will bundle products and services to provide you with overall cost savings. How likely are you to consider a bundled offering that includes the device you are interested in and a service that automatically manages your energy usage during high energy price times (peak)?

Q25b And how likely are you to consider a bundled offering that includes the device you are interested in, and additional energy management devices?

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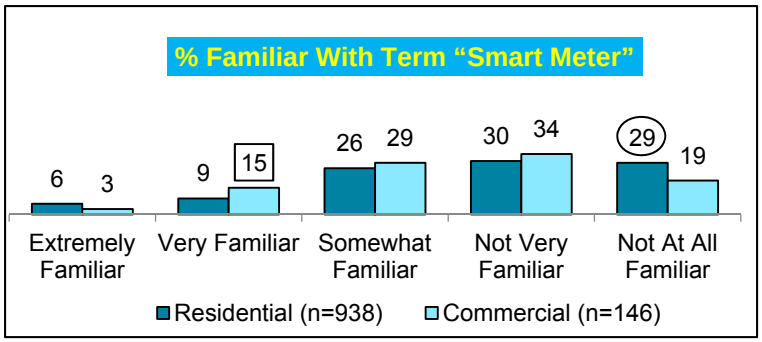
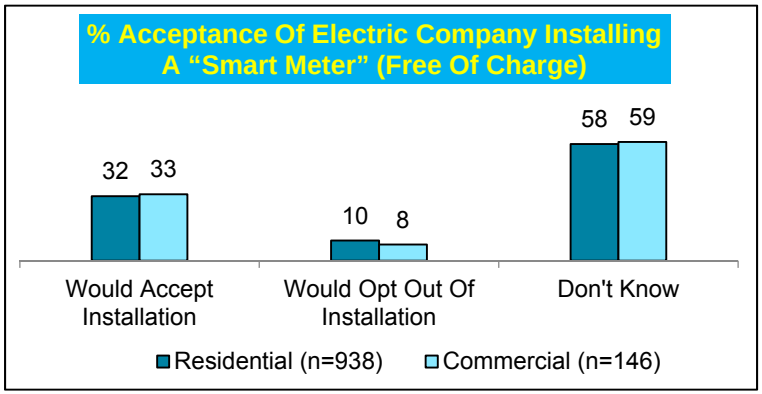
Other Topics: Smart Meters

- Based on name-only, there was low Familiarity with **"Smart Meters"**. However, Customers did not reject the idea of free of charge installation of one by their electric company.

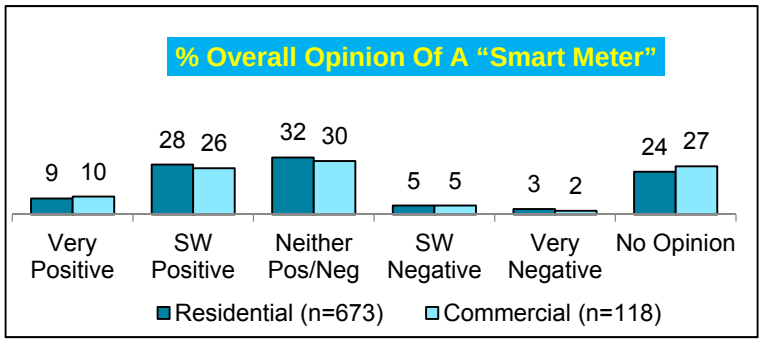




Q26 How familiar are you with the term, "Smart Meter"?

Q29 Based upon all that you know or have heard about "Smart Meters", if you were given the choice to have your electric company install – free of charge – a "Smart Meter" (in your home) (at your business), would you accept one or opt-out of having one?

- **Overall Opinion of "Smart Meters"** were mainly positive to neutral. Reasons for positive reactions were varied and summarized below.



Top Reasons For Positive Opinions Of "Smart Meters"	Residential	Commercial
Total **Who Are Positive** Per Segment	(61)	(12)
Would help me understand my usage	15	16
Would save money	12	--
Helps me monitor/control my thermostat	11	--
More efficient/contribute to more efficient energy	10	16
Would save energy/help with energy	8	9

Q27 Which of these best describes your overall opinion of a "Smart Meter"?

Q28 Why do you feel that way?

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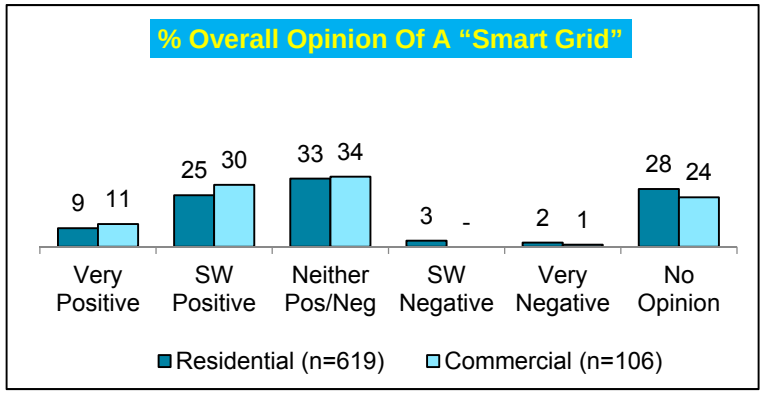
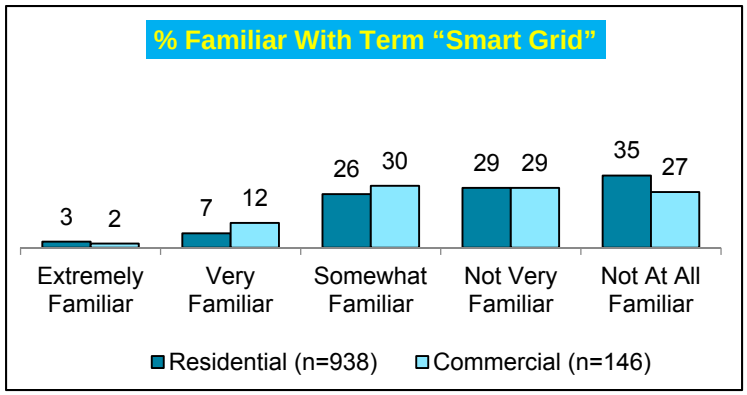
Other Topics: Smart Grid

- Based again only on the name, there was also low **Familiarity** with the term **"Smart Grid"** – with mainly neutral-to-positive **Opinions** of it (and few negatives).

- Reasons given for positive reactions were limited but included mentions of this providing better control/conservation, saving money, and improving reliability.





Top Reasons For Positive Opinions Of "Smart Grid"
(Note small number of responses)
Good way to manage/control/help conserve energy
Saves money
Improve reliability/would make the grid more reliable
Reduce costs/lowers costs
More efficient/would make the grid more efficient

Q30 How familiar are you with the term, "Smart Grid"?

Q31 Which of these best describes your overall opinion of a "Smart Grid"?

Q32 Why do you feel that way?

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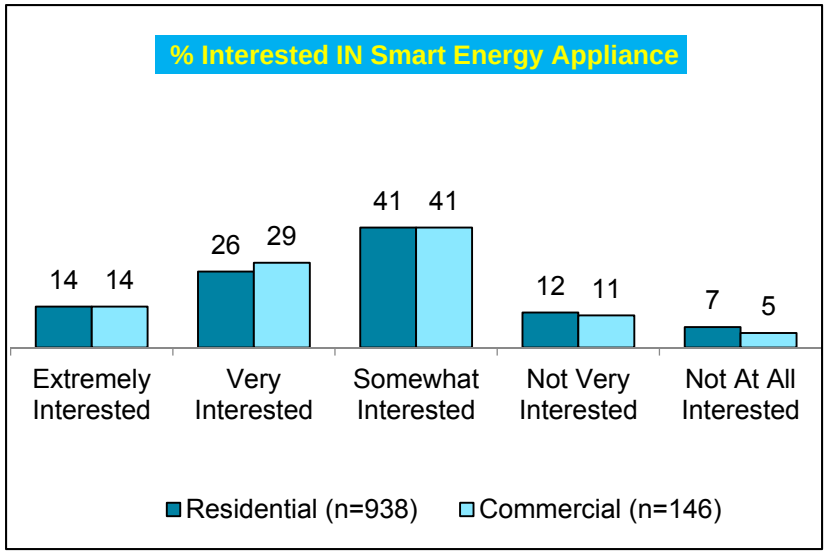
Other Topics: Smart Appliance

- There was only modest interest in **Smart Energy Appliances** (those that learn from your usage/preferences, optimize usage, and are controllable from a remote device).
- Only 40% of Residential Customers and 43% of Commercial Customers were Extremely or Very Interested in this idea.
- However, there is opportunity from another 40% that are somewhat interested. Less than 20% would not have any interest in Smart Energy Appliances.



QN33 How interested are you in smart energy appliances that learn from your usage and preferences, optimize energy usage, and allow you to adjust settings from a remote device anytime?

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Other Topics: High Tech Energy Management

- We asked which Companies they **Would Go To For Info** on and which they would **Consider As Providers** of High Tech Energy Management Services.
- The leading mention, by far, in terms of both Info and Provider was "Your Energy Utility Company Such As National Grid."

Firms They Would Go To For Info On High Tech Energy Mgt Services (%)	Residential	Commercial
Total Per Segment	(938)	(146)
Your Energy Utility Company Such As National Grid	**49**	**51**
Thermostat & Heating/AC Equip Mfrs. (e.g., Honeywell/Nest)	34	33
A Network Tech Company Such As Google Or Microsoft	14	13
A Telecomm/Cable Company Such As Verizon Or Comcast	7	6
A Security Company Such As ADT Or Brinks	4	3
Other Types Of Companies	4	2
Don't Know/Can't Say	36	32

Firms They Would Consider As Providers Of High Tech Energy Mgt Services (%)	Residential	Commercial
Total Per Segment	(938)	(146)
Your Energy Utility Company Such As National Grid	**51**	**47**
Thermostat & Heating/AC Equip Mfrs. (e.g., Honeywell/Nest)	29	33
A Network Tech Company Such As Google Or Microsoft	10	**16**
A Telecomm/Cable Company Such As Verizon Or Comcast	8	11
A Security Company Such As ADT Or Brinks	4	6
Other Types Of Companies	2	1
Don't Know/Can't Say	36	35

Q34 If you were to consider a high-tech energy management service to help you manage the energy usage levels of your (home) (business), which of the following types of companies would you go to for information on these services? Please click on all that apply.

Q35 And which of the following types of companies would you consider to provide your high-tech energy management service? Please click on all that apply.

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Other Topics: Information Sharing

- Finally, we asked about 3 possible points of **Information Sharing Between Utility and Customer** and found that there was highest interest in Being Informed About Planned Work In The Area, followed by Being Notified Of Power Restoration After Outages, and with lower interest in Sending Photos/Other Info To Utility When A Situation Can Cause An Outage.

Information Sharing About Electric Service Ratings (% T3B, 8-9-10 On 1-10 Agreement Scale)	Residential	Commercial
Total Per Segment	(304)	(68)
Would Like To Be Informed About Planned Work In My Area That May Or May Not Cause Interruption In Electric Service	80	81
When Outage Occurs, I Would Like My Utility Co. To Notify Me When Power Is Restored	60	68
Would Likely Send Photos/Other Info To Utility Co. When Situation Can Cause Outage In My Area	45	53

Q35a A benefit of Modernizing The Electric Grid will be the ability to easily share information about electric service in your area. Please indicate how much you agree or disagree with each of the following statements as it relates to your (home) (business).

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Key Findings

- **Grid Modernization had more saliency among Commercial Customers, who (compared to Residential Customers) had higher Familiarity (20% vs. 13%), placed higher Importance (72 vs. 61%), and had greater Interest In Learning More About It (55% vs. 50%).**

- **The study identified 10 Grid Modernization Table Stakes shared by both Residential and Commercial Customers that should be considered in solution development and messaging. These are shown below, along with their classification into Value groupings:**

  1. Want To See How Much Appliances/Equipment Use Impacts Bill (Informed)
  2. Want Variety Of Solutions To Help Me Manage Energy Usage (Choice)
  3. Would Like More Transparency Into Usage As It Impacts My Bill (Informed)
  4. Want Price Options Making Bill Accurately Reflect My Usage (Choice)
  5. Want Opportunity To Save By Using Power When CPU Is Lower (Cost)
  6. Want To Better Control How/When I Use Power (Control)
  7. I Want To Choose How/When I Use Energy (Choice)
  8. I'm Hands-On When It Comes To Controlling Energy (Control)
  9. Community Needs To Put More Green Power On Grid (Environment)
  10. Willing To Turn Up Thermostat To Help Prevent Outages (Reliability)

- **The two Customer groups also shared a Sleeper Value for Convenience…**

  1. Want To Conveniently Manage Use With New Technology (Convenience)

- **In addition, the #1 and #2 Combinations of Values for the greatest reach were the same in each segment: #1 being a combo of** "Community Needs To Be Able To Put More Green Power On The Grid" **plus** "See How Much Appliances/Equipment Use Impacts My Bill"; **and #2 being** "Hands-On When It Comes To Controlling Use" **plus** "See How Much Appliances/Equipment Use Impacts My Bill";

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Key Findings

- **In findings from <u>other topics</u> covered in the study:**
  - Most Customers were willing to Reduce Electricity Usage during Peak Periods in Exchange for a Billing Credit.
  - Residential Customers were more willing than Commercial to Shift Some Usage From High Demand Times, and a majority were interested in trying A Time Of Use Pricing Plan if their utility company automatically enrolled them in it.
  - There was clear interest in Energy Management Devices, and in Interactive/Programmable Thermostats.
  - And there was moderate interest in A Bundle That Includes An Energy Management/Interactive Device & Automatic Peak Usage Management Service and in A Bundle Of Different Energy Management Devices (without Automatic Peak Usage Service).
  - Customers need more education on Smart Meters, Smart Grid, and Smart Appliances, but Customers do not seem to reflexively reject them.
  - National Grid is clearly their authority on High Tech Energy Management Services.
  - Finally, thinking of possible points of Information Sharing Between Utility and Customer, we found highest interest in Being Informed About Planned Work In The Area, followed by Being Notified Of Power Restoration After Outages, but with lower interest in Sending Photos/Other Info To Utility When A Situation Can Cause An Outage.

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Distributed Generation & Storage:
Customer Needs & Values And Other Topics

D G & S

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Stated Importance Of Value Propositions

- After exposure to the Distributed Generation & Storage concept shown earlier here, we asked NG Customers to tell us what they need and value within the context of what we labeled for them as "Making Your Own Electricity".

- To get a clearer sense of Values, we approached this in two ways. First, we captured **Stated Importance** by having Customers rate a list of 23 Value Propositions one-by-one (rotated) using a 1-10 agreement rating scale. As shown to the right in a summary of high agreement (8-9-10 ratings), there are only a few Values that rise to the top across both groups.

Stated Importance Ratings (% T3B, 8-9-10 On 1-10 Agreement Scale)	Residential	Commercial
Total Per Segment	(913)	(118)
COST: Would Install Tech To Make On-Site If Electric Bill Zeroes Out	**57**	**58**
INFORMED: Want Elec Co. To Inform Of Variety Of Elec Sources	**53**	**42**
VALUE: Like Things w/Long Lasting Impact & Continuous Benefits	**48**	**60**
SECURITY: Secure Knowing Elec. Cleanly Generated Via Own Tech	**45**	37
CONTROL: If Could Make My Own Electricity, Would Feel Empowered	**44**	35
INFORMED: Want Trusted Partner For Options On How To Make Own	**43**	**44**
COST: Need More Cost Effective Way To Heat Home/Bus. & Water	41	**46**
INFORMED: Tech More Valuable If Can See Real-Time How Much Made	40	**42**
RELIABILITY: Key To Make Own Is Having 24/7 Power Even If Grid Down	40	39
CONVEN: w/Time Stress, 1-Time Install To Make Own Is A Good Choice	38	**43**
SECURITY: Self-Reliant & Rather Make Own Elec. Than Rely On Grid	37	33
COST: Would Only Install Tech To Make My Own Elec To Get Savings	36	**46**
CHOICE: I Want To Choose Where My Electricity Comes From	36	31
COST: Rather Lock In Cost Of Tech To Make Own Than Pay Going Rates	35	41
ENVIRO: Concern w/Env Impact Of Trad'l Elec, Prefer To Generate Own	34	31
RELIABILITY: Need To Avoid Outages, So Would Consider Making Own	31	28
IDENTITY: Having Tech. Making Elec. On-Site Says Something Positive	31	**46**
VALUE: Looking For Upgrade w/25 Yr Benefits Even If Payback=10/3 Yrs	31	**49**
RELIABILITY: Concerned Re Wide. Outages, Want To Be More Resilient	29	24
ENVIRO: Want To Reduce Carbon Footprint w/Tech That Makes On-Site	24	21
INFORMED: Elec. Co 1st Info Source For Installing Tech To Make Own	23	20
COST: Benefits Of Making Own Elec. Outweigh Purchase/Install Costs	17	21
IDENTITY: Want To Be Seen Having Latest Tech,eg, Equip To Make Own	12	31

Q15 Following are some statements about (CELL CONCEPT). Please use the slider to indicate the extent to which you agree or disagree with each statement as it relates to your (home) (business).

Yellow indicates leaders within each Customer segment.

31

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Comparative Importance Of Value Propositions

- Later, we had Customers react to the 23 DG&S-related Value Propositions on a direct **Comparative Importance** basis using the Max Diff testing and analytical technique.
  - Max Diff calculates importance for a longer list of attributes by showing respondents sub-sets of all of the attributes and asking them to choose the one they agree with most and the one they disagree with most.
- We see more discrimination in results from Max Diff than in Stated Importance, and similar leaders in both segments. The top items in each segment's list related mainly to Cost and Value.

Q23 On each of the next screens, you will see a short list of statements about (CELL CONCEPT) as it relates to your (home) (business). From each list, please choose the one statement that you AGREE with Most and then choose the one statement that you DISAGREE with Most.

Comparative Importance Ratings (% Of Comparisons In Which Each Value Statement Had Higher Agreement Than Others)	Residential	Commercial
Total Per Segment	(913)	(118)
COST: Would Install Tech To Make On-Site If Electric Bill Zeroes Out	78.5	79.4
VALUE: Like Things w/Long Lasting Impact & Continuous Benefits	74.7	76.3
COST: Would Only Install Tech To Make My Own Elec To Get Savings	67.3	68.8
COST: Need More Cost Effective Way To Heat Home/Bus & Water	66.8	61.7
CONTROL: If Could Make My Own Electricity, I Would Feel Empowered	66.6	59.0
COST: Rather Lock In Cost Of Tech Make Own Than Pay Going Rates	61.7	62.8
INFORMED: Want Trusted Partner For Options On How To Make Own	59.4	62.3
RELIABILITY: Key For Making Own Is 24/7 Power Even If Grid Down	58.2	52.5
SECURITY: Secure Knowing Elec. Cleanly Generated Via My Own Tech	57.2	47.0
CONVEN: w/Time Stress, 1-Time Install To Make My Own Is Good Choice	55.7	60.7
SECURITY: Self-Reliant & Rather Make Own Elec. Than Rely On Grid	55.5	50.1
INFORMED: Want Elec Co. To Inform Me Of Elec Sources Available	55.3	53.1
ENVIRO: Concern w/Env Impact Of Trad'l Elec, Prefer To Generate Own	53.4	45.4
VALUE: Looking For Upgrade w/25 Yr Benefits Even If Payback=10/3 Yrs	48.9	60.0
INFORMED: Tech More Valuable If Can See Real-Time How Much Made	45.9	46.4
CHOICE: I Want To Choose Where My Electricity Comes From	44.2	36.5
INFORMED: Elec Co = 1st Info Source For Installing Tech To Make Own	40.3	41.8
ENVIRO: Want To Reduce Carbon Footprint w/Tech That Makes On-Site	39.3	33.6
RELIABILITY: Need To Avoid Outages, So Would Consider Making Own.	39.2	31.9
RELIABILITY: Concerned Re Wide. Outages Want To Be More Resilient	34.3	28.3
COST: Benefits Of Making Own Elec Outweigh Purchase/Install Costs	27.5	28.8
IDENTITY: Having Tech. Making Elec On-Site Says Something Positive	17.1	34.7
IDENTITY: Want To Be Seen Having Latest Tech, eg, Equip To Make Own	8.3	18.5

Yellow indicates leaders within each Customer segment.

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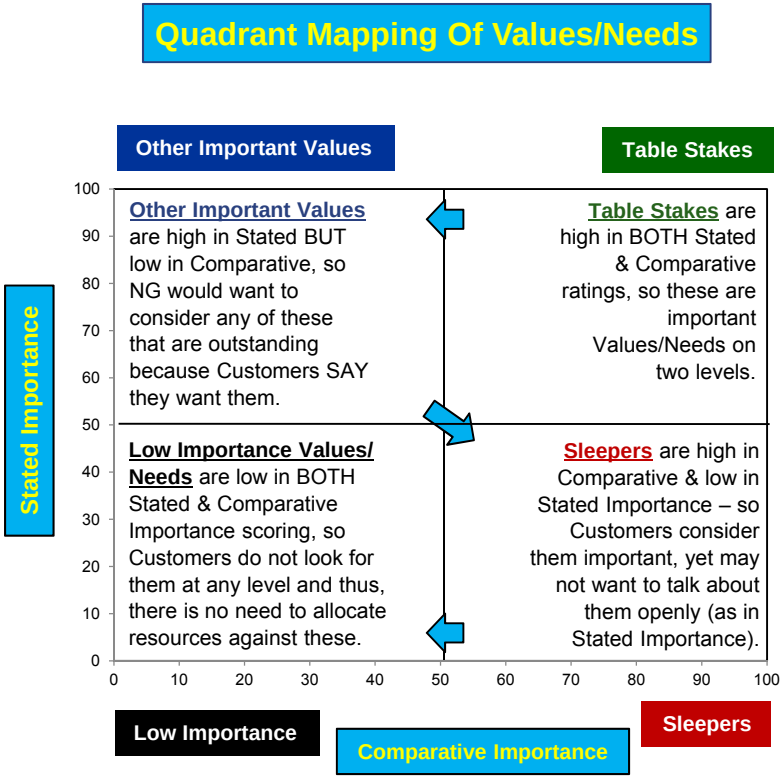
Hierarchy Of Values & Identifying Table Stakes

- To assess the **relative importance of the 23 DG&S-related Value Propositions** and to **identify the Table Stakes** among them, we plotted the two Importance scores (Stated Importance ratings and Comparative Importance Max Diff scores) in a Quadrant Map.

- To the right is a guide to the thinking behind use of these data and mapping and how they can be used to both establish a hierarchy of importance and to identify Table Stakes.



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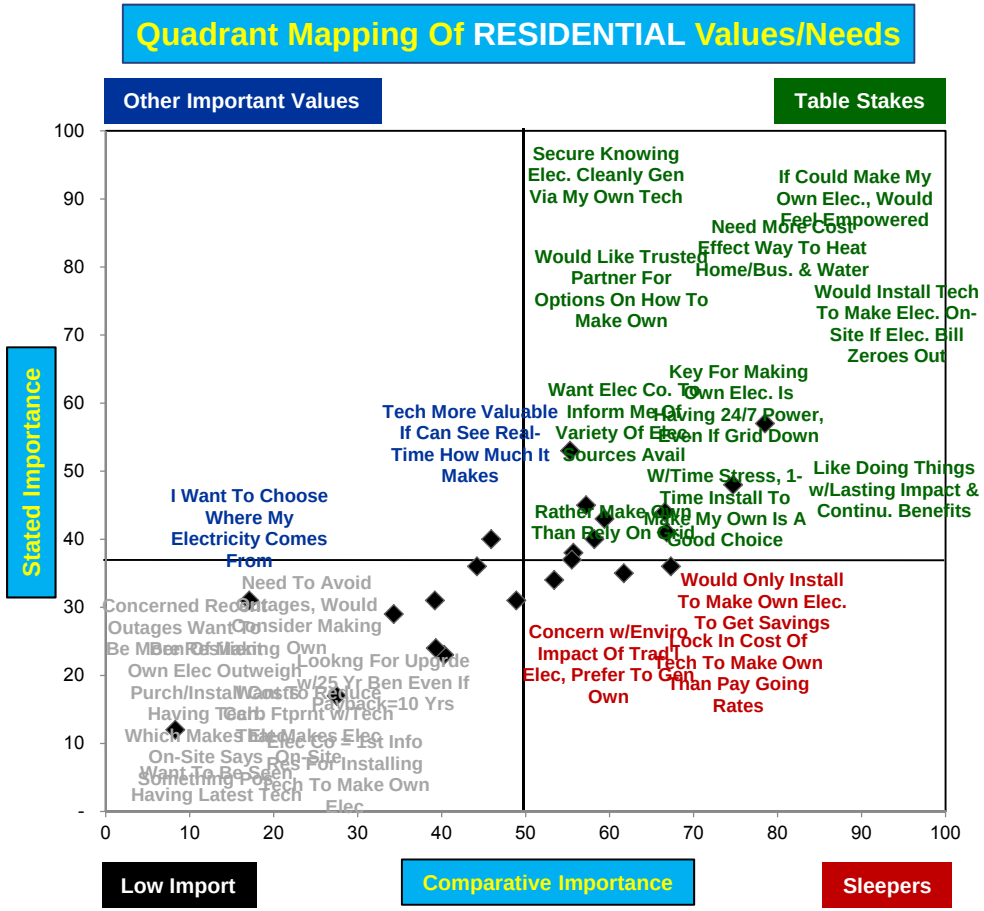
Values & Table Stakes (Cont'd.)

- In the DG&S section of the study, Quadrant Mapping showed that Table Stakes **among Residential Customers** included mainly Cost, Value and Informed items:

1. Would Install Tech To Make Electricity On-Site If Electric Bill Zeroes Out (COST)
2. Like Doing Things w/Long Lasting Impact & Continuous Benefits (VALUE)
3. Need More Cost Effective Way To Heat Home & Water (COST)
4. If Could Make My Own Electricity, I Would Feel Empowered (CONTROL)
5. Key For Making Own Elec Is Having 24/7 Power, Even If Grid Down (RELIABILITY)
6. With Time Stress, 1-Time Install To Make My Own Is A Good Choice (CONVENIENCE)
7. Secure Knowing Elec. Cleanly Gen Via My Own Tech (SECURITY)
8. Want Electric Company To Inform Me Of Variety Of Electricity Sources Available (INFORMED)
9. Would Like Trusted Partner For Options On How To Make Own (INFORMED)
10. Rather Make Own Then Rely On Grid (VALUE)



Q15 Use the slider to indicate the extent to which you agree or disagree with each statement as it relates to your (home) (business).
Q21 Pease choose the one statement that you AGREE with Most and then choose the one statement that you DISAGREE with Most.

34

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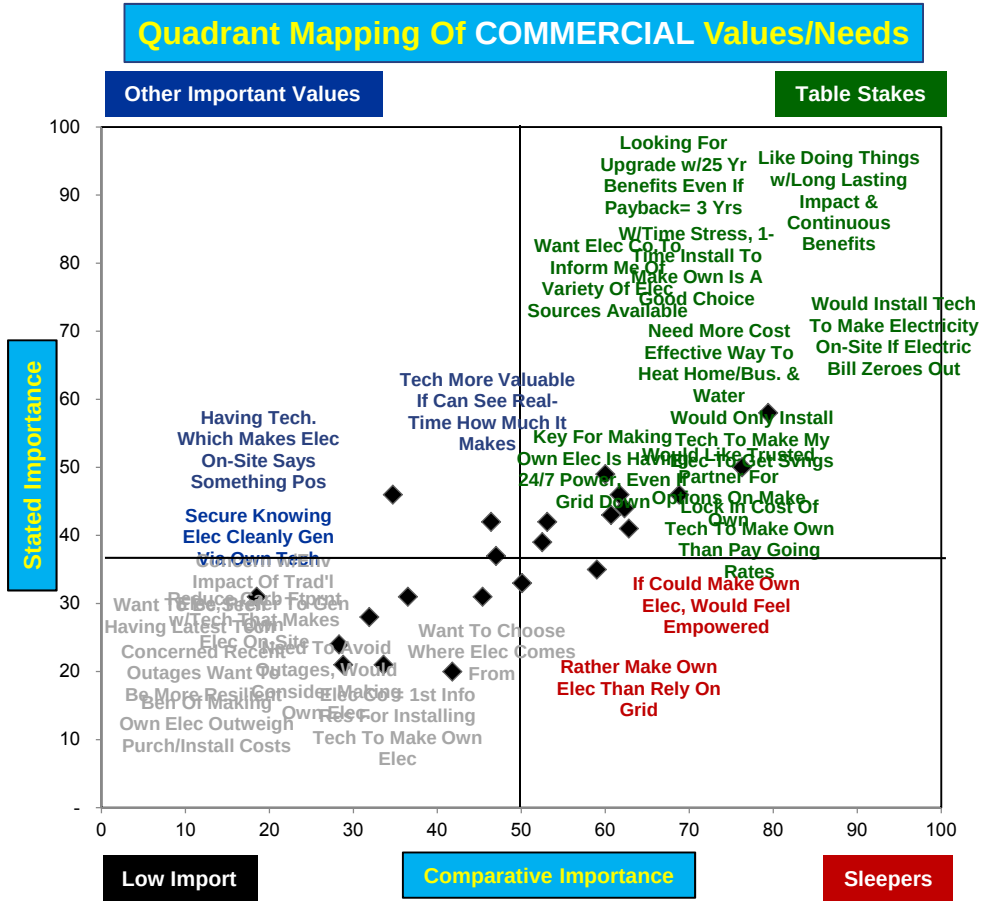
Values & Table Stakes (Cont'd.)

- The Table Stakes **among Commercial Customers** were very similar and thus also centered around Cost, Value and Informed items:

1. Would Install Tech To Make Electricity On-Site If Electric Bill Zeroes Out (COST)
2. Like Doing Things w/Long Lasting Impact & Continuous Benefits (VALUE)
3. Would Only Install Tech To Make My Own Elec To Get Savings (COST)
4. Looking For Upgrade w/25 Yr Benefits (VALUE)
5. Want Electric Company To Inform Me Of Variety Of Electricity Sources Available (INFORMED)
6. Would Like Trusted Partner For Options On How To Make Own (INFORMED)
7. Lock In Cost Of Tech To Make Own Than Pay Going Rates (COST)
8. Need More Cost Effective Way To Heat Home & Water (COST)
9. W/Time Stress, 1-Time Install To Make Own Is A Good Choice (CONVENIENCE)
10. Key For Making Own Elec Is Having 24/7 Power, Even If Grid Down (RELIABILITY)



Q15 Use the slider to indicate the extent to which you agree or disagree with each statement as it relates to your (home) (business).
Q21 Pease choose the one statement that you AGREE with Most and then choose the one statement that you DISAGREE with Most.

35

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Top Combinations Of Value Propositions

- Analysis to this point has focused on identifying the top Value Propositions. Another objective of the research was to **identify Top Combinations of Value Propositions**. We addressed this objective using TURF Analysis…
  - **TURF = Total Unduplicated Reach & Frequency.** This analytical technique looks for the net, non-duplicative, gain in appeal of adding different Values together in combo.
- The TURF work showed that the **top combos of TWO Values** all included at least one statement associated with Cost, and that one pairing was in the top 4 in both segments:
  - "I Would Install Technology To Make Electricity On-Site If My Electric Bill Zeroes Out" (Cost) AND "Concern w/Env Impact, So Prefer To Generate Own" (Environment).

Top Combinations Of TWO Values (% From TURF Analysis Of Max Diff Scores)	Resi-dential		Com-mercial	
TOP RESIDENTIAL COMBINATIONS	(913)	Rank	(118)	Rank
COST: Would Install Tech To Make On-Site If Bill Zeroes Out ENVIRO: Concern w/Env Impact, So Prefer To Generate Own	**53.6**	**#1**	55.3	#4
RELIABILITY: Key To Own Is 24/7 Power Even If Grid Down COST: Would Install Tech To Make On-Site If Bill Zeroes Out	**52.3**	**#2**	51.1	#12
SECURITY: Secure Elec. Cleanly Generated Via Own Tech COST: Would Install Tech To Make On-Site If Bill Zeroes Out	**51.7**	**#3**	51.9	#8
TOP COMMERCIAL COMBINATIONS	(913)	Rank	(118)	Rank
COST: Would Install Tech To Make On-Site If Bill Zeroes Out VALUE: Like Things w/Long Lastg Impact & Continuous Benefit	48.4	#8	**56.6**	**#1**
COST: Would Only Install Tech To Make Own For Savings ENVIRO: Concern w/Env Impact, So Prefer To Generate Own	48.4	#8	**55.7**	**#2**
COST: Would Install Tech To Make On-Site If Bill Zeroes Out COST: Would Only Install Tech To Make Own For Savings	45.6	#14	**55.3**	**#3**

Total Possible Combinations = 253

Yellow highlighting indicates this combination is among the leaders in both Customer segments.

Q23 On each of the next screens, you will see a short list of statements about (CELL CONCEPT) as it relates to your (home) (business). From each list, please choose the one statement that you AGREE with Most and then choose the one statement that you DISAGREE with Most.

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Top Combinations Of Value Propositions

- We found that there was substantial gain in reach of roughly 10-15 points in moving from combinations of 2 to **combos of 3 Value Propositions**, though there was less gain in then moving on to combos of 4 or 5 (which are also difficult to address in a single Solution area).

- However, in moving from combos of 2 to 3, we lost the similarities between Residential and Commercial that we just saw – though there was still at least one Cost value in each combo in both segments.

Q23 On each of the next screens, you will see a short list of statements about (CELL CONCEPT) as it relates to your (home) (business). From each list, please choose the one statement that you AGREE with Most and then choose the one statement that you DISAGREE with Most.

Top Combinations Of THREE Values (% From TURF Analysis Of Max Diff Scores)	Resi-dential		Com-mercial	
TOP RESIDENTIAL COMBINATIONS	(913)	Rank	(118)	Rank
RELIABILITY: Key To Making Own Is 24/7 Power Even If Grid Down **COST: Would Install Tech To Make On-Site If Bill Zeroes Out** **ENVIRO: Concern w/Env Impact, So Prefer To Generate Own**	**65.0**	**#1**	61.6	#21
RELIABILITY: Key To Making Own Is 24/7 Power Even If Grid Down **COST: Would Install Tech To Make On-Site If Bill Zeroes Out** **SECURITY: Secure Elec. Cleanly Generated Via Own Tech**	**63.2**	**#2**	58.2	#66
COST: Would Install Tech To Make On-Site If Bill Zeroes Out **CONTROL: If I Could Make My Own, I Would Feel Empowered** **RELIABILITY: Key To Making Own Is 24/7 Power Even If Grid Down**	**62.8**	**#3**	57.5	#84
TOP COMMERCIAL COMBINATIONS	(913)	Rank	(118)	Rank
COST: Would Install Tech To Make On-Site If Bill Zeroes Out **COST: Would Only Install Tech To Make Own For Savings** **ENVIRO: Concern w/Env Impact, So Prefer To Generate Own**	58.8	#14	**66.8**	**#1**
ENVIRO: Concern w/Env Impact, So Prefer To Generate Own **COST: Would Install Tech To Make On-Site If Bill Zeroes Out** **VALUE: Like Things w/Long Lastg Impact & Continuous Benefits**	59.2	#13	**66.6**	**#2**
COST: Would Only Install Tech To Make Own For Savings **ENVIRO: Concern w/Env Impact, So Prefer To Generate Own** **VALUE: Like Things w/Long Lastg Impact & Continuous Benefits**	56.4	#36	**66.1**	**#3**

Total Possible Combinations = 1,771

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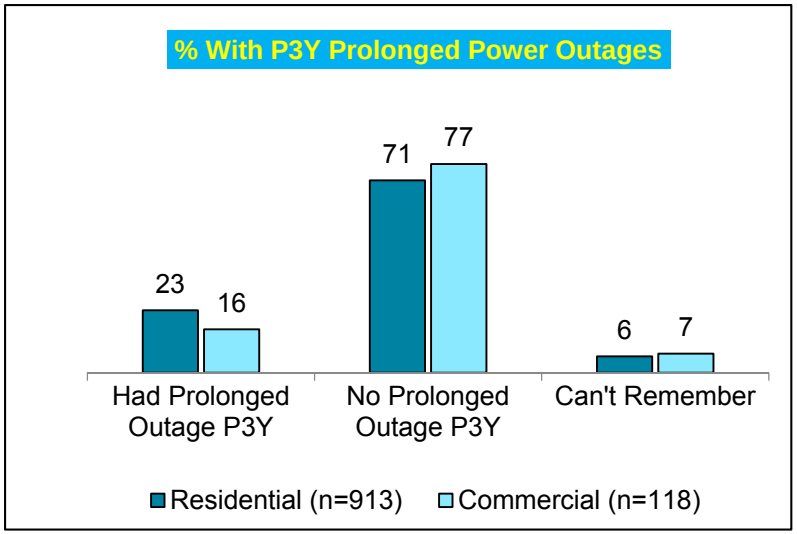
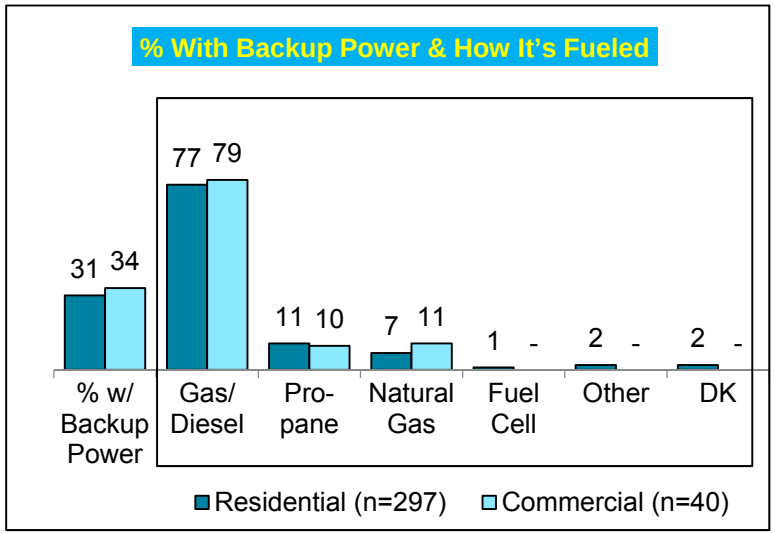
Other Topics: Outages & Backup Power

- Turning to other topics covered in the DG&S section of the study, we found that 23% of Residential Customers and 16% of Commercial Customers had **Prolonged (1+Day) Power Outages in the Past 3 Years**.

- About 3 in 10 Customers of each segment **Have Backup Power** (Fueled Mainly By Gasoline/Diesel).





Q17 In the past 3 years, have you experienced a prolonged power outage of more than one day at your (home) (business)?

Q18 Do you currently have any source of backup power, such as a generator, at your (home) (business) that can be used during a power outage?

Q19 And how is your backup power fueled?

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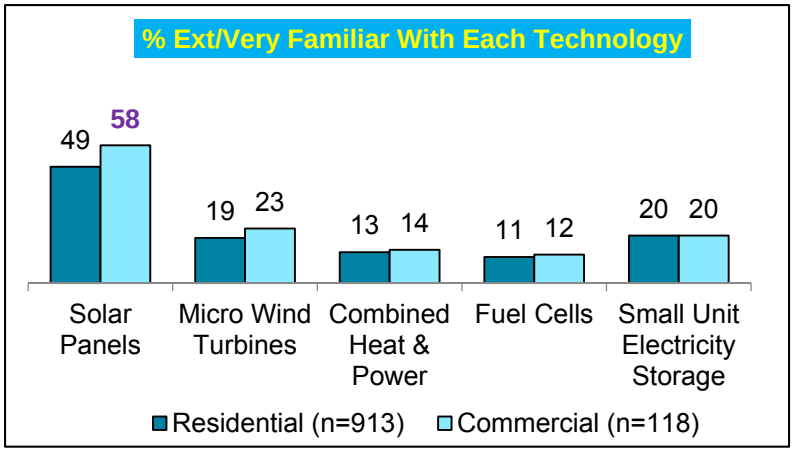
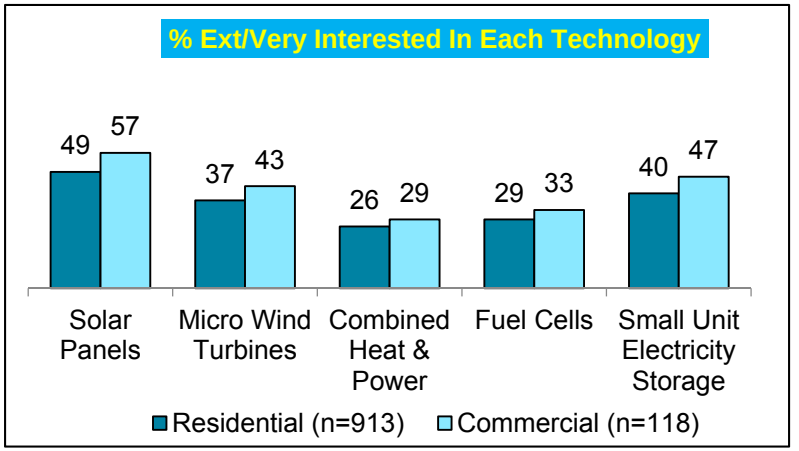
Other Topics: Energy Storage Technologies

- After presenting respondents with general descriptions of five specific Energy Storage Technologies (see below), we found that they were far more **Familiar** with Solar Panels than the other types, and generally more **Interested** in Solar as well – though Interest levels in all other storage types were substantial too, especially Interest in Small Unit Electricity Storage and Micro Wind Turbines. Note that Residential and Commercial Customers were very similar in both Familiarity and Interest.





FULL DESCRIPTIONS OF ENERGY TECHNOLOGIES RATED HERE

Solar Panels That Make Electricity From The Sun

Micro Wind Turbines With Propellers Small Enough To Put On A Home Or Building And That Make Electricity From The Wind

Combined Heat And Power or Co-Generation - A Unit That Makes Heat & Electricity From Natural Gas\

Fuel Cells – A Small Unit That Generates Electricity Through A Chemical Reaction, With Few Or No Environmental Emissions

Electricity Storage – A **Small Unit** Such As A Battery Or Flywheel That Collects Energy From A Source Of Power Generation And Saves It For Future Use When There Is More Demand For Electricity Than Can Be Supplied

Q25 Electricity can be stored in small units at your (home) (business) that collect energy from intermittent generation sources like wind turbines and solar panels. This technology enables you to use the stored power at a later time when the wind isn't blowing and the sun isn't shining, or if there is an outage that interrupts power flow from the power grid. Following are some of the types of technologies used in Making & Storing Your (Home's) (Business') Own Electricity that were mentioned earlier. Please indicate how FAMILIAR you were with each technology before the survey today.

Q26 And how INTERESTED are you in each technology?

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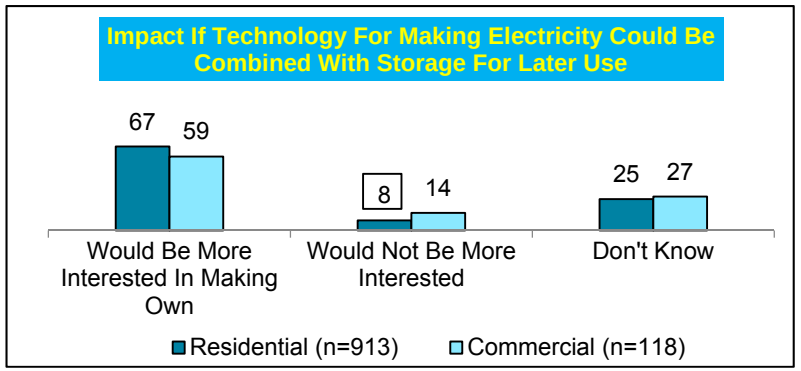
Other Topics: Make & Store Technologies

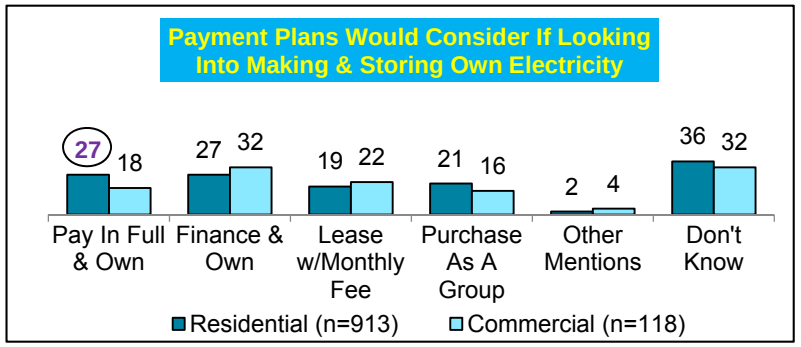
- About two-thirds of each segment said they would be **More Interested In Making Their Own Electricity If The Technology To Make Is Combined With Storage**.
- There was some uncertainty about **Make & Store Payment Plans**, with no clear preference for one method over the others.
- **Renting Space To A Company To Install, Run & Maintain Make & Store Technologies** had appeal to 48% of Commercial Customers but significantly less appeal (32%) to Residential.

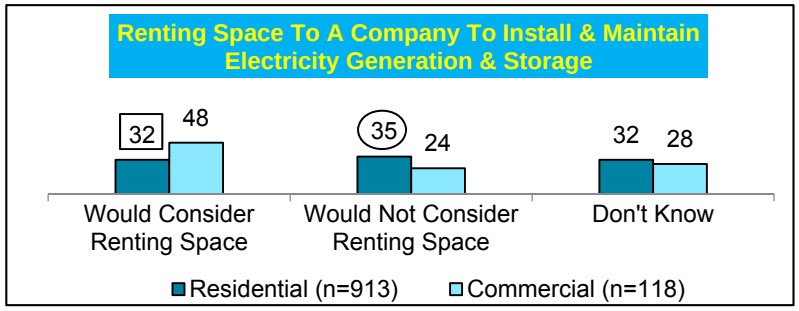
Q27 If you knew that the technology (you) (your company) chose to Make Electricity could be combined with a storage solution that allows you to store electricity to use at a later time, such as when there is a power outage, would you be MORE interested in Making Your Own (Home's) (Business') Electricity?

Q28 Which of the following would you consider if you decided to look into one of these technologies for Making & Storing Your Own Electricity?

Q29 And would you consider renting out space on your property to a company so that they could install, own, and maintain one of these technologies we've been discussing for making and/or storing electricity? You would be offered a fair market rental value for the space used, but the company would own and retain any profit from the electricity generated.







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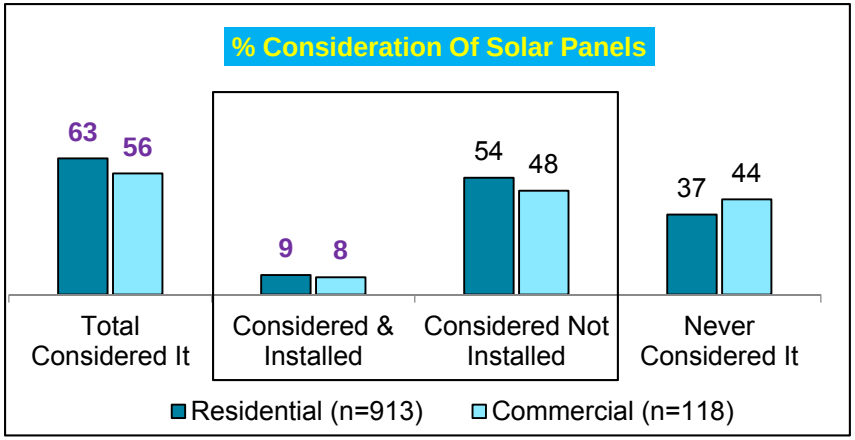
Other Topics: Attitudes Toward Solar Panels

- 63% of Residential and 56% of Commercial Customers said that they have **Considered Installation Of Solar Panels** for their home/business and just under 10% of each segment said they have actually Installed Solar Panels.

- Among those in each segment who had Considered But Not Installed Solar Panels, the top **Barrier To Installation Of Solar Panels** was Cost-Related, mainly that the cost was just too high for them.



There has been a substantial Increase in Consideration of Solar Panels (up in each cell by 14-16 points) and having Installed Solar Panels (up 5-7 points in each cell)

Reasons For Considering But Not Installing Solar Panels (%)	Residential	Commercial
Total Per Segment Who Considered But Did Not Install Solar Panels	(491)	(57)
High price/too expensive/cost prohibitive (unspecified)	**28**	**35**
Too many trees/was told I need to remove some trees first	10	2
Appearance/don't like how they look	6	-
Can't afford/don't have the money now	6	2
We rent/do not own the home/building we live in	5	11
Planning to move/was moving	5	-

Q21 Have you ever considered or installed Solar Panels for your (home)(business)?

Q22 Why did you decide not to install Solar Panels at your (home)(business)?

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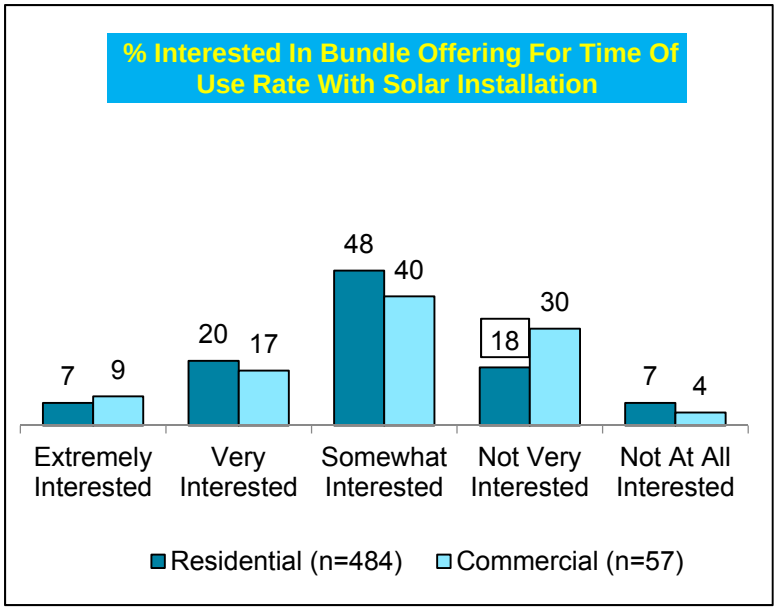
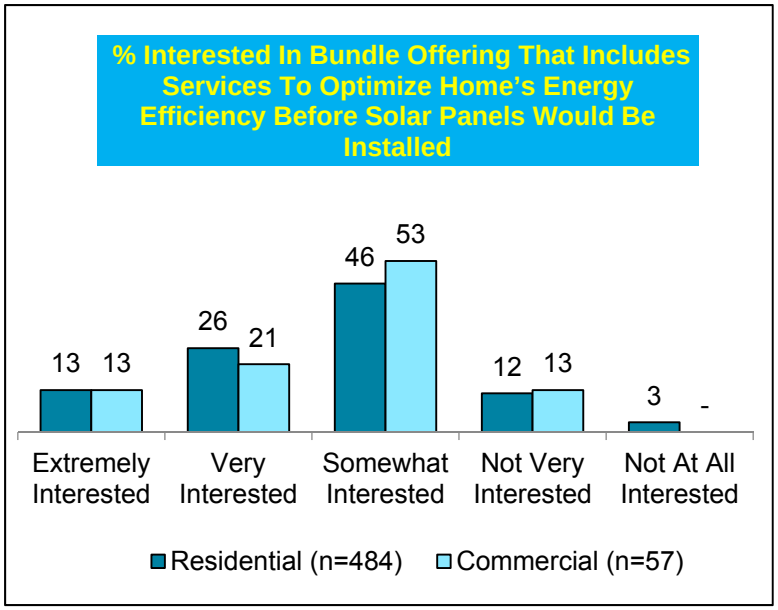
Other Topics: Bundle Offerings For Solar Panels

- Among those who had considered Solar Panels, there was low interest (about 25% across segments) in a **Solar Time Of Use Rate Bundle**, and only slightly higher interest (about 35%) in a **Bundle That Optimizes Energy Efficiency Before Solar Panels Are Installed**.





Q21a You mentioned that you have considered solar panels. Sometimes companies will bundle products and services to provide you with overall cost savings. How likely are you to consider a bundled offering that switches you to a time of use rate with your solar installation for your (home) (business)? Time of use rates is the practice of setting electricity prices higher in the daytime and lower in the early morning and nighttime in order to shift some usage away from when the demand is highest and help customers avoid higher costs by managing when they use energy.

Q21b And how likely are you to consider a bundled offering for solar that includes services to optimize the energy efficiency of your home before solar panels would be installed?

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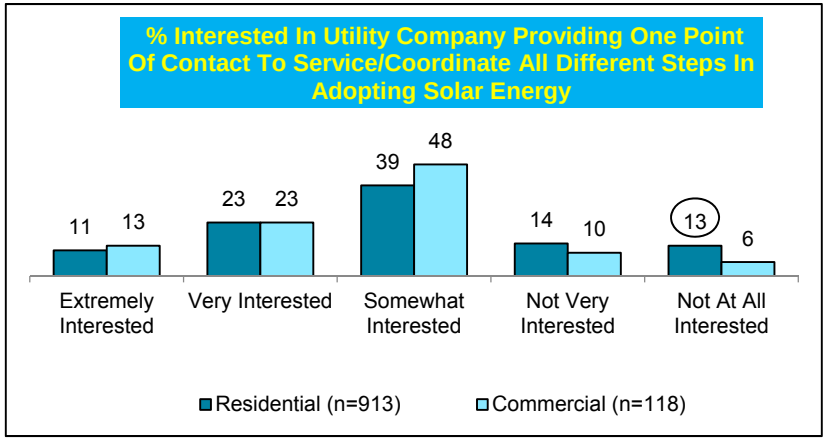
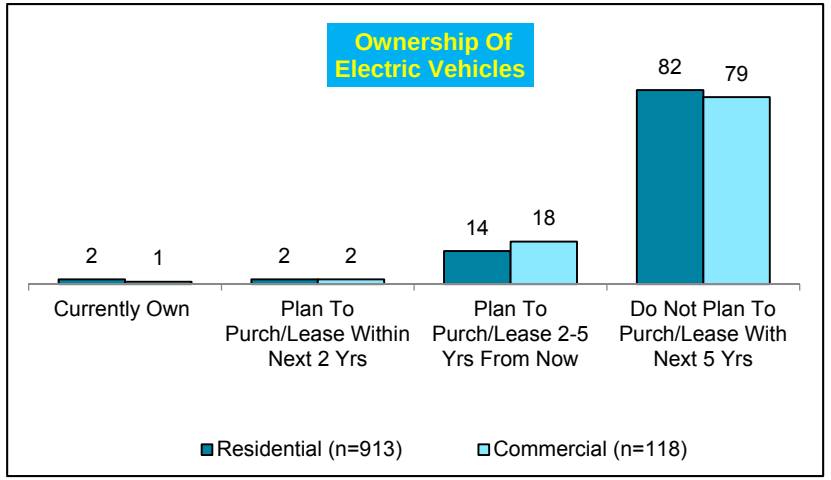
Other Topics: One-Stop Solar & AFV Ownership

- Regardless of current Solar use, all respondents were asked about their **Interest In Their Utility Company Providing One Point Of Contact For All Solar Needs** and results showed that about one-third were Extremely/ Very Interested in the concept.

- We also asked about **Ownership Of Electric Vehicles** and found that only 1-2% of both Customer segments now own one, with just 2% of each group saying they **Plan To Purchase/Lease One N2Years**. Note: while questions are somewhat different, similar results were found for Electric Vehicles in the AFV samples.





Q31a As you may or may not know, a decision like adopting solar energy requires multiple steps – from roof assessment, financing options, installing panels and connection to electric service – provided by different sources. How interested would you be in a service from your utility to provide one point of contact to service/coordinate all these different steps?

Q31b Switching topics now, which one statement best reflects your ownership status when it comes to electric vehicles? These are vehicles that run on electricity and are re-charged with electricity after being plugged in to an electric source or outlet for a sufficient amount of time.

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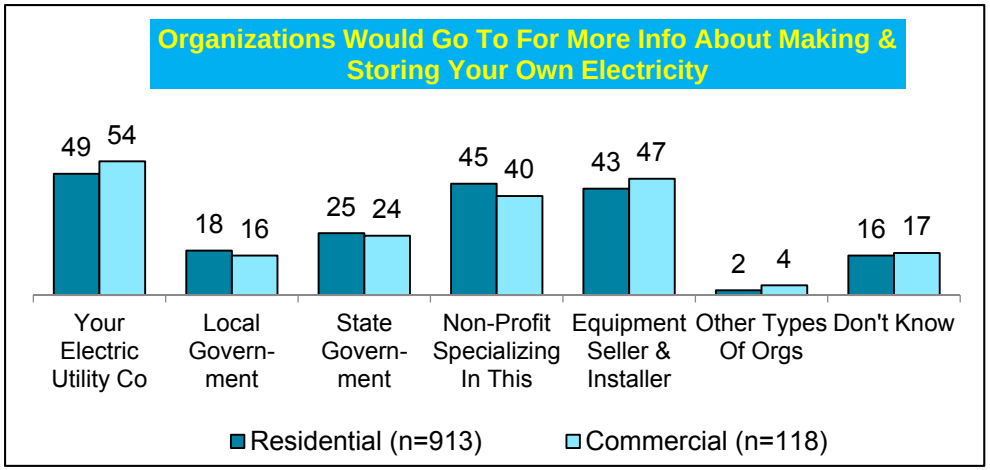
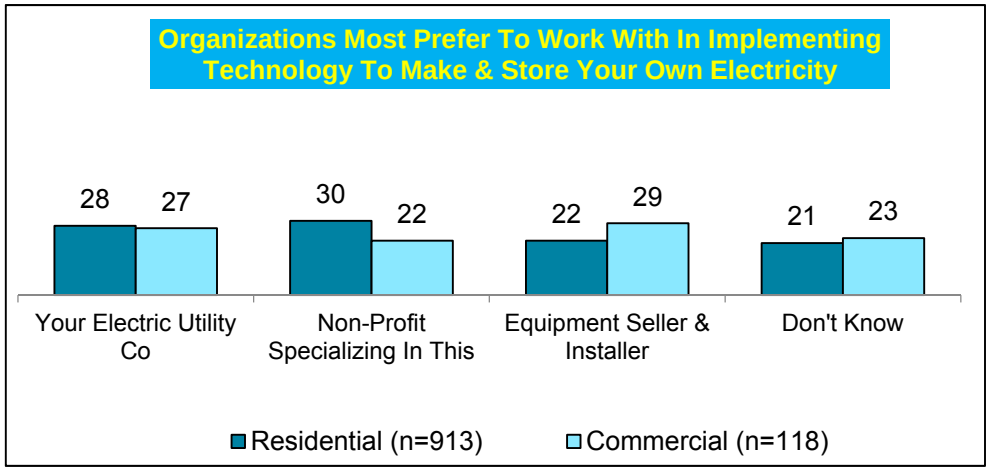
Other Topics: Organizations They Would Trust

- Finally for DG&S, we asked about the types of organizations they would rely on in terms of Making & Storing Their Own Electricity.
- In terms of types they **Would Go To For More Information**, there were 3 clear leaders – Your Electric Utility Company, A Company That Sells & Install These Types of Equipment and Specialized Non-Profits.
- All 3 types were also important as **Organizations They Would Prefer To Work With In Implementing Technology**.





Q30 Based upon all that you now know, which of the following types of organizations would you go to for more information about Making & Storing Your (Home's) (Business') Own Electricity?

Q31 And which of the following types of organizations would you most prefer to work with to implement the type of technology needed to Make & Store Your (Home's) (Business') Own Electricity?

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Key Findings

- **DG&S had about equal Familiarity by segment (~25%), but was stronger among Residential in terms of Importance (54 vs 38%), and in generating Interest In Learning More About It (51% vs 41%).**

- **The study identified 7 Table Stakes shared by both Residential and Commercial Customers that should be considered in solution development and messaging:**
  1. Would Install The Technology To Make Electricity On-Site If Electric Bill Zeroes Out (Cost)
  2. Like Doing Things w/Long Lasting Impact & Continuous Benefits (Value)
  3. Need A More Cost Effective Way To Heat Home/Bus. & Water (Cost)
  4. Key For Making Own Elec. Is Having 24/7 Power, Even If Grid Down (Reliability)
  5. With Time Stress, A 1-Time Install Of Equipment To Make Own Electricity Is A Good Choice (Convenience)
  6. Want Electric Company To Inform Me Of Variety Of Electricity Sources Available (Informed)
  7. Would Like Trusted Partner For Options On How To Make Own (Informed)

- **As seen above, Cost and Value are powerful values in DG&S. Those two values were also present in the strongest Combination of Values in both the Residential and Commercial segments.**

  - **However, the one combo that emerged as strongest (having the greatest reach) in BOTH segments was one that included Cost plus an Environment value:** "Would Install The Technology To Make Electricity On-Site If Electric Bill Zeroes Out" **and** "Concern w/Env Impact, So Prefer To Generate Own".

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Key Findings

- **In findings from <u>other topics</u> covered in the study:**
  - About 23% of Residential and 16% of Commercial Customers have had Prolonged Power Outages, and about one-third have Backup Power (mainly Gas/Diesel).
  - Of all of the Energy Storage Technologies covered here, Solar Panels had highest Familiarity and Interest. Two other technologies also generated strong interest -- Small Unit Electricity Storage and Micro Wind Turbines.
  - Over half of Customers said that they have Considered Installation Of Solar Power, and about 10% have Installed it. Cost is clearly the top barrier to use.
    - Among those who have considered Solar, there was low interest in a Solar Time Of Use Rate Bundle and in a Bundle That Optimizes Energy Efficiency Before Solar Panels Are Installed.
    - There was strong Interest In Their Utility Company Providing One Point Of Contact For All Solar Needs.
  - Interest in Generation Technology increases if it allows Storage, but there was uncertainty about Payment Plans. Renting Space To A Company To Install, Run & Maintain Make & Store Technologies appealed to 48% of the Commercial segment but to only 32% of Residential.
  - 3 types of Organizations have highest DG&S credibility: Utilities, Equipment Sellers/Installers, and Non-Profits.

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Alternative Fuel Vehicles:
Customer Needs & Values And Other Topics

A F V

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AFV

Stated Importance Of Value Propositions

- After exposure to the AFV concept shown earlier, we asked Customers to tell us what they need and value within the context of Alternative Fuel Vehicles.
- We approached this in two ways. First, we captured **Stated Importance** by having Customers rate a list of 22 Value Propositions one-by-one (rotated) using a 1-10 agreement rating scale.
- As shown in the summary of high agreement (8-9-10) ratings to the right, there are 4 Value Propositions which top the list for both segments.

Stated Importance Ratings (% T3b, 8-9-10 On 1-10 Agreement Scale)	Residential	Commercial
Total Per Segment	(1143)	(121)
CONVENIENCE: Even w/Savings, Concern On Re-Fuel/Chg Stas	**65**	**63**
INFORMED: In Choosing, Would Seek Advice From Trusted Ptner	**57**	**53**
CHOICE: Consider AFV Only W/Pricing Plans/Re-Fueling Options	**54**	**51**
SECURITY: Prefer To Fuel Vehicles With Fuel Sourced In America	**48**	**55**
COST: Even If High Initial Costs, Would Consider AFV b/c Of Savings	46	47
SIMPLICITY: Might Pay More Upfront If Maintenance Was Simpler	44	45
INFORMED: Need To Understand Energy Co's AFV Role	44	44
IDENTITY: Important To Set Example By Supporting US Econ/Jobs	44	55
SECURITY: Prefer Purchase American Veh. b/c It Supports Economy	40	51
IDENTITY: Important To Set Example By Reducing Impact On Enviro.	38	39
CONFIDENCE: Uncertain About Future Supply/Cost Of Gas/Diesel	37	32
GREATER GOOD: Would Pay More For Veh. Supporting Comm.Good	36	45
INFORMED: Need More Info From Energy Co. To Make AFV Decision	34	36
INFORMED: Want Energy Co Keep Me Informed Re: AFVs/Charging	31	34
CONFIDENCE: Uncertain About Future Supply/Cost Of Elec/NatGas	29	24
INFORMED: Switching To AFV Easier If I had Trusted Advisor	28	30
INFORMED: Think of Energy Co.As Partner To Help Choose An AFV	17	17
CONFIDENCE: Wouldn't Cons b/c Concerned Re: Elec./NatGas Prices	16	17
IDENTITY: AFV's At Home/Bus. Says Something Positive About Me	14	33
ENVIRONMENT: Way We Generate Elec In NE US Enviro-Friendly	12	14
ENVIRONMENT: Retrieving Natural Gas Via Fracking Enviro-Friendly	10	16
IDENTITY: Want To Be Thot Of As Having Latest/Greatest Technology	10	27

Q15 Following are some statements about (CELL CONCEPT). Please use the slider to indicate the extent to which you agree or disagree with each statement as it relates to your (home) (business).

Yellow indicates leaders within each Customer segment.

48

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Comparative Importance Of Value Propositions

- Later, we had Customers react to the 22 AFV-related Value Propositions on a direct **Comparative Importance** basis using the Max Diff technique.
  - Max Diff calculates importance for a longer list of attributes by showing respondents sub-sets of all of the attributes and asking them to choose the one they agree with most and the one they disagree with most.
- As in other Solutions areas, we found more discrimination in results from Max Diff than from Stated Importance, though the leaders in Stated were also among the leaders here. In addition, the top Values (in yellow to the right) were mostly similar across Customer segments and covered a range of issues/Value types.

Q30 On each of the next screens, you will see a short list of statements about (CELL CONCEPT) as it relates to your (home) (business). From each list, please choose the one statement that you AGREE with Most and then choose the one statement that you DISAGREE with Most.

Comparative Importance Ratings (% Of Comparisons In Which Each Value Statement Had Higher Agreement Than Others)	Residential	Commercial
Total Per Segment	(1143)	(121)
CONVENIENCE: Even w/Savings, Concern On Re-Fuel/Chg Stas	**79.5**	**72.7**
CHOICE: Consider AFV Only W/Pricing Plans/Re-Fueling Options	**73.5**	**67.3**
COST: Even If High Initial Costs, Would Cons AFV b/c Of Savings	**70.4**	**63.8**
SECURITY: Prefer To Fuel Vehicles With Fuel Sourced In America	**65.8**	**68.3**
INFORMED: In Choosing, Would Seek Advice From Trusted Ptner	**64.0**	**59.2**
SIMPLICITY: Might Pay More Upfront If Maintenance Was Simpler	**63.6**	**54.3**
CONFIDENCE: Uncertain About Future Supply/Cost Of Gas/Diesel	**60.7**	**55.4**
GREATER GOOD: **Would Pay More For Veh. Supporting Comm.Good**	**59.0**	**50.9**
IDENTITY: **Important To Set Example By Reducing Impact On Enviro.**	**57.9**	**53.9**
INFORMED: **Need To Understand Energy Co's AFV Role**	**57.5**	**51.8**
SECURITY: Prefer Purchase American Veh. b/c It Supports Economy	**56.8**	**62.1**
CONFIDENCE: Uncertain About Future Supply/Cost Of Elec/NatGas	**56.1**	49.3
INFORMED: Switching To AFV Easier If I had Trusted Advisor	56.0	53.6
IDENTITY: Important To Set Example By Supporting US Econ/Jobs	54.7	**62.2**
INFORMED: Want Energy Co Keep Me Informed Re: AFVs/Charging	47.3	49.0
INFORMED: Need More Info From Energy Co. To Make AFV Decision	46.4	45.4
CONFIDENCE: Wouldn't Cons b/c Concerned Re: Elec./NatGas Prices	36.9	33.4
INFORMED: Think of Energy Co. As Partner To Help Choose An AFV	30.9	33.5
ENVIRONMENT: Way We Generate Elec In NE US Enviro-Friendly	29.9	32.6
IDENTITY: AFV's At Home/Bus. Says Something Positive About Me	25.3	37.2
ENVIRONMENT: Retrieving Natural Gas Via Fracking Enviro-Friendly	19.3	23.7
IDENTITY: Want To Be Thot Of As Having Latest/Greatest Technology	12.4	27.5

Yellow indicates leaders within each Customer segment.

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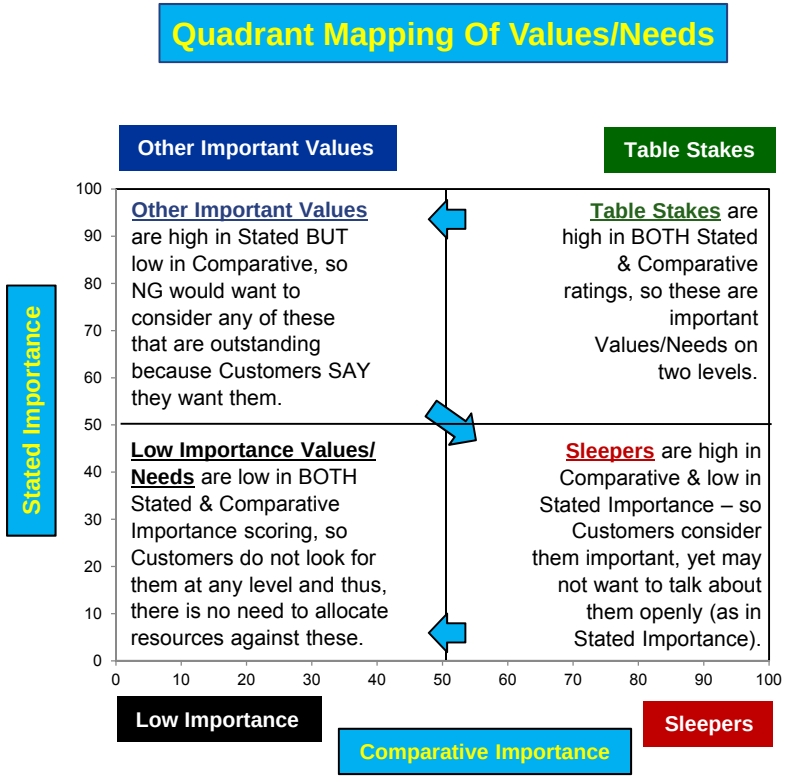
Hierarchy Of Values & Identifying Table Stakes

- To assess the **relative importance of the 22 AFV-related Value Propositions** and to **identify the Table Stakes** among them, we plotted the two Importance scores (Stated Importance ratings and Comparative Importance Max Diff scores) in a Quadrant Map.

- To the right is a guide to the thinking behind use of these data and mapping and how they can be used to both establish a hierarchy of importance and to identify Table Stakes.



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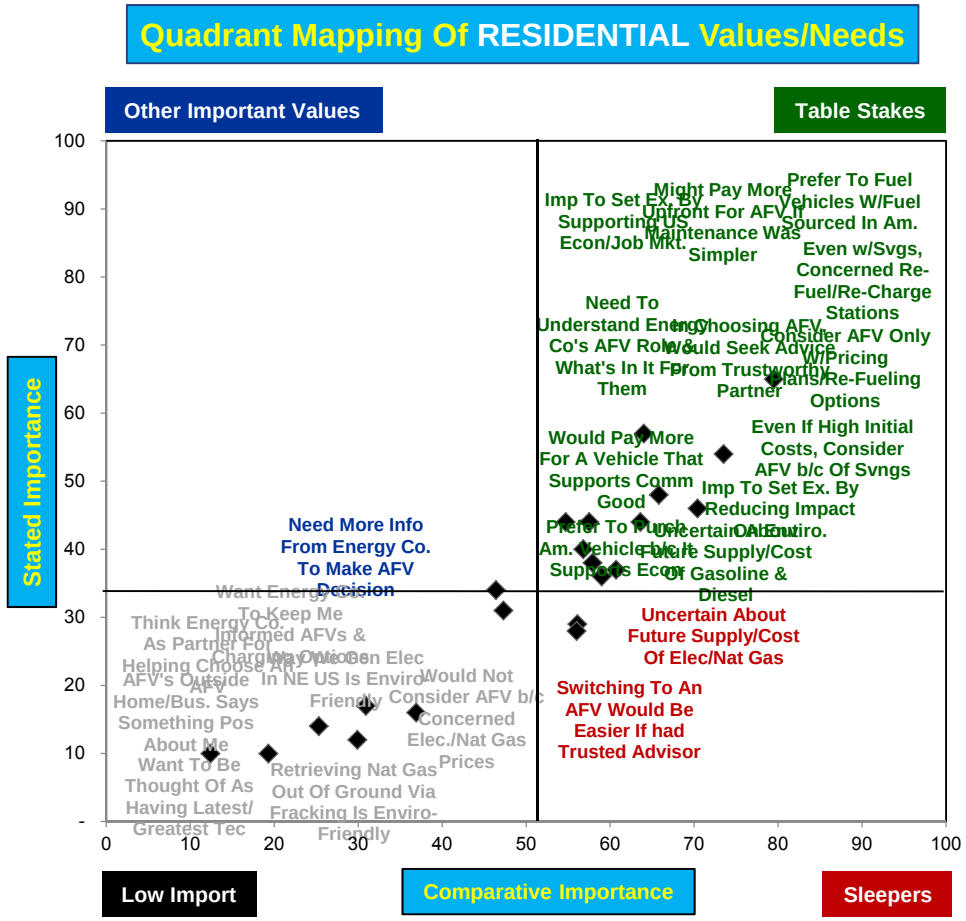
Values & Table Stakes (Cont'd.)

- Quad Mapping showed **Residential** Table Stakes represented all Value types:
  1. Even w/Savings, Concerned About Re-Fuel/Re-Charge Stations (CONVENIENCE)
  2. In Choosing AFV, Would Seek Advice From Trustworthy Partner (INFORMED)
  3. Would Consider AFV Only With Pricing Plans/Re-Fueling Options (CHOICE)
  4. Would Prefer To Fuel Vehicles With Fuel Sourced In America (SECURITY)
  5. Even If High Initial Costs, Would Consider AFV b/c Of Savings (COST)
  6. Important To Set Example By Reducing Impact On Environment (IDENTITY)
  7. Uncertain About Future Supply/Cost Of Gasoline And Diesel (CONFIDENCE)
  8. Might Pay More Upfront For AFV If Maintenance Was Simpler (SIMPLICITY)
  9. Prefer To Purchase American Vehicle b/c It Supports Economy (SECURITY)
  10. Need To Understand Energy Co's AFV Role & What's In It For Them (INFORMED)
  11. Would Pay More For A Vehicle That Supports Community Good (GREATER GOOD)
- There was also this Sleeper –
  1. Switching To An AFV Would Be Easier If Had Trusted Advisor (INFORMED)



Q15 Use the slider to indicate the extent to which you agree or disagree with each statement as it relates to your (home) (business).
Q21 Pease choose the one statement that you AGREE with Most and then choose the one statement that you DISAGREE with Most.

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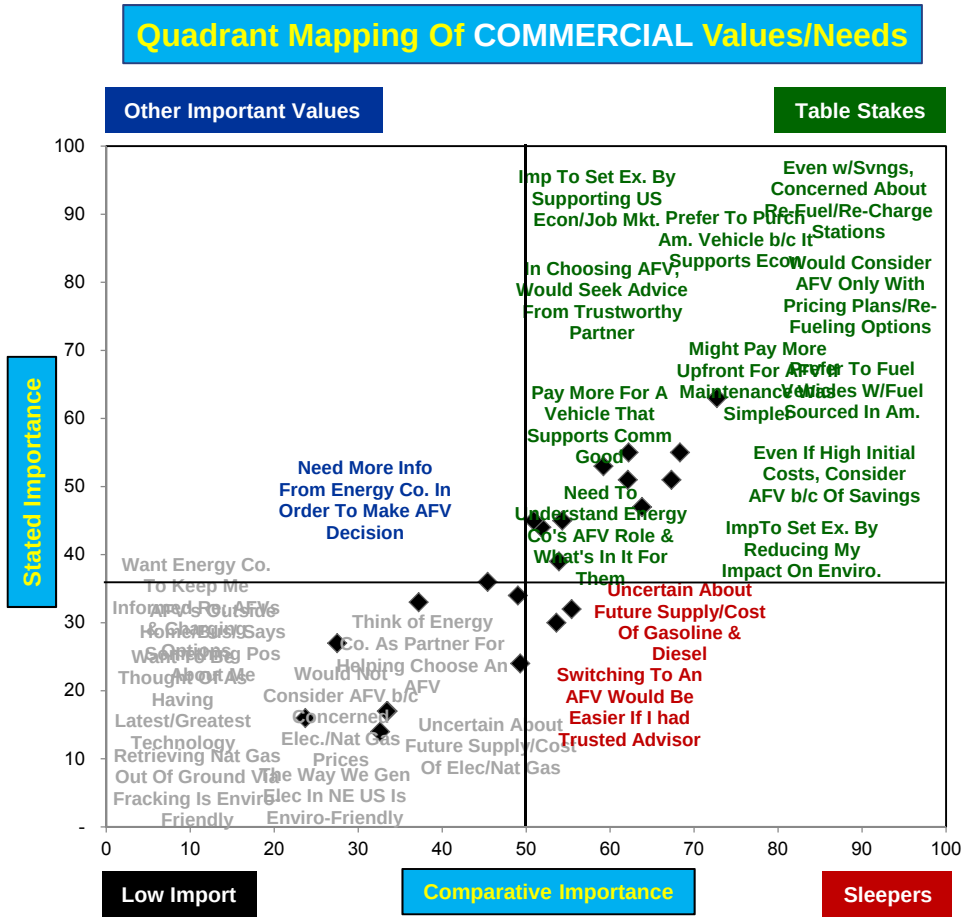
Values & Table Stakes (Cont'd.)

- The same was true of Table Stakes for the **Commercial** segment…
  1. Even w/Savings, Concerned About Re-Fuel/Re-Charge Stations (CONVENIENCE)
  2. Would Consider AFV Only With Pricing Plans/Re-Fueling Options (CHOICE)
  3. Would Prefer To Fuel Vehicles With Fuel Sourced In America (SECURITY)
  4. Even If High Initial Costs, Would Consider AFV b/c Of Savings (COST)
  5. Important To Set Example By Reducing Impact On Environment (IDENTITY)
  6. Prefer To Purchase American Vehicle b/c It Supports Economy (SECURITY)
  7. Important To Set Example By Supporting US Economy/Job Market (IDENTITY)
  8. In Choosing AFV, Would Seek Advice From Trustworthy Partner (INFORMED)
  9. Might Pay More Upfront For AFV If Maintenance Was Simpler (SIMPLICITY)
  10. Would Pay More For A Vehicle That Supports Community Good (GREATER GOOD)
  11. Need To Understand Energy Co's AFV Role & What's In It For Them (INFORMED)
- And there was again this Sleeper –
  1. Switching To An AFV Would Be Easier If Had Trusted Advisor (INFORMED)



Q15 Use the slider to indicate the extent to which you agree or disagree with each statement as it relates to your (home) (business).
Q21 Pease choose the one statement that you AGREE with Most and then choose the one statement that you DISAGREE with Most.

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Top Combinations Of Value Propositions

- Analysis so far has focused on finding the top Value Propositions, but another objective was to **identify Top Combinations of Values** which we addressed using TURF Analysis…
  - **TURF = Total Unduplicated Reach & Frequency.** This analytical technique looks for the net, non-duplicative, gain in appeal of adding different Values together in combo.
- This showed that the **top combos of TWO Values** were very similar for the Residential and Commercial groups, and that two pairings (highlighted in yellow) were #1 or #2 in both –
  - The Cost Value, " Even If High Initial Costs, I Would Consider An AFV Because Of Monthly Savings" **AND** the Convenience Value, "Even With Savings, I Am Concerned About Re-Fueling/Re-Charging Stations".

Top Combinations Of TWO Values (% From TURF Analysis Of Max Diff Scores)	Resi-dential	Com-mercial
TOP RESIDENTIAL COMBINATIONS	(1143) Rank	(304) Rank
COST: Even If High Initial Costs, Consider AFV b/c Of Savings CONVENIENCE: Even w/Savings, Concern On Re-Fuel/Chg Stas	**52.0 #1**	46.7 #2
CONVENIENCE: Even w/Savings, Concern On Re-Fuel/Chg Stas IDENTITY: Imp To Set Example By Reducing Impact On Enviro.	**51.9 #2**	48.7 #1
CONVENIENCE: Even w/Savings, Concern On Re-Fuel/Chg Stas GREATER GOOD: Pay More For A Veh. Supporting Comm Good	**49.1 #3**	44.1 #4
TOP COMMERCIAL COMBINATIONS	(1143) Rank	(304) Rank
CONVENIENCE: Even w/Savings, Concern On Re-Fuel/Chg Stas IDENTITY: Imp To Set Example By Reducing Impact On Enviro.	**51.9 #2**	48.7 #1
COST: Even If High Initial Costs, Consider AFV b/c Of Savings CONVENIENCE: Even w/Savings, Concern On Re-Fuel/Chg Stas	**52.0 #1**	46.7 #2
CONVENIENCE: Even w/Savings, Concern On Re-Fuel/Chg Stas SIMPLICITY: Pay More Upfront For AFV If Maint Was Simpler	48.1 #4	**44.4 #3**

Total Possible Combinations = 231

Yellow highlighting indicates this combination is among the leaders in both Customer segments.

Q30 On each of the next screens, you will see a short list of statements about (CELL CONCEPT) as it relates to your (home) (business). From each list, please choose the one statement that you AGREE with Most and then choose the one statement that you DISAGREE with Most.

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Top Combinations Of Value Propositions

- We found some gain in reach in moving from combinations of 2 to **THREE Values**, but less gain in moving on to combos of 4 or 5 (which in any event are difficult to address in a single Solution area).
- And, in moving from 2 to 3, we still see a lot of commonalities in combo scores between customer segments, with all leading combos for one segment still within the top 7 for the other.
  - Note that one of the top combinations of three is among the leaders in both segments and it includes the Value groupings of Security, Convenience and Identity.

Q30 On each of the next screens, you will see a short list of statements... From each list, choose the one statement that you AGREE with Most and the one you DISAGREE with Most.

Top Combinations Of THREE Values (% From TURF Analysis Of Max Diff Scores)	Resi-dential		Com-mercial	
TOP RESIDENTIAL COMBINATIONS	(1143)	Rank	(304)	Rank
COST: Even If High Initial Costs, Consider AFV b/c Of Savings CONVENIENCE: Even w/Savings, Concern On Re-Fuel/Chg Stas SECURITY: Prefer Purch. American Veh. b/c It Supports Economy	**58.8**	**#1**	53.0	#5
COST: Even If High Initial Costs, Consider AFV b/c Of Savings CONVENIENCE: Even w/Savings, Concern On Re-Fuel/Chg Stas SECURITY: Prefer To Fuel Vehicles With Fuel Sourced In America	**58.7**	**#2**	52.6	#7
SECURITY: Prefer Purch. American Veh. b/c It Supports Economy CONVENIENCE: Even w/Savings, Concern On Re-Fuel/Chg Stas IDENTITY: Imp To Set Example By Reducing Impact On Enviro.	**58.5**	**#3**	54.6	#1
TOP COMMERCIAL COMBINATIONS	(1143)	Rank	(304)	Rank
SECURITY: Prefer Purch. American Veh. b/c It Supports Economy CONVENIENCE: Even w/Savings, Concern On Re-Fuel/Chg Stas IDENTITY: Imp To Set Example By Reducing Impact On Enviro.	58.5	#3	**54.6**	**#1**
CONVENIENCE: Even w/Savings, Concern On Re-Fuel/Chg Stas IDENTITY: Imp To Set Example By Reducing Impact On Enviro. SECURITY: Prefer To Fuel Vehicles With Fuel Sourced In America	58.2	#4	**53.9**	**#2**
COST: Even If High Initial Costs, Consider AFV b/c Of Savings CONVENIENCE: Even w/Savings, Concern On Re-Fuel/Chg Stas IDENTITY: Imp To Set Example By Reducing Impact On Enviro.	58.1	#5	**53.6**	**#3**

Total Possible Combinations = 1,540

Yellow highlighting indicates this combination is among the leaders in both Customer segments.

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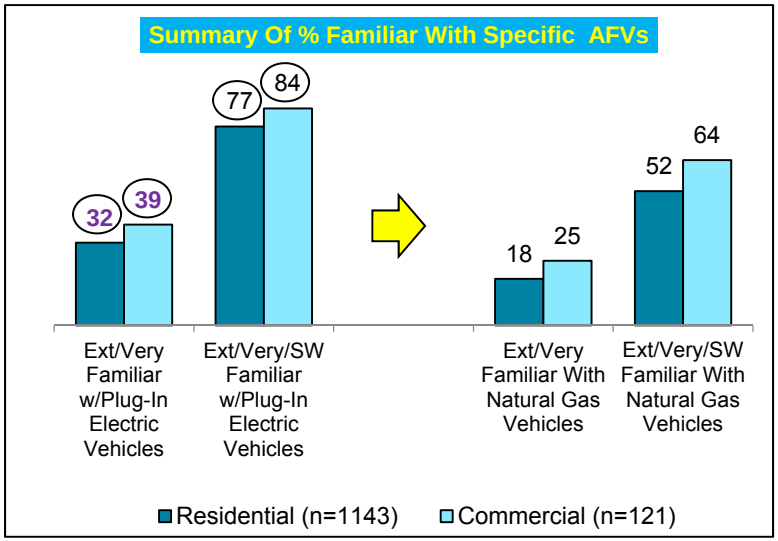
Other Topics: AFV Familiarity & Info Sourcing

- Turning to other topics covered in the AFV section of the study, we found that there was higher **Familiarity with Plug-In Electrics** than with **Natural Gas AFVs**.

- While "Your Local Energy Company" was not a leader as a go-to for **Info About AFVs**, it was #2 as a go-to for **Info On Re-Fueling Options**.



% Mentions Of AFV Information Sources	Residential	Commercial
Total Per Segment	(1143)	(121)
Would Go To For Information About AFVs		
Online/Internet Search	**79**	**70**
Automotive Reviews/Resources (e.g., Edmunds, Kelly)	**65**	**59**
An Automobile Manufacturer	**56**	**55**
A Friend Or Family Member	**47**	**41**
Your Local Energy Company	**31**	**39**
An Automobile Dealer	34	35
Customers Or Business Colleagues	-	37
State Government	20	18
Local Government	12	11
Would Go To For Info On Re-Fueling Options For AFVs		
Online/Internet Search	**79**	**73**
Your Local Energy Company	**51**	**53**
Automotive Reviews/Resources (e.g., Edmunds, Kelly)	**43**	**32**
An Automobile Manufacturer	**42**	**32**
A Friend Or Family Member	**40**	**32**
An Automobile Dealer	36	31
Customers Or Business Colleagues	-	28
State Government	29	20
Local Government	27	12

Q17 …how familiar you were with each type of AFV before the survey today.
Q18 Which of the following would you turn to for information about AFVs?
Q19 And which of the following would you turn to for info about re-fueling options?

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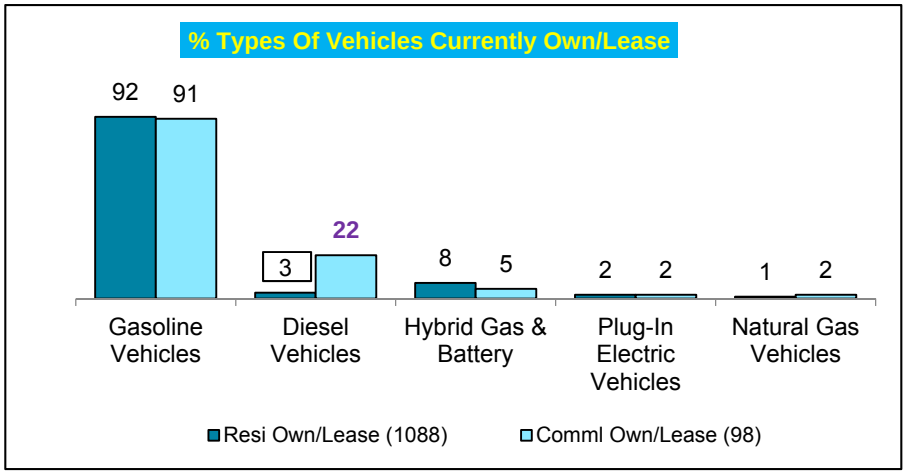
Other Topics: Vehicles Currently Own/Lease

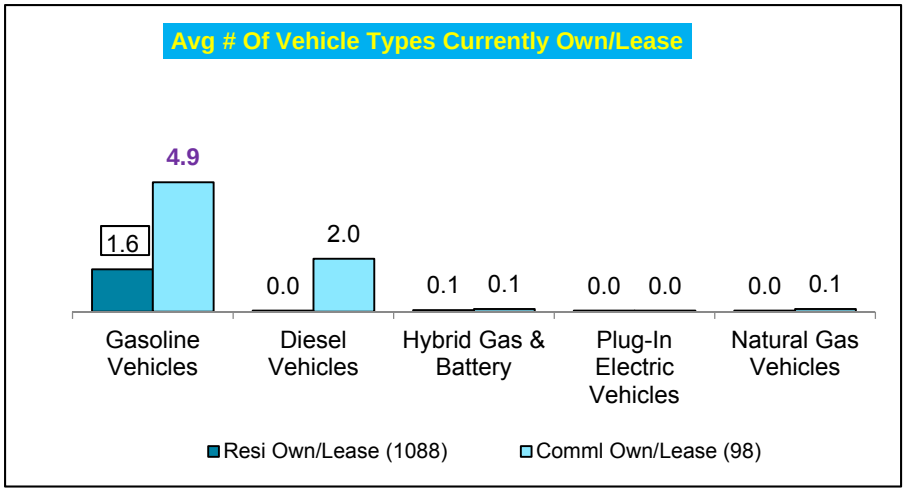
- 2% of each segment said that they already **Own A Plug-In Electric Vehicle** and about 2% said they **Own A Natural Gas Vehicle**. Hybrid Gas & Battery is more prevalent at ~5-8% of each segment.

- In terms of **How Many Vehicles They Own Of Each Type**, Residential Customers own an average of about 2 Gasoline Vehicles, with minor levels of other types. Commercial Customers, on the other hand, own about 7+ vehicles – which are mostly Gasoline Vehicles or Diesel Vehicles.

Q20 You indicated that (you currently own or lease a vehicle) (your company currently owns or leases vehicles). Which if any of the following types of vehicles do you own/lease?

Q21 Please enter the number of different types of vehicles that (you own or lease) (your company owns or leases).





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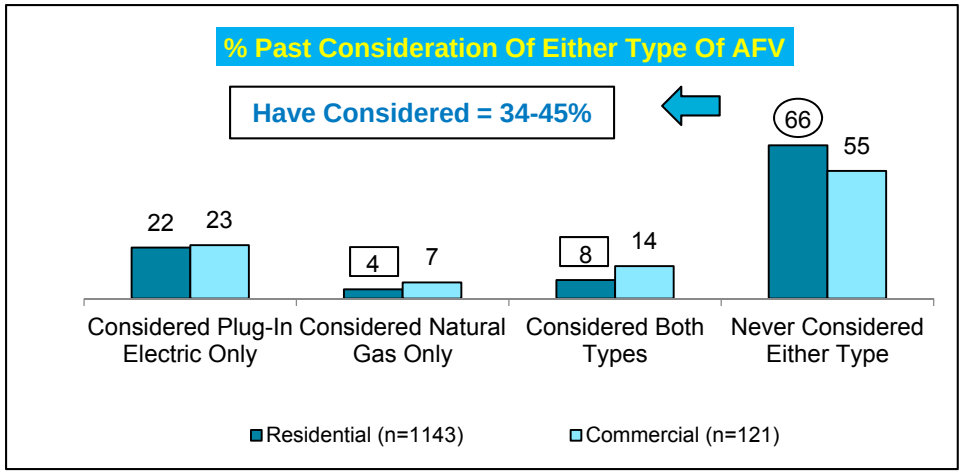
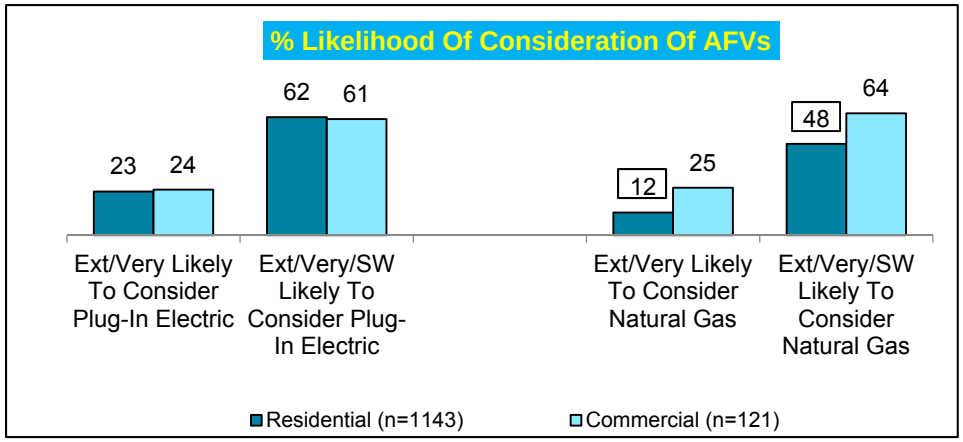
Other Topics: AFV Consideration

- 34% of Residential and 45% of Commercial **Have Considered An AFV** in the past – mainly a Plug-In Electric.
- About a quarter of customers are extremely/very **Likely To Consider Purchasing** a Plug-In Electric and 12% (Residential) and 25% (Commercial) show interest in a Natural Gas AFV.
- Add in those who are somewhat likely to consider each type and **Consideration** of an AFV climbs about one-half to two-thirds of both segments.





Q23 Have you ever considered purchasing either type of Alternative Fuel Vehicle in the past?

Q22 Based on everything you now know about Alternative Fuel Vehicles, how likely would you be to consider each type of Alternative Fuel Vehicle for your (next vehicle purchase)(next company vehicle purchase)?

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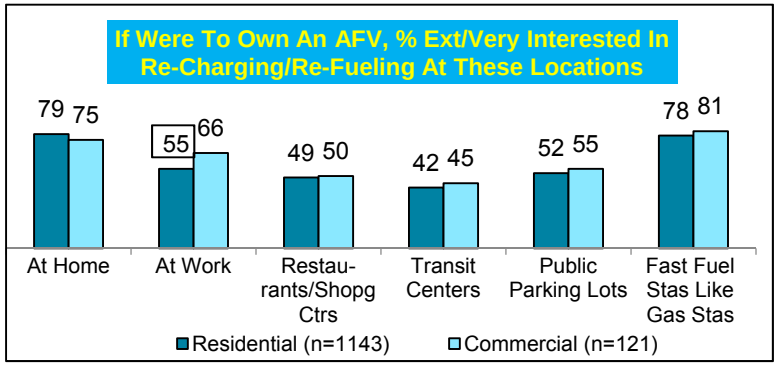
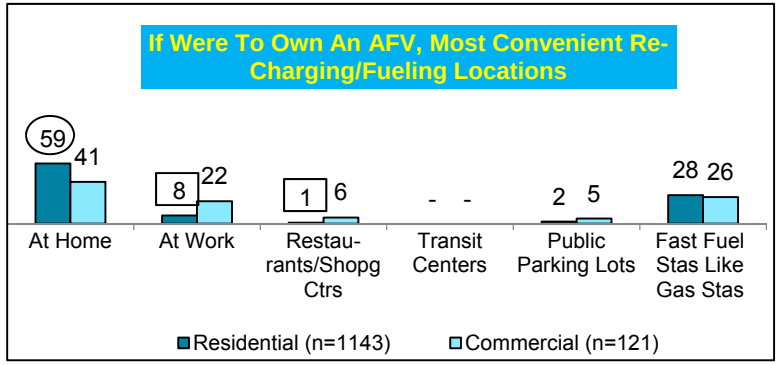
Other Topics: Re-Charging/Re-Fueling An AFV

- About 40% of each Customer segment were **Aware of Plug-In Electric AFV Charging Stations** but only ~10-15% were **Aware Of Natural Gas Filling Stations**.

% Awareness Of Electric Charging Stations & Natural Gas Filling Stations	Residential	Commercial
Total Per Segment	(1143)	(121)
% Aware Of Plug-In Electric Charging Stations…	38	41
Near Your Home	10	11
Near Your Work	12	12
Near Local Restaurants Or Shopping Centers	19	19
Near Local Transit Centers (Train Stations/Airports)	11	12
Near Local Public Parking Lots	10	13
Don't Know/Never Noticed	62	59
% Aware Of Natural Gas Filling Stations…	9	14
Near Your Home	4	5
Near Your Work	3	7
Near Local Restaurants Or Shopping Centers	3	2
Near Local Transit Centers (Train Stations/Airports)	3	3
Near Local Public Parking Lots	2	1
Don't Know/Never Noticed	91	86

- If they owned an AFV, they would want to refuel/recharge at **Home, at Fast Fuel Stations**, or – in the case of **Commercial Customers in particular – at Work**.





Q24 Do you know if there are any Plug-In Electric Vehicle charging stations near any of the following locations?
Q25 Do you know if there are any Natural Gas Vehicle filling stations near any of the following locations?
Q26 Imagine that you own an Alternative Fuel Vehicle and indicate how interested you would be in re-fueling or re-charging the vehicle at each of these locations.
Q27 And which of these possible locations would be most convenient to you for re-fueling or re-charging an Alternative Fuel Vehicle?

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Other Topics: Re-Charging/Re-Fueling (Cont'd.)

- Asked what **Types Of Organizations Should Be Responsible For Installing AFV Re-charging & Re-fueling Stations** and separately which should be responsible for **Providing Re-Charging & Re-Fueling Services**, both Customer segments had very similar responses.

- Top mentions on each measure were:
  - "Energy Utility Companies Such As National Grid".
  - "Companies With Core Businesses In Electric Vehicle Charging or Natural Gas Fueling".
  - And "Existing Gas Stations Such As ExxonMobil or Shell".

% Mentions Of Organizations That Should Be Responsible For Installing Stations And Providing AFV Re-Charging & Re-Fueling Services	Residential	Commercial
Total Per Segment	(1143)	(121)
Responsible For Installing Re-Charging/Re-Fueling Stations		
Energy Utility Companies Such As National Grid	**59**	**56**
Co w/Core Business In Elec Veh Charging/Nat Gas Fueling	**57**	**53**
Existing Gas Stations Such As ExxonMobil or Shell	**48**	**47**
State Dept. Of Transportation Or Public Transit Authority	42	32
Energy Services Co/Retailer, e.g., Direct Energy/NRG Energy eVgo	29	27
Contractors Such As Electricians Or Plumbers	9	9
Telecom Companies Such As Verizon Or Comcast	3	6
A High Tech Company Such As Google	6	10
None Of The Above	4	4
Responsible For Providing Re-Charging/Re-Fueling Service		
Energy Utility Companies Such As National Grid	**60**	**59**
Co w/Core Business In Elec Veh Charging/Nat Gas Fueling	**57**	**50**
Existing Gas Stations Such As ExxonMobil or Shell	**53**	**54**
State Dept. Of Transportation Or Public Transit Authority	39	32
Energy Services Co/Retailer, e.g., Direct Energy/NRG Energy eVgo	32	30
Contractors Such As Electricians Or Plumbers	6	7
A High Tech Company Such As Google	6	11
Telecom Companies Such As Verizon Or Comcast	3	5
None Of The Above	4	6

Q28 Who do you think should be responsible for installing electric vehicle charging and natural gas fueling stations?

Q29 And who do you think should be responsible for providing electric vehicle charging and natural gas fueling services in the future?

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Other Topics: Barriers To AFV Purchase/Lease

- Top **Barriers To Purchase/ Lease Of An AFV** were heavily related to the unknowns around Distance Constraints, Cost, and Maintenance:
  - How Far It Could Travel Per Tank/Charge.
  - Fuel Options/Availability.
  - Initial Cost and Fueling Cost vs. Gas/Diesel.
  - Ease/Time in Re-Fueling or Re-Charging.
  - And Maintenance.

Q33 We would like to know what factors, if any, are most likely to keep (you) (your company) from purchasing an Alternative Fuel Vehicle in the future.

% Barriers To Purchase/Lease Of An AFV	Residential	Commercial
Total Per Segment	(1143)	(121)
Concern About How Far It Could Travel On A Full Tank/Charge	69	54
Concern About Fuel Options And Availability	60	47
Initial Cost May Be Too High Compared To Similar Gas or Diesel	57	51
Concern About Ease/Time To Re-Fuel/Re-Charge	61	43
Concern About Maintaining It After Purchase (How To and Cost)	46	42
Concern About Quality & Performance Of AFVs On The Market	39	30
Cost Of Fuel Not That Much Lower Than Gas Or Diesel	30	23
Concern About Safety Ratings Of AFVs On The Market	28	14
Lack Of Incentives-To-Buy Offered By Gov't., Local Utility, Or Dealers	31	31
Concern About Safety Of The Fuel Or Recharging/Refueling	24	13
Would Not Know Where To Buy Such A Vehicle	23	33
Concern About Future Trade-in Value	26	27
Concern About Features Or Options That Come Now With AFVs	15	18
Have Not Seen AFVs From Auto Mfrs or Dealers I Know & Trust	14	12
Do Not Believe An AFV Will Fit Needs (Seating, Towing, Cargo, Etc.)	16	25
Concern About Look/Styling Of AFVs Not On Market	13	4
Not Seeing Good Industry Or User Reviews Of AFVs	10	14
Family/Friends/Neighbors/Business Associates Do Not Reco AFVs	4	7
(COMML) Concern Installing Fuel/Charg Sta At Business	0	22
(COMML) Concern Cost, Process Of Installing Sta At Business	0	24

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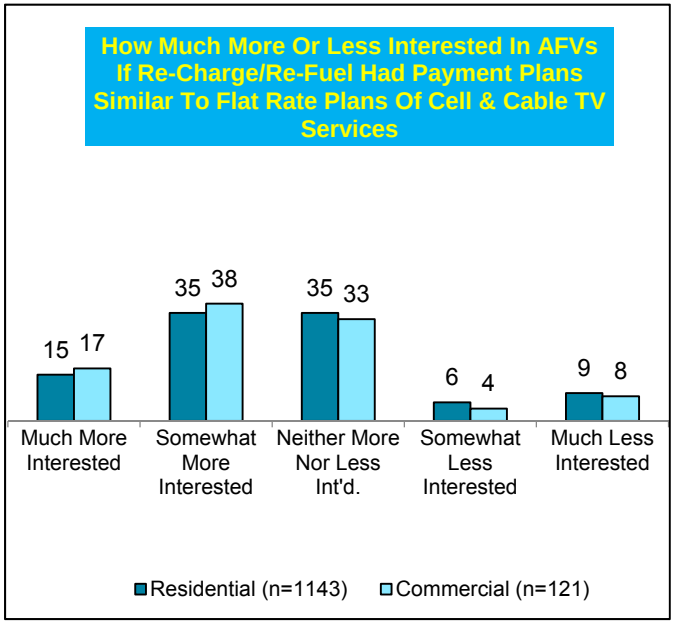
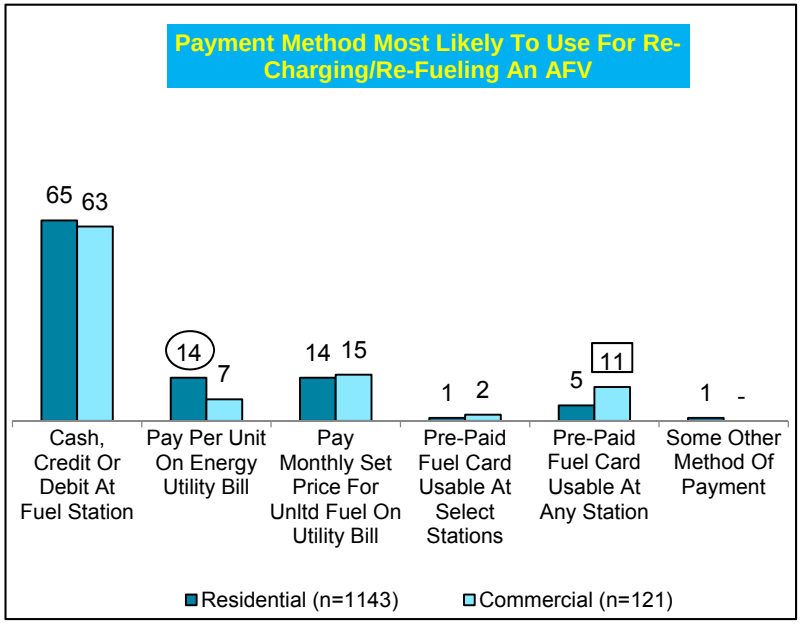
AFV

Other Topics: Paying For Re-Charge/Re-Fuel

- There was fairly limited AFV motivational value in **Payment Plans For Re-Charging/Re-Fueling similar to the Flat Rate Plans Of Cell & Cable TV**.



- In terms of **How They Would Like To Pay** for Re-Charging/Re-Fueling, most want to pay as they do for non-AFV vehicles: Cash, Credit or Debit at Fuel Stations. There was lower interest in Payment Per Unit On Energy Utility Bill.



Q34 You are probably familiar with the pricing plans for cell phone service, where you are offered unlimited minutes at a flat rate; or for cable TV service, where you are offered a menu of choices at different flat rates. How much more or less interested would you be in purchasing an Alternative Fuel Vehicle (Commercial Cell: for your company) if the pricing plans for re-fueling/re-charging them were similar to the flat rate plans you see with cell phone or cable television service?

Q35 Following are different ways (a person) (a company) can pay for their re-fueling/re-charging of an Alternative Fuel Vehicle. Which one would you be most likely to use to pay for your re-fueling/re-charging of an Alternative Fuel Vehicle?

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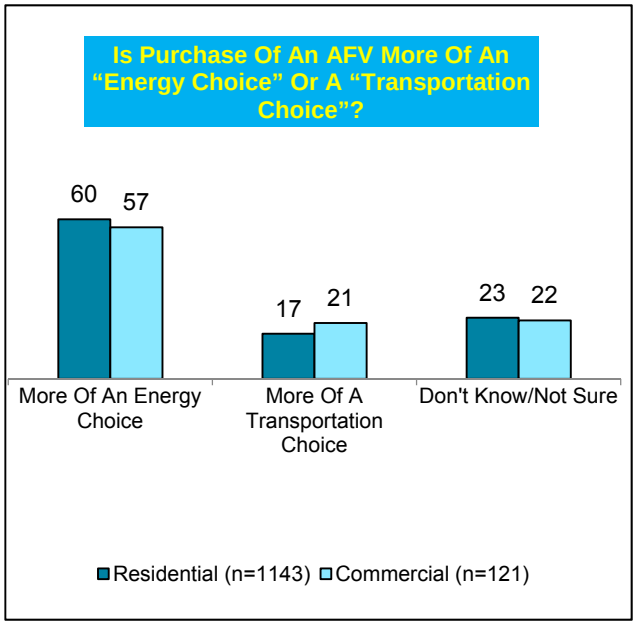
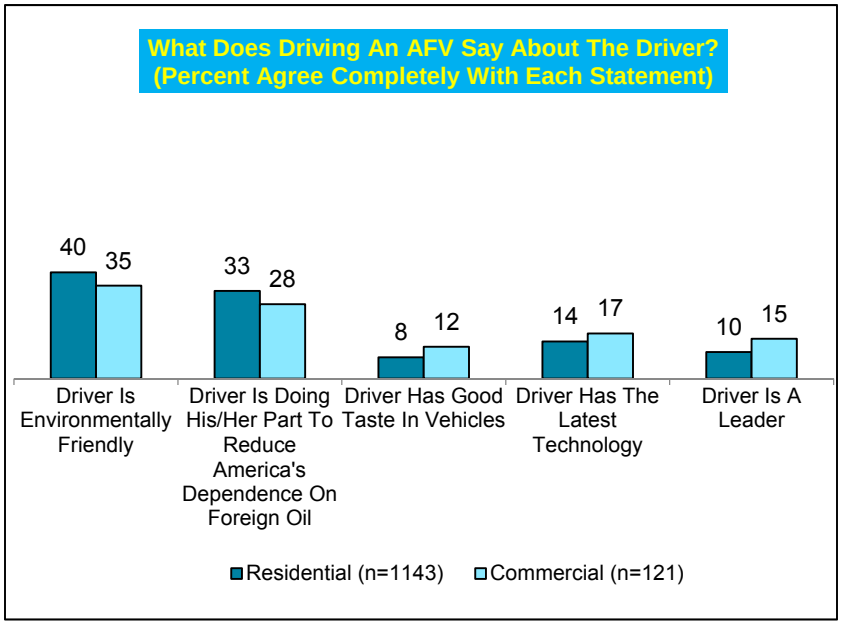
Other Topics: Perceptions Of AFVs & AFV Drivers

- Finally for AFV, we asked about perceptions and, first, it was clear that **Purchase** Of An AFV is viewed as more of An Energy Choice than A Transportation Choice.



- And **Driving** An AFV says more about the driver being Environmentally Friendly and Doing Their Part To Reduce America's Dependence On Foreign Oil than it does about Style, Technology, or Leadership.



Q36 Do you consider the purchase of an Alternative Fuel Vehicle that runs on electricity or natural gas as more of an "energy choice" or more of a "transportation choice"?

Q37 Following are some statements that may or may not describe a driver of an Alternative Fuel Vehicle. For each statement, please indicate how much you agree or disagree that it describes a person who drives an Alternative Fuel Vehicle.

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AFV

Key Findings

- **Key metrics for Alternative Fuel Vehicles was stronger among Commercial Customers: Familiarity (45% vs 28%), Importance (51% vs 47%), and Interest In Learning More About It (51% vs 40%).**

- **The study identified 10 highly varied Table Stakes shared by both Residential and Commercial Customers that should be considered in solution development and messaging :**

  1. Even w/Savings, Concerned About Re-Fuel/Re-Charge Stations (Convenience)
  2. In Choosing AFV, Would Seek Advice From Trustworthy Partner (Informed)
  3. Would Consider AFV Only With Pricing Plans/Re-Fueling Options (Choice)
  4. Would Prefer To Fuel Vehicles With Fuel Sourced In America (Security)
  5. Even If High Initial Costs, Would Consider AFV b/c Of Savings (Cost)
  6. Important To Set Example By Reducing Impact On Environment (Identify)
  7. Might Pay More Upfront For AFV If Maintenance Was Simpler (Simplicity)
  8. Prefer To Purchase American Vehicle b/c It Supports Economy (Security)
  9. Need To Understand Energy Co's AFV Role & What's In It For Them (Informed)
  10. Would Pay More for A Vehicle That Supports Community Good (Greater Good)

- **Plus, one common Sleeper:** Switching To An AFV Would Be Easier If Had Trusted Advisor (Informed)

- **As expected, the strongest Combinations of Values were dominated by the Table Stakes. In addition, the top combinations were very similar for the two Customer segments (two combos were #1 and #2 in each group). The top two were:**

  - "Even If High Initial Costs, I Would Consider An AFV Because Of Monthly Savings" **AND** "Even With Savings, I Am Concerned About Re-Fueling/Re-Charging Stations"; and…
  - "Important To Set Example By Reducing Impact On The Environment" **AND** "Even With Savings, I Am Concerned About Re-Fueling/Re-Charging Stations".

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AFV

Key Findings

- **In findings from <u>other topics</u> covered in the study:**
  - There is far higher Familiarity with Plug-In Electric Vehicles than Natural Gas AFVs. About 10% already own an AFV (mainly Gas-Battery Hybrids), but 34% of Residential and 45% of Commercial customers have considered an AFV (mainly Plug-In Electric) and one-half to two-thirds are open to consideration of one in the next few years.
  - "Local Energy Company" was seen as a major Info source about Re-Fueling Options but not about AFV themselves. About 40% of each Customer segment are Aware Of Plug-In Electric AFV Charging Stations but only ~10-15% are Aware Of Natural Gas Filling Stations. If they owned an AFV, they would want to refuel/recharge at Home, at Fast Fuel Stations, or – in the case of Commercial Customers in particular – at Work.
  - Customers assigned high credibility to "Energy Utility Companies Such As National Grid" for both Installing Stations and Providing Service for AFV Re-Charging/Re-Fueling.
  - Barriers To AFV Purchase/Lease centered around uncertainty about Distance Constraints, Cost, and Maintenance.
  - Customers were not highly interested in Flat Rate Re-Fuel/Charge Plans and preferred how they pay now at a filling station.
  - Perceptually, AFVs are an Energy (not Transportation) Choice and speaks more to a Driver being Environmentally Friendly and Helping Reduce America's Dependence On Foreign Oil than to their Style, Tech-Forwardness, or Leadership.

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Appendix

Other Data From The Study

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How GRID MOD Statements Were Truncated In Report

Complete Statement	Truncated Statement Used In Report
I would be willing to turn up the thermostat on my air conditioner a few degrees on a hot day if I knew that it helped to avoid a widespread power outage	**Would Turn Up Thermostat To Help Prevent Outage**
I want to contribute to a more reliable electric grid to help prevent power outages in my area	**Will Contrib To Reliable Grid To Prevent Outages**
I would be willing to pay a little more on my electric bill each month if that meant money went towards technology that reduced power outages	**Wld Pay More If $$s Went To Tech To Reduce Outages**
I want to better control how and when I use power in my home/business	**I Want To Better Control How And When I Use Power**
I am a “hands-on” kind of person when it comes to controlling energy use in my home/business	**“Hands-On” When It Comes To Controlling Energy Use**
I want to choose how and when I use energy in my home/business	**I Want To Choose How/When I Use Energy**
I want a choice of energy pricing options that would make my monthly electric bill more accurately reflect the costs of my energy usage patterns	**Want Price Options So Bill Accu Reflects My Usage**
I would like to choose from a variety of solutions that will help me manage energy usage in my home/business	**Want Variety Of Solutions To Help Me Manage Usage**
I would like more transparency into my energy usage in my home/business so that I can know how my energy use impacts my electric bill	**Want More Transparency How Usage Impacts Bill**
It would be useful if at any time I could see how much energy the appliances and equipment in my home/business use and how much that costs on my electric bill	**Want To See How Much Apps/Equip Use Impacts Bill**
I'm interested in better managing energy usage in my home/business, but I don't have the time or knowledge to do it	**Want To Better Mge Usage, But Lack Time & Know**
I am willing to trade a bit of control over my energy use in exchange for more convenient ways to save on my energy bills – for example, earning a credit and saving on my bill by agreeing to let my energy supplier remotely control my thermostat on occasion without impacting the comfort of my home/business	**Trade Ctrl To Save, e.g., Allow Remote Thermo Ctrl**
I want a more convenient way to manage energy use in my home/business using new technology	**Want To Conveniently Manage Use w/New Tech**
I would like my energy utility company to provide me with real-time advice on how to use energy more wisely in my home/business	**Want Real-Time Advice From Energy Co.On Wise Use**
I would like to get personalized energy-saving recommendations from my energy utility company based on my home's/business's energy usage patterns	**Personalized Energy-Saving Recos Based On Usage**
I would like a trusted advisor to inform me of ways that I can better manage energy use in my home/business	**Want Trusted Advisor To Inform On Energy Use Mgmt.**
I want the opportunity to save money on my electric bill by using power at times of day when the cost per unit of energy is lower	**Want Oppty To Save By Using Power When CPU Lower**
I am willing to change my habits at home/work in order to save money on my energy bills each month even if it's a little less convenient or comfortable	**Will Change Habits To Save $$, Even If Less Convenient**
I'm concerned about the cost of a reliable power grid, which everyone in my community has to pay for in their monthly electric bill	**Concerned Cost Reliable Grid, Which Community Pays For**
My community needs to be able to put more renewable or “green” power on the grid, such as solar or wind power	**Community Needs To Be Able To Put More Green Power On Grid**

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How DG&S Statements Were Truncated In Report

Complete Statement	Truncated Statement Used In Report
Self-reliance is important to me, so I would be interested in making electricity at my home/business rather than relying on the power grid	**Self-Reliant & Rather Make Own Elec. Than Rely On Grid**
I would feel more secure knowing that the electricity I use at home/work is cleanly generated, using technology that makes electricity at my home/business	**Secure Knowing Elec. Cleanly Generated Via Own Tech**
The key reason I would want technology that makes electricity at my home/business is so that I could have power on at all times – even if the grid is down	**Key To Make Own Is Having 24/7 Power, Even If Grid Down**
Power outages are a problem I need to avoid, so I would consider making electricity at my home/business to ensure that the power is always on	**Need To Avoid Outages, So Would Consider Making Own Elec.**
The impact of recent widespread power outages is concerning to me and I want to find ways to make my home/business more resilient	**Concerned Re Wide Outages, Want To Be More Resilient**
I want people to think of me as someone/my business as one with the latest and greatest technology, like equipment that makes my/my company's own electricity	**Want To Be Seen w/Latest Tech, eg, Equip To Make Own**
Having technology at your home/business that makes electricity on-site says something positive about me/my business	**Having Tech. Making Elec On-Site Says Something Positive**
I am concerned about how our traditional sources of electricity impact the environment and I would prefer to generate my own energy at my home/business	**Concern w/Env Impact Of Trad'l Elec, So Prefer To Generate Own**
I want to reduce my home's/business' carbon footprint and I'm willing to spend money to do it with technology that makes electricity for my home/business	**Want To Reduce Carbon Footprint w/Tech That Makes On-Site**
The only reason I would install technology that makes electricity for my home/business would be to save money on electricity costs each month	**Would Only Install Tech To Make My Own Elec To Get Savings**
The benefits of making my own electricity at home/work outweigh the costs to purchase and install the technology	**Benefits Of Making Own Elec Outweigh Purchase/Install Costs**
I would install technology to make electricity at my home/business if I knew that it could zero out my electricity bill each month	**I Would Install Tech To Make Elec On-Site If Electric Bill Zeroes Out**
I would prefer to lock-in the cost of technology to make my own electricity for my home/business every day rather than pay the going rate for electricity each month	**Rather Lock In Cost Of Tech To Make Own Than Pay Going Rates**
If I were able to make my own electricity at home/work, I would feel empowered to better control my costs, environmental impact, and power quality	**If Could Make My Own Electricity, I Would Feel Empowered**
I want to choose where my electricity comes from	**I Want To Choose Where My Electricity Comes From**
I like to do things that will have a lasting impact on my home/business, so I look for solutions that have continuous benefits	**Like Doing Things w/Long Lasting Impact & Continuous Benefits**
I'm interested in energy management but I don't always have time to be involved, so a one-time project such as installing equipment to make electricity at my home/business would be a good choice for me	**w/Time Stress, 1-Time Install To Make Own Is Good Choice**
I am looking for home/business upgrades that will give me benefits for 25 years even if they pay back in 10 years/3 years	**Looking For Upgrade w/25 Yr Benefits Even If Payback=10/3 Yrs**
My electric utility company would be my first resource for information if I were interested in installing technology to make my own electricity at my home/business	**Elec Co 1st Info Source For Installing Tech To Make Own**
If I were interested in making my own electricity at my home/business, I would like to be able to work with one trusted partner who can advise me on all the options available to me	**Want Trusted Partner For Options On How To Make Own**
Technology that makes electricity at my home/business would be more valuable to me if I could see how much electricity it is making at any given moment	**Tech More Valuable If I Can See Real-Time How Much Made**
I want my electric utility company to keep me informed about the variety of electricity sources available to me	**Want Elec Co.To Inform Me Of Variety Of Elec Sources**
I need a more cost effective way to heat my home/business and hot water tank	**Need More Cost Effective Way To Heat Home/Bus & Water**

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How AFV Statements Were Truncated In Report

Complete Statement	Truncated Statement Used In Report
I would only consider a plug-in electric or a natural gas vehicle if I knew that there were pricing plans and options for re-fueling	**Consider AFV Only w/Pricing Plans/Re-Fueling Options**
Even if an electric or a natural gas vehicle costs more upfront, I would consider one if I were sure that I/my business would save money every month on fuel and maintenance (total cost of ownership)	**Even If High Initial Costs, Would Consider AFV b/c Of Savings**
Even if I would save money on the cost of fuel, I would be concerned about the convenience of finding a place to charge a plug-in electric vehicle or refuel a natural gas vehicle	**Even w/Savings, Concerned About Re-Fuel/Re-Chge Stas**
I may be willing to pay more upfront for a plug-in electric or a natural gas vehicle if I knew that maintaining the vehicle would be more simple than maintaining a gasoline vehicle	**Might Pay More Upfront For AFV If Maintenance Was Simpler**
In choosing an alternative fuel vehicle/vehicles, I would want to get advice from a trustworthy partner	**In Choosing, Would Seek Advice From Trusted Ptnr**
I think of my energy utility company as a partner that can help me choose an electric or natural gas vehicle and fueling options that work for me/my business	**Think of Energy Co. As Partner To Help Choose An AFV**
I want people to think of me as someone/my business as one with the latest and greatest technology	**Want To Be Thot Of As Having Latest/Greatest Technology**
Having a plug-in electric vehicle charging station outside my home/business says something positive about me/my business	**AFV's At Home/Bus. Says Something Positive About Me**
It's important to set an example by reducing my impact on the environment	**Important To Set Example By Reducing Impact On Enviro.**
It's important to set an example by supporting the American economy and job market	**Important To Set Example By Supporting US Econ/Jobs**
I would not consider an electric or a natural gas vehicle for my next vehicle because I'm concerned about the future price of electricity or natural gas	**Wouldn't Cons b/c Concerned Re: Elec./NatGas Prices**
I'm uncertain about the future supply and cost of electricity or natural gas	**Uncertain About Future Supply/Cost Of Elec/NatGas**
I'm uncertain about the future supply and cost of gasoline and diesel fuel	**Uncertain About Future Supply/Cost Of Gas/Diesel**
I need to better understand my energy utility company's role in alternative fuel vehicles – for example, what is in it for my energy utility company?	**Need To Understand Energy Co's AFV Role**
I need more information from my energy utility company in order to make a decision about a plug-in electric or natural gas vehicle	**Need More Info From Energy Co. To Make AFV Decision**
I want my energy utility company to keep me informed about electric or natural gas vehicles and charging /fueling options available to me	**Want Energy Co. To Keep Me Informed Re: AFVs/Charging**
The way we get natural gas out of the ground in America (through hydraulic fracturing, or "fracking") is environmentally friendly	**Retrieving Natural Gas Via Fracking Enviro-Friendly**
The way we generate electricity in the northeastern US is environmentally friendly	**Way We Generate Elec In NE US Enviro-Friendly**
I would prefer to purchase a vehicle that is made in America (regardless of the automaker) because it supports our economy	**Prefer Purch. American Veh. b/c It Supports Economy**
I would prefer to fuel my vehicle(s) with fuel that is sourced in America	**Prefer To Fuel Vehicles With Fuel Sourced In America**
I would consider paying more for a vehicle that supports the greater good of my community – made here, runs on local fuels, and is better for the environment	**Pay More For A Veh. Supporting Comm Good**
Switching my vehicle/my company's vehicles to natural gas or plug-in electric vehicles would be easier if I had a trustworthy advisor to help me make decisions and implement	**Switching To An AFV Would Be Easier If I had Trusted Advisor**

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Sample Demographic Comparisons

RESIDENTIAL	GRID MOD	DG&S	AFV
Total Per Cell	(938)	(913)	(1143)
Male	53	56	73
Female	47	44	27
Mean Age:	53.2	52.4	52.4
Mean HH Size:	2.6	2.6	2.6
Median HH Income:	$76,000	$74,000	**$93,000**
% Married/In A Domestic Partnership	64	64	65
% With Any College	82	84	86
Caucasian	84	85	78
African-American	2	2	3
Hispanic/Latino	3	2	2
Asian-American	1	3	4
Other/Refused	11	9	12
Single Family Home	72	75	70
Apartment	12	10	12
Duplex, Triplex Or Townhouse	7	5	8
All Others (Condo, Coop, Mobile, etc.)	3	3	3
Homeowners	79	81	79
Renters	17	16	17
Neither	1	1	1
Refused	3	2	3
Utilities Included In Rent	2	1	3
Utilities Not Included In Rent	98	98	97

COMMERCIAL	GRID MOD	DG&S	AFV
Total Per Cell	(146)	(118)	(121)
Male	71	72	73
Female	29	28	27
Mean Age:	55.1	55.2	52.4
Median No. People at Location:	5.4	4.9	6.1
Mean Years In Business:	31.0	26.1	28.6
Median Years In Business:	23.0	21.0	23.0
Mean No. of Locations:	2.1	2.2	2.1
Standalone Bldg. w/1 Bus. Inside	43	38	35
Standalone Bldg. w/1+ Bus. Inside	22	24	39
Office Park	3	4	5
Part Of Strip-mall (Adjoining Bus.)	7	8	8
Home Or Residence	9	14	7
Other	6	7	3
Refused	10	5	3
Rent/Lease The Building	34	24	39
Own The Building	52	71	55
Other	4	2	2
Don't Know/Not Sure	-	-	1
Refused	10	2	3

Classification Questions

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Respondent Attitudes Toward National Grid

RESIDENTIAL	GRID MOD	DG&S	AFV
Total Per Cell	(938)	(913)	(1143)
Q56-Energy Products NG Provides			
Natural Gas	1	1	(48)
Electricity	85	85	[33]
Both NG & Electricity	14	14	19
Q59-Rating Level Of Trust NG Advice			
1=Not At All…10=Completely			
Top-3 Box Rating (Rated 8-9-10)	58	56	[44]

COMMERCIAL	GRID MOD	DG&S	AFV
Total Per Cell	(146)	(118)	(121)
Q56-Energy Products NG Provides			
Natural Gas	1	1	(37)
Electricity	66	68	[24]
Both NG & Electricity	34	32	39
Q59-Rating Level Of Trust NG Advice			
1=Not At All…10=Completely			
Top-3 Box Rating (Rated 8-9-10)	(65)	45	44

* Above data on Q56, Energy Products NG Provides, were self-reported, so they do not show 100% Electric Customers under Grid Mod or DG&S columns – even though we know all were Electric Customers because survey invitations for Grid Mod and DG&S were sent only to NG Electric Customers. (The AFV cell included BOTH Natural Gas and Electric Customers.)

Classification Questions As Annotated Above

○ Indicates data significantly higher than both points of comparative data (95% confidence level).
□ Indicates data significantly lower than both points of comparative data (95% confidence level).
If difference is not vs. both points of comparative data, an arrow indicates which are different.

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National Grid Smart Energy Solutions Pilot

Final Evaluation Report

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National Grid

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May 5, 2017

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Table of Contents

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The following appendices are provided in a separate document:

- Appendix F – Graphs of Event Impacts by Hour for Residential Customers
- Appendix G – Graphs of Event Impacts by Hour for Commercial Customers
- Appendix H – Graphs of Event Impacts for Residential Customers by Demographic Subgroup

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GLOSSARY OF KEY TERMS AND ACRONYMS

Pricing:
Critical Peak Pricing (CPP) – Referred to as Smart Rewards Pricing in National Grid's program marketing materials. In the Smart Energy Solutions program this rate structure combines a TOU rate with critical peak pricing in which customers are charged higher rates for energy during Peak Events.

Peak Time Rebate (PTR) – Referred to as Conservation Day Rebate in National Grid's program marketing materials. A rate structure in which customers are provided a credit, or rebate, for reducing their energy usage during Peak Events.

Time of Use (TOU) – A rate structure in which participants pay a predetermined tiered rate in which higher prices generally coincide with peak periods and lower prices with off-peak periods.

Customer Types:
Active Participant – An active participant is one who is deemed to have taken actions above simply being on a rate. This household or business is utilizing technology and taking actions to modify their behavior in reaction to the new rate and technology afforded by their participation in the Pilot. Specifically, for this evaluation active participants are those who have opted into a technology package above the default (e.g., opted into Levels 2, 3, or 4), or participants on the default technology package (Level 1) who have visited the WorcesterSmart web portal.

Passive Participant – A customer in the Pilot who is on the default technology package (Level 1) and has not visited the WorcesterSmart web portal.

Peak Times:
Peak Period – Weekdays from 8 a.m. to 8 p.m.

Off-Peak Period – All hours that are not defined as Peak Periods or Peak Events. Includes all weekend, evening, and holiday hours.

Conservation Day – A day on which a Peak Event is called.

Peak Event – A period of time for which critical peak pricing will be in effect. Customers are notified in advance of the specific Peak Event hours for a given Conservation Day. CPP customers are charged a higher rate during a Peak Event and PTR customers can earn a rebate for conserving during a Peak Event.

Enabling Technologies:
AMI (advanced metering infrastructure) Meter – An advanced meter, also referred to as a "smart meter", that records consumption in intervals and communicates that information via a communications network back to the utility for monitoring and billing purposes. AMI meters enable two-way communication between the meter and the central system.

Direct Load Control Device – Device that allows customers to manage large appliances, such as an electric hot water heater or pool pump, which is controlled via broadband Internet connection.

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Homeview App – Also referred to as the “mobile app” or “app”. Allows customers to view their IHD remotely and access real-time energy usage and cost information. Also, allows customers to remotely monitor and control their Pilot thermostat if they have one.

In-home display (IHD) – Referred to as a digital picture frame in National Grid’s program marketing materials. An electronic graphical display device which provides information and graphics about energy usage and cost that is updated on a regular basis based on data from the utility meter. Customers may also upload their own personal photographs for display on this device.

Programmable-Controllable Thermostat (PCT) – A programmable thermostat, also referred to as a “smart thermostat”, which can also be controlled or signaled via the Home Area Network or another communications method.

Smart Plug – An intelligent 3-prong outlet that customers plug appliances into, which can also be controlled or signaled via the Home Area Network or broadband Internet connection.

WorcesterSmart Web portal – Also referred to as the “web portal”. An internet website accessible to all participants in the Pilot that enables them to see more advanced information on their energy consumption. The web portal also provides performance feedback for Pilot participants during Conservation Days.

Acronyms:
AMI: Advanced Metering Infrastructure
CAC: Central Air Conditioning
CPP: Critical Peak Pricing
DPU: Massachusetts Department of Public Utilities
DRMS: Demand Response Management System
EEAC: Energy Efficiency Advisory Council
GCA: Green Communities Act
IHD: In-Home Display
LEAN: Low-Income Energy Action Network
PCT: Programmable-Controllable Thermostat
PTR: Peak Time Rebate
SaaS: Software as a Service
TOU: Time of Use

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DISCLAIMER

This report was prepared by Navigant Consulting, Inc. (Navigant) for National Grid. The work presented in this report represents Navigant's professional judgment based on the information available at the time this report was prepared. Navigant is not responsible for the reader's use of, or reliance upon, the report, nor any decisions based on the report. NAVIGANT MAKES NO REPRESENTATIONS OR WARRANTIES, EXPRESSED OR IMPLIED. Readers of the report are advised that they assume all liabilities incurred by them, or third parties, as a result of their reliance on the report, or the data, information, findings, and opinions contained in the report.

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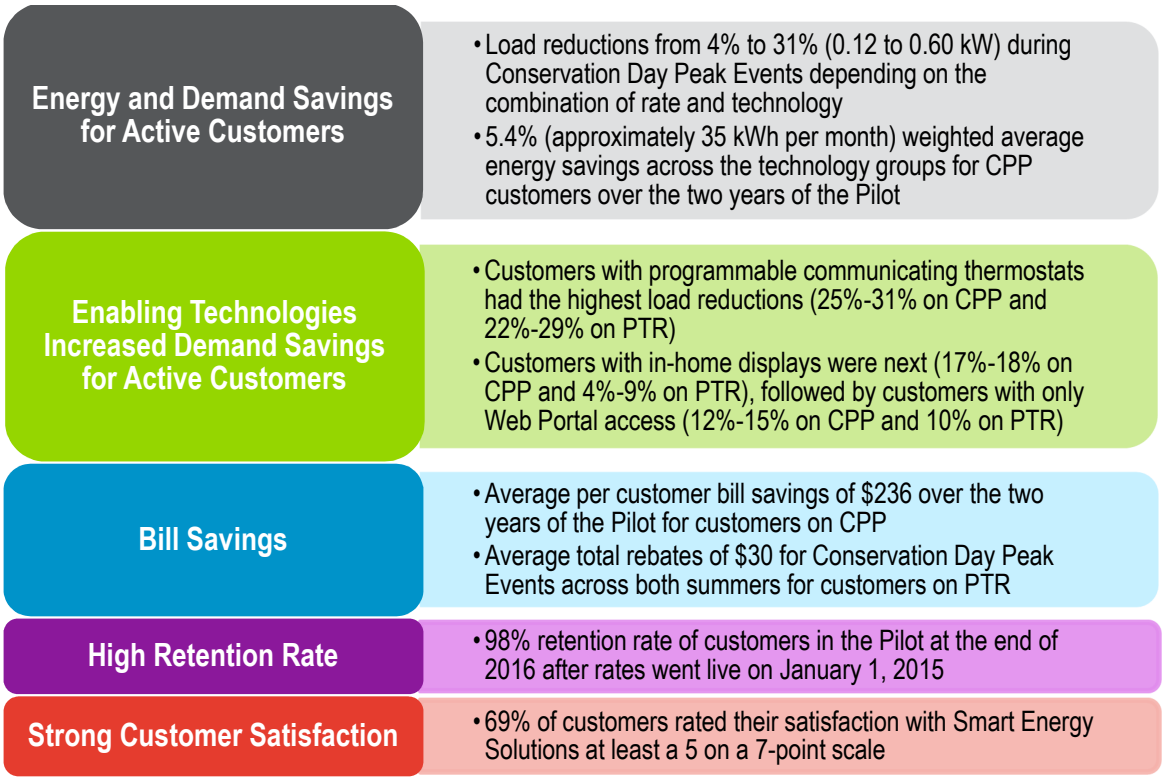
EXECUTIVE SUMMARY

Massachusetts Electric Company and Nantucket Electric Company d/b/a/ National Grid's (the Company or National Grid) Smart Energy Solutions Pilot program (the Pilot or Smart Energy Solutions) is an innovative smart grid pilot featuring deployment of a unique combination of advanced meters, customer-facing technologies, and time-of-use (TOU) rates. The informational portion of the Pilot began in 2013, rates went live in January 2015, and implementation ran through the end of 2016. National Grid filed for a two-year extension of the Pilot and the Massachusetts Department of Public Utilities (DPU) approved an interim extension that extends the Pilot until a final decision is reached in 2017. The Pilot also included advanced distribution grid-side technologies which are the subject of a separate report.[1] This evaluation, conducted by Navigant Consulting, Inc. (Navigant or the evaluation team), covers customer-side Pilot activities through the end of 2016. Navigant conducted the evaluation of the Pilot in accordance with the *Common Evaluation Framework*[2] produced by the Massachusetts Smart Grid Collaborative Technical Subcommittee (the Collaborative), a stakeholder group convened by the DPU to develop consistent evaluation themes and techniques across smart grid pilot programs in the state. Key findings include demonstration of significant energy and Peak Event savings, the important role of technology, and strong customer satisfaction (Figure E-1).

Figure E-1. Key Findings from Evaluation of Smart Energy Solutions



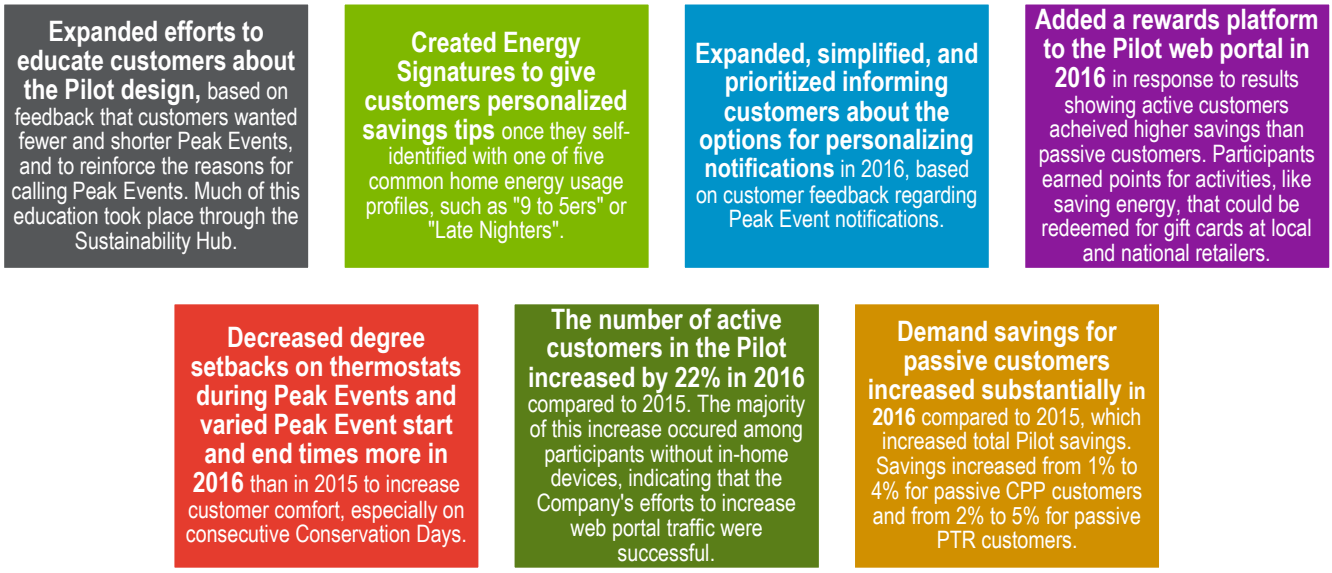
Source: Navigant analysis
Note: CPP refers to Critical Peak Pricing and PTR refers to Peak Time Rebate.

[1] National Grid. *Interim Grid-Facing Evaluation Report*, March 31, 2016.

[2] D.P.U. 10-82, Massachusetts Smart Grid Collaborative Technical Subcommittee, *Common Evaluation Framework*, March 23, 2011.

There were several changes in the Pilot design and outcomes in its second year (2016) compared to its first year (2015), which are summarized in Figure E-2. The design changes were primarily made based on customer feedback collected during the first year of the Pilot,[3] and reflect National Grid's "listen, test, learn" philosophy regarding continuous improvement to program offerings.

Figure E-2. Key Changes in Pilot Design and Outcomes in 2016



Source: Navigant analysis
Note: CPP refers to Critical Peak Pricing and PTR refers to Peak Time Rebate. Active participants are those who opted to receive one of the Pilot technology packages or who had no technology but visited the program web portal at least once; any customers without technology who did not visit the web portal are characterized as passive.

The Smart Energy Solutions Pilot

As shown in Figure E-3, Smart Energy Solutions was deployed in four phases.

Phase 1. **Meter Deployment & Awareness.** In this initial phase the Company raised awareness about and installed advanced metering infrastructure (AMI) meters (also referred to as "smart meters") in approximately 15,000 homes and businesses. Five percent of customers offered AMI meters refused them.

Phase 2. **Introduction of Benefits.** In the second phase the Company introduced Smart Energy Solutions to raise customer awareness and create an expectation of more to come. Customer education efforts continued throughout the Pilot.

Phase 3. **Choice.** In Phase 3 National Grid customers chose between two Pilot rates, a TOU Critical Peak Pricing (CPP) rate and a Peak Time Rebate (PTR) rate, and four technology packages that offered varying levels of information and control via web portal access, phone app, in-

[3] See Navigant. 2016. *National Grid Smart Energy Solutions Pilot Interim Evaluation Report.* Prepared for National Grid.

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home displays (IHDs), programmable-controllable thermostats (PCTs), direct load control devices, and smart plugs.[4] The Sustainability Hub was also opened during Phase 3 as a resource for customers. The Hub provides hands-on education and engagement through a holistic approach, integrating various advanced technologies into a demonstration home.

Phase 4. **Focus on Customer Control.** Phase 4 began with the rates going live in January 2015. The Company called Conservation Days with specific Peak Event hours on high-demand days, educated customers about their bills, assisted them in using the tools available to understand and control their energy usage, and allowed them to customize their participation through the many options available in the Pilot.

Based on its experience with the Pilot, National Grid understands the importance of gradual and ongoing customer outreach and education to introduce new concepts and technologies. By introducing demand response and connected devices early on, the hope was customers would better understand and benefit from incremental savings that may be realized from the introduction of AMI and time-based rates. National Grid has filed for a two-year extension of the Pilot and the DPU has approved an interim extension. Under the interim extension, the Pilot will remain in effect until the DPU comes to a final decision. If the proposal for extending the Pilot is approved or if the Company's Grid Modernization Plan is approved, the Company envisions offering Smart Energy Solutions participants the option to receive similar savings and benefits as they have enjoyed to date, in line with what is proposed in the Company's Grid Modernization Plan in D.P.U. 15-120. Otherwise, the Pilot participants will revert to basic rates and will be eligible for the same demand response incentives as other customers in the Company's service territory. Pilot participants who received in-home devices will be able to keep them regardless of the outcome of the extension.

The Company hopes to transition to a more advanced and integrated demand response management system (DRMS) that will be deployed during the Grid Modernization plan period if approved. The functionalities of this enterprise DRMS include the ability to schedule, dispatch, control and conduct evaluation, measurement, and verification of load curtailment demand response events.[5]

[4] Customers also had the option to remain on the Basic Rate, effectively leaving the Pilot, or to leave National Grid by switching to a competitive supplier. As a result, the Pilot contained an "opt-out" element for customers who did not want TOU/CPP, and an "opt-in" element for customers who chose the PTR rate or any of the technology packages. This design and customer flexibility set the Pilot apart from other utility dynamic rate pilots. Therefore, comparisons to other programs are anecdotal, as direct comparisons do not exist.

[5] National Grid. D.P.U. 15-120. *Grid Modernization Plan at Attachment 8.* August 19, 2015.

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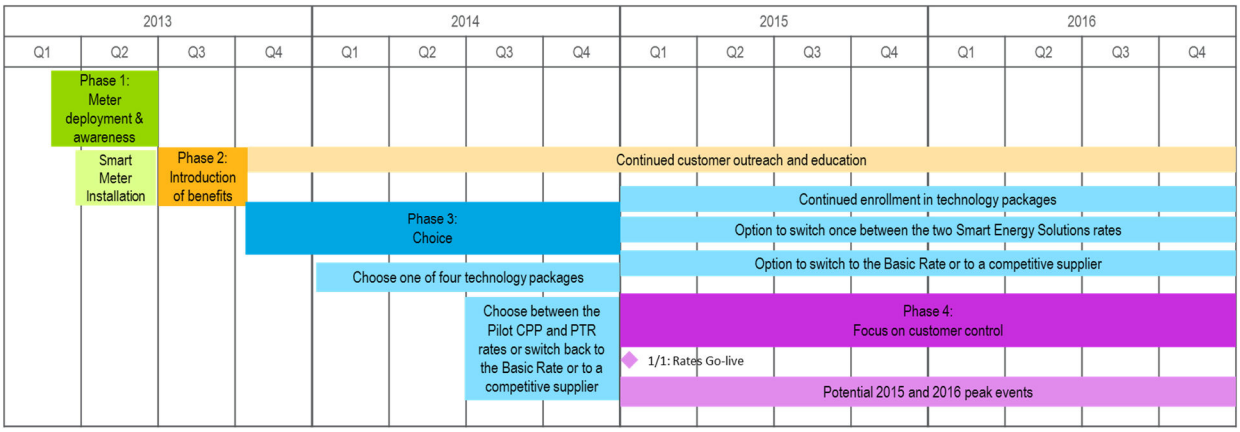
Figure E-3. Four-Phase Rollout of Smart Energy Solutions



Source: Navigant and National Grid

Consistency with Green Communities Act

The Pilot design complied with and exceeded the requirements of Section 85 of the Green Communities Act (GCA or the Act) passed in Massachusetts in 2008. The Act mandated that each investor-owned electric utility conduct a smart grid pilot with the overall objective of reducing active participants' peak and average loads by at least 5%. The pilot program must include, at a minimum, the following:

- Deployment of advanced meters that measure and communicate electricity consumption on a real-time basis;
- Automated energy management systems in customers' home and facilities;
- Time of use or hourly pricing for a minimum of 0.25 percent of the company's customers;
- Remote monitoring and control equipment on the Company's electric distribution system; and,
- Advanced technology to operate an integrated grid network communication system in a limited geographic area.

The DPU has recognized four unique elements of Smart Energy Solutions that differentiate it from other Section 85 pilot programs.[6]

1. The Company ***implemented the customer-facing and grid-facing components of the Pilot within one city***, a portion of Worcester, to allow National Grid to ascertain whether a comprehensive deployment of smart grid technologies produced synergistic customer benefits.
2. The Company ***deployed the program on an opt-out basis***, meaning all eligible customers in the Worcester area were offered an AMI meter and enrolled in Smart Energy Solutions by default but had the option to opt-out if they weren't interested. Relative to opt-in programs where eligible customers must actively choose to participate, opt-out programs reach many more customers and thus have higher savings potential.

[6] D.P.U. Order 11-129. *Petition of Massachusetts Electric Company and Nantucket Electric Company, each d/b/a National Grid for approval of a smart grid pilot program.* August 3, 2012.

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3. The ***default pricing option for the Pilot is a TOU rate, and the vast majority of Pilot participants remained on this rate***. Additionally, nearly 1,000 customers opted into technology packages which included in-home devices. Having a significant number of customers on a TOU rate with enabling technologies represented a unique opportunity to study these smart grid pilot components across a broad segment of the population.
4. National Grid's ***comprehensive outreach and education campaign combined both traditional and community-based elements***. It was designed to encourage customers to permanently change their energy consumption behavior in response to the price signals and other Pilot messaging. The Pilot also included the creation of the Sustainability Hub which serves as a model energy center in the community where National Grid provides hands-on education and engagement through a holistic approach, integrating various smart elements into a demonstration home.

Definition of Active Customers

In the context of an opt-out pilot, the GCA's goal of reaching 5% savings for "active" customers must be interpreted carefully. Some of the participants in an opt-out pilot will never actively engage with the program components. For evaluation purposes, Navigant defined active participants as anyone who opted into any in-home technologies and anyone with no in-home technology who logged into the Pilot web portal at least once.[7] Customers with no in-home technology who never logged into the web portal were considered "passive" participants in the Pilot. In other words, the passive customers did not adopt technologies or check their electricity usage; these customers could still take actions to save energy as they were enrolled in the Pilot rates and received notifications for the Peak Events. By this definition, just under 25% of the Pilot participants were active at the end of 2016. This increased from just under 20% at the end of 2015.

Customer Decision-Making and Flexibility

Among smart grid pilots, Smart Energy Solutions was relatively complex with several key decision points for customers, as illustrated in Figure E-4.

[7] Active customers were defined as of October 12, 2016, which was after the last Peak Event of the 2016 summer season.

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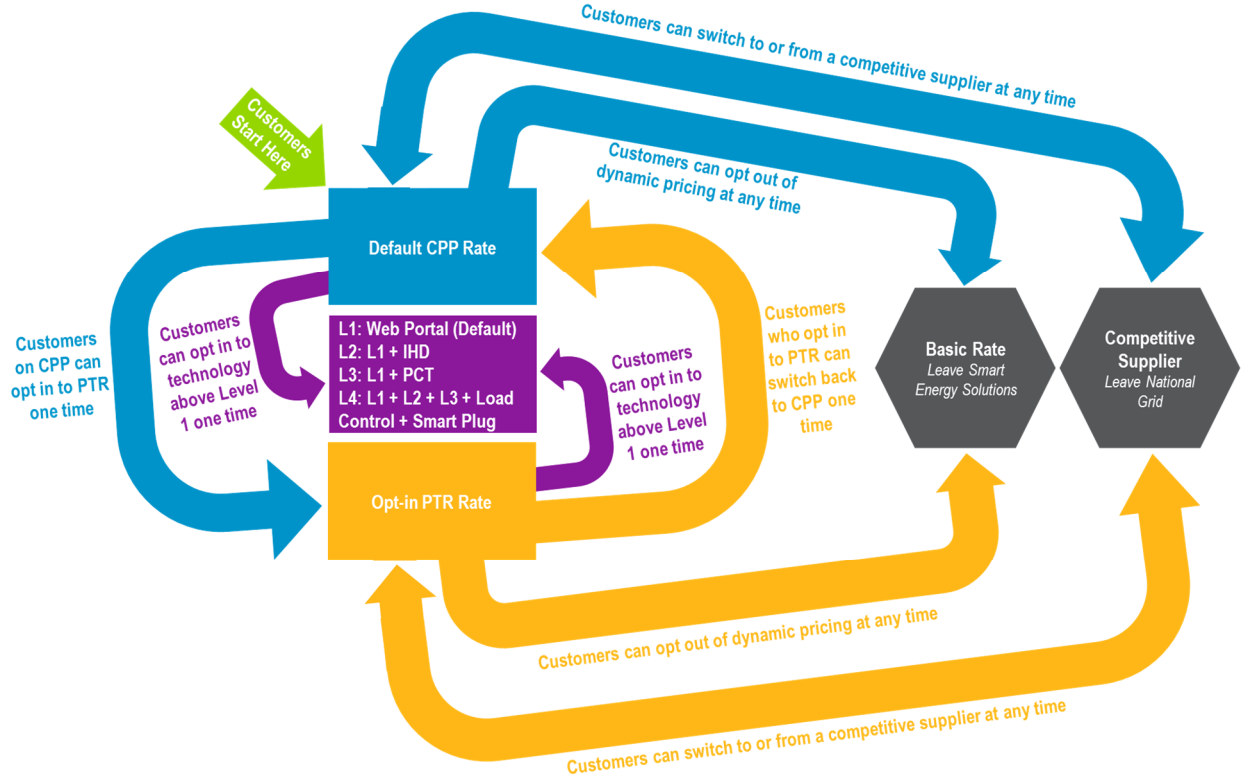
Figure E-4. Smart Energy Solutions Customer Decision Points



Source: Navigant
Note: L1 = Technology Level 1, L2 = Technology Level 2, L3 = Technology Level 3, L4 = Technology Level 4, IHD = in-home display, PCT = programmable-controllable thermostat.

Smart meters and choice of rates. Eligible customers in the Worcester area who accepted a smart meter were enrolled onto the CPP rate by default.[8] Customers had the option to opt into the PTR rate one time during the Pilot; customers who initially opted into the PTR rate could switch back to the CPP rate one time. Customers could also choose to switch back to the Basic Rate, thus opting out of the Pilot, or to switch to and from a competitive supplier, thus leaving or returning to National Grid, at any time.

Technology choice. Customers on the CPP and PTR rates also had a choice of four technology packages, with Level 1 (web portal only) as the default. Some of the technology packages had eligibility requirements related to internet access and central air conditioning.[9] Technology options became more advanced, offering more electricity usage information and control, from Level 1 to Level 4:

[8] Customers had the option to decline the smart meter and, therefore, opt out of the Pilot at the onset. Five percent of customers offered an AMI meter declined to accept it.

[9] For example, in order to be eligible for the Level 2 package with a digital picture frame, customers had to have a high-speed broadband Internet connection. To be eligible for Level 3 with a PCT, customers had to have central air conditioning. To be eligible for Level 4 with a PCT and a smart plug and/or load control device, customers had to have central air conditioning and a high-speed broadband Internet connection.

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- Level 1: Personal electric use information, via access to a web portal;
- Level 2: Level 1 plus an IHD with energy use and real time cost information and access to this information through the web portal;
- Level 3: Level 1 plus a programmable-controllable thermostat (PCT) and a mobile app to view the PCT schedule; or,
- Level 4: Level 1, Level 2, and Level 3 plus a smart plug and, for some customers, a wired load control device, and additional capability in the mobile app to show load control and smart plug usage.

Conservation Days. During each summer of the Pilot (2015 and 2016), National Grid called 20 Conservation Days on days with expected high demand. Customers received notifications one day ahead and could opt to receive them the day of each Conservation Day as well. On these days, the price of electricity increased during designated hours, called Peak Event hours, which varied between Conservation Days. In 2015, the Peak Events averaged 6.75 hours in length and totaled 135 hours. Events were slightly longer in 2016, averaging 6.95 hours in length and totaling 139 hours. National Grid's events were longer and called more days in a row than events from other comparable programs. For example, one of the most well-known critical peak pricing programs, Southern California Edison's, is limited to 60 hours per year,[10] and NSTAR's[11] smart grid pilot included a total of 15 events from 3-5 hours each over two summers.[12] On the CPP rate, customers were incented to conserve electricity, or shift usage to non-Peak Event hours, and thus avoid paying the high electricity prices during Peak Event hours. On the PTR rate, customers received a rebate for any electricity conserved during those hours.

Community Partnership and Sustainability Hub

To ensure that the Pilot was a collaborative effort with the community, National Grid partnered with the City of Worcester to host the September 2011 Green2Growth Summit (Summit). The Summit provided valuable insights into customers' visions regarding the future of energy delivery in their city. National Grid learned that its customers are increasingly aware of new opportunities to manage their energy consumption and are open to learning more about the potential uses and benefits of smart technology. Based on information gathered through the Summit, the Company revised the Pilot's Outreach & Education plan, implemented in Phases 2-4 of Figure E-3, and developed a Sustainability Hub in Worcester to continue engaging customers. The Sustainability Hub was envisioned and built as a focal point for the successful implementation of the Pilot. In addition to being the physical presence of the Pilot in Worcester, the Sustainability Hub serves as a model energy center in the community, where National Grid provides hands-on education and engagement through a holistic approach, integrating various smart elements into a demonstration home. As of the end of 2016, over 8,200 people had visited the Sustainability Hub, and it was mentioned by many customers as a useful source of information alongside direct mail, the Smart Energy Solutions website, and National Grid's Customer Contact Center (see Figure 2-15). A survey administered by the Sustainability Hub also found that customers ranked the Hub

[10] Summer Advantage Incentive fact sheet <https://www.sce.com/wps/wcm/connect/d0d870bf-68f5-41b0-a930-3c082652b443/NR580V40410_CPP.pdf?MOD=AJPERES>

[11] NSTAR is now called Eversource Energy.

[12] NSTAR Smart Grid Pilot Final Technical Report, AMR BASED DYNAMIC PRICING. DE-OE0000292. Prepared for: U.S. Department of Energy On behalf of NSTAR Gas and Electric Corporation. August 4, 2014.

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highly as a source of information (see APPENDIX C).

Statewide Common Evaluation Framework

Navigant conducted the evaluation of the Pilot in accordance with the *Common Evaluation Framework*[13] produced by the Massachusetts Smart Grid Collaborative Technical Subcommittee (the Collaborative), a stakeholder group convened by the DPU to develop consistent evaluation themes and techniques across smart grid pilot programs in the state. The evaluation included quantitative measures of energy, demand, and customer bill impacts, as well as qualitative measures for customer engagement, satisfaction, and perceptions through customer surveys, interviews, and focus groups.

Impact Assessment

This evaluation addresses the impacts of the Pilot on demand during Peak Events, overall energy consumption, and customer bills. The impact findings in this report are primarily focused on residential customers. Commercial customers were a very small portion of the Pilot participants and outcomes were explored for them to the extent possible based on the constraints of the small sample. Where possible, each set of impacts was broken out by technology/price groups as prescribed by the Common Evaluation Framework. For Level 1, Navigant evaluated each of the impacts for both active and passive customers.

Table E-1 shows total and percentage demand and energy savings and total bill savings for residential customers in the Pilot. Total savings are the sum of savings across all residential customers in the program. For the Peak Event savings, the total savings are shown for the "average event", which is the average across all Peak Event hours across all 20 Peak Events of each summer, and for the "maximum event", which is the single Conservation Day with the highest average savings across the Peak Event hours. Percentage savings are the weighted average of savings across the residential technology/price plan groups.

Table E-1. Total and Percentage Savings for Residential Customers

Impact Category		2015			2016		
		Total Savings	Percentage for Active Customers	Percentage for All Customers	Total Savings	Percentage for Active Customers	Percentage for All Customers
Peak Event Savings	Average Event*	0.55 MW	16.8%	3.9%	1.02 MW	16.8%	7.2%
	Maximum Event**	1.59 MW	29.0%	12.3%	2.28 MW	24.0%	14.3%
Energy Savings ***		215 MWh	4.3%	0.2%	1,358 MWh†	6.3%	2.0%
Bill Savings‡		$997,621	-	-	$772,879	-	-

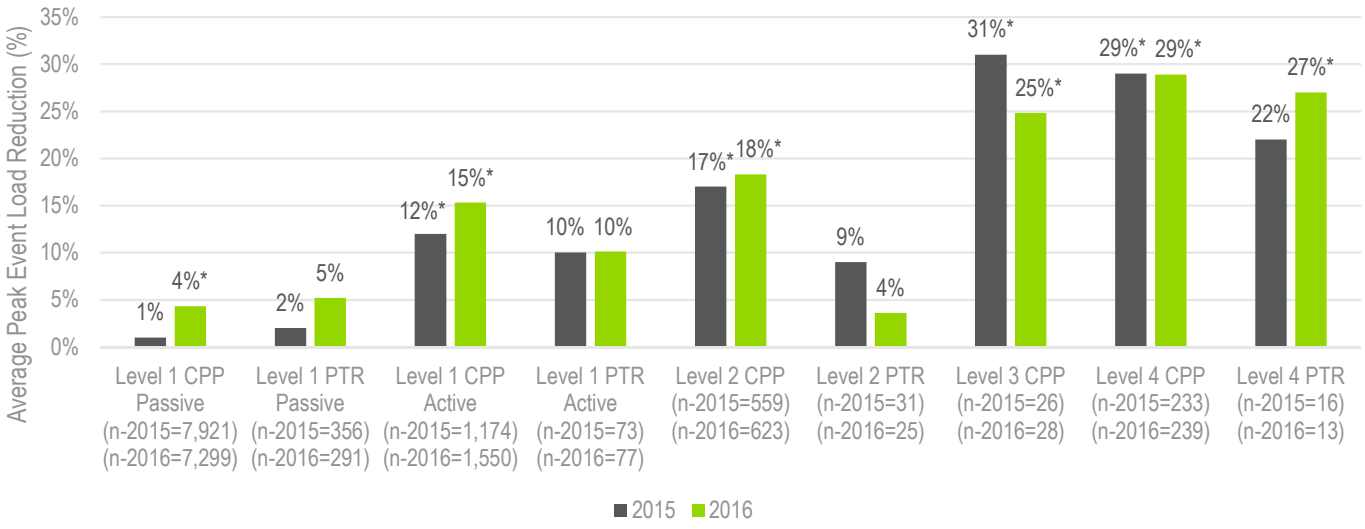
Source: Navigant analysis
* This is the total demand savings among all participants, averaged across all 20 events in the summer of each year.
** This is the total demand savings for 6/23/2015 and 7/25/2016, the Conservation Days with the highest savings for each summer.
*** This includes energy savings for CPP customers only, as energy savings were neither expected nor found for PTR customers.
† The considerable increase in energy savings in 2016 was driven primarily by a spike in savings in July, Navigant did not find any evidence suggesting this result was erroneous. This is discussed more fully in Section 3.2.1.
‡ This includes total bill savings for CPP customers and rebates for PTR customers.

[13] D.P.U. 10-82, Massachusetts Smart Grid Collaborative Technical Subcommittee, *Common Evaluation Framework*, August 10, 2011.

The Pilot was developed to meet the GCA goal of achieving peak and average load reductions of 5% or greater for the active customers in the Pilot. In Navigant's analysis, peak load reduction was examined in the demand analysis and average load reduction in the energy analysis. In both 2015 and 2016, active residential customers in the Pilot achieved an average of a 17% peak load reduction during Peak Events. Active CPP participants achieved an average load reduction of 4.3% in 2015 and 6.3% in 2016, which averaged to 5.4% over the whole of the Pilot.[14] Demand savings in 2015 and 2016 may be slightly underestimated because hourly data from 2014 was used to estimate the baseline. In 2014 customers had access to usage information through the Pilot web portal but the Pilot rates were not yet live, so they may have already been conserving relative to their pre-2014 usage as they were more aware of their electricity usage.[15]

Active customers achieved average Peak Event load reductions of up to 31%, and in-home technology increased demand savings. Figure E-5 shows the average percentage peak load reduction across the 20 events of each summer for each of the technology/price groups. Whether on the CPP or PTR rate, customers achieved greater demand reductions with more advanced technology. The savings for CPP customers were statistically significant at the 90% confidence level for all active participants in both years, and for passive participants in 2016. The savings for customers on the PTR rate were not statistically significant at any technology level in 2015, and only for Level 4 in 2016. The lack of statistical significance for the PTR rate was due to small sample sizes on that rate. At each technology level, active CPP customers conserved more electricity than their PTR counterparts. Passive PTR customers saved more than passive CPP customers, which could be due to a higher level of engagement since they had to opt in to the PTR rate.

Figure E-5. Average Peak Event Load Reductions by Technology/Price Group



Source: Navigant analysis
Note: An asterisk (*) indicates that the majority of the event hours throughout the summer were statistically significant at the 90% confidence level for the indicated group. Additionally, n refers to the number of customers used in this particular analysis, not the total number of customers in each technology/price group.

[14] Energy savings, or average load reductions, were neither expected nor found for PTR customers as these customers were not on a TOU rate.

[15] Hourly data prior to April 2014 when smart meters were installed was not available.

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Absolute peak load reductions for each technology/price group in each summer are shown in Table E-2.

Table E-2. Average Absolute Peak Event Load Reductions per Customer by Residential Technology/Price Group

Technology/Price Group	2015 Absolute Savings (kW)	2016 Absolute Savings (kW)
Level 1 CPP Passive	0.01	0.05
Level 1 PTR Passive	0.03	0.07
Level 1 CPP Active	0.13	0.17
Level 1 PTR Active	0.12	0.12
Level 2 CPP	0.20	0.21
Level 2 PTR	0.13	0.05
Level 3 CPP	0.53	0.49
Level 4 CPP	0.56	0.60
Level 4 PTR	0.50	0.60

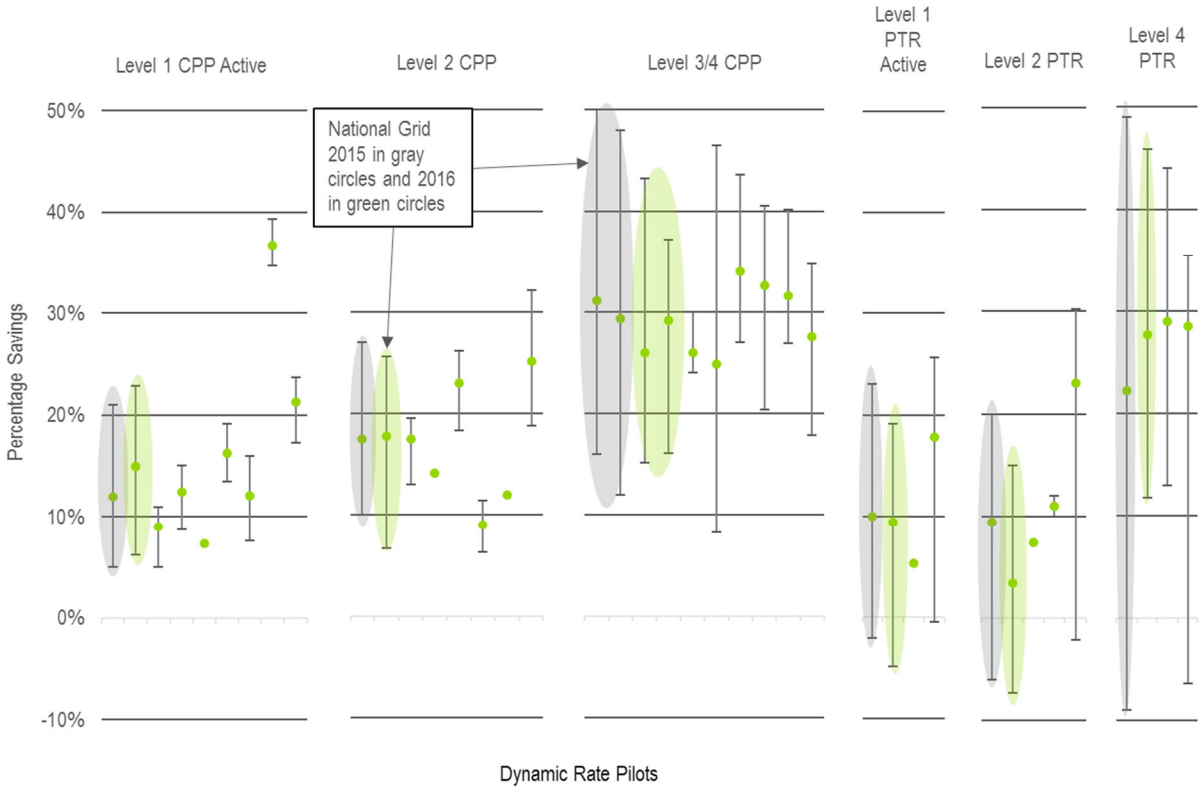
Source: Navigant analysis

Peak Event savings were comparable to other dynamic rate pilots. In percentage terms, the peak event impacts for active customers in the Pilot were similar to those from other, primarily opt-in, programs.[16] Comparisons of the Pilot to several other programs around the country are shown in Figure E-6. The comparisons include the average, maximum, and minimum impact when possible, or the average impact when the minimum and maximum could not be found. The comparisons are grouped by the Pilot's technology/price groups, and the comparison programs are matched to the Pilot groups based on the descriptions of the price plans and the enabling technologies in the comparison program's report. The Pilot groups are highlighted in gray in 2015 and green in 2016.[17]

[16] Passive customers in Level 1 also had savings, but they are not shown in Figure E-6 because all of the comparison programs are opt-in. Passive customers in an opt-out program are fundamentally different from customers in an opt-in program in terms of their motivation to participate in a program.

[17] The specific utility for each of the comparable pilots can be seen in Figure 3-2.

Figure E-6. Peak Event Impacts Percentage Comparisons to Other Utilities



Source: Navigant analysis and the Smart Grid Investment Grant Program

Low-income customers achieved Peak Event impacts similar to other customers in two of the three technology/price groups examined. Three technology/price groups (Level 1 CPP Active, Level 1 CPP Passive, and Level 2 CPP) had enough low-income customers to analyze whether their Peak Event impacts differed from the larger group. In the two Level 1 groups, the impacts for low-income customers were not statistically different from the rest of the group; 87% of all Pilot participants were in the Level 1 CPP groups, meaning for the bulk of the Pilot low-income customers had the same impacts as other customers. However, in Level 2 the low-income customers had lower Peak Event savings than the group as a whole. As discussed further in Section 3.1.3, possible reasons for this difference in Level 2 include (1) lower central air conditioning penetration for the low-income customers, (2) low-income customers may have less discretionary energy usage and thus less energy to save, and (3) low-income customers may have been less able to shift their usage than other residential customers. The difference could also be a spurious finding since low-income customers had the same impacts as other customers in two of the three groups analyzed.

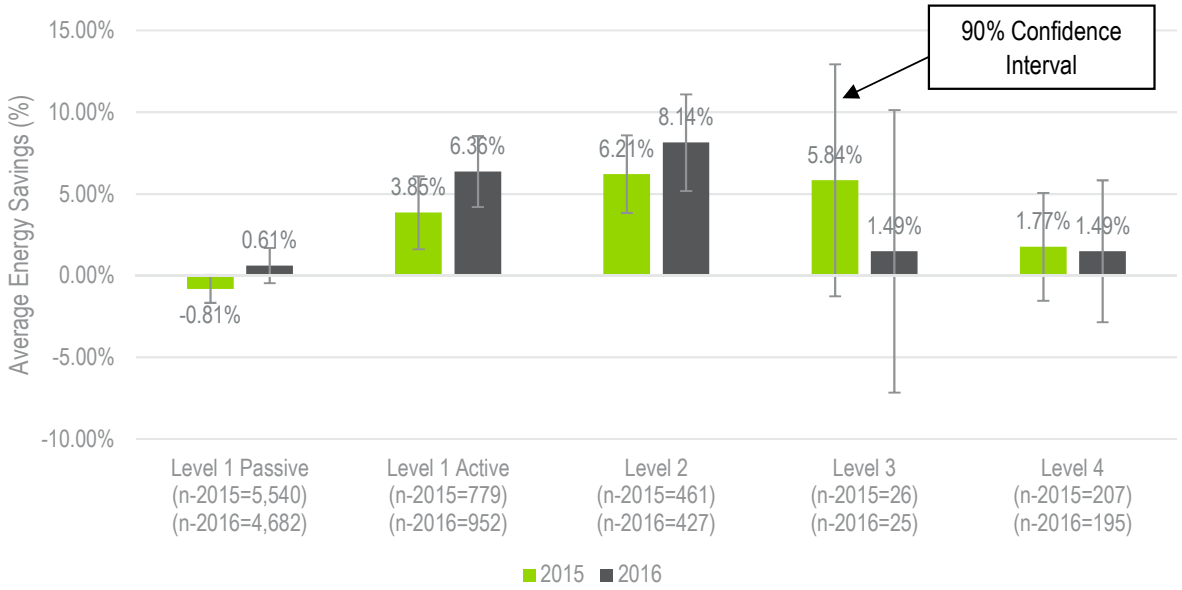
CPP customers achieved average energy savings of up to 8% over the two years of the Pilot.

Figure E-7 shows the average percentage energy impacts with 90% confidence intervals for CPP customers in different technology levels in each year of the Pilot.[18] In both years, energy savings for

[18] Navigant also examined energy savings for PTR customers but did not find any significant savings outside of peak events; PTR customers were not expected to achieve significant energy savings because they did not pay TOU rates.

active participants were highest for Level 2 customers (49 kWh per month) and lowest for Level 4 customers (12 kWh per month). Active Level 1 customers saved 32 kWh per month, and Level 3 customers saved 25 kWh per month. Although the point estimates of energy savings changed from 2015 to 2016, the changes were not statistically significant indicating the energy savings were similar across the two years of the Pilot. It is unclear why Level 4 customers saved less than Level 3 customers in 2015 since the two groups had similar technologies; however, the 90% confidence bounds for the two estimates overlap and the sample sizes are relatively small for monthly billing analysis, which may have contributed to the discrepancy; additionally, the discrepancy disappeared in 2016 when the point estimate for Level 3 customers fell considerably. The estimates of energy savings for passive customers in Level 1 were very small and not statistically significant in either year.

Figure E-7. Average Energy Impacts for CPP Customers by Technology Level

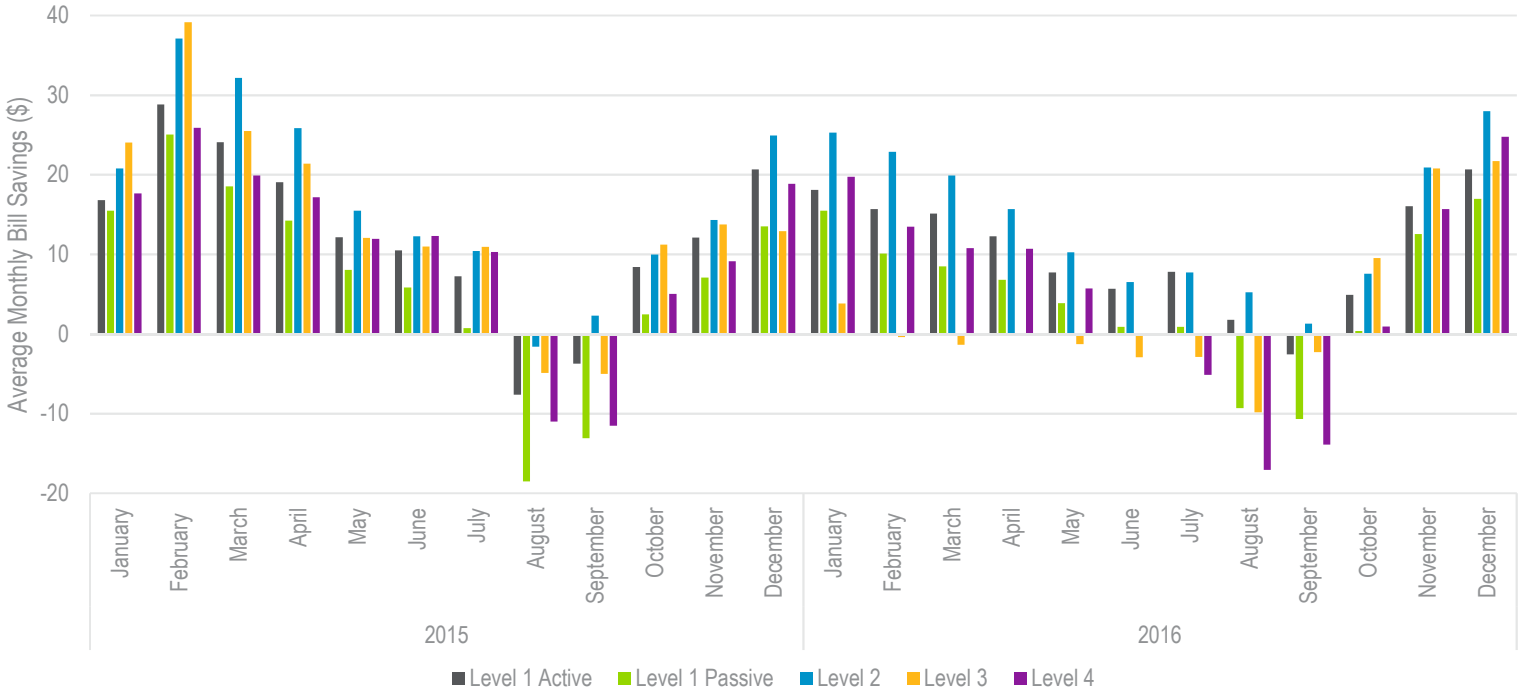


Source: Navigant analysis
Note: n refers to the number of customers used in this particular analysis, not the total number of customers in each technology/price group.

CPP customers averaged $236 in bill savings over the two years of the Pilot. Figure E-8 shows the average bill savings by month and year for CPP customers. The month of each bill was defined as the last day of the billing period. This means that on average, bills in each month contain an equal number of days in the current month and the previous month, for example bills in May reflect usage in the second half of April and the first half of May. On average across technologies, bill savings were highest in February 2015, which reflects January and February 2015 usage, when customers were still adjusting to the new TOU rate. Unless there was a Peak Event, customers saved money on the TOU rate because the TOU rate was lower than the Basic Rate for non-Peak Event hours. Customers' bills went up in August and September of each year and July of 2016, reflecting usage in July, August, and September, which was expected, since July and August were when the majority of the Peak Events were called each year. The expectation was that summer bills, when Peak Events occurred, would increase but this would be balanced by bill savings throughout the rest of the year. Average per-customer bill savings over the two years of the Pilot were $375 for Level 2, $272 for active customers in Level 1, $206 for Level 3, $191 for Level 4, and $136 for passive customers in Level 1. For each group, bill savings were higher in 2015 than in 2016 despite the fact that energy savings were higher in 2016. Increases in energy savings do not

necessarily produce increases in bill savings because of the high price during Peak Events. For example, the highest energy savings occurred in July 2016, but that did not produce high bill savings in that month because eleven Peak Events were called, increasing bills in that month for many customers.

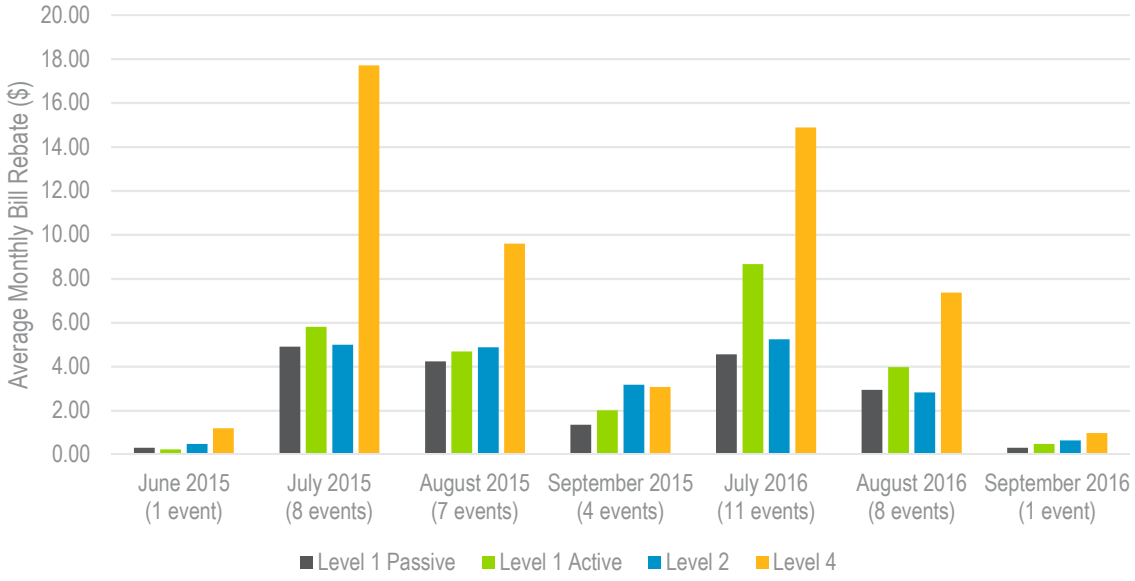
Figure E-8. Average Bill Savings for CPP Customers



Source: Navigant analysis

PTR customers averaged approximately $30 in bill rebates over the two years of the Pilot. The bill savings for PTR customers came from the monthly rebate earned during Peak Events based on the payments made by National Grid. Figure E-9 shows the average bill rebates by month and year for PTR customers. Over the two years, Level 4 customers achieved the highest average rebate of $1.37 per event, active Level 1 customers averaged $0.65 per event, Level 2 customers averaged $0.56 per event, and passive Level 1 customers averaged $0.46 per event. As with CPP customers, bill rebates for PTR customers were slightly lower in 2016 than in 2015 for most of the technology groups, while active customers in Level 1 had essentially the same rebate in both years (increasing by $0.02 in 2016 compared to 2015).

Figure E-9. Average Bill Rebates for PTR Customers



Source: Navigant analysis

The Pilot exhibited small load shifting impacts. Navigant examined load shifting around Peak Events (i.e., in the hours just before (pre-cooling) or after (snapback) the Peak Event), from weekdays to weekends, and from peak to off-peak times on non-Conservation Days. CPP customers were expected to exhibit all three types of load shifting because of the TOU nature of the rate, whereas PTR customers may have shifted load around Peak Events but did not have a strong incentive to exhibit the other two types of load shifting. Overall, Navigant found that each type of load shifting was: (1) small compared to the Peak Event impact, (2) mostly larger for CPP than PTR customers as expected, and (3) mostly larger for customers with higher levels of technology.

Customer Engagement and Experience

This evaluation addresses customers' experiences with Smart Energy Solutions through the end of 2016. It looks at customers' expectations of the program, their reasons for participating, and their experience during the two summers of Conservation Days. Key findings include strong customer satisfaction, a desire to continue with the Pilot, and a high retention rate (i.e., few customers dropping out of Smart Energy Solutions and going back to the Basic Rate).

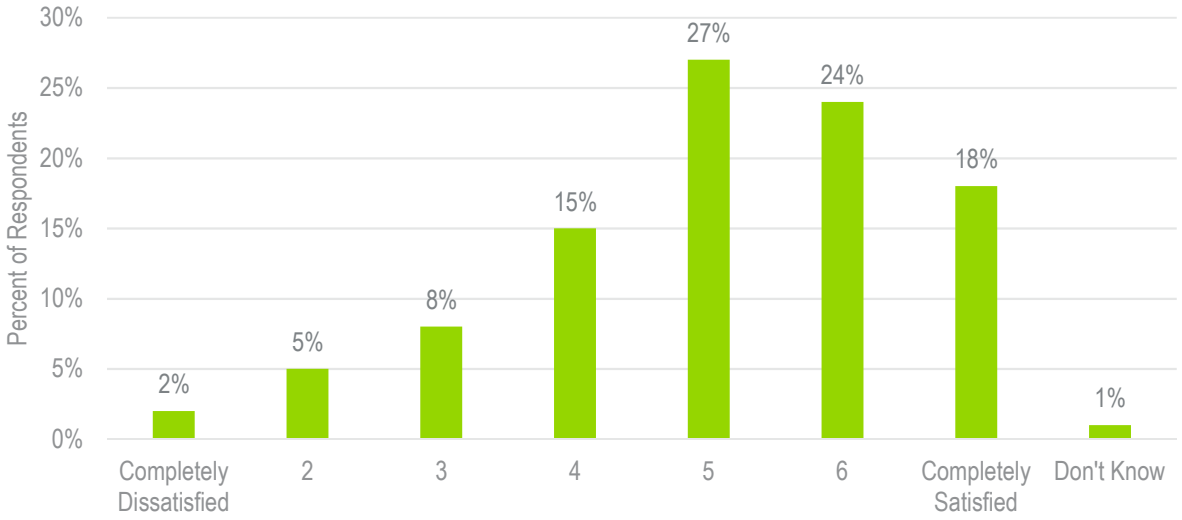
Strong satisfaction. As shown in Figure E-10, 69% of customers reported satisfaction with the Pilot of at least 5 on a 7-point scale,[19] with 18% rating their satisfaction a 7 out of 7.[20] The weighted average satisfaction was 5.06. This satisfaction rating was similar to those from several dynamic rate pilots from

[19] National Grid customers could also indicate that they were "unsure/don't know" or refuse the question.

[20] In 2015, 72% of customers reported being "Very" or "Somewhat" satisfied with the Pilot on a 3-category scale. The satisfaction scale was changed in 2016 to better align with DPU guidelines.

other utilities, including NSTAR, DTE, and MN Power. Converted to a 7-point scale, NSTAR customers gave their pilot an average satisfaction rating of 5.6, 86% of DTE customers rated their pilot at least 4.2 out of 7, and MN Power customers rated their Pilot an average of 3.9 – 4.3 out of 7. As an opt-out Pilot, it is commendable that Smart Energy Solutions achieved satisfaction ratings similar to opt-in pilots, because customer motivations are different between opt-in and opt-out programs.

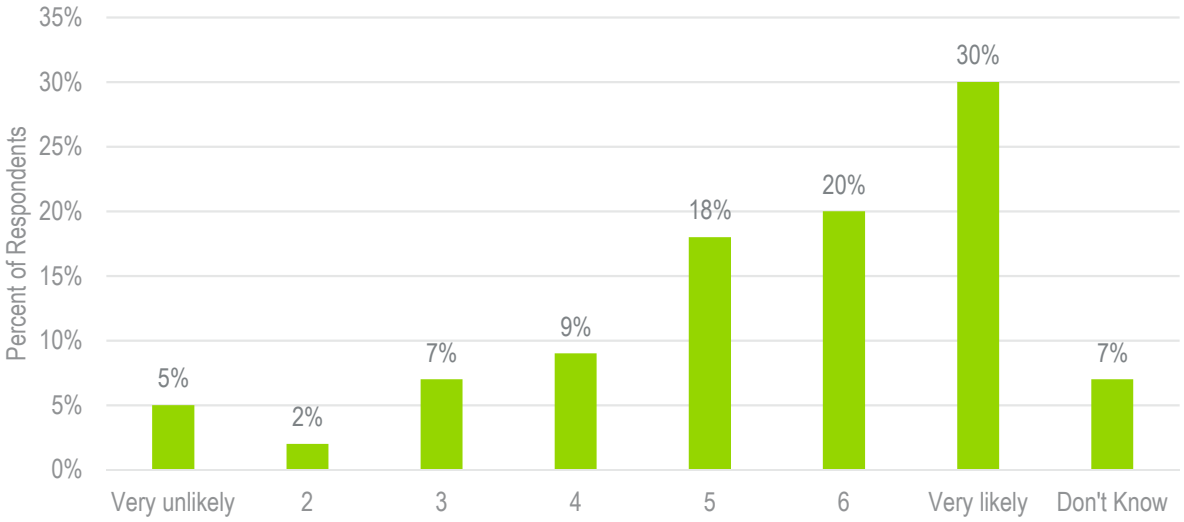
Figure E-10. Participant Overall Satisfaction with Smart Energy Solutions



Source: Navigant analysis of 2016 end of pilot survey (N=615)

Desire to Continue with the Pilot. Over two-thirds of participants indicated that they would like to continue with the Pilot if it were extended with the same conditions (Figure E-11). Almost one-third of customers (30%) indicated that their likelihood of continuing was a 7 on a 7-point scale, suggesting that these customers were enthusiastic about their experiences to date.

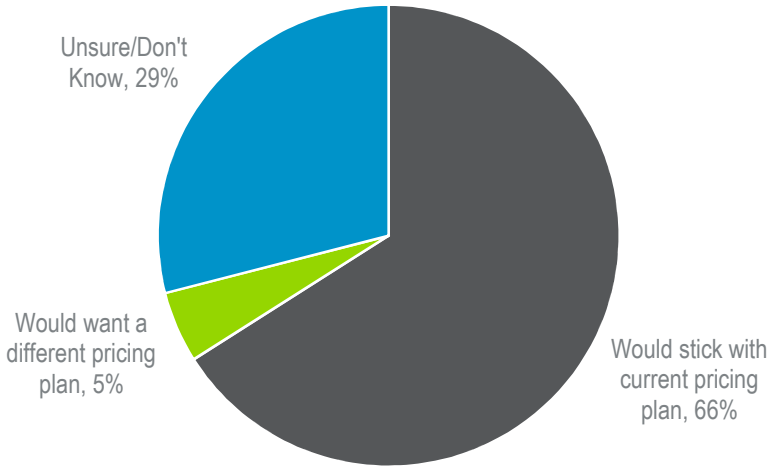
Figure E-11. Customers' Likelihood to Continue with Smart Energy Solutions



Source: Navigant analysis of 2016 end of pilot survey (N=615)

Additionally, most customers (66%) indicated that they would choose to stay on their current rate if the Pilot were extended, as shown in Figure E-12. Only 5% said they would definitely want to switch rates, with the rest being unsure.

Figure E-12. Customers' Interest in Continuing with Current Pricing Plan



Source: Navigant analysis of 2016 end of pilot survey (N=615)

High acceptance and retention rates. Since a foundational aspect of the Pilot was customer acceptance of AMI meters, National Grid monitored the percentage of customers who declined to install a meter and found it to be approximately 5% out of approximately 15,000 sites. Navigant surveyed a sample of 70 decliners. Three-quarters of those refusing the meter had no initial interest in participating in the program. Taking the categories of all reasons for declining the meter, the most common was 'Generic', which included not believing they would benefit and just not wanting a smart meter.

The CPP and PTR rates went live in January 2015 and almost 11,000 customers were enrolled.[21] Compared to one-year customer retention rates in other utility dynamic rate pilots, National Grid had high customer retention, even after two years, as shown in Figure E-13.[22] One thing of note is that, as an opt-out program, the Pilot was quite large compared to the size of a typical opt-in program. Opt-out program design is a relatively new industry concept, and based on research to date, retention rates appear to be similar for opt-in and opt-out programs.[23] However, by definition, customers in an opt-in program have a

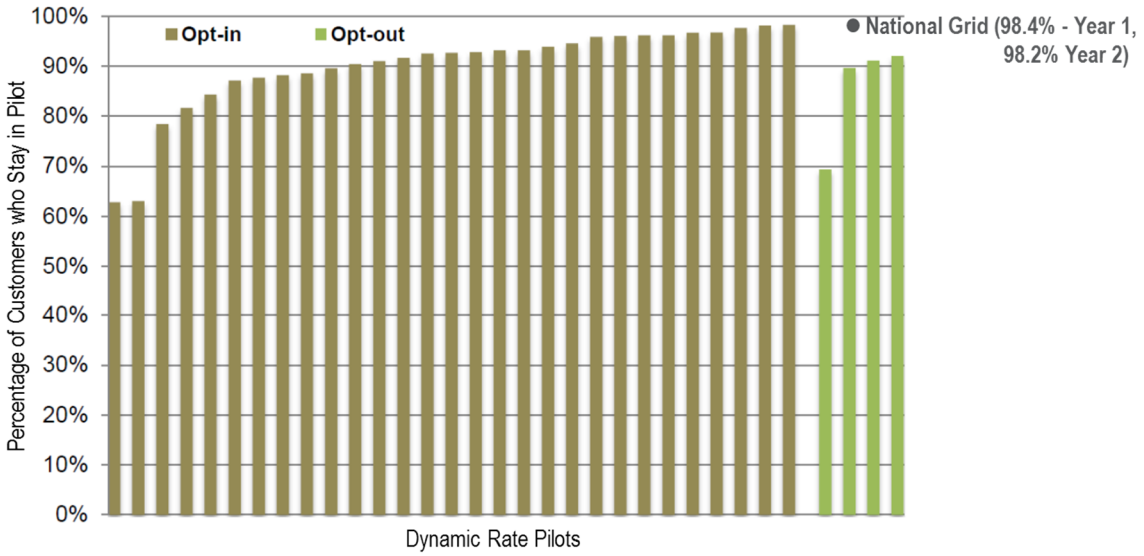
[21] The difference between the 15,000 customers offered an AMI meter and the 11,000 enrolled in the Pilot is accounted for by customers who get electricity from a competitive supplier, moved out before the Pilot rates went live, or chose to drop out of the Pilot before it started.

[22] Figure E-13 shows U.S. Department of Energy Smart Grid Investment Grant (SGIG) dynamic rate pilot retention rates. Ten utilities undertook several pilot studies during the SGIG period and reported their experience in recruiting and retaining customers. Each bar in the chart represents a single treatment group within one of the utility pilots.

[23] Cappers, P., H. Liesel, R. Scheer. *American Recovery and Reinvestment Act of 2009: Interim report on customer acceptance, retention, and response to time-based rates from the consumer behavior studies*. LBNL-183029. June 2015.

different motivation to participate in a dynamic rate pilot than customers in an opt-out program. Customers who participate in opt-in programs tend to be enthusiastic early adopters and not likely to drop out of a program they signed up for. Opt-out programs capture all customers, many of whom may follow "default bias", which means that they tend towards the default offering rather than accepting alternative offerings. Yet, given the fact that opt-out programs target the general population, we would anticipate lower retention rates over time. The 98% retention rate achieved by National Grid after two years running the Pilot—coupled with the fact that the Company called more event days in each summer than any other dynamic rate pilot—is remarkable.[24]

Figure E-13. Customer Retention Rate Based on Whether the Utility Used Opt-In or Opt-Out Recruitment



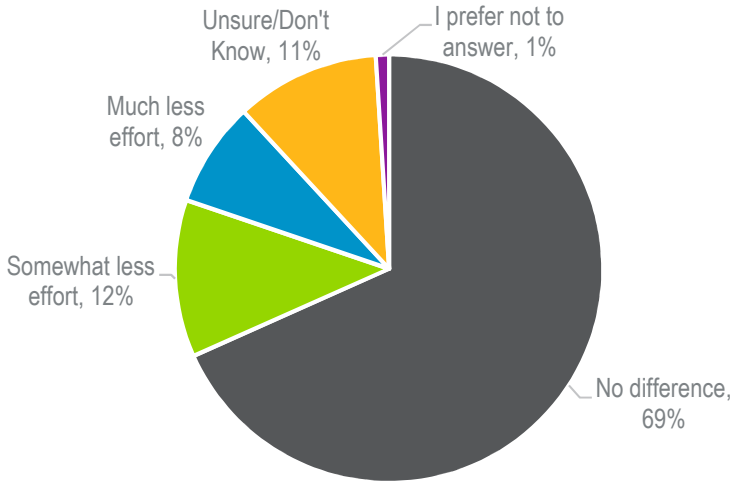
Source: Lawrence Berkeley National Laboratory and Navigant analysis

Low impact of bill protection on CPP rate customers. CPP customers were eligible for bill protection if they stayed on the CPP rate for at least 12 consecutive months; bill protection meant that if at the end of the year their bills were higher than they would have been on the Basic Rate, the customer received a credit in the amount of the difference. At the end of the Pilot, almost half of the customers on the CPP rate (40%) said that they were aware of the bill protection feature. However, as shown in Figure E-14, over two-thirds of those who knew about it said that the feature made no difference in their efforts to manage their electricity use. This means that most CPP customers likely did not reduce their energy savings behaviors because they knew they would get bill protection at the end of the year. Approximately 20% of the CPP participants did say that knowing about bill protection made them put "somewhat less" or "much less" effort into saving energy. To explore this further, Navigant matched the survey results to the usage data and examined the Peak Event impacts for active customers in Level 1 CPP who said they

[24] Over time, customer retention reflects how many customers remain in the Pilot rather than dropping out. The retention rate considers only those customers who actually drop out of the Pilot and excludes those who moved or switched to a competitive supplier, which could have happened for any number of reasons unrelated to the Pilot.

were aware or unaware of the bill protection feature.[25] This analysis did not reveal statistically significant differences in impacts and neither group had consistently higher or lower impacts than the other, supporting the conclusion that bill protection awareness did not influence customers' actions in the Pilot.

Figure E-14. Effect of Bill Protection on Customers' Efforts to Manage Electricity



Source: Navigant analysis of 2016 end of pilot survey (N=229)

Lessons Learned from Program Implementation Staff

National Grid identified lessons learned from the Pilot through meetings with members of National Grid's implementation team. This process captured key learnings, including aspects that worked well and also opportunities identified during Pilot implementation. Lessons learned that are relevant to the customer-facing evaluation in this report were identified in the following areas:

- Advanced Metering Infrastructure (AMI)
- Billing
- Outreach and Education
- Customer Service
- Peak Events
- In-Home Technology Installation

Table E-3 identifies the key success and opportunity in each of these areas. Chapter 5 discusses each of these learnings in more depth.

[25] We examined active customers in Level 1 CPP because this group contained the largest number of customers who answered this question. In this group, there were 71 customers who were aware of bill protection and 101 who were unaware.

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Table E-3. Key Successes and Opportunities Compiled by Program Implementation Staff

Pilot Area	Success	Opportunity
AMI	National Grid found that the opt-out approach to the pilot was instrumental in simplifying the planning, scheduling, communication, and initial technology successes, including the Early Field Trial.	Implementing business process improvements that would streamline and accommodate evolving customer scenarios in AMI deployment and management.
Billing	National Grid was able to successfully support a wide variety of billing scenarios, under both current tariffs and Smart Grid tariffs, using AMI meter data.	Innovative bill design and presentment will allow National Grid to demonstrate the energy and bill savings to the customer.
Outreach and Education	Extensive outreach and education were critical to creating awareness and interest among customers and motivating them to participate actively in the Pilot.	Providing more customized information to help customers maximize savings in light of their specific energy usage characteristics would have supported higher savings and enhanced the customer experience.
Customer Service	Providing access to dedicated support services and the Sustainability Hub allowed customers to receive quick access to information and resolution of issues.	Increasing accessibility of the web portal via a streamlined account creation process would support customers in coming to view online access as a key interface with National Grid.
Peak Events	Optimizing peak event communications by providing and promoting communication options, and customizing peak event characteristics to make participation easier for customers, supported the achievement of higher participation and savings levels in the second year.	Creating greater understanding of the purpose of Peak Events, the ways in which they are determined, and the benefits of in-home technologies in enabling customers to save.
In-Home Technology Installation	The installation and customer education process received positive feedback from customers.	Making the steps of the installation process very clear to customers to reduce the incidence of incomplete and cancelled technology installations.

Source: National Grid

Key Learnings from Smart Energy Solutions

Before and throughout the Pilot, National Grid implemented a “listen, test, learn” approach that is based on “on the ground” conversations and reflections on the Pilot. This feedback, combined with learning, generally leads to continuous improvement in program delivery. National Grid conducted extensive program marketing in the lead up to initiating meter installations, the first phase of the program. These activities included convening a public summit to discuss the proposed program, development of brochures explaining the program, and establishment of the staffed, physical Sustainability Hub within the Pilot program area. National Grid also partnered with local schools to offer Energy Ambassador internships at the Sustainability Hub. Clark University offered annual internships, and Worcester Polytechnic Institute students worked at the Sustainability Hub as part of the Energy Ambassador program they created. Ambassadors host Sustainability Hub tours and attend outreach events to educate customers throughout the community. Presenting the personal side of the Company is the backbone of “listen, test, learn”, and is the inspiration for sending National Grid employees and Ambassadors into the community. It is also the basis for hosting visitors at the Sustainability Hub for the dual purpose of educating customers and listening to their concerns and feedback. The application of the “listen, test, learn” approach throughout the Pilot led to several important changes from the first summer to the second, which were outlined in Figure E-2.

Several broad themes emerged regarding customer response to the Pilot design and implementation.

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Impacts for active customers (17% peak load reduction and 5.4% average load reduction over the two years of the Pilot) met the goals established through Section 85 of the GCA, and the majority of customers were satisfied with the Pilot. Figure E-15 summarizes key learnings from the two years of Smart Energy Solutions.

Figure E-15. Key Learnings from Smart Energy Solutions

Smart Energy Solutions shows the viability of opt-out design.

- The program enrolled ~11,000 participants, which is many more than could have been recruited in an opt-in design.
- The retention rate after two years was 98%, which is higher than many comparable opt-in programs.
- Program satisfaction was strong, with 69% of participants rating the Pilot at least a 5 on a 7-point scale.

It is important to choose the default options in an opt-out program carefully.

- Smart Energy Solutions defaulted customers onto the CPP rate and web portal, with no additional in-home technology.
- Approximately 95% of customers were still on the default price plan and 90% on the default technology level after the two years of the Pilot.
- Although satisfaction was strong, "default bias" is likely to be a factor in customers staying on the default enrollment options in the opt-out design.

Long Peak Events and Peak Events called on consecutive days did not significantly affect savings or satisfaction.

- Despite calling more Peak Events (including on consecutive days) and longer Peak Events than similar programs, Smart Energy Solutions acheived similar satisfaction and savings.
- However, some customers did express a desire for shorter events ending earlier in the evening.

In-home devices increased demand savings, but much of the total savings were acheived with just a web portal.

- Customers with in-home devices had significantly higher demand savings (up to 31%) than those without any technology (up to 15%).
- Customers without technology who visited the program web portal saved approximately twice as much in the second year of the Pilot as those who did not visit the web portal (this may be attributable to differences in motivation as well as to the web portal itself).
- Customers without technology made up 90% of the participants in the Pilot and approximately 70% of the total Peak Event savings.
- Customers with IHDs saved the most energy, followed by those with web portal access only. Those with PCTs had higher demand savings but lower energy savings.

Customers on the CPP rate saved more than those on the PTR rate.

- At each technology level, active customers on the CPP rate saved more than those on the PTR rate.
- Passive customers saved more on the PTR rate, but that could be due to a slightly higher level of engagement since they had to opt in to the PTR rate.
- The motivations to save on the CPP rate are greater than for the PTR rate, as on the CPP rate customers face higher bills if they don't save.

The PTR rate may be more appropriate than the CPP rate for those on fixed budgets or with health issues.

- Although the CPP rate saves money over the course of the year, bills do increase for many customers in the summer, potentially making the PTR rate a better choice for customers on a fixed or limited income.
- Additionally for those who have a limited ability to reduce their energy usage (because of elderly, ill, or limited mobility household members, pets who need cooler temperatures, electric medical equipment, etc.) the PTR rate may be more appropriate.

Information needs to be provided multiple times via multiple channels.

- Despite a plethora of communication from National Grid, half of customers without technology did not know it was available, and of the 40% who knew it was available, many did not understand the benefits.
- Additionally, many customers (56%) did not realize they had the option to switch price plans.
- Based on the focus groups, low-income customers had low awareness of the rates and technologies despite the high potential benefits to this group.

Customers want options to personalize notifications.

- Customers cited issues with the amount and methods of Conservation Day notifications in 2015, and responded well to additional promotion and simplification of personalization options in 2016.

Source: Navigant analysis

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Evaluation Report Structure

This report is organized in the following chapters:

- **Chapter 1: Introduction**, describes the Pilot and summarizes the evaluation focus and objectives;
- **Chapter 2: Smart Energy Solutions Program Design**, summarizes rate design and technology choice, as well as program marketing, participation and segmentation;
- **Chapter 3: Impact Assessment**, summarizes the results of the peak event impact analysis, energy impact analysis, bill savings, and load shifting;
- **Chapter 4: Customer Experience Assessment**, summarizes participation drivers, participant awareness, engagement, and satisfaction;
- **Chapter 5: Lessons Learned from Program Implementation Staff**, discusses key learnings identified by program implementation staff, including aspects that worked well and also opportunities identified during Pilot implementation;
- **Chapter 6: Key Findings and Learnings**, draws everything together to provide key findings;
- **Appendices A through E,** provide detailed methodologies and results; and
- **Appendices F, G, and H** are provided as separate documents, and show graphs of event impacts by hour for residential customers, graphs of event impacts by hour for commercial customers, and graphs of event impacts for residential customers by demographic subgroup, respectively.

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1. INTRODUCTION

Massachusetts Electric Company and Nantucket Electric Company d/b/a/ National Grid's (the Company or National Grid) Smart Energy Solutions Pilot program (the Pilot or Smart Energy Solutions) is an innovative smart grid pilot combining deployment of advanced meters, customer-facing technologies, and time-of-use (TOU) rates. The informational portion of the Pilot began in 2013, rates went live in January 2015, and implementation ran through the end of 2016. National Grid has filed for a two-year extension of the Pilot and the Massachusetts Department of Public Utilities (DPU) has granted an interim extension while they make a final decision. The Pilot also includes advanced distribution grid-side technologies which are the subject of a separate report.[26] This Pilot recruited customers through an opt-out model for residential customers and small businesses across a range of income and other demographic characteristics, providing a case study across a broad population sample. This evaluation, conducted by Navigant Consulting, Inc. (Navigant or the evaluation team), covers customer-side Pilot activities through the end of 2016. Navigant conducted the evaluation of the Pilot in accordance with the *Common Evaluation Framework*[27] produced by the Massachusetts Smart Grid Collaborative Technical Subcommittee (the Collaborative), a stakeholder group convened by the DPU to develop consistent evaluation themes and techniques across smart grid pilot programs in the state.

1.1 Smart Energy Solutions Pilot Description

Smart Energy Solutions was built on two important design principles focused on the customer and the distribution grid, respectively. First, the Pilot provided a new customer experience with regard to electricity delivery in the form of dynamic pricing, load control, and advanced communication interfaces. Second, the Company enhanced grid operations through advanced distribution technologies designed to markedly improve system reliability and operational efficiency. More specifically, Smart Energy Solutions included the following components:

- **Dynamic pricing** including TOU, critical peak pricing (CPP), and peak time rebates (PTR);
- **Advanced customer-side technologies**, including in-home displays (IHDs), programmable communicating thermostats (PCTs or smart thermostats), and other load controlling devices; and,
- **Advanced grid-side technologies**, including advanced communication systems, capacitor controls, and grid automation.

As shown in Figure 1-1, Smart Energy Solutions was deployed in four phases.

Phase 1. **Meter Deployment & Awareness.** In this initial phase the Company raised awareness about and installed advanced metering infrastructure (AMI) meters (also referred to as "smart meters") in approximately 15,000 homes and businesses. Five percent of customers offered AMI meters refused them.

Phase 2. **Introduction of Benefits.** In the second phase the Company introduced Smart Energy Solutions to raise customer awareness and create an expectation of more to come. Customer

[26] National Grid. *Interim Grid-Facing Evaluation Report*, March 31, 2016.

[27] D.P.U. 10-82, Massachusetts Smart Grid Collaborative Technical Subcommittee, *Common Evaluation Framework*, March 23, 2011.

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education efforts continued throughout the Pilot.

Phase 3. **Choice.** In Phase 3 National Grid customers chose between two Pilot rates, a TOU CPP rate and a PTR rate, and four technology packages that offered varying levels of information and control via web portal access, phone app, IHDs, PCTs, direct load control devices, and smart plugs.[28] The Sustainability Hub was also opened during Phase 3 as a resource for customers. The Hub provides hands-on education and engagement through a holistic approach, integrating various advanced technologies into a demonstration home.

Phase 4. **Focus on Customer Control.** Phase 4 began with the rates going live in January 2015. The Company called Conservation Days with specific Peak Event hours (Peak Events) on high-demand days, educated customers about their bills, assisted them in using the tools available to understand and control their energy usage, and allowed them to customize their participation through the many options available in the Pilot.

Based on its experience with the Pilot, the Company has observed the importance of gradual and ongoing customer outreach and education to introduce new concepts and technologies. By introducing demand response and connected devices early on, the hope was that customers would better understand and benefit from incremental savings that could be realized from the introduction of AMI and time-based rates. National Grid has filed for a two-year extension of the Pilot and the DPU has approved an interim extension. Under the interim extension the Pilot will remain in effect until the DPU comes to a final decision. If the proposal for extending the Pilot is approved or if the Company's Grid Modernization Plan is approved, the Company envisions offering Smart Energy Solutions participants the option to receive similar savings and benefits as they have enjoyed to date, in line with what is proposed in the Company's Grid Modernization Plan in D.P.U. 15-120. Otherwise, the Pilot participants will revert to basic rates and will be eligible for the same demand response incentives as other customers in the Company's service territory. Pilot participants who received in-home devices will be able to keep them regardless of the outcome of the extension.

The Company hopes to transition to a more advanced and integrated demand response management system (DRMS) that will be deployed during the Grid Modernization plan period if approved. The functionalities of this enterprise DRMS include the ability to schedule, dispatch, control and conduct evaluation, measurement, and verification of load curtailment demand response events.[29]

[28] Customers also had the option to remain on the Basic Rate, effectively leaving the Pilot, or to leave National Grid by switching to a competitive supplier. As a result, the Pilot contained an "opt-out" element for customers who didn't want TOU/CPP, and an "opt-in" element for customers who chose PTR or any of the technology packages. This design and customer flexibility set the Pilot apart from other utility dynamic rate pilots. Therefore, comparisons to other programs are anecdotal, as direct comparisons do not exist.

[29] National Grid. D.P.U. 15-120. *Grid Modernization Plan at Attachment 8*. August 19, 2015.

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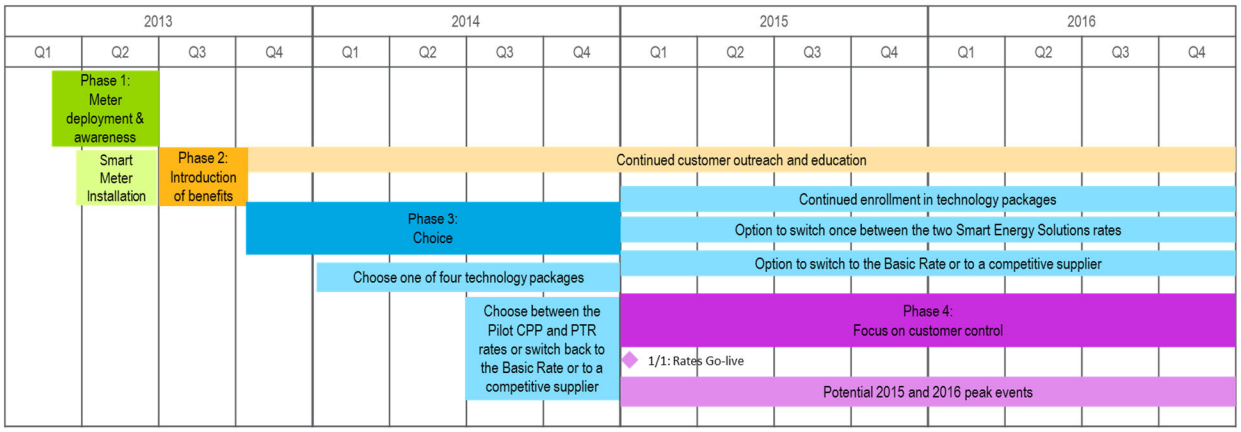
Figure 1-1. Four-Phase Rollout of Smart Energy Solutions



Source: Navigant and National Grid

1.1.1 Consistency with the Green Communities Act

The Pilot design complied with and exceeded the requirements of Section 85 of the Green Communities Act (GCA or the Act) passed in Massachusetts in 2008. The Act mandated that each investor-owned electric utility conduct a smart grid pilot with the overall objective of reducing active participants' peak and average loads by at least 5%. The pilot program must include, at a minimum, the following:

- Deployment of advanced meters that measure and communicate electricity consumption on a real-time basis;
- Automated energy management systems in customers' home and facilities;
- Time of use or hourly pricing for a minimum of 0.25 percent of the company's customers;
- Remote monitoring and control equipment on the Company's electric distribution system; and,
- Advanced technology to operate an integrated grid network communication system in a limited geographical area.

The Company adhered to these GCA principles by:

- Offering an opt-out TOU pricing option to approximately 15,000 customers, who make up more than 0.25% of National Grid's approximately 1.3 million customers;
- Seeking to achieve, for those customers who actively participated in Smart Energy Solutions, peak and average load reductions of at least 5%; and,
- Utilizing advanced technology to operate an integrated grid network communication system in a limited geographic area, including but not limited to:
    - Smart meters that provide real-time measurement and communication of energy consumption;
    - Automated load management systems embedded within current demand-side management programs; and,
    - Remote status detection and operation of distribution system equipment.

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The Massachusetts Department of Public Utilities (DPU) recognized four unique elements of Smart Energy Solutions that differentiate it from other Section 85 pilot programs.[30]

1. The Company ***implemented the customer-facing and grid-facing components of the Pilot within one city***, a portion of Worcester, to allow National Grid to ascertain whether a comprehensive deployment of smart grid technologies produced synergistic customer benefits.
2. The Company ***deployed the program on an opt-out basis***, meaning all eligible customers in the Worcester area were offered an AMI meter and enrolled in Smart Energy Solutions by default but had the option to opt out if they weren't interested. Relative to opt-in programs where eligible customers must actively choose to participate, opt-out programs reach many more customers and thus have higher savings potential.
3. The ***default pricing option for the Pilot was a TOU rate, and the vast majority of Pilot participants remained on this rate***. Additionally, nearly 1,000 customers opted into technology packages which included in-home devices. Having a significant number of customers on a TOU rate with enabling technologies represented a unique opportunity to study these smart grid pilot components across a broad segment of the population.
4. National Grid's ***comprehensive outreach and education campaign combined both traditional and community-based elements***. It was designed to encourage customers to permanently change their energy consumption behavior in response to the price signals and other Pilot messaging. The Pilot also included the creation of the Sustainability Hub which serves as a model energy center in the community where National Grid provides hands-on education and engagement through a holistic approach, integrating various smart elements into a demonstration home.

1.1.2 Definition of Active Customers

In the context of an opt-out pilot, the GCA's goal of reaching 5% savings for "active" customers must be interpreted carefully. Some of the participants in an opt-out pilot will never actively engage with the program components. For evaluation purposes, Navigant defined active participants as anyone who opted into any in-home technologies and anyone with no in-home technology who logged into the Pilot web portal at least once.[31] Customers with no in-home technology who never logged into the web portal were considered "passive" participants in the Pilot. In other words, the passive customers did not take any actions to adopt technologies or check their electricity usage; however, these customers could still take actions to save energy as they were enrolled in the Pilot rates and received notifications for the Peak Events. By this definition, just under 25% of the Pilot participants were active at the end of 2016. This increased from just under 20% at the end of 2015.

1.1.3 Customer Decision-Making and Flexibility

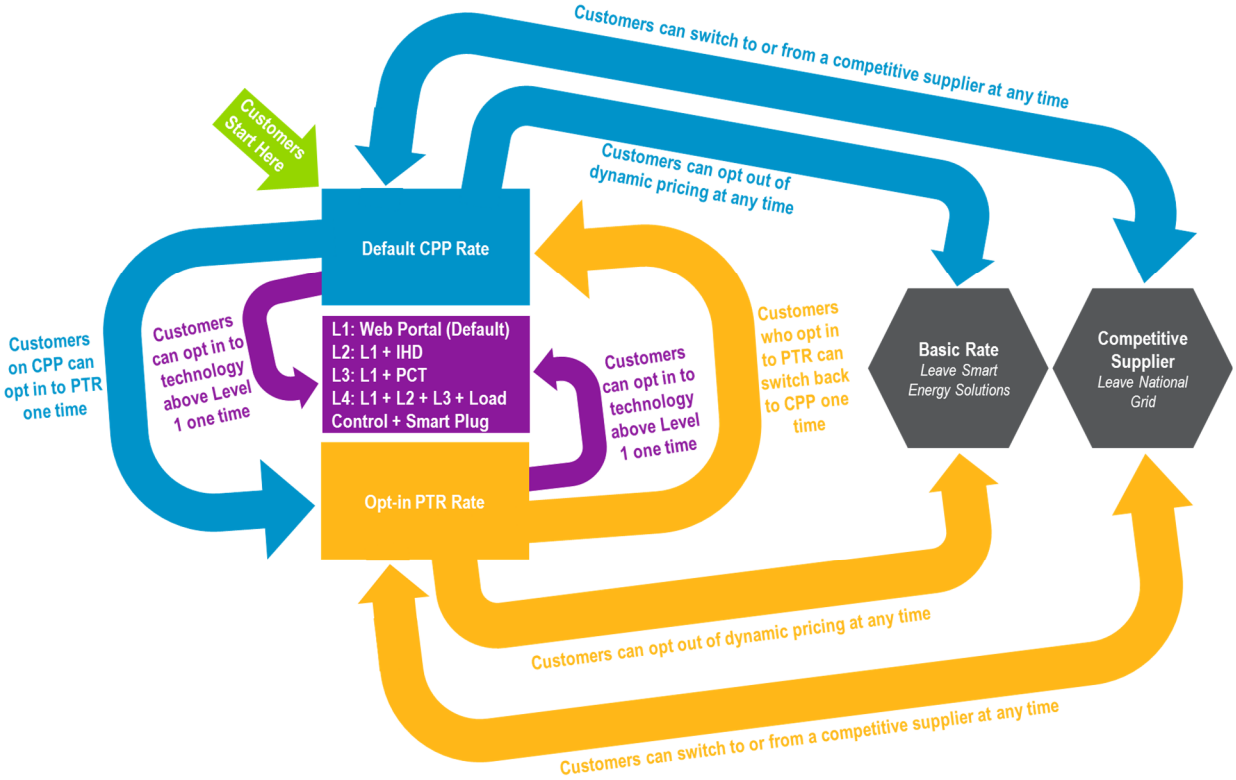
Among smart grid pilots, Smart Energy Solutions was relatively complex with several key decision points

[30] D.P.U. Order 11-129. *Petition of Massachusetts Electric Company and Nantucket Electric Company, each d/b/a National Grid for approval of a smart grid pilot program.* August 3, 2012.

[31] Active customers were defined as of October 12, 2016 which was after the last Peak Event of the 2016 summer season.

for customers, as illustrated in Figure 1-2.

Figure 1-2. Smart Energy Solutions Customer Decision Points



Source: Navigant
Note: L1 = Level 1, L2 = Level 2, L3 = Level 3, L4 = Level 4, IHD = in-home display, PCT = programmable communicating thermostat.

Smart meters and choice of rates. Eligible customers in the Worcester area who accepted a smart meter were enrolled onto the CPP rate by default.[32] Customers had the option to opt into the PTR rate one time during the Pilot; customers who initially opted into the PTR rate could switch back to the CPP rate one time. Customers could also choose to switch back to the Basic Rate, thus opting out of the Pilot, or to switch to and from a competitive supplier, thus leaving or returning to National Grid, at any time. Customers using a competitive supplier effectively left the pilot, thus reducing the program population.

Technology choice. Customers on the CPP and PTR rates also had a choice of four technology packages, with Level 1 (web portal only) as the default. Some of the technology packages had eligibility

[32] Customers also had the option to decline the smart meter and, therefore, opt out of the Pilot at the outset.

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requirements related to internet access and central air conditioning.[33] Technology options became more advanced, offering more electricity usage information and control, from Level 1 to Level 4:

- Level 1: Personal electric use information, via access to a web portal;
- Level 2: Level 1 plus an IHD with energy use and real time cost information and access to this information through the web portal;
- Level 3: Level 1 plus a programmable-controllable thermostat (PCT) and a mobile app to view the PCT schedule; or,
- Level 4: Level 1, Level 2, and Level 3 plus a smart plug and, for some customers, a wired load control device, and additional capability in the mobile app to show load control and smart plug usage.

Conservation Days. According to the approved Pilot design, National Grid could call up to 30 Conservation Days each year on days with expected high demand. High humidity (dew point levels) in combination with high temperatures typically drove customer usage upward and initiated the process of calling a Conservation Day. On these days, the price of electricity increased during designated hours, called Peak Event hours. On the CPP rate, customers were incented to conserve electricity, or shift usage to non-Peak Event hours, and thus avoid paying the high electricity prices during Peak Event hours. On the PTR rate, customers received a rebate for any electricity conserved during these hours.

National Grid used day-ahead ISO New England (ISO-NE) usage data and day-ahead weather forecasts for the City of Worcester to project whether to call a Conservation Day for customers in the Pilot. The ISO-NE usage forecast was adjusted based on the Worcester weather forecast and an event was proposed if a specific MW threshold[34] was met or exceeded for the next day. The suggested number of Peak Event hours (including start and end time) and the thermostat override temperature were then sent for Director approval. If approved, the event was scheduled through the CEIVA Entryway system and notifications were made to all customers the day before the event through the customer's preferred communication methods (email, SMS text message, and/or phone call). Customers who opted into day-of notification were also notified on the day of the Peak Event.

National Grid called twenty Peak Events in each summer of the Pilot (2015 and 2016). Events ranged from four to eight hours in length and maximum temperature and relative humidity ranged from 79°F to 92°F and 67% to 100%, respectively. The Peak Events averaged 6.75 hours in length and totaled 135 hours in 2015. Events were slightly longer in 2016, averaging 6.95 hours in length and totaling 139 hours. Nine of the Peak Events in 2015 and 10 in 2016 ran for the maximum length of eight hours. Seventeen of the 20 events in 2015 and 16 of the 20 events in 2016 were part of a back-to-back series, when events occurred multiple days in a row. The length of the event and weather are shown for each Peak Event in Figure 1-3.

[33] For example, in order to be eligible for the Level 2 package with a digital picture frame, customers had to have a high-speed broadband Internet connection. To be eligible for Level 3 with a PCT, customers had to have central air conditioning. To be eligible for Level 4 with a PCT and a smart plug and/or load control device, customers had to have central air conditioning and a high-speed broadband Internet connection.

[34] As of the writing of this report, the threshold was 22,315 MW.

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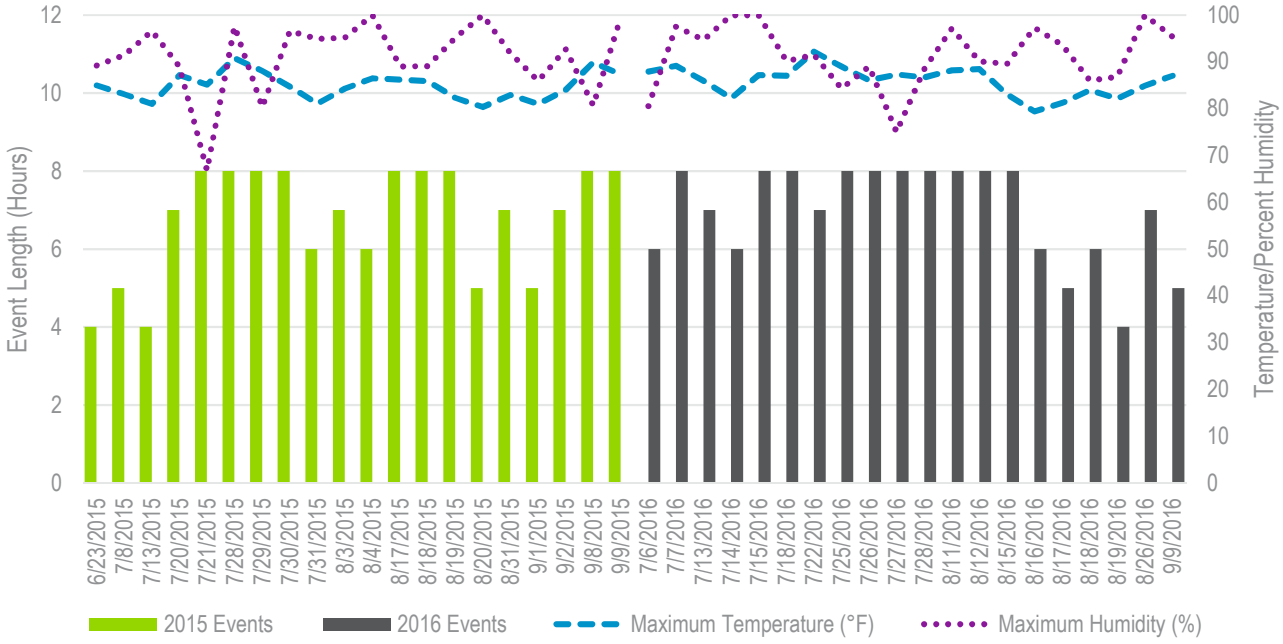
Figure 1-3. Summary of Peak Event Length, Temperature, and Humidity

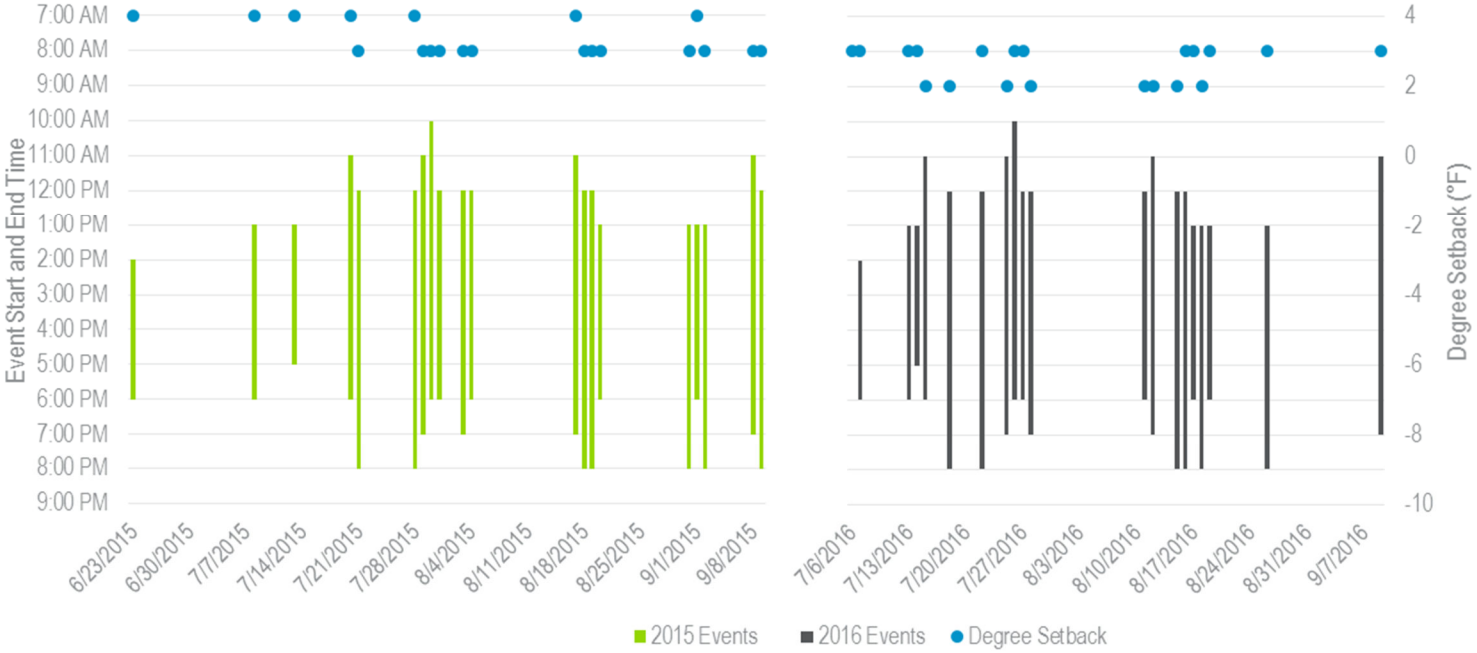


Source: Navigant analysis

The weather was relatively similar across the two summers of the Pilot. The average Conservation Day temperature was 75°F in 2015 and 76°F in 2016. Similarly, the average maximum temperature on Conservation Days was one degree hotter in 2016 than 2015, going from 85°F to 86°F. The Conservation Day humidity was also similar, averaging 67% in 2015 and 65% in 2016 and achieving average maximums of 91% in each year.

Compared to 2015, the Peak Event start and end times were more varied in 2016, especially on days of back-to-back Peak Events as shown in Figure 1-4. Additionally, the degree setbacks for the customers with PCTs were lower in 2016 than in 2015. In 2015 degree setbacks were 3 or 4°F, averaging 3.4°F, and in 2016 degree setbacks were 2 or 3°F, averaging 2.6°F. These changes were made in response to customer feedback at the end of the 2015 Peak Event season.

Figure 1-4. Summary of Peak Event Start and End Times and Degree Setback



Source: Navigant analysis

1.1.4 Community Partnership and Sustainability Hub

To ensure that the Pilot was a collaborative effort with the community, National Grid partnered with the City of Worcester to host the September 2011 Green2Growth Summit (Summit). The Summit provided valuable insights into customers' visions regarding the future of energy delivery in their city. National Grid learned that its customers are increasingly aware of new opportunities to manage their energy consumption and are open to learning more about the potential uses and benefits of smart technology. Based on information gathered through the Summit, the Company revised the Pilot's Outreach & Education plan, implemented in Phases 2-4 of Figure 1-1.

As an additional means of engaging customers, based on information gathered through the Summit, the Company developed a Sustainability Hub in Worcester (Figure 1-5). The Sustainability Hub serves as a model energy center in the community where National Grid provides hands-on education and engagement through a holistic approach, integrating various smart elements into a demonstration home. At the end of 2016, over 8,200 people have visited the Sustainability Hub since it opened, and it has been mentioned by many customers as a useful source of information alongside direct mail, the Smart Energy Solutions website, and National Grid's Customer Contact Center.[35] A survey administered by the Sustainability Hub also found that customers ranked the Hub highly as a source of information (see APPENDIX C).

[35] As of January 3, 2017.

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Figure 1-5. National Grid Sustainability Hub

Source: National Grid

1.1.5 Statewide Common Evaluation Framework

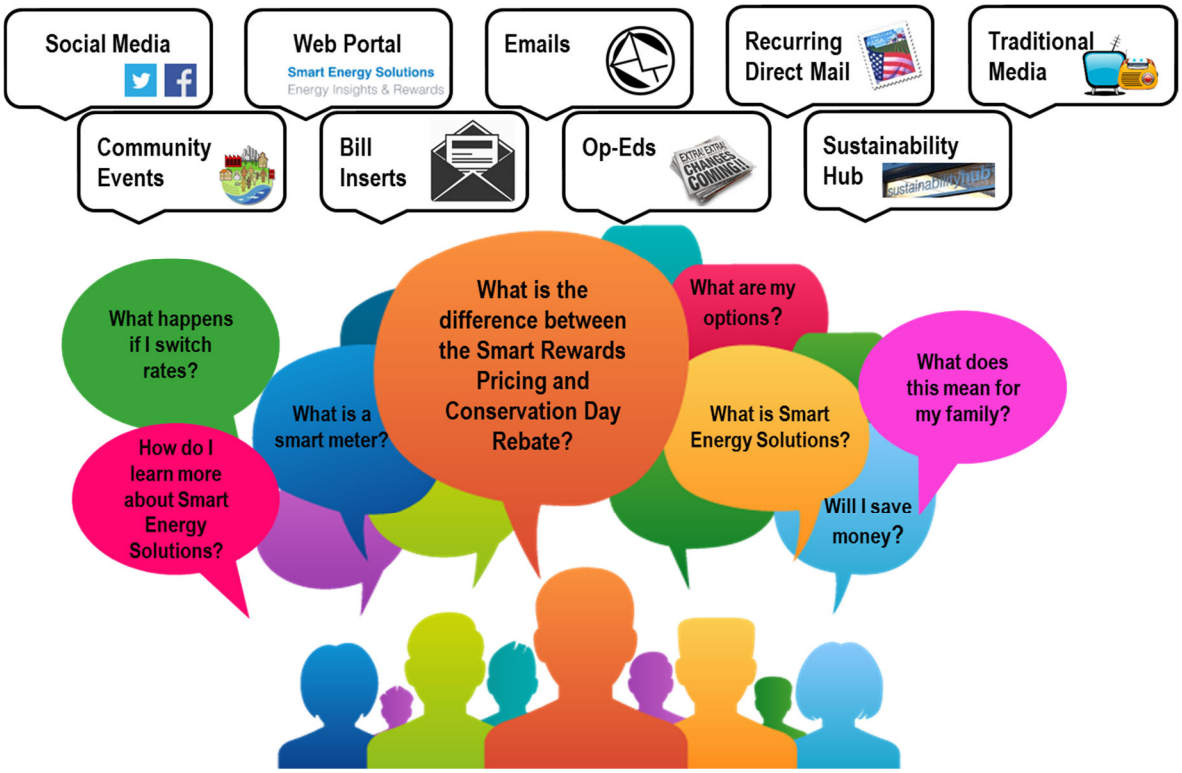
Navigant conducted the evaluation of the Pilot in accordance with the *Common Evaluation Framework*[36] produced by the Massachusetts Smart Grid Collaborative Technical Subcommittee (the Collaborative), a stakeholder group convened by the DPU to develop consistent evaluation themes and techniques across smart grid pilot programs in the state. The evaluation included quantitative measures of energy, demand, and customer bill impacts, as well as qualitative measures for customer engagement, satisfaction, and perceptions through customer surveys, interviews, and focus groups.

1.2 Evaluation Focus and Objectives

Smart Energy Solutions focused on understanding the customer experience with dynamic rates and advanced technologies. As shown in Figure 1-6, National Grid had multiple communications channels to provide customers with information about the program and the rates and technologies available. This evaluation focused on customer awareness of smart meters, rates, and technologies; the choices customers made to adopt and use smart meters, rates, and technologies; and the savings that resulted from the use of each technology.

[36] D.P.U. 10-82, Massachusetts Smart Grid Collaborative Technical Subcommittee, *Common Evaluation Framework*, March 23, 2011.

Figure 1-6. National Grid's Multiple Program Communication Channels with Customers



Source: Navigant analysis

1.2.1 Impact Evaluation Objectives and Approach

The primary focus of the impact evaluation was on whether the expected energy and demand savings were realized. In particular, the impact evaluation estimated the following:

1. **Peak Event Impacts,** which are demand savings (MW) during Peak Events called in the summers of 2015 and 2016;
2. **Energy Impacts,** which are energy savings (MWh) from the Pilot in 2015 and 2016; [37]
3. **Bill Impacts,** which are dollar savings on customer bills in 2015 and 2016; and,
4. **Load Shifting** around Peak Events, including snapback and pre-cooling, and from peak to off-peak times in 2015 and 2016.

Each of these objectives is explored for customers in different price plans with different levels of enabling technology. Where possible, Navigant also explored these impacts for different demographic subgroups. The impact findings in this report are primarily focused on residential customers. Commercial customers were a very small portion of the Pilot participants and outcomes were explored for them to the extent possible based on the constraints of the small sample. Short descriptions of each methodology are

[37] To a lesser extent, Navigant also examined savings from 2014 when the informational portion of the Pilot was in effect but the Pilot pricing had not yet gone into effect.

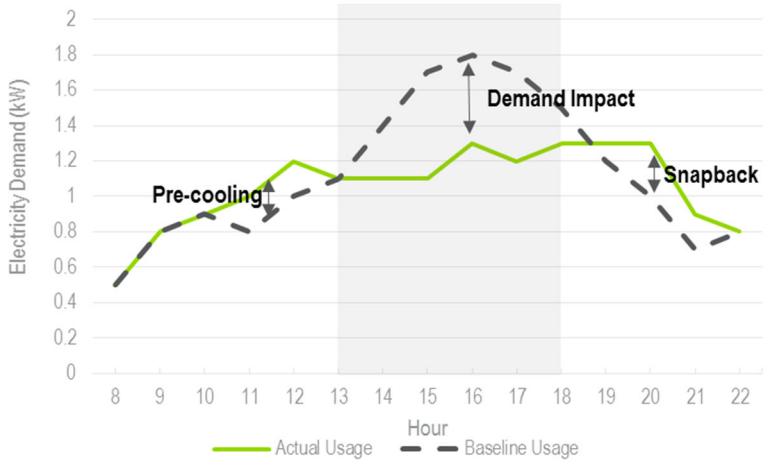
presented here and detailed explanations are included in APPENDIX A.

Peak Event Impacts

Navigant estimated demand savings during each Peak Event by regression to predict fitted usage from 8 a.m. to 10 p.m. on each Conservation Day controlling for temperature, humidity, day of the week, month, and a customer fixed effect that controlled for all observed and unobserved customer-specific variables that do not change through time.[38] 2014 was used as the pre-program baseline for each year with Peak Events. Demand savings were then determined as follows:

1. Fitted usage is the model's prediction of what usage would have been in the absence of a Peak Event, and forms the baseline or "counter-factual" usage.
2. The regression coefficient which estimated the demand savings in each hour of each Peak Event is the same as subtracting actual usage from the fitted baseline for each hour of the Peak Event.[39] The possibility of pre-cooling and snapback were also accounted for in this process, which is illustrated in Figure 1-7.

Figure 1-7. Illustration of Hypothetical Demand Impacts for an Event from 1 p.m. to 6 p.m.



Source: Navigant

[38] Navigant's method to determine Peak Event savings differed from the method National Grid used internally. National Grid calculated reduced usage as the difference between metered usage during the Event and "normal" usage, defined as average usage during the ten prior non-holiday, non-Conservation Day weekdays after accounting for a day of adjustment to capture weather differences, time of event, pre-cooling, etc. Details of National Grid's method can be found in: D.P.U. No. 1237, Tariff for Basic Service, September 3, 2014. Both of these methods are consistent with MA evaluation protocols and are intended for different purposes. National Grid's method is intended to produce faster feedback on the program results in support of monthly customer billing, whereas Navigant's method uses more data over a longer time horizon to allow for the most robust estimate of savings for the Pilot as a whole, making it more appropriate for post hoc evaluation.

[39] In 2015, a day-of adjustment was used to make fitted usage a more accurate approximation for the actual usage that would have occurred if a Conservation Day had not been called by National Grid. For this adjustment, actual usage was subtracted from fitted usage for each Conservation Day for the time from 8 a.m. until the start of the Peak Event. This day-of adjustment was dropped in 2016 to simplify the calculation of standard errors. The adjustment was very small and did not make a statistically significant difference in program peak savings impacts.

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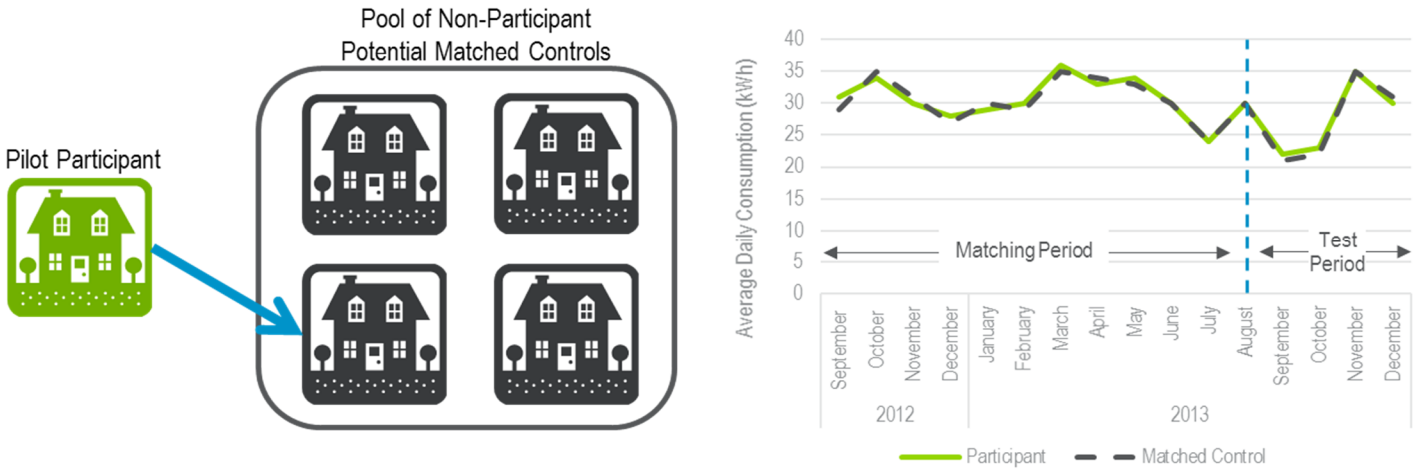
Energy Impacts

In order to calculate energy impacts, the evaluation team selected a group of matched control customers from a large pool of non-participant households. Participants were matched by identifying a non-participant that had energy usage similar to that of each participant over a 12-month period before the Pilot started to provide the counter-factual usage if the participants had not been in the Pilot.[40] The 12-month matching period went from September 2012 to August 2013, leaving a 4-month test period from September 2013 to December 2013 to ensure that the matches were performing well (i.e., continued to have usage similar to the participants) outside of the matching period but before the program started. This matching process is illustrated in Figure 1-8. Regression analysis of monthly billing data using the participants and matched controls was then used to estimate the annual reduction in energy usage for 2014 and the reduction by month in 2015 and 2016.

Figure 1-8. Hypothetical Illustration of Choosing Matched Control Households with Similar Pre-Pilot Energy Usage



Source: Navigant

Bill Impacts

Bill savings for customers on the CPP rate were calculated by subtracting the actual participant bill amount from the counter-factual bill amount if the participant had not joined the program. The counter-factual bill amount was based on the counter-factual usage estimated by the energy impact analysis.

Bill savings for customers on the PTR rate came from the rebates paid by National Grid for reducing peak consumption during Peak Events on Conservation Days. National Grid calculated reduced peak consumption as the difference between metered usage during the Peak Event and "normal" usage, defined as average usage during the ten prior non-holiday, non-Conservation Day weekdays after accounting for a day-of adjustment to capture weather differences, time of event, pre-cooling, etc. The reduction was multiplied by the cost of the rebate to determine the rebate due to the customer.[41]

[40] To avoid the issue of control customers moving out, only controls who had billing data through the end of 2016 were used.

[41] Details can be found in: D.P.U. No. 1237, Tariff for Basic Service, September 3, 2014.

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Load Shifting

The regressions to estimate demand savings also included coefficients to capture load shifting attributable to the Pilot. Navigant captured load shifting on the same day as a Peak Event by estimating pre-cooling and snapback. Load shifting from weekdays, when TOU rates were in effect for CPP customers, to weekends, when customers were charged a flat rate, was also estimated. Navigant also examined whether the Pilot caused non-event peak impacts where customers shift loads from on-peak to off-peak times on days when a Peak Event was not called. Load shifting to the weekend and non-event peak impacts are expected for TOU customers, but not necessarily for PTR customers since these customers were not charged a higher peak time rate which would incent them to shift usage to off-peak times or weekends.

1.2.2 Customer Experience Evaluation Objectives and Approach

The primary focus of the customer experience evaluation was on customer engagement and experience. The Smart Energy Solutions evaluation plan was developed by an independent consultant in accord with the *Common Evaluation Framework*[42] produced by the Collaborative, a stakeholder group convened by the DPU to develop consistent evaluation themes and techniques across the three smart grid pilot programs in Massachusetts. The Collaborative recognized that each program had some unique characteristics, particularly the National Grid opt-out program design, so the framework was made broad enough to accommodate different program designs but still provide comparable data from each. The Collaborative included National Grid and other participating investor-owned utilities, the Low-income Energy Action Network (LEAN), the Massachusetts Attorney General, and the Energy Efficiency Advisory Council (EEAC) chief evaluation consultant. As part of the *Common Evaluation Framework*, the Collaborative developed a base set of required surveys, reporting requirements, protocols, and reporting tables.

The Collaborative raised a number of key research questions related to customer experience in the Pilot. These research questions focused on marketing and education. As Smart Energy Solutions was an opt-out program, wherein customers could opt out of the smart meter and opt out of the default time-based rate, the evaluation team applied the *Common Evaluation Framework* marketing questions that apply to meter installations, rate selection, and adoption of the program's technology offerings. Additionally, the framework applies to marketing means and messages used for recruiting and their effects, results of multiple recruiting waves and techniques, how participants learned of the program, and their reasons for participation or nonparticipation; these topics were not particularly applicable to the Pilot due to its opt-out nature.[43] To address the framework topics, extensive surveying was conducted over the two years of the Pilot (Figure 1-9).[44] The evaluation also included convening focus groups for low-income participants in both years and interviewing commercial participants to gain additional insights to supplement the surveys. In total, the surveys, focus groups, and interviews achieved approximately 4,800 completes.

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[42] D.P.U. 10-82, Massachusetts Smart Grid Collaborative Technical Subcommittee, *Common Evaluation Framework*, March 23, 2011.

[43] Survey findings regarding motivations driving customer participation in the Pilot are included in Section 4.1, and mechanism for how customers heard about the Pilot are included in APPENDIX C.

[44] The surveys were designed by Navigant and implemented by Bellomy Research, a professional survey company, at several key points in the program. All surveys, excepting the pre-pilot survey, were conducted online, using email to invite participants to survey links. Online responses were supplemented by telephone contacts, using both inbound (participants called in) and outbound techniques, to ensure a broader sample of survey participants.

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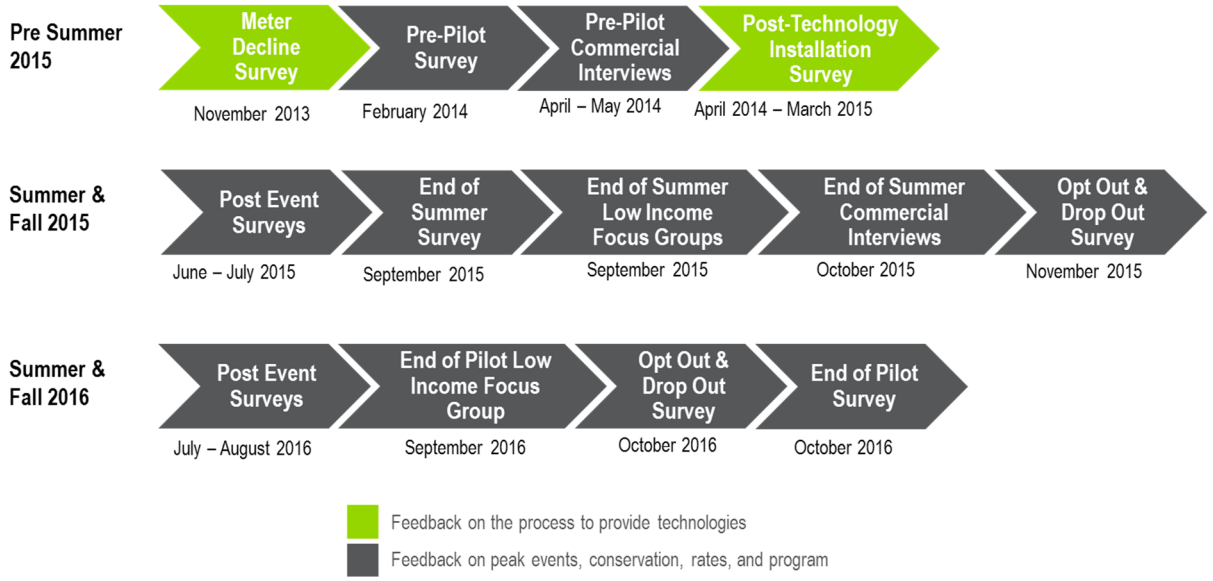
Figure 1-9. Smart Energy Solutions Surveys, Interviews, and Focus Groups



Source: Navigant analysis

Below is a description of the activities depicted in Figure 1-9 and the elements of the customer experience they sought to capture.

- **Meter decline survey:** Determine why customers declined a smart meter and whether they were aware that not installing one would preclude them from participating in Smart Energy Solutions.
- **Pre-pilot survey:** Characterize participant demographics, appliance saturations, and living conditions that might impact participants' ability to adjust their energy usage during regular peak hours (8 am to 8 pm) and Peak Event hours, such as household members who require air conditioning or special medical equipment that must operate during Peak Events.
- **Pre-pilot commercial interviews:** Through five interviews in 2014, anecdotally characterize commercial customer understanding of the program, rates, and knowledge and acceptance of program technologies, as well as their ability to adjust their energy usage during Peak Events.
- **Post installation survey:** Evaluate the experiences of customers who signed up for technology Level 2, 3, or 4 (refer to Section 2.2 for more detail on the technology levels), which provided no-cost in-home installation of an IHD, smart thermostat, and smart plug and load control device, respectively. This survey asked about the promptness and quality of the installation, problems encountered, the conduct of installers, and related issues.
- **Post event surveys:** These surveys were conducted within a one to ten day period after two of the 20 Peak Events called during each summer to learn about the methods and efficacy of National Grid's pre-event information, energy-related actions taken by the customer before and during the event, comfort levels during the event, satisfaction with program technology, and overall satisfaction with the program.
- **2015 end of summer survey:** After the last Peak Event called during the summer of 2015, this survey aimed to understand customer experiences with the program over the course of the summer, including how they coped with multi-day events, events lasting several hours, changes in household patterns resulting from the events, and how well technology performed and how

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useful it was. The survey also looked for trends or changes in these areas over the course of the summer.

- **2015 end of summer low-income focus groups:** Navigant hosted two low-income focus groups at the end of the 2015 summer – one for Level 1 customers and one for Level 2 customers – to gauge their understanding of the program and rates, experiences with the program over the course of the summer, technology use (for Level 2 customers only), and recommendations to improve the program.
- **2015 end of summer commercial interviews:** Through four interviews in 2015, anecdotally characterize commercial customer understanding of the program, rates, and technologies, assess their experiences with the program over the course of the summer, and collect their recommendations to improve the program.
- **Opt-out and drop out surveys:** Ascertain customer perceptions and motivations for moving from one rate to the other and/or dropping out of the program altogether. There were very few participants who took either of those actions during the Pilot. Customers who switched to competitive suppliers, and therefore are no longer National Grid supply customers, were not surveyed.
- **2016 end of pilot survey:** After the last Peak Event called in the two-year Pilot, this survey aimed to understand customer experiences with the program over the course of the entire Pilot, including many of the same themes from the 2015 end of summer survey. This survey also asked about knowledge of and response to bill protection and how customers changed their behavior from the first summer to the second. Additionally, the survey looked for trends and changes over the course of the Pilot.
- **2016 end of pilot low-income focus group:** Navigant hosted one low-income focus group at the end of the Pilot for customers with and without technology. The topics were similar to those covered in the focus groups at the end of the 2015 summer.

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2. SMART ENERGY SOLUTIONS PROGRAM DESIGN

Smart Energy Solutions offered customers a choice between two new dynamic rates and four technology packages that provided electricity usage information and control. The technology packages offered varying levels of information and control via a web portal, mobile app, IHD, PCT, smart plug, and direct load control device. Starting in the spring of 2014, customers began selecting their rate plan and technology package. To support customer choice, the Pilot allowed customer to change rates one time and technology package enrollment any time.

The three key elements of this chapter are:

1. **Rate Design –** the dynamic rate that applies to Pilot participants, depending on whether they accepted the default CPP rate or opted into the PTR rate.
2. **Technology Choice –** the set of in-home and communications technologies selected by participants and provided by National Grid to provide customers with pricing and usage information, conservation tips, and the ability to better control their energy consumption.
3. **Program Marketing, Participation, and Segmentation –** the self-selection of customers into the various rate and technology categories, the strategy used to recruit customers into the different rates and technologies, and the demographic breakdown of the eligible customer population.

2.1 Rate Design

Smart Energy Solutions offered two dynamic rate designs: 1) a TOU rate combined with CPP and 2) a PTR rate. Participating customers had the opportunity to save money on both rates, but CPP customers could potentially incur higher bills if they did not reduce consumption during higher priced periods. These rates went live at beginning of 2015 and remained active through December 2016.[45] As discussed in Section 1.1, customers could leave the Pilot at any point by opting out of the dynamic rates or switching to a competitive electricity supplier, and they could switch between the two Pilot rates once.[46]

According to the Pilot design, National Grid could call up to 30 high demand days per year, called Conservation Days (Figure 2-1). Customers chose the frequency and method of Conservation Day notification. Everyone was notified of Conservation Days one day ahead and they could choose to be notified on the day of the event as well. The price of electricity increased during designated hours, called Peak Event hours, on these days. The length of the Peak Event varied across the Conservation Days. On the CPP rate, customers paid reduced rates outside of Peak Event hours and were incented to conserve electricity to avoid paying high electricity prices during Peak Events. On the PTR rate, customers received a rebate for conserving electricity during these hours.

[45] The rates continue in 2017 under the interim extension of Smart Energy Solutions granted by the DPU.

[46] Customers who left National Grid for a competitive supplier received a letter from National Grid informing them that they could no longer participate in Smart Energy Solutions because they were no longer a National Grid customer. Customers could of course return to National Grid, and if they did so they received a letter informing them that they would be re-enrolled in the Pilot on the default CPP rate.

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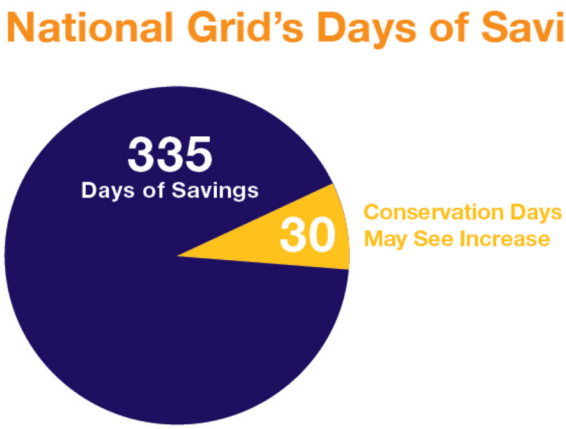
Figure 2-1. Smart Energy Solutions Conservation Days

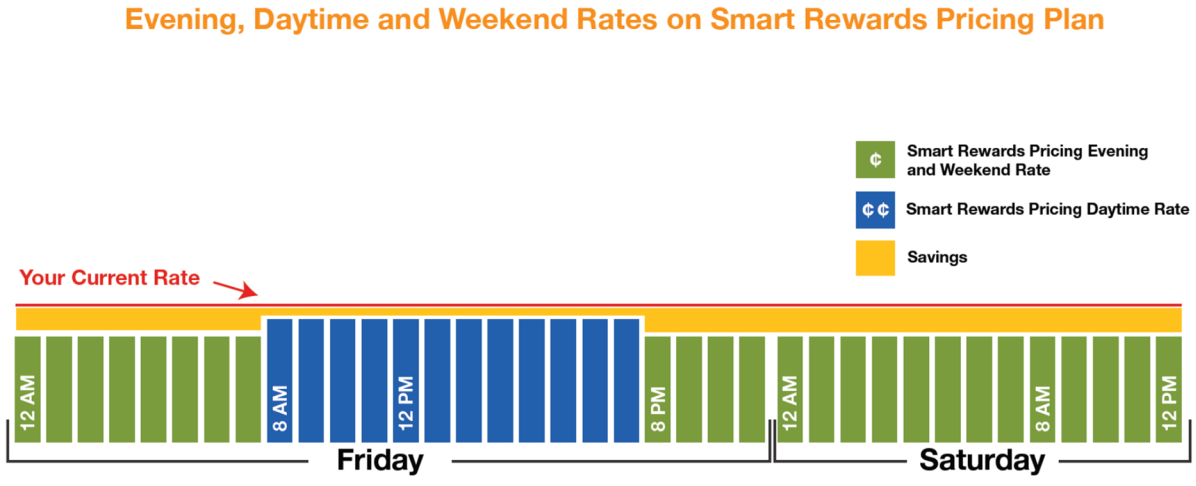


Source: National Grid

2.1.1 Critical Peak Pricing

The Pilot CPP rate combined a daytime TOU rate and a critical peak rate during Peak Event hours. The Pilot CPP rate offered a base TOU structure with lower daytime rates and even lower night, holiday, and weekend rates. Customers were encouraged to shift energy-intensive weekday activities to any time before 8:00 a.m., after 8:00 p.m., or to weekends. As shown in Figure 2-2, customers paid a lower rate than the current Basic Rate every day of the year. The TOU Evening and Weekend rate was in effect all day on weekends and holidays, and every weekday from 8:00 p.m. to 8:00 a.m. From 8:00 a.m. to 8:00 p.m. on weekdays, customers paid a slightly higher rate, called the Daytime Rate.

Figure 2-2. TOU for Evening, Daytime, and Weekend Rates

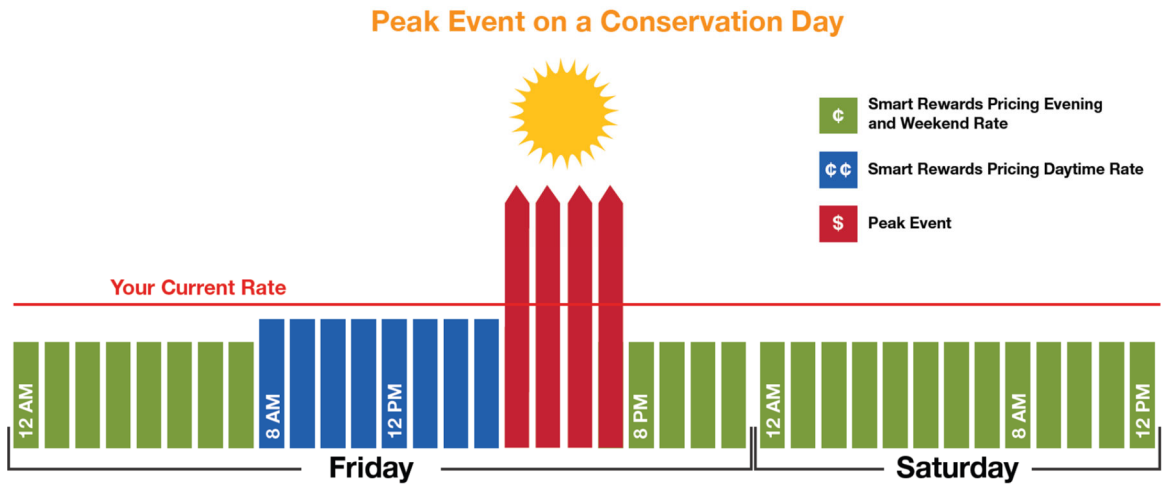


Source: National Grid
Note: "Your Current Rate" refers to the Basic Rate customers were on before the start of Smart Energy Solutions.

In addition to the TOU rate in effect every day, National Grid called Conservation Days where a higher rate was charged during certain Peak Event hours. An example of these hours and the associated CPP

prices is shown in red in Figure 2-3. These customers were eligible for bill protection if they stayed on the CPP rate for at least 12 consecutive months; this meant that if at the end of the year their bills were higher than they would have been on the Basic Rate, the customer received a credit in the amount of the difference.

Figure 2-3. Critical Peak Pricing During a Conservation Day Peak Event



Source: National Grid
Note: "Your Current Rate" refers to the Basic Rate customers were on before the start of Smart Energy Solutions.

2.1.2 Peak Time Rebate

The PTR rate allowed customers to stay on their current service rate, rather than switching to the CPP rate, and earn a rebate when they reduced consumption below their normal use during Peak Event hours on Conservation Days. The rebate was given to customers in the form of a monthly credit applied at the end of each billing cycle, which was the cumulative rebate for all of the Peak Events that occurred during that billing cycle.

The rebate was based on a per-kWh credit that applied to any reduced energy usage during Peak Event hours. National Grid calculated reduced usage as the difference between metered usage during the Event and "normal" usage, defined as average usage during the ten prior non-holiday, non-Conservation Day weekdays after accounting for a day-of adjustment to capture weather differences, time of event, pre-cooling, etc.[47] Customers were not penalized for usage which was higher than normal.

2.2 Technology Choice

The core components of National Grid's smart technology end-to-end solution were advanced metering infrastructure (AMI), in-home energy management devices, two-way communications systems, cloud computing, National Grid system modifications and data processing, and distribution grid communication and standards. These components directly supported the customer-facing portion of Smart Energy Solutions. National Grid offered Smart Energy Solutions customers an assortment of in-home energy

[47] D.P.U. No. 1237, Tariff for Basic Service, September 3, 2014.

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management tools and technologies for free. Customers could sign up on the National Grid website, by mail, by calling National Grid, in person at the Sustainability Hub, or at any of the community events that National Grid attended with a Smart Energy Solutions information booth. As discussed in Section 1.1, National Grid allowed customers to select from these technologies throughout the Pilot in order to maximize customer choice and provide opportunities for new customers who moved into the Pilot area to sign up.

The technologies provided by National Grid included both a foundational infrastructure and several optional in-home devices:

1. **Foundational Infrastructure -** consisted of smart meters and access to a web portal with electricity usage information via desktop computer or mobile device. This foundational infrastructure was provided to all participants, even those passive participants who accepted a smart meter but otherwise did not actively participate in the Pilot.
2. **In-Home Devices –** consisted of any of three additional levels of devices including a communicating digital picture frame or in-home display (IHD) (Level 2), a Wi-Fi-enabled smart thermostat, or programmable communicating thermostat (PCT) (Level 3), and smart plugs and load control devices (Level 4).

2.2.1 Foundational Infrastructure

To enable Smart Energy Solutions, National Grid installed two-way AMI communications and smart meters, developed cloud computing capabilities, and, on an ongoing basis, offered customers a variety of in-home devices (further detailed in Section 2.2.2). AMI communications consist of a meter headend, wireless mesh network and cellular backhaul, and a network manager, which is integrated with the Company's software as a service (SaaS) systems. As a result, National Grid can provide real-time interconnection for customers to control their smart thermostats remotely and monitor their electricity usage from any online or mobile device, anytime and anywhere. The two-way communication infrastructure is also being used to enable the Pilot's distribution automation equipment, which supports reliability and efficiency gains and can facilitate distributed energy resources and electric vehicle charging station integration.

National Grid offered four technology packages, or levels, for customers to choose from. Pilot participants were automatically enrolled in Level 1 and had the option to opt into one of the three higher technology levels with in-home devices. Customers who opted in to a higher level still had access to Level 1.

In Level 1, illustrated in Figure 2-4, customers had access to their electricity usage information via the Smart Energy Solutions web portal that is accessible by desktop and mobile devices, which provided personalized online graphical electric usage information, comparisons to friends and neighbors, and the opportunity to participate in contests to win prizes for conserving electricity.[48] In 2016, the web portal also included a rewards platform which allowed customers to earn points for saving energy and engaging with the program. Points could be redeemed for gift cards at national and local retailers.

[48] Logging into this web portal at least once distinguished active customers from passive customers in Level 1.

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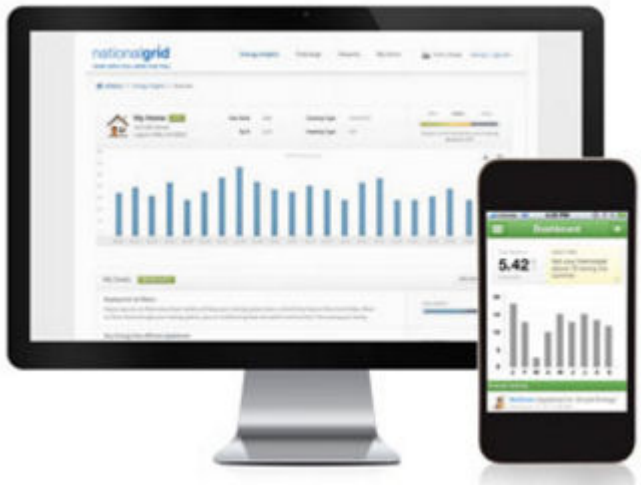
Figure 2-4. Level 1: Web Portal (Accessible by Desktop and Mobile Device)



Source: National Grid

2.2.2 In-Home Devices

Figure 2-5 shows Level 2, which provided a digital picture frame—also called an IHD—that provides real-time energy usage and cost information as well as conservation tips from National Grid.

Figure 2-5. Level 2: Web Portal, Mobile App, and Digital Picture Frame

Source: National Grid

Interested customers with central air conditioning (CAC) qualified for Level 3, which included a smart thermostat, also called a PCT, which can be remotely controlled by National Grid (Figure 2-6). The PCT allowed these customers, if they so chose, to "set it and forget it" on Conservation Days, ensuring their participation in a Peak Event. Customers with a smart thermostat also had the option to opt out of a Peak

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Event before it started, maintaining the set temperature of their thermostat, or to override the utility setback temperature at any time during a Peak Event.

Figure 2-6. Level 3: Web Portal, Mobile App, and Smart Thermostat

Source: National Grid

Lastly, customers could opt to install all of the aforementioned devices along with smart plugs and load control devices in their home through Level 4 (Figure 2-7). The smart plugs allow customers to remotely adjust any appliance plugged into them, such as a window unit air conditioner. The load control devices, installed for only some customers in Level 4, work with devices such as water heaters and/or pool pumps.

Figure 2-7. Level 4: Web Portal, Mobile App, Digital Picture Frame, Smart Thermostat, Smart Plug, and Load Control Devices

Source: National Grid

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2.3 Program Marketing, Participation, and Segmentation

Before and throughout the Pilot, National Grid implemented a "listen, test, learn" approach that is based on "on the ground" conversations and reflections on the Pilot. This feedback, combined with learning, leads to continual improvement. National Grid conducted extensive program marketing in the lead up to initiating meter installations, the first phase of the program. These activities included convening a public summit to discuss the proposed program, development of brochures explaining the program, and establishment of the staffed, physical Sustainability Hub within the Pilot program area. National Grid also partnered with local schools. Clark University offered annual internships, and Worcester Polytechnic Institute created a student Sustainability Ambassador program. Ambassadors host Sustainability Hub tours and attend outreach events to educate customers throughout the community. Presenting the personal side of the Company is part of the "listen, test, learn" approach, and is the inspiration for sending National Grid employees and Ambassadors into the community. It is also the basis for hosting visitors at the Sustainability Hub for the dual purpose of educating customers and listening to their concerns and feedback.

As the program progressed, additional materials were developed and disseminated, including descriptions of the technology levels, rates, and events; welcome kits; and so on. National Grid conducted extensive recruiting campaigns for the program technology options, including a variety of incentives and promotions, but found participant response in 2014 to be somewhat less than expected resulting in an extended signup period that extended throughout the Pilot.[49]

2.3.1 Technology and Rate Enrollment

Table 2-1 shows the distribution of customers in the various technology levels as of January 1, 2017. At that time, approximately 91% of Pilot participants were subscribed to Level 1, followed by 6% of participants in Level 2, 2% of participants in Level 4, and only 0.3% of participants in Level 3. Approximately 95% stayed on the default CPP rate.

Table 2-1. Customer Enrollment by Technology Level and Price Plan (as of January 1, 2017)

Level	Price Plan	Number of Residential Customers	Number of Commercial Customers
1 (AMI meter + web portal + mobile app)	CPP - Active	1,456	26
	CPP - Passive	7,459	456
	PTR - Active	92	1
	PTR - Passive	338	18
2 (Level 1 + digital picture frame)	CPP	640	1
	PTR	32	0
3 (Level 1 + smart thermostat)	CPP	28	0
	PTR	4	0
4 (Level 1 + Level 2 + Level 3 + load control devices)	CPP	237	0
	PTR	15	2
Total		**10,301**	**504**

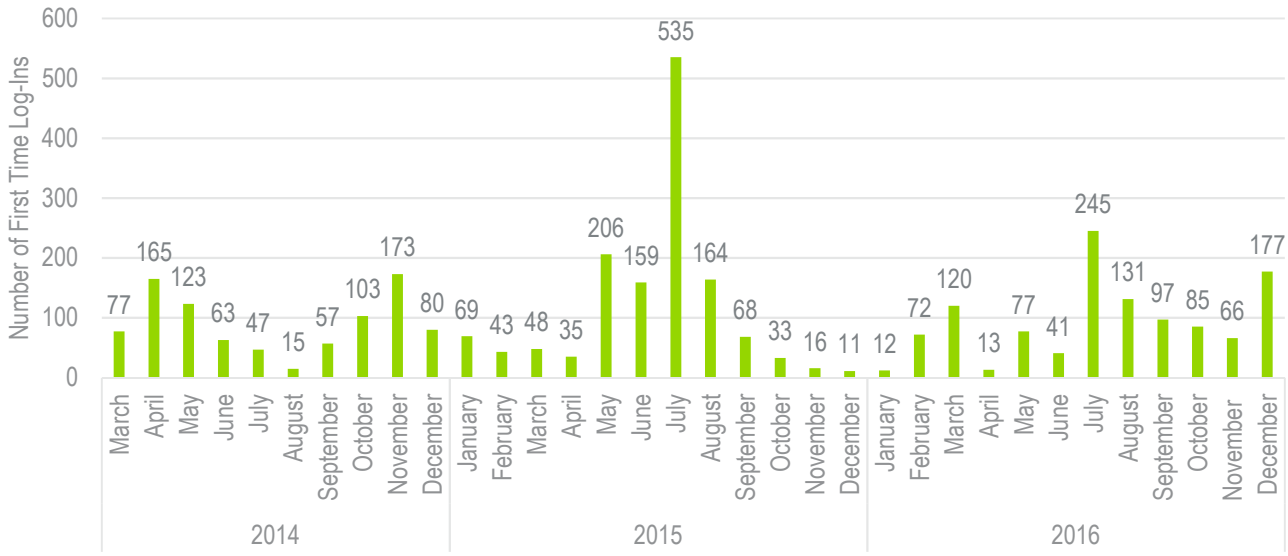
Source: Navigant analysis
Note: The active/passive status of Level 1 customers was determined as of October 12,2016 which was after the final event of the 2016 summer season.

[49] Although active promotion ended in 2015, Pilot customers were able to enroll in the technology packages through the end of 2016 if they wished to do so and met the eligibility requirements.

There were a total of 2,504 active customers in the Pilot at the end of 2016; an increase of 478 (or 22%) compared to the end of 2015. This is the net increase, meaning it includes increases resulting from new customers joining the Pilot and achieving an active status, increases from passive customers shifting to active (either by accessing the web portal or opting into a technology package), and decreases due to active customers leaving the Pilot. National Grid undertook efforts to increase active participation in the second summer of the Pilot, such as launching the rewards platform, described further in Section 2.3.2.

Figure 2-8 shows the first time that active customers logged into the portal throughout the pilot by month. In both 2015 and 2016, the highest frequency of initial log-ins to the portal was in July, which is also when Conservation Days ramped up in each summer. The high frequency of initial log-ins in July indicates that Peak Events piqued customers' interest in Smart Energy Solutions. May and June of 2015 also had a high frequency of initial log-ins, which likely related to increased program marketing before the Pilot Conservation Days started, as well as the test event held in May 2015. There was also an uptick in initial log-ins in February and March of 2016, which is when the rewards platform was launched.

Figure 2-8. Frequency of First Time Web Portal Log-ins by Month



Source: Navigant analysis

In addition to tracking web portal log-ins, National Grid tracked when customers installed technology packages. As shown in Figure 2-9, technology installs peaked at the start of the program. There continued to be over forty new installations per month through March 2015. New technology installations tapered down significantly after the first quarter of 2015 but continued throughout 2015 and 2016. There were slight upticks in installs in June, September, and October of 2015 which may be related to messaging around the test event and first real Conservation Day in May and June and the wrap up of the first summer of Peak Events in September and October.

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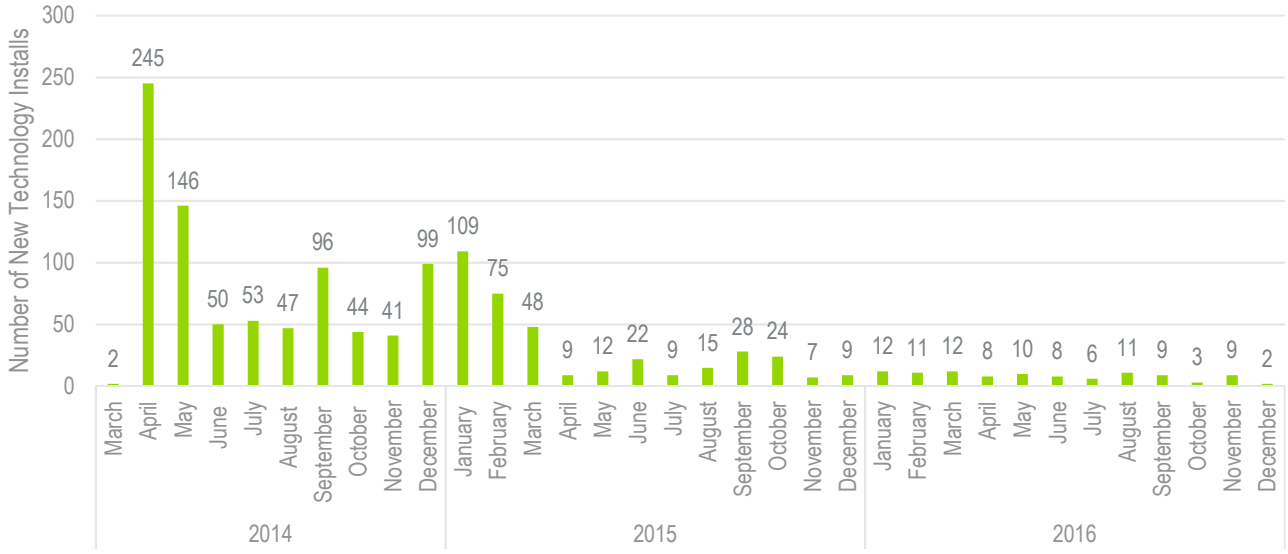
Figure 2-9. Number of Technology Installs by Month



Source: Navigant analysis

Although National Grid's Pilot design was unique and challenging to compare to other pilots for many reasons, a few comparisons suggest that National Grid's customers adopted technologies at comparable rates to other pilots. The Company offered customers several technology packages, which customers were able to sign up for throughout the Pilot. In contrast, NSTAR's opt-in 2012-2013 time-based rate pilot offered customers specific rate and technology combinations – standard rate with an IHD, PTR with an IHD and PCT, CPP with IHD and PCT, and CPP with IHD. National Grid and NSTAR customers opted for the IHD at similar rates: 9% for National Grid and 7% for NSTAR.[50,51]

At the end of the Pilot, National Grid asked Level 1 customers why they did not sign up for a technology package. Approximately 40% of Level 1 customers were aware of the technologies; however, those who were aware showed a lack of understanding of the benefits of the technologies and a lack of interest in them; this is discussed further in Section 4.2.2. As of May 7, 2015,[52] 15% of customers who ordered a technology package had to cancel it due to technical issues at their home. The prevalence of reasons for cancelling are shown in Figure 2-10. These reasons were categorized into six areas:

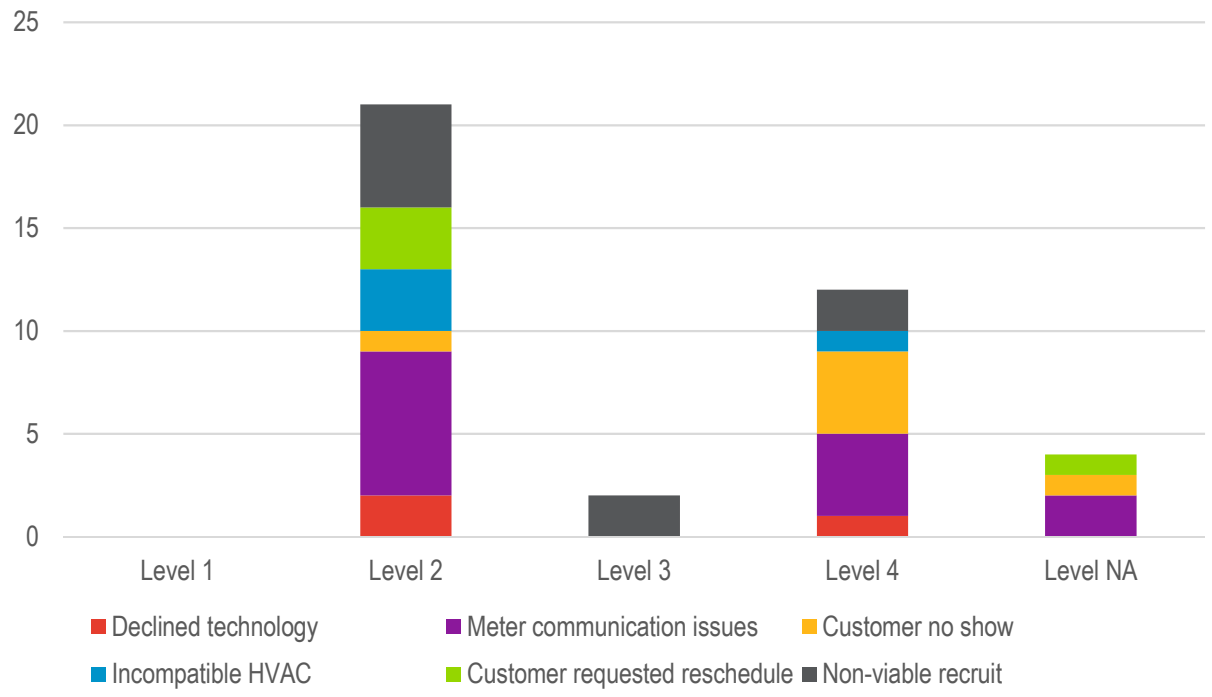
[50] NSTAR (Eversource) pilot customers opted in to the pilot voluntarily, and were randomly assigned to one of the rate and technology combinations to the extent possible, given that they needed to have central air conditioning to use the PCT. All customers received an IHD when they decided to participate in the Pilot, so the IHD enrollment rate was determined to be the same as the Pilot enrollment rate of 7%. All National Grid customers who signed up for technology packages 2 and 4 received an IHD. As of January 1, 2017 the combined enrollment rate for these two technology levels was 9%.

[51] Navigant. *NSTAR Smart Grid Pilot Final Technical Report: AMR Based Dynamic Pricing*. DE-OE0000292. Prepared for U.S. Department of Energy on behalf of NSTAR Gas and Electric Corporation. August 2014.

[52] National Grid summarized reasons for customer cancelation in a response to an information request to the Massachusetts Attorney General (Information Request AG-1-7) in D.P.U. 10-82.

1. "Declined technology" indicated that the customer changed their mind or did not want any technology on the spot. In one case, the landlord had ordered the technology but did not live at the home and the tenant declined the technology;
2. "Meter communication issues" were due to technology not receiving a signal from the meter, typically because it was too far away from where the customer wanted to install the technology;
3. "Customer no show" were instances of the technician showing up to install the technology but the customer was not home and was unresponsive to phone calls;
4. "Incompatible HVAC" were instances of furnace or central air conditioning that were incompatible with the PCT, or instances where customers did not have central air conditioning in order to use the PCT;
5. "Customer requested reschedule" were due to emergencies, or customers needing to install Wi-Fi in order to connect the technologies;
6. "Non-viable recruit" were customers who wanted the technology but could not install it for a reason other than those listed above. These reasons included inability to schedule an appointment even after the Company made multiple attempts to reschedule, inability to connect technology to the internet because they didn't have it or their equipment was incompatible, and inability to install technology because a tenant did not have landlord permission.

Figure 2-10. Reasons for Customer Cancelation of Technology Installation by Technology Level as of May 7, 2015[53]



Source: Navigant analysis

[53] Level NA = customer's requested technology level not recorded.

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2.3.2 Marketing and Recruitment

In an effort to attract as many customers as possible into the Pilot and the higher technology levels, National Grid used the following recruitment strategies:

- Conducted a door-to-door campaign in Fall 2014 to advertise the Pilot and enroll customers, with a specific focus on enrolling high-potential Level 3 and Level 4 customers;
- Held a continued stream of events and educational sessions at the Sustainability Hub to educate customers about and showcase the various technologies;
- Sustainability Ambassadors from the Sustainability Hub attended community events (including farmers' markets, community sporting events, concert series on town commons, community festivals, and Worcester Public Library events) around Worcester to promote, discuss, and enroll customers in the technology levels;
- Sent customers rate enrollment packages, technology enrollment packages, monthly reports, and quarterly newsletters with Pilot updates;
- Allowed customers to enroll in technology Levels 2, 3, and 4 throughout the Pilot;
- Conducted practice Peak Events in May 2015 and May 2016 to test customer communications, meter signals and event loading, as well as to market the rates and technologies to customers;
- Included a technology enrollment form in the monthly paper report mailed to customers in August 2015 and included consistent reminders about the available technologies in other communications;
- Launched a rewards platform in February 2016 allowing customers to earn points for saving energy and engaging with the program, which could be redeemed for gift cards at national and local retailers; and,
- Created new collateral that built on data collected from the first year of the Pilot. An example is the Energy Signature graphics that illustrated the most common customer usage patterns with specific tips on how to more effectively save energy and money given the design of the Pilot. These graphics were shared with customers through existing communication channels and through the Sustainability Hub.

After the Pilot began, National Grid continued its marketing campaign in order to keep customers engaged and informed about their technology and rate options. National Grid used op-eds in the Worcester Telegram & Gazette, direct email newsletters, conservation tips to customers, bill inserts, and mailed materials in its marketing efforts.[54] Figure 2-11 shows an example of a Smart Energy Solutions bill insert, sent before the summer 2015 season began, which is illustrative of the materials sent by email as well. National Grid continued to send these tips and newsletters and held a Smart Energy Solutions event in August 2015 at the Worcester Public Library to answer customer questions about the program. Customers could also get their questions answered anytime at the Sustainability Hub.

[54] Though not part of National Grid's marketing effort, local media channels covered the Pilot, providing publicity and insights for customers. Refer to APPENDIX E for examples of media coverage.

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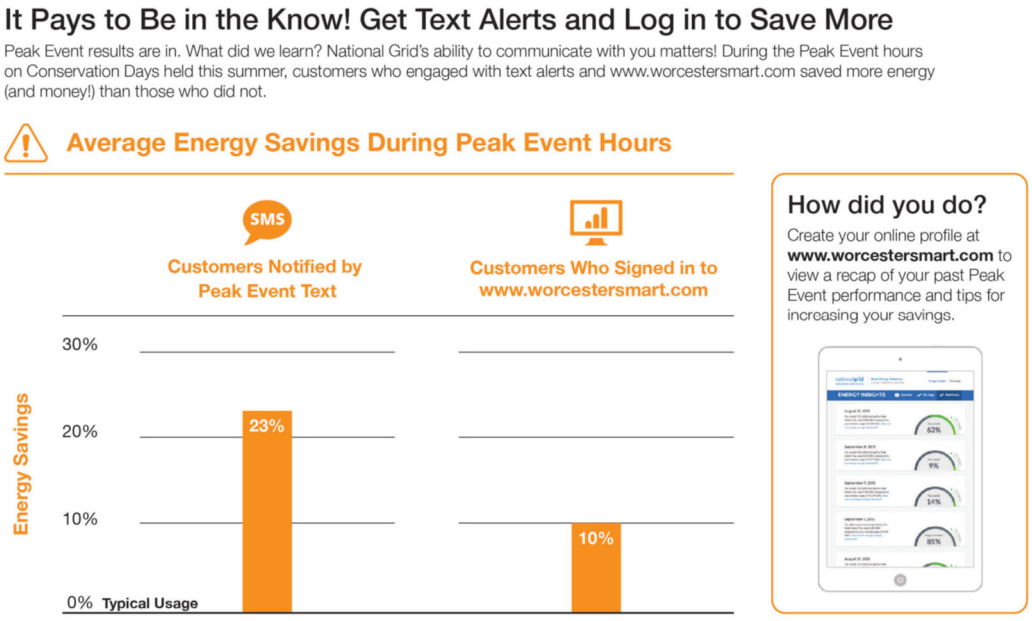
Figure 2-11. Excerpt from Smart Energy Solutions Bill Insert Sent in May 2015

Source: National Grid

After receiving customer feedback via surveys, low-income customer focus groups, and commercial customer interviews, National Grid responded to customers' need for additional information, specifically about event notifications and potential savings. Figure 2-12 is an illustrative example from one of National Grid's mailers to customers in October 2015, which reminds customers that they can be notified of Peak Events via several channels, not just phone calls. This example also shows anticipated savings achieved by customers who were notified by these alternative channels. This mailer echoes materials sent by National Grid throughout the Pilot to customers reminding them that they could choose to be notified about events via multiple communication channels.

Figure 2-12. Excerpt from Smart Energy Solutions Mailer Sent in October 2015



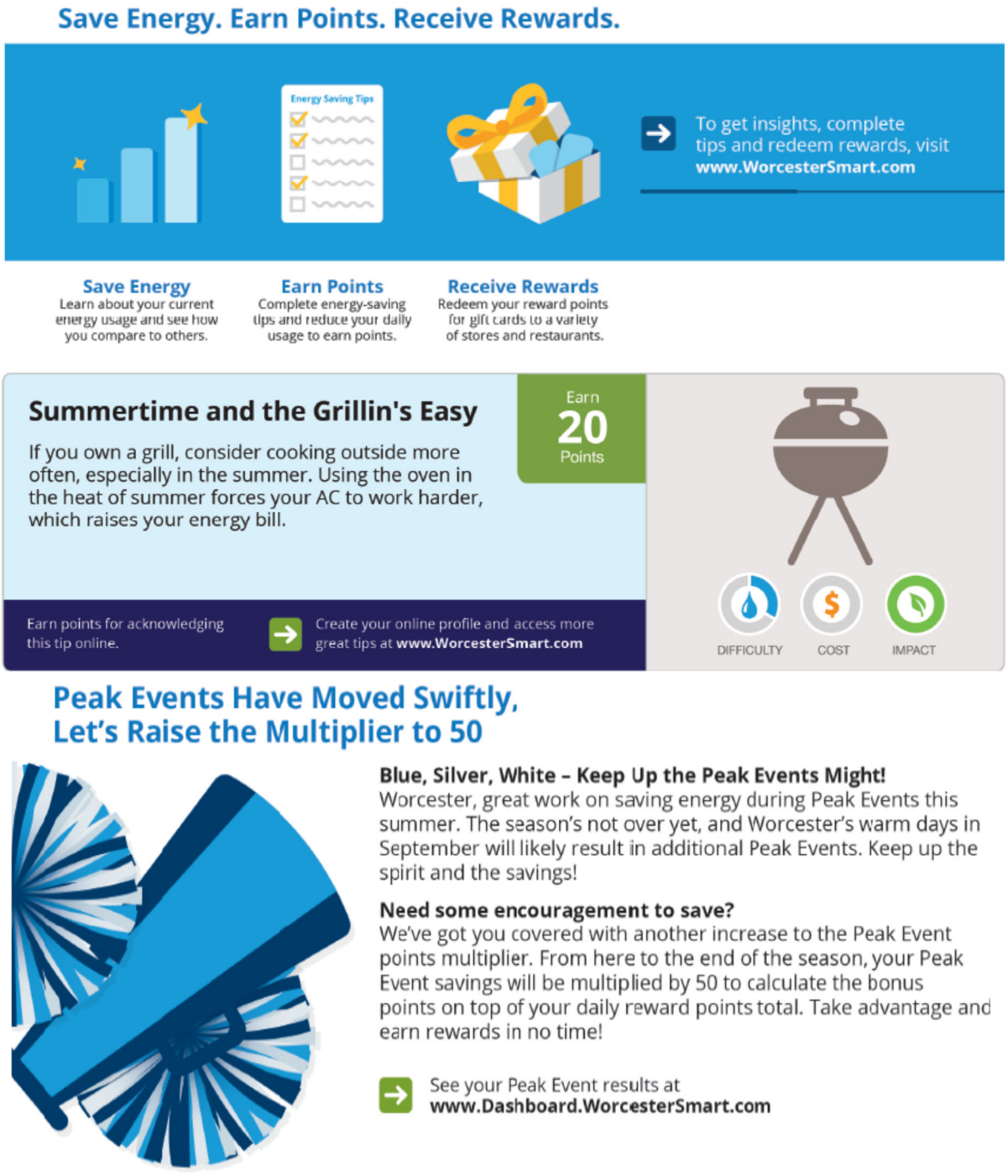
Source: National Grid

National Grid added a rewards platform to the Pilot web portal in February 2016 aimed at increasing engagement with the program. Points were earned in a variety of ways. For example, Smart Energy Solutions customers could earn points every day through saving energy. The customer's daily earnings were based on energy savings compared to their energy consumption on past similar weather days, so the more they saved the more points they earned. Customers also earned points by completing energy-savings tips, logging into the web portal for the first time, taking certain actions such as enrolling in or completing selected National Grid programs, signing up to receive Peak Event notifications via text message, completing the home profile on the WorcesterSmart web portal, or visiting the National Grid Sustainability Hub. Points could be redeemed for a variety of gift cards to national and local food, entertainment and retail establishments. Figure 2-13 contains a few illustrative examples from National Grid mailers highlighting the rewards platform. The outcomes of National Grid's internal assessment of the reward platform's effectiveness are shown in APPENDIX D. Highlights of this assessment include:

- Web portal logins increased considerably (from an average of 323 per week to 360 per week) after the launch of the rewards platform;
- The click-to-open rates for Peak Event-related emails sent the day before and the day of a Peak Event increased by 18.4% and 9.2%, respectively; and,
- In a National Grid administered survey, the rewards platform received the highest satisfaction score compared to other portions of the portal (such as Peak Event content and energy-saving tips), with 83% of customers rating the rewards feature at least a 4 on a 5-point scale.

The results of this National Grid assessment suggest that the rewards platform was a significant driver of site traffic and engagement.

Figure 2-13. Excerpts on Rewards Platform from Smart Energy Solutions Mailers in June and August 2016



Source: National Grid

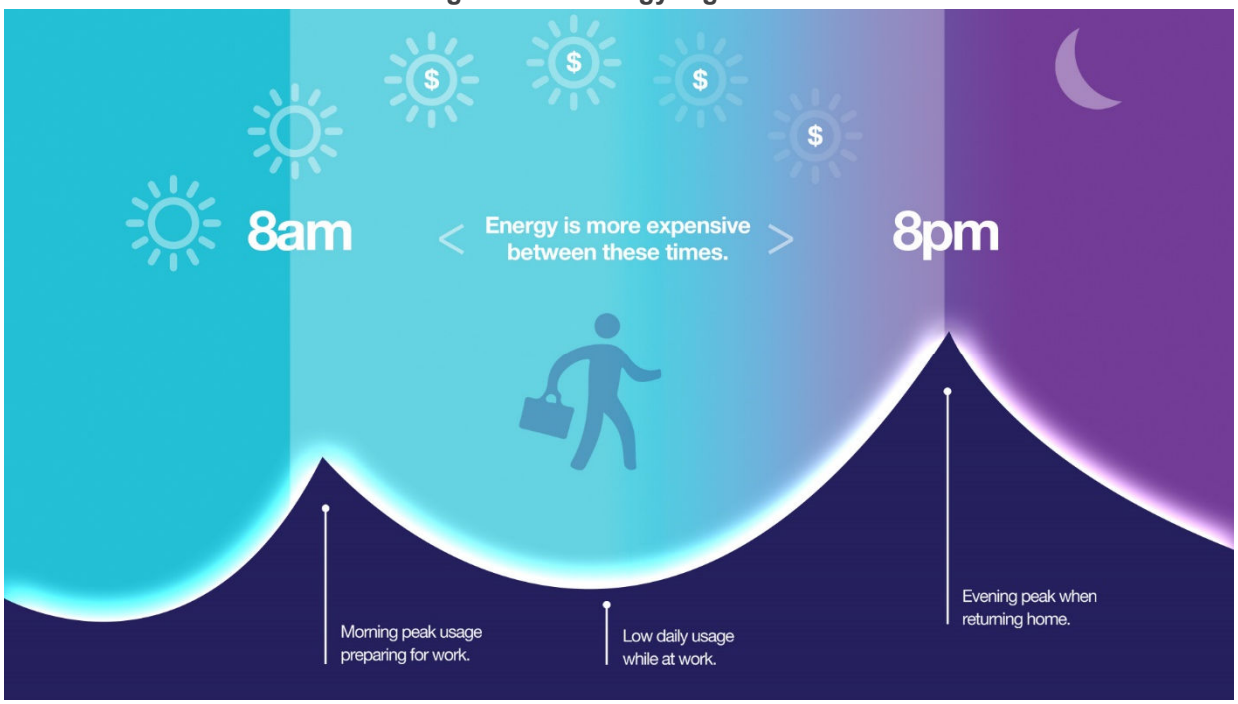
Energy Signatures were another new feature added to the Pilot in 2016. National Grid used customer data to create five common "energy signatures" or load profiles. Customers could self-identify with one of the signatures to receive personalized tips on how to conserve energy both during and outside of Peak

Events. The five signatures were:

- 9 to 5ers – These customers have a predictable, 9-5 work schedule. Their electricity use is characterized by a slight morning spike before work, low daily usage while at work, and a larger evening peak when they return home from work.
- The Late Nighters – These customers are awake late at night. Their electricity use is characterized by a morning increase before starting the day, low daily usage, and an extended increase in electricity use in the evening.
- The Even Keels – These customers have steadier electricity usage throughout the day than other signatures. Their electricity use is characterized by a very small increase in use in the morning and again in the evening, but is generally constant over the day.
- The Double Peakers – These customers are often families or group living situations. Their electricity use is characterized by a defined morning peak while everyone gets ready for the day, low daily usage while everyone is out, and a large evening peak when everyone returns home.
- Homebodies – These customers are at home during the day time hours and might work from home. Their electricity use looks like a bell shaped curve over the day – there is a steady morning increase that results in a midday peak and then decreases to low nighttime usage.

An example of the 9 to 5ers signature is shown in Figure 2-14.

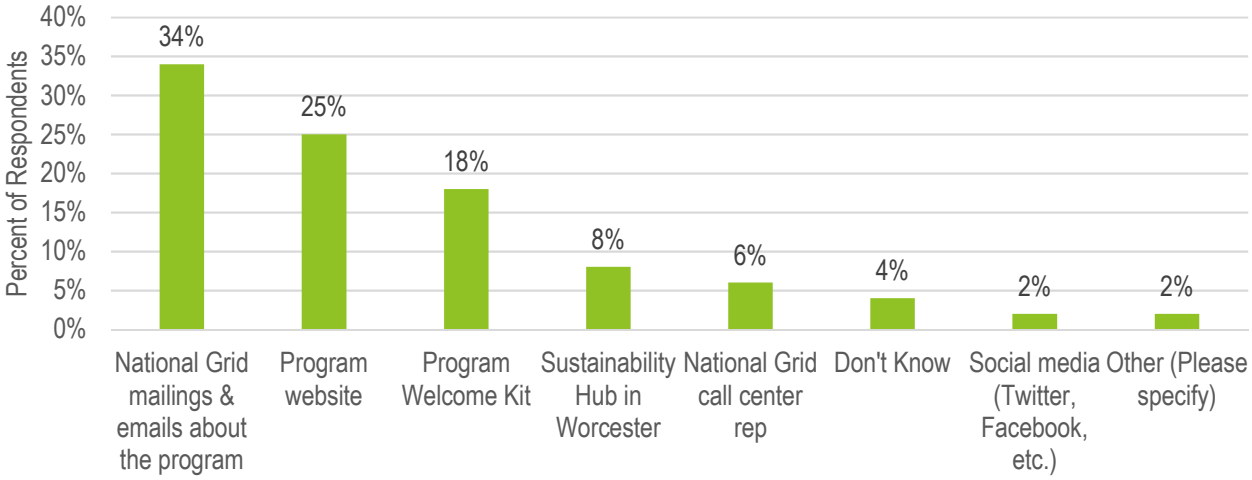
Figure 2-14. Energy Signatures



Source: National Grid

At the end of the Pilot, customers were asked which sources of information were the most useful to them in learning about the Pilot (Figure 2-15). The most frequently cited responses were the National Grid mailings and emails about the Pilot (34%), the program website (25%), and the program Welcome Kit (18%).

Figure 2-15. Most Useful Sources of Information about the Pilot



Source: Navigant analysis of end of pilot survey (N=600)

2.3.3 Customer Segmentation

National Grid defined eight overlapping customer segmentation subgroups based on demographic characteristics (demographic subgroups). With the exception of the renter data, the demographic data was purchased by National Grid from InfoGroup and Core Logic and matched to Pilot accounts by combinations of address, phone number, and/or customer name. The renter data was sourced from a combination of MA tax parcel records and the Company's customer database; customers were identified as likely renters if the name on the tax parcel did not match the name in the customer database.[55,56] The subgroups and their definitions are provided in Table 2-2.[57]

[55] These customers were identified as "likely" renters because there was not sufficient information to determine whether the account holder was a renter or a family member, etc. Customers without data in the MA tax parcel records were not classified.

[56] Renters were not included as a demographic subgroup in National Grid's original smart grid pilot evaluation plan (D.P.U. 11-129 Exhibit EHW-3. December 22, 2011). National Grid and the evaluation team chose to add the group in 2016.

[57] In 2012, National Grid revised customer segment definitions. The Pilot area had fewer low-income customers than expected, and it was assumed that only 20% of customers would remain on the CPP rate. As a result, the number of low-income customers with medium usage decreased in the estimated customer segment. Reference: National Grid. D.P.U. 11-129: Response to Record Request AG-1. May 11, 2012.

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Table 2-2. Demographic Subgroups

Demographic Subgroup	Definition
Low-income	Customers on R2 rate[58]
High Income	Customers on R1 rate with income greater than $100,000 based on demographic data
Low Use	Customers on R1 rate with low energy use
Medium Use	Customers on R1 rate with medium energy use
High Use	Customers on R1 rate with high energy use
Seniors	Customers 65 and older
Small Home	Customers with homes 1,000 sq. ft. or less
Large Home	Customers with homes over 2,500 sq. ft.
Renter	Account that likely belongs to a renter

Source: National Grid

Table 2-3 shows the demographic subgroup distribution in the Pilot as of October 4, 2016, except for the renter data which was identified as of February 2017.[59]

Table 2-3. Demographic Subgroup Distribution (as of October 4, 2016)

Pilot Participation By Treatment		All Residential Accounts	Non-Low-income Standard Residential Rate			Low-income Residential Rate (R-2)	Additional Population Segments				
			Low Use	Medium Use	High Use		High Income	Seniors	Small Home	Large Home	Renter
Level 1	CPP	8,942	2,338	4,611	870	923	1,459	1,710	5,014	175	2,740
	PTR	406	87	174	38	73	66	98	243	4	96
Level 2	CPP	634	105	387	76	62	155	95	276	13	104
	PTR	30	4	17	5	3	8	4	13	1	1
Level 3	CPP	28	4	21	3	0	10	8	12	1	4
	PTR	3	0	2	0	0	1	1	0	0	0
Level 4	CPP	235	25	160	43	7	101	35	85	17	13
	PTR	14	1	7	2	2	5	0	4	0	1
Total		**10,292**	**2,564**	**5,379**	**1,037**	**1,070**	**1,805**	**1,951**	**5,647**	**211**	**2,959**

Source: Navigant analysis

As previously mentioned, National Grid anticipated that 80% of customers would opt out of CPP and into

[58] In many of the customer surveys, Navigant also collected self-reported data to capture customers whose income was at or below 200% of the federal poverty levels and 60% of the area median income. In 2015, Navigant found that the survey results did not vary based on which definition of low income was used; therefore, the R2 rate definition was used in the analyses throughout this report.

[59] October 4th, 2016 was chosen as these were the customers available to be surveyed for the end of pilot survey, the last major evaluation item included in this evaluation. This breakdown includes all active, residential customers who did not a) switch to a competitive supplier, or b) drop out of the Pilot.

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PTR, but the data revealed that only 5% of customers had done so at the end of the two years of the Pilot. Further discussion of how the demographics changed across the two years of the Pilot and how the demographics of active and passive customers differed is included in Section 3.1.3.

Table 2-4 shows how the population of active customers changed across the two years of the Pilot. Each cell shows the percentage of customers in a given demographic group and technology/price group. Renters were left out of this analysis since that data was only collected for 2016. Level 1 for each price plan is split out, since there were both active and passive customers in that level, and then all active customers are shown (including active Level 1 customers and customers in Levels 2, 3, and 4). Compared to 2015, active customers in 2016 were:

- More likely to be low use (difference of +10% for all active customers)
- Less likely to be low-income (difference of -6% for all active customers)
- Less likely to be high income (difference of -4% for all active customers)
- More likely to have a small home (difference of +17% for all active customers)

As discussed in Section 3, the Pilot savings for active customers did not change significantly from the first to the second summer. This indicates that the demographic changes described in this section did not have much impact on the Pilot savings. Impacts by demographic group are discussed in Section 3.1.3, but most of the demographic groups were too small to examine. The changes in the quantity of some demographic groups across the two summers, along with the similarity in program impacts, lends anecdotal evidence to the idea that the demographic subgroups have similar savings.

Table 2-4. Demographics of Active Customers in 2015 versus 2016

Technology/Price Group	Year	Low Use	Medium Use	High Use	Low Income	High Income	Seniors	Small Home	Large Home
Level 1 CPP - Active	2015	25%	53%	12%	7%	18%	16%	40%	2%
	2016	27%	56%	10%	6%	17%	13%	55%	2%
Level 1 PTR - Active	2015	29%	53%	8%	10%	16%	10%	30%	0%
	2016	22%	55%	10%	8%	18%	17%	49%	0%
All Active Customers	2015	13%	59%	13%	13%	25%	17%	33%	2%
	2016	23%	59%	11%	7%	21%	14%	50%	2%

Source: Navigant analysis

Table 2-5 shows how the populations of active and passive customers differed in 2016. Each cell shows the percentage of customers in a given demographic group and technology/price group. Level 1 for each price plan is split out, since there are both active and passive customers in that level, and then all customers are shown. Compared to passive customers, active customers in 2016 were:

- Less likely to be low-income (difference of -4% for all customers)
- More likely to be medium use (difference of +10% for all customers)
- More likely to be high income (difference of +6% for all customers)
- Less likely to be seniors (difference of -6% for all customers)
- Less likely to have a small home (difference of -7% for all customers)

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- Less likely to be renters (difference of -7% for all customers)

Since there were substantial efforts to drive customers to the web portal and convert them from passive to active status in the second year of the Pilot, looking at the groups that were less likely to be active customers in 2016 may shed light on groups that need special outreach. In particular, active customers were less likely to be low-income customers and they were less likely to be seniors; two groups which are often considered hard to reach. The focus groups also indicated that low-income customers may need focused outreach to gain as much as possible from the Pilot. Active customers were also less likely to be renters but the difference was smaller among Level 1 customers than in the Pilot population as a whole; this suggests renters were less likely to install technology packages but were almost as likely to visit the web portal. Renters had particular problems installing technologies due to the need for landlord permission and meter communication issues in multi-family housing.

Table 2-5. Demographics of Active versus Passive Customers in 2016

Technology/Price Group	Customer Type	Low Use	Medium Use	High Use	Low Income	High Income	Seniors	Small Home	Large Home	Renter
Level 1 CPP	Active	27%	56%	10%	6%	17%	13%	55%	2%	27%
	Passive	27%	49%	9%	11%	15%	19%	57%	2%	29%
Level 1 PTR	Active	22%	55%	10%	8%	18%	17%	49%	0%	23%
	Passive	21%	37%	10%	20%	16%	27%	63%	1%	26%
All Customers	Active	23%	59%	11%	7%	21%	14%	50%	2%	22%
	Passive	27%	49%	9%	11%	15%	20%	57%	2%	29%

Source: Navigant analysis

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3. IMPACT ASSESSMENT

As laid out in National Grid's 2011 Evaluation Plan and in accordance with the *Common Evaluation Framework*, Navigant conducted impact analyses on four main topics:

1. **Peak Event Impacts**, which are demand savings (MW) during Peak Events called in the summer of 2015 and 2016;
2. **Energy Impacts**, which are energy savings (MWh) from the Pilot in 2015 and 2016; [60]
3. **Bill Impacts**, which are dollar savings on customer bills in 2015 and 2016; and
4. **Load Shifting** around Peak Events, including snapback and pre-cooling, and from peak to off-peak times in 2015 and 2016.[61]

This report covers impacts for the period from the start of the Pilot through the end of 2016. Impacts for each of the four analyses listed above were calculated for customer groups defined by technology level and price plan.[62] Where possible, Navigant also estimated impacts by demographic subgroup. The impact findings in this report are primarily focused on residential customers. Commercial customers made up less than 5% of the Pilot participants and outcomes were explored for them to the extent possible based on the constraints of the small sample. Detailed descriptions of the impact methodologies for each of the four topics above are included in APPENDIX A.

The Pilot was developed to meet the GCA goal of achieving peak and average load reductions of 5% or greater for those customers who actively participated in the Pilot.[63] In Navigant's analysis, peak load reduction was examined in the demand analysis and average load reduction in the energy analysis. Throughout this report, except in Section 3.1.2 where peak load reductions by Peak Event hour are discussed, the peak load reduction shown for a given Peak Event is the average load reduction across all the hours of that Peak Event. In both 2015 and 2016, active residential customers in the Pilot achieved an average of a 17% peak load reduction on Conservation Days. Active CPP participants[64] achieved an average load reduction of 4.3% in 2015 and 6.3% in 2016, which averaged to 5.4% over the whole Pilot. The demand savings may be slightly underestimated because hourly data from 2014 was used to estimate the baseline. In 2014, customers had access to usage information from the Pilot but the Pilot rates were not yet live, so they may have already been conserving as they were more aware of their

[60] To a lesser extent, Navigant also examined savings from 2014 when the informational portion of the Pilot was in effect but the Pilot pricing had not yet gone into effect.

[61] Although load shifting impacts are not specifically identified in the *Common Evaluation Framework*, the team that developed National Grid's impact evaluation plan added this component to the evaluation scope of work.

[62] Impacts were not calculated in any of the analyses for Level 3 PTR customers as this group had only one customer in 2015 and two customers in 2016.

[63] As discussed previously, in the context of this opt-out Pilot, Navigant defined active customers as anyone who opted into one of the three higher technology packages (Levels 2-4) and anyone on the default technology package (Level 1) who logged into the web portal at least once. Customers in Level 1 who never logged into the web portal were considered passive participants in the Pilot.

[64] Energy savings or average load reductions were neither expected nor found for PTR customers as these customers were not on a TOU rate and thus did not have a monetary incentive to save energy outside of Peak Events.

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electricity usage.[65] Navigant did find small energy savings from the Pilot in 2014. For the energy savings analysis, Navigant used 2013 as the pre-program year which was prior to any Pilot activities.

Table 3-1 shows total and percentage demand and energy savings and total bill savings for residential customers in each year of the Pilot. Total savings are the sum of savings across all residential customers in the program. For the Peak Event savings, the total savings are shown for the "average event", which is the average across all Peak Event hours across all 20 Peak Events of each summer, and for the "maximum event", which is the single Conservation Day with the highest average savings across the Peak Event hours. Percentage savings are the weighted average of savings across the residential technology/price plan groups. Peak Event savings stayed almost the same for active customers in 2015 versus 2016, but savings for passive customers increased considerably in 2016. Energy savings also increased in 2016 compared to 2015, driven primarily by a spike in savings in July 2016 (as discussed in Section 3.2.1). Total bill savings decreased in 2016 compared to 2015 (as discussed in Section 3.3).

Table 3-1. Total and Percentage Savings for Residential Customers

Impact Category		2015			2016		
		Total Savings	Percentage for Active Customers	Percentage for All Customers	Total Savings	Percentage for Active Customers	Percentage for All Customers
Peak Event Savings	Average Event*	0.55 MW	16.8%	3.9%	1.02 MW	16.8%	7.2%
	Maximum Event**	1.59 MW	29.0%	12.3%	2.28 MW	24.0%	14.3%
Energy Savings***		215 MWh	4.3%	0.2%	1,358 MWh†	6.3%	2.0%
Bill Savings‡		$997,621	-	-	$772,879	-	-

Source: Navigant analysis
* This is the total demand savings among all participants, averaged across all 20 events in the summer of each year.
** This is the total demand savings for 6/23/2015 and 7/25/2016, the Conservation Days with the highest savings for each summer.
*** This includes energy savings for CPP customers only, as energy savings were neither expected nor found for PTR customers.
† The considerable increase in energy savings in 2016 was driven primarily by a spike in savings in July, Navigant did not find any evidence suggesting this result was erroneous. This is discussed more fully in Section 3.2.1.
‡ This includes total bill savings for CPP customers and rebates for PTR customers.

Navigant also broke down the total Peak Event savings in 2016 to consider how much of the savings came from the pricing versus the technologies to address the question of how much of the savings could be achieved through price plans alone. To do this Navigant looked at what portion of the total savings came from customers in Level 1. Table 3-2 shows the portion of the total Peak Event savings that were achieved by passive customers in Level 1, which is similar to a program with just price plans, and by all customers in Level 1, which is similar to a program with price plans and a web portal. Seventy percent of the average total Peak Event savings in 2016 was achieved by all Level 1 customers (active and passive) and the remaining 30% of the savings came from customers who opted into one of the technology packages (although customers with technology accounted for only 10% of the customers in the Pilot). Passive customers in Level 1 made up 42% of the average total Peak Event savings in 2016, indicating this amount could have been achieved by the price plans alone.

[65] Hourly data was not available prior to April 2014 when smart meters were installed.

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Table 3-2. 2016 Peak Event Savings from Level 1 Customers

	Total Savings from All Customers	Total Savings from Passive Level 1 Customers	Portion of Savings from Passive Level 1 Customers	Total Savings from All Level 1 Customers	Portion of Savings from All Level 1 Customers
Average*	1.02 MW	0.43 MW	42%	0.72 MW	70%
Maximum**	2.28 MW	1.32 MW	58%	1.84 MW	81%

Source: Navigant analysis

Navigant did not find any statistically significant Peak Event impacts for commercial customers.[66] This finding matches the survey results for commercial customers, in which most businesses indicated that they were unable to adjust their usage during business hours when Peak Events were most likely to be called (see Section 4.2.8). This result should not be over interpreted to conclude that the Pilot was ineffective for commercial customers. The sample sizes for commercial customers on the PTR rate and in the higher technology levels were too small to draw any conclusions. It is possible that with the proper enabling technologies commercial customers were saving during Peak Events. It is also possible that subsets of commercial customers, for example those who were able to shift energy intensive activities to the evening or overnight, saved on the Pilot. There is not enough data for such possibilities to be explored.

3.1 Peak Event Impacts

Navigant estimated demand savings during each Peak Event by regression to predict fitted usage from 8 a.m. to 10 p.m. on each Conservation Day, controlling for temperature, humidity, day of the week, month, and a customer fixed effect that controlled for all observed and unobserved customer-specific variables that do not change through time. The evaluation team estimated savings for each technology/price group combination with the exception of the Level 3 PTR group, which only had one customer in 2015 and two customers in 2016. A detailed description of the methodology is included in APPENDIX A.

In both 2015 and 2016, active residential customers in the Pilot achieved an average 17% peak load reduction on Conservation Days. This means that the Pilot exceeded the GCA goal of achieving a 5% peak load reduction amongst active customers.

3.1.1 Average Peak Event Impact

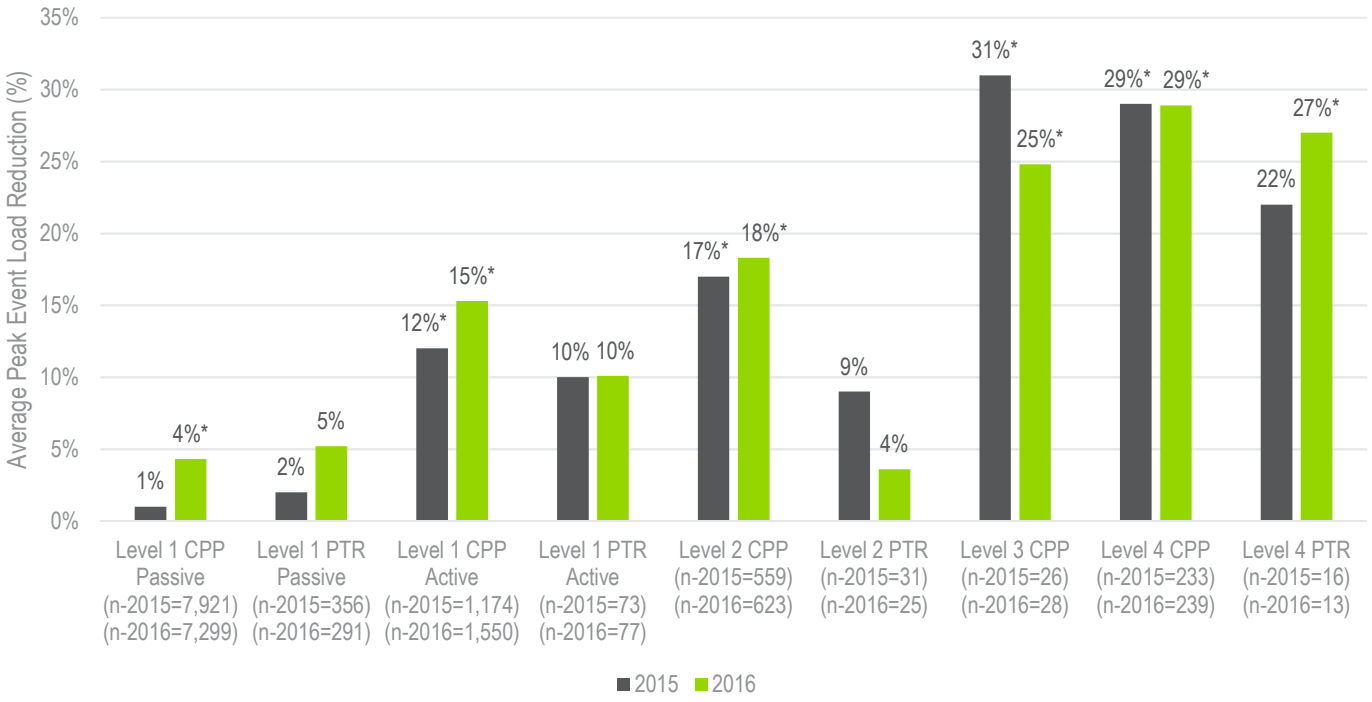
Figure 3-1 shows the average percentage peak load reduction across all the events of each summer for each of the residential technology/price groups.[67] Whether on the CPP or PTR rate, customers achieved greater demand reduction with more advanced technology. For active customers at each technology level, CPP customers conserved more electricity than their PTR counterparts. Passive PTR customers

[66] Energy impacts for commercial customers were not analyzed as the group was too small to produce statistically significant results, and energy impacts were not expected because the group did not have any Peak Event impacts.

[67] This is the average across all 20 Peak Events for each summer averaged across all the hours of each individual Peak Event.

saved more than passive CPP customers, which could reflect that these customers have a higher level of engagement since they had to opt in to the PTR rate. Impacts for passive customers on both price plans increased considerably in 2016 compared to 2015. Impacts for most of the other groups stayed fairly consistent over the two years. Level 3 and 4 customers had very similar savings, suggesting that the smart thermostats received by customers in those two levels drove their savings.

Figure 3-1. Average Percent Peak Event Load Reductions by Residential Technology/Price Group



Source: Navigant analysis
Note: An asterisk (*) indicates that the majority of the event hours throughout the summer were statistically significant at the 90% confidence level for the indicated group. Additionally, n refers to the number of customers used in this particular analysis, not the total number of customers in each technology/price group.

Table 3-3 shows the average absolute savings per customer across all the events of each summer for each technology/price group in each year.

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Table 3-3. Average Absolute Peak Event Load Reductions per Customer by Residential Technology/Price Group

Technology/Price Group	2015 Absolute Savings (kW)	2016 Absolute Savings (kW)
Level 1 CPP Passive	0.01	0.05
Level 1 PTR Passive	0.03	0.07
Level 1 CPP Active	0.13	0.17
Level 1 PTR Active	0.12	0.12
Level 2 CPP	0.20	0.21
Level 2 PTR	0.13	0.05
Level 3 CPP	0.53	0.49
Level 4 CPP	0.56	0.60
Level 4 PTR	0.50	0.60

Source: Navigant analysis

In percentage terms, the impacts for active residential customers in the Pilot were similar to those from other, primarily opt-in, programs.[68] Comparisons of the Pilot to several other programs around the country are shown in Figure 3-2. The comparisons include the average, maximum, and minimum impact when possible, or the average impact when the minimum and maximum could not be found. The comparisons are grouped by the Pilot's technology/price groups, and the comparison programs are matched to the Pilot groups based on the descriptions of the price plans and the enabling technologies in the comparison program's report. The comparisons for Level 1 are to other programs with no technology, comparisons for Level 2 are to programs with IHDs, and Levels 3 and 4 are grouped together and compared to other programs with PCTs. The Pilot groups are highlighted in gray for 2015 and green for 2016. A similar graph showing absolute comparisons is included in APPENDIX B.

[68] Passive customers in Level 1 also had savings, but they are not shown in Figure 3-2 because all of the comparison programs are opt-in. Passive customers in an opt-out program are fundamentally different from customers in an opt-in program in terms of their motivation to participate in a program.

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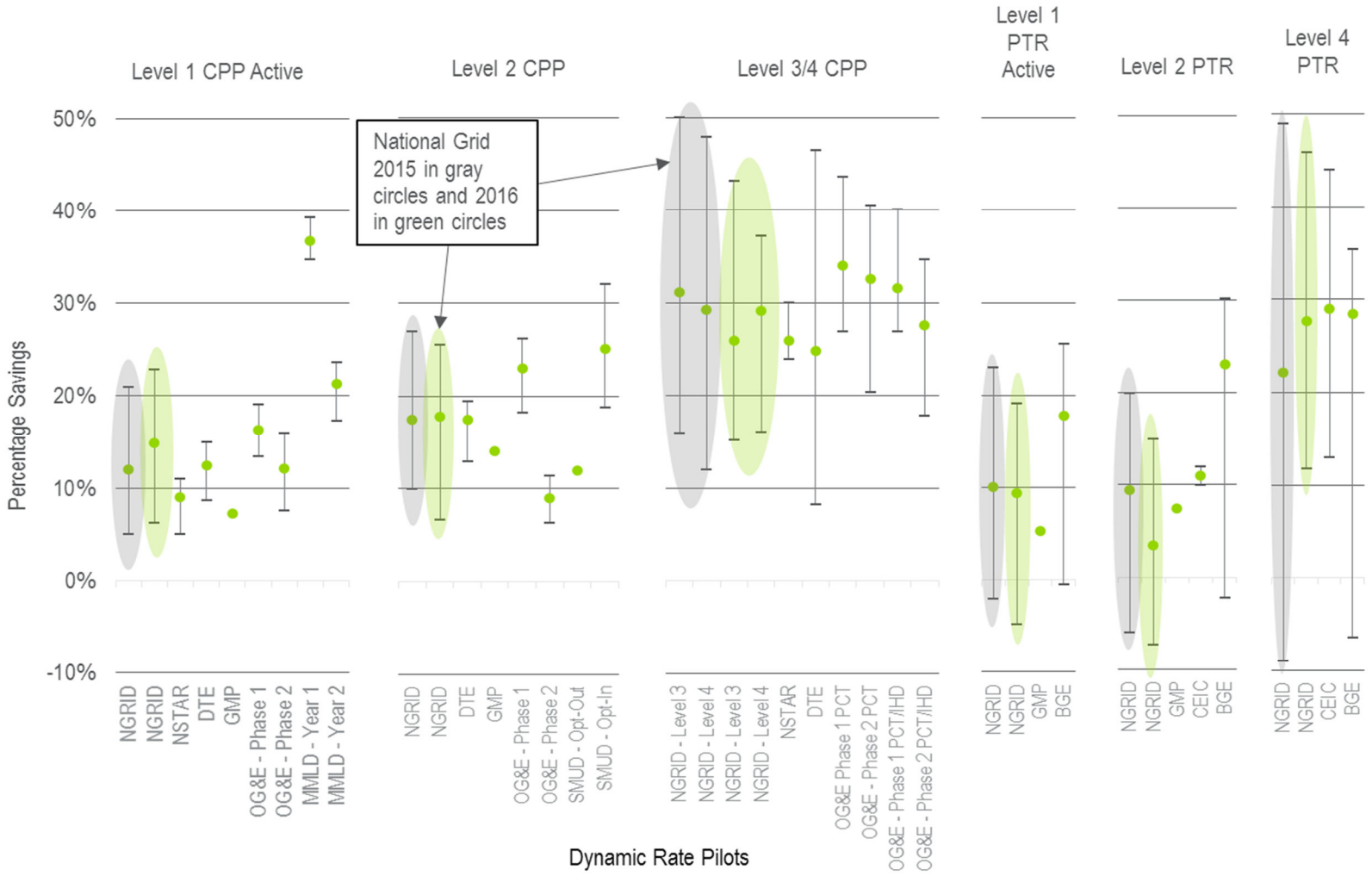
Figure 3-2. Residential Peak Event Impacts Percentage Comparison to Other Utilities



Source: Navigant analysis and the Smart Grid Investment Grant program
Note: NGRID = National Grid; NSTAR is now Eversource Energy; DTE = DTE Energy; GMP = Green Mountain Power; OG&E = Oklahoma Gas and Electric; MMLD = Marblehead Municipal Light Department; SMUD = Sacramento Municipal Utility District; BGE = Baltimore Gas and Electric; CEIC = Cleveland Electric Illuminating Company

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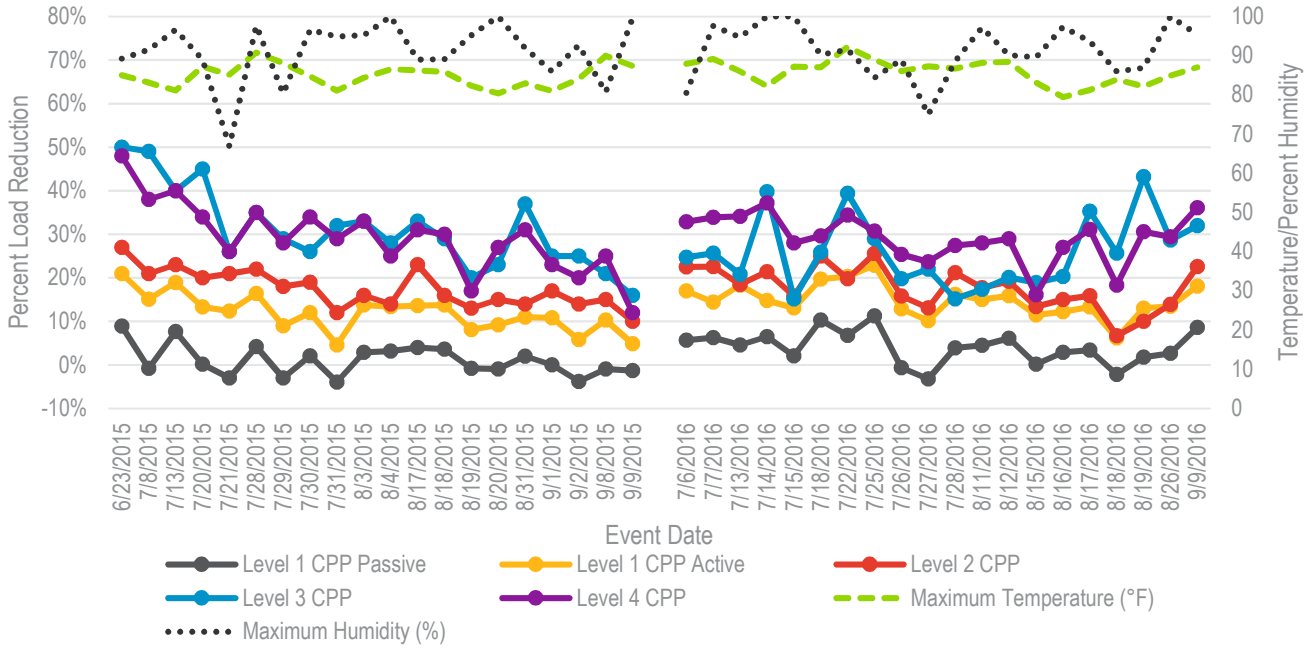
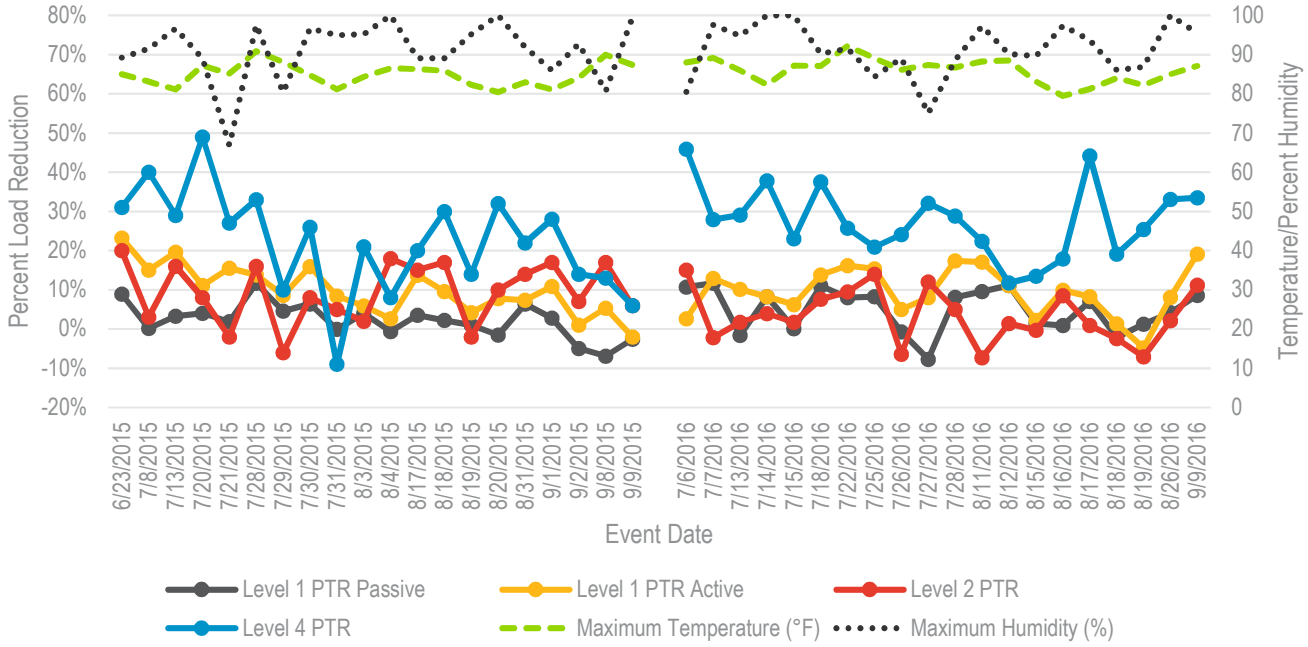
Figure 3-3 shows the average percentage impact for each event for the five residential CPP customer groups, and Figure 3-4 shows the average percentage impact for each event for the four residential PTR groups. For almost all of the technology/price groups, the impact was highest for the first Peak Event on June 23rd, 2015, and this may indicate initial excitement or novelty surrounding the first event. In 2015 for both price plans, Level 1 (active and passive) and Level 2 had relatively stable impacts throughout the summer, while Level 3 (CPP only) and Level 4 impacts declined throughout the summer. This matches with the survey data (Figure C-5), which showed that Level 3 and 4 customers were more likely to override their thermostats as the 2015 summer went on. In 2016 all of the technology/price groups had relatively stable impacts throughout the summer. This may indicate learning that occurred from the first summer to the second. Another reason for the difference may be that 2015 had more events in September than 2016 when many families are busy with back to school and change their behavior patterns compared to the rest of the summer. Another major difference from 2015 to 2016 was the increase in savings for passive customers in Level 1 which may be due to ramp-up similar to that seen in Home Energy Report programs wherein savings commonly increase from the first year into the second and sometimes even the third year of the program; examining savings for a third summer would shed further light on this trend. Similar graphs showing the absolute impact and tables showing the average percentage and absolute impact by event are in APPENDIX B.

Figure 3-3. Percentage Savings for CPP Customers



Source: Navigant analysis

Figure 3-4. Percentage Savings for PTR Customers



Source: Navigant analysis

Figure 3-5 shows the percentage savings during each Peak Event for customers with PCTs (Levels 3 and 4) and the degree setback on the thermostat for each Peak Event. National Grid remotely adjusted these customers' thermostats by the degree setback shown,[69] although customers had the option to opt-out of the event or override their thermostat at any time. Based on Figure 3-5 there do appear to be slightly higher savings associated with a higher degree setback, but the effect decays during back-to-back Peak Events. One might expect that a higher setback temperature would be correlated with a higher rate of opt-outs and overrides among thermostat customers; however, the data did not show this. A higher degree setback was slightly positively correlated with a higher percentage of customers with a thermostat opting out before the Peak Event started,[70] but it was negatively correlated with the percentage of customers overriding the thermostat during the Peak Event.[71] The rate of opt-outs and overrides was most strongly correlated with the length of the Peak Event; the longer the Peak Event the higher the percentage of customers choosing to opt out before or override during the Peak Event.[72] These trends are shown in Figure 3-6. The fact that opt-outs and overrides were more highly associated with the length of the Peak Event than the degree setback may indicate that customers noticed how long the Peak Event lasted more than they noticed how extreme the temperature shift was. This was further supported by the fact that opt-

[69] Setback was relative to the setting on the thermostat when the Peak Event began, not to the programmed temperature for that time. Thus if a customer increased or decreased their thermostat prior to the event their temperature was still increased by the specified degrees. The setback was not reinstated if the customer changed their thermostat setting once the Peak Event had started.

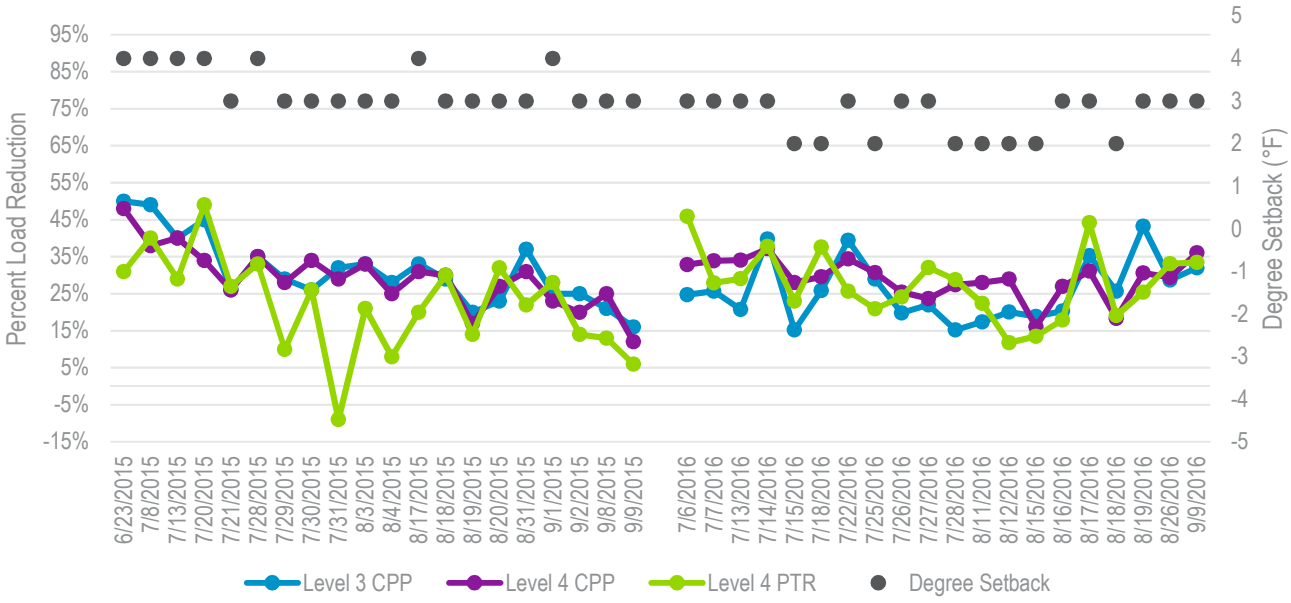
[70] Correlation coefficient of 0.30.

[71] Correlation coefficient of -0.27.

[72] The correlation coefficient between the length of the Peak Event and opt-outs and overrides was 0.30 and 0.54, respectively.

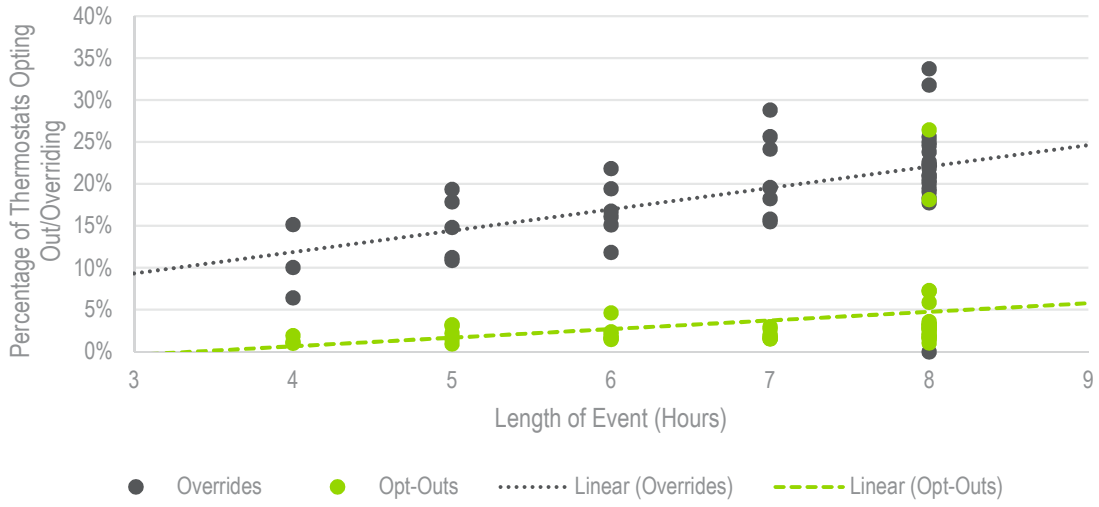
outs and overrides were also positively correlated with the end time of the Peak Event, meaning customers were more likely to opt-out/override the later into the evening a Peak Event went.[73]

Figure 3-5. Degree Setback and Percentage Savings for Customers with PCTs



Source: Navigant analysis

Figure 3-6. Length of the Peak Event and Percentage of Thermostat Customers Opting Out/Overriding



Source: Navigant analysis

[73] The correlation coefficient between the end time of the Peak Event and opt-outs and overrides was 0.33 and 0.50, respectively.

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Navigant looked at how the Peak Event load reductions differed over back-to-back events in 2016.[74] As shown in Table 3-4, the first day of a back-to-back event had average savings of 9% across all technology/price groups while subsequent days averaged 6%. The effect was slightly stronger for the lower technology groups as compared to the groups with PCTs (Level 3 and 4).

Table 3-4. Average Percentage Peak Event Load Reductions during Back-to-Back Peak Events

Technology/Price Group	Level 1 CPP Passive	Level 1 PTR Passive	Level 1 CPP Active	Level 1 PTR Active	Level 2 CPP	Level 2 PTR	Level 3 CPP	Level 4 CPP	Level 4 PTR	Weighted Average
First Day of a Back-to-Back Event	6%	7%	17%	12%	20%	6%	26%	30%	29%	9%
Subsequent Days (2-5) of a Back-to-Back Event	2%	3%	13%	8%	16%	1%	26%	28%	27%	6%

Source: Navigant analysis

3.1.2 Impacts by Event Hour

To assess the event impacts by hour, Navigant created graphs of average usage on each event day for each technology/price group. Figure 3-7 shows one such graph for Level 3 CPP for the first event on June 23rd, 2015. The x-axis plots the hours of the day, and the event period is highlighted in red. Usage is plotted on the primary y-axis with actual usage as the solid black line and fitted baseline usage as the dotted blue line. The 90% confidence interval on the adjusted fitted baseline during the event period and snapback period is shown in the lighter blue dot-dash lines. Temperature is plotted on the secondary y-axis as the dotted grey line. Similar graphs are available for each event for each technology and price plan group in the separately attached Appendix F for residential customers and Appendix G for commercial customers.

[74] Back-to-back events were defined as those where a Conservation Day occurred on two or more consecutive days. Conservation Days that spanned over a weekend, i.e., when a Peak Event was called on a Friday and the following Monday (the next day that was eligible for an event), were not counted as back-to-back.

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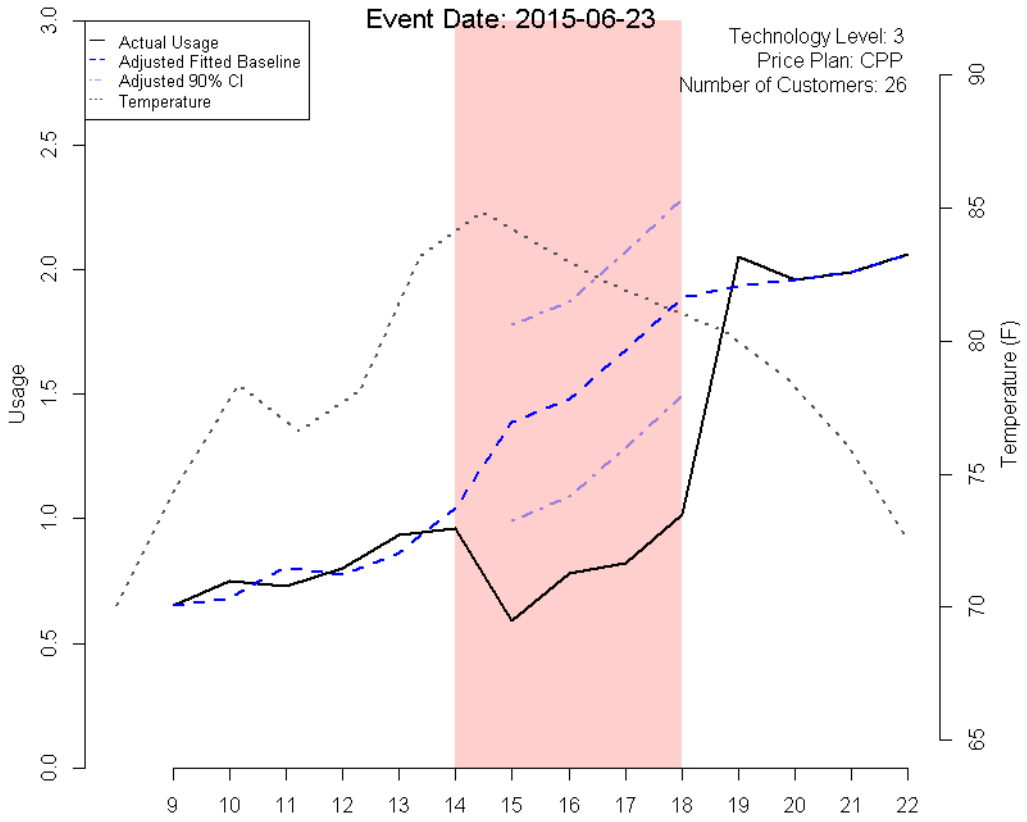
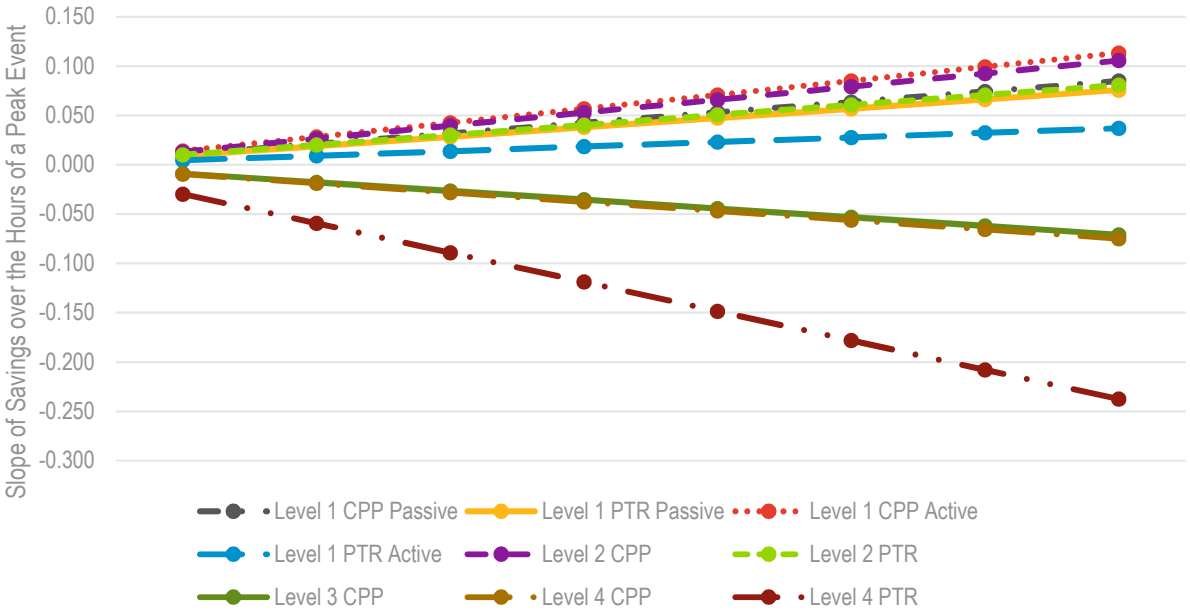
Figure 3-7. Level 3 CPP Actual and Baseline Usage on 2015-06-23



Source: Navigant analysis

To summarize how the load reductions changed through the hours of a Peak Event, Navigant calculated the average slope of the load reduction across the Peak Event hours for each technology/price group (i.e., the slope of the difference between the dotted blue line and the solid black line during Peak Events such as that shown in Figure 3-7). This analysis shows whether the impacts, on average across all the Peak Events, increased, decreased, or stayed the same throughout the hours of a Peak Event. Figure 3-8 shows lines with the same slope as the change in load reductions over the hours of a Peak Event for each technology/price group. The three groups with PCTs had slightly negative slopes, indicating that the impacts degraded a small amount over the hours of a Peak Event. All the other groups had slightly positive slopes indicating the impacts grew slightly over the hours of a Peak Event. Despite these trends by technology/price group, in general, across the groups, the slopes of the impacts were small indicating that savings only grew or fell a small amount over the hours of a Peak Event.

Figure 3-8. Savings Persistence Over the Course of a Peak Event



Source: Navigant analysis

3.1.3 Impacts by Demographic Subgroup

Impacts were estimated for 26 residential demographic subgroups as indicated by shading in Table 3-5.[75] Graphs similar to Figure 3-7 are provided in the separately attached Appendix H for each of the events for each demographic subgroup. A threshold of 100 customers was used to decide whether there was enough data to estimate results for a demographic subgroup.[76] Navigant made an exception to that threshold to estimate impacts for low-income customers in Level 1 CPP active and Level 2 CPP. Additionally, renter data was only collected in 2016 and so only one year of impacts was analyzed for those subgroups.[77]

Across all the subgroups only three had statistically significant differences in Peak Event impacts from the group as a whole: low-income customers in Level 2 CPP and renters in Level 1 CPP (both active and passive) had lower impacts than those technology/price groups as a whole. Impacts for low-income customers were also estimated for active and passive customers in Level 1 CPP, but for each of those groups no statistically significant difference was found between low-income customers and the group as a whole. Since 87% of all Pilot participants were in the Level 1 CPP groups we know that most of the low-income customers had the same impacts as other customers. Impacts for renters were also estimated for Level 2 CPP and while the differences were not statistically significant, impacts for renters were

[75] Navigant did not estimate commercial customer impacts by demographic subgroup because the overall group size was too small to yield statistically significant results.

[76] A threshold of 100 was used to ensure a chance of statistical significance in the results.

[77] Renters were not included as a demographic subgroup in National Grid's original smart grid pilot evaluation plan (D.P.U. 11-129 Exhibit EHW-3. December 22, 2011). National Grid and the evaluation team chose to add this group in 2016.

consistently lower than for the group as a whole, as in Level 1.

Table 3-5. Peak Event Impact Estimation Groups in 2015/2016[78]

Technology/ Price Group		Non-Low Income			Low Income	High Income	Seniors	Small Home	Large Home	Renter
		Low Use	Medium Use	High Use						
Level 1: Web Portal Only	CPP - Active	297/438	640/905	142/154	88/101	212/269	189/202	481/889	24/28	427
	CPP - Passive	2,071/ 2,165	3,874/ 3,887	818/732	1,096/ 860	1,287/ 1,219	1,922/ 1,527	3,566/ 4,486	156/149	2,313
	PTR – Active	21/17	39/42	6/8	7/6	12/14	7/13	22/38	0/0	18
	PTR - Passive	110/61	146/110	33/30	65/60	37/47	85/80	122/186	3/4	78
Level 2: IHD	CPP	75/112	334/391	76/76	76/63	143/156	98/96	185/285	11/12	104
	PTR	3/1	16/15	7/5	5/3	4/8	6/3	11/10	1/1	1
Level 3: PCT	CPP	3/4	20/21	2/3	1/0	12/10	7/8	9/12	1/1	4
	PTR	0/0	1/1	0/0	0/0	1/1	0/0	0/0	0/0	0
Level 4: Tech Combos	CPP	25/26	151/164	44/42	13/9	91/103	37/34	68/87	20/18	13
	PTR	1/1	9/7	3/2	3/1	4/5	0/0	4/3	0/0	1

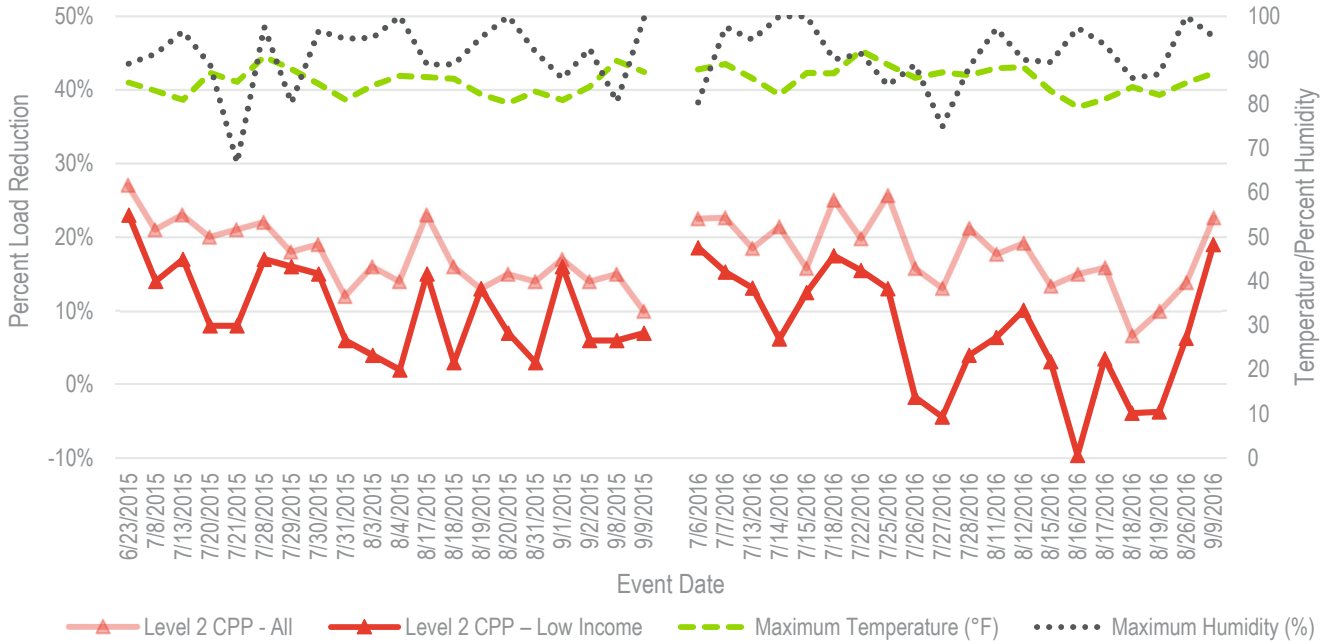
Source: Navigant analysis
Note: The first number in each box shows the sample size in 2015 while the second shows 2016, except for the renter demographic subgroup where data was only collected in 2016. Because of the change in the number of customers, impacts were only estimated for passive low use customers in Level 1 PTR in 2015 and for low use customers in Level 2 CPP in 2016; all other shaded demographic subgroups were estimated in both years.

Impacts for Low-Income Customers

Figure 3-9 shows the average percentage impact for each event for low-income customers and all customers in Level 2 CPP. In 2015, the impact for low-income customers averaged 10% compared to 17% for the group as a whole. The difference grew in 2016, with low-income customers averaging 7% compared to 18% for the group as a whole. For each event across both summers, low-income customers had lower savings than the group as a whole.

[78] The customer counts in this table differ slightly from the customers count in Table 2-3 due to small differences in the logic used to include customers in the impact analysis versus in the survey. For example, customers who went inactive during the summer of 2015 were not included in the survey sample but they were included in the impact analysis up until their account went inactive.

Figure 3-9. Event Savings for Low-Income Customers in Level 2 CPP



Source: Navigant analysis

There are several possible explanations for why low-income customers would save less than other customers:

1. Central air conditioning (CAC) penetration may be lower among low-income customers;
2. Low-income customers may have less discretionary energy usage and thus less energy to save;
3. Low-income customers may have been less able to shift their usage than other residential customers; or
4. The finding may be an anomaly, given that two of the three technology/price groups for which low-income customers were analyzed did not show statistically significant differences.

The next several paragraphs go through the first three hypotheses sequentially. For each hypothesis, we first explain it in more detail and then discuss what, if anything, we were able to do to assess its likelihood. The fourth explanation is not discussed in more detail since we cannot assess its likelihood.

Lower CAC penetration for the low-income customers: For example, low-income customers may be more likely to have window AC units rather than CAC. To further examine this possibility, Navigant identified customers likely to have CAC in Level 2 CPP as described in Section A.2 of APPENDIX A. Navigant then estimated the demand impacts during Peak Events for each summer for four income/CAC groups within Level 2 CPP: standard-income customers with CAC, low-income customers with CAC, standard-income customers without CAC, and low-income customers without CAC. For customers with and without CAC, the demand impacts were lower for low-income customers than standard-income customers in both percentage and absolute terms in 2015, as shown in Table 3-6. In 2016, the impacts for low-income customers without CAC rose substantially, and were higher than for standard-income customers, but the group of customers was quite small. This means that although CAC penetration may have been lower for low-income customers, it appeared that low-income customers had lower percentage demand savings

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regardless of the presence of CAC in 2015 but they may have done better than standard-income customers without CAC in 2016. The customers in Level 2 had IHDs but not PCTs; it is possible that with a PCT the disparity between low-income and other residential customer impacts would diminish.

Table 3-6. Demand Impacts for Level 2 CPP by Income and CAC

		2015			2016		
Income	CAC	Customer Count	Percentage Impacts	Absolute Impacts	Customer Count	Percentage Impacts	Absolute Impacts
Standard-Income	Y	284	20%	0.267	249	20%	0.286
Low-Income	Y	37	9%	0.143	23	6%	0.090
Standard-Income	N	164	18%	0.152	148	14%	0.126
Low-Income	N	35	11%	0.110	21	24%	0.235

Source: Navigant analysis

Low-income customers may have less discretionary energy usage and thus less energy to save: The lower impacts may be due to a tendency to have less discretionary energy usage and thus less energy to save, which is a common result found in evaluation.[79] Low-income customers are likely to already be conscious of their energy usage and its impact on their budget and thus may have been conserving more energy than other customers before the Pilot. Since they are already engaging in conservation behaviors, they have fewer improvements that they can make.

Low-income customers may have been less able to shift their usage than other residential customers: This was a concern when designing the Pilot and although, according to the pre-pilot and end of pilot surveys, low-income customers indicated that they could effectively shift their usage (see Figure 4-3 and Figure 4-4), it is possible that they over-estimated their ability to adjust their usage. Low-income customers may have had medical conditions that required them to run equipment throughout the day, such as HEPA air filters. They may also be more likely to live with children or elderly family members who were home during Peak Events and needed to stay comfortable, making them less able to adjust their AC usage.[80] As reported in the focus groups, some low-income customers may also have had shift work that caused them to be home during the day.

After exploring these possibilities, it seems unlikely that lower CAC penetration drove the lower savings for low-income customers. Low-income customers have lower energy usage overall than other customers which could mean they have less discretionary usage to cut but we do not have conclusive evidence of this. The focus group discussions lend anecdotal evidence to the possibility that low-income customers have more barriers to shifting usage than other customers, but the focus groups were not large enough to

[79] See for example IEE Whitepaper (2010). *The Impact of Dynamic Pricing on Low Income Customers*.

[80] The low-income focus groups suggested that some low-income customers experience these conditions but the sample sizes were not large enough to conclude that these conditions are more prevalent for low-income customers than for residential customers in general.

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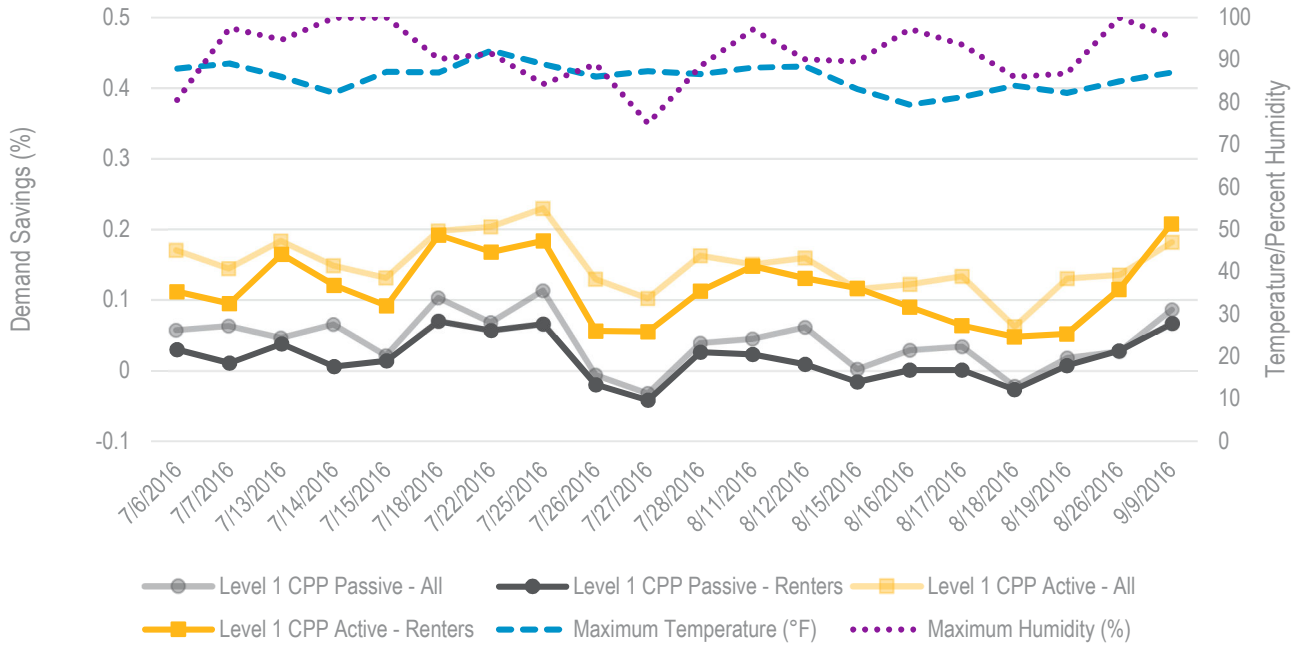
be considered conclusive. Finally, it is impossible to rule out the possibility that this result for Level 2 was simply an anomaly and that on the whole low-income customers in the Pilot are achieving results similar to other residential customers. This is supported by the finding that impacts for low-income customers were not statistically different from other customers in Level 1 CPP.

Impacts for Renters

Figure 3-10 shows the average percentage impact in each Peak Event for renters and all customers in Level 1 CPP, both active and passive, in 2016. Over all the events, the impact for passive renters averaged 2% compared to 4% for the group as a whole, and the impact for active renters averaged 12% compared to 15% for the group as a whole. For each event in each group, the average savings for renters were no more than for the group as a whole. Impacts for renters were also estimated for Level 2 CPP and while the differences in that group were not statistically significant, the same pattern was evident in that renters had lower impacts than the group as a whole. The lower savings for renters as compared to other customers likely stems from the particular challenges renters face in conserving electricity. For example, renters may or may not pay their own electric bill and they often have to get landlord permission for many conservation activities (such as buying new appliances).

Figure 3-10. Event Savings for Renters in Level 1 CPP



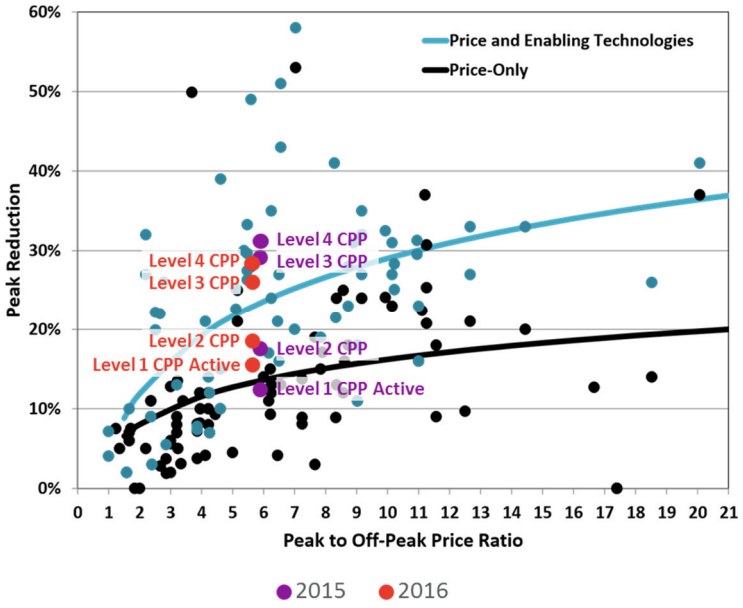
Source: Navigant analysis

3.1.4 Price Responsiveness

For the residential customers on the CPP price plan, Navigant was able to estimate the price responsiveness at each technology level. As shown in Figure 3-11, the level of price responsiveness for active customers was similar to that of other pricing programs. The figure shows Faruqui and Sergici's (2013) arc of price responsiveness, which is based on 137 pricing treatments in 34 programs worldwide; the Pilot price responsiveness is plotted in purple for 2015 and red for 2016 for each of the four active

CPP groups.[81] The arc plots the percentage peak reduction in electricity usage for various peak to off-peak price ratios for programs with and without enabling technologies. Although the off-peak and critical peak prices changed between the 2015 and 2016 summers, the peak to off-peak price ratio was approximately six in both years (note: 2016 is staggered just slightly to the left of 2015 for ease of viewing, but the ratio was actually the same in the two years).[82] The responsiveness for active customers in Level 1 was right at the average for price-only programs in 2015 and rose slightly in 2016. Level 2 was between the average for programs with and without enabling technologies in both years, which was expected given that an IHD is a relatively low-level enabling technology. Levels 3 and 4 were slightly above the average for programs with enabling technologies in both years, though slightly lower in 2016 than in 2015; both years fell well within the range seen at a peak to off-peak ratio of six.

Figure 3-11. Arc of Price Responsiveness for Active CPP Customers



Source: Faruqui and Sergici (2013) and Navigant analysis
Note: 2016 is staggered just slightly to the left of 2015 for ease of viewing, but the ratio was actually the same in the two years.

3.2 Energy Impacts

In order to calculate residential energy impacts, the evaluation team selected a group of matched control customers from a large pool of non-participant households that had similar patterns of energy usage in a 12-month period before the Pilot started to provide the counter-factual usage if the Smart Energy Solutions participants had not been in the Pilot.[83] The 12-month matching period went from September 2012 to August 2013, leaving a 4-month test period from September 2013 to December 2013 to ensure

[81] Faruqui, Ahmad and Sergici, Sanem, Arcturus: International Evidence on Dynamic Pricing (July 1, 2013). Available at SSRN: http://ssrn.com/abstract=2288116.

[82] Prices for the Pilot rates and the Basic Rate are shown in Table A-1 and Table A-2 in APPENDIX A.

[83] To avoid the issue of control customers moving out, only controls who had billing data through the end of the 2016 were used.

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that the matches were performing well (i.e., continued to have usage similar to the participants) outside of the matching period but before the program started. Regression analysis of monthly billing data using the participants and matched controls was then used to estimate the annual reduction in energy usage, controlling for weather, for 2014 and the reduction by month in 2015. A detailed description of the methodology, along with graphs showing the quality of the matches, is included in APPENDIX A.[84]

Overall, active CPP participants[85] achieved an average load reduction of 4.3% in 2015 and 6.3% in 2016, which averaged to 5.4% over the whole Pilot. This means the Pilot exceeded the GCA goal of achieving a 5% average load reduction for active customers.

3.2.1 2015 & 2016 Impacts

Figure 3-12 shows the average percentage energy impacts with 90% confidence intervals for CPP customers in different technology levels in 2015 and 2016. Navigant also examined energy savings for PTR customers but did not find any significant savings; PTR customers were not expected to achieve significant energy savings because they did not pay TOU rates. In both years, energy savings for active participants were highest for Level 2 customers (43 kWh per month in 2015 and 55 in 2016) and lowest for Level 4 customers (13 kWh per month in 2015 and 11 in 2016). Active Level 1 customers saved 24 kWh per month in 2015 and 39 in 2016, and Level 3 customers saved 39 kWh per month in 2015 and 10 in 2016. Although the point estimates of energy savings changed from 2015 to 2016, the changes were not statistically significant, indicating that the energy savings were similar across the two years of the Pilot. It is unclear why Level 4 customers saved less than Level 3 customers in 2015 since the two groups had similar technologies; however, the 90% confidence bounds for the two estimates overlap and the sample sizes are relatively small for monthly billing analysis, which may have contributed to the discrepancy. Additionally, the discrepancy disappeared in 2016 when the point estimate for Level 3 customers fell considerably. The estimates of energy savings for passive customers in Level 1 were very small and not statistically significant in either year.

[84] Navigant did not estimate energy impacts by demographic subgroup because there was not enough data to do billing analysis on these smaller groups. Given that there were few differences in demand savings across the demographic subgroups it is unlikely that there were differences in energy savings.

[85] Energy savings, or average load reductions, were neither expected nor found for PTR customers as these customers were not on a TOU rate and thus did not have a financial incentive to save energy outside of Peak Events.

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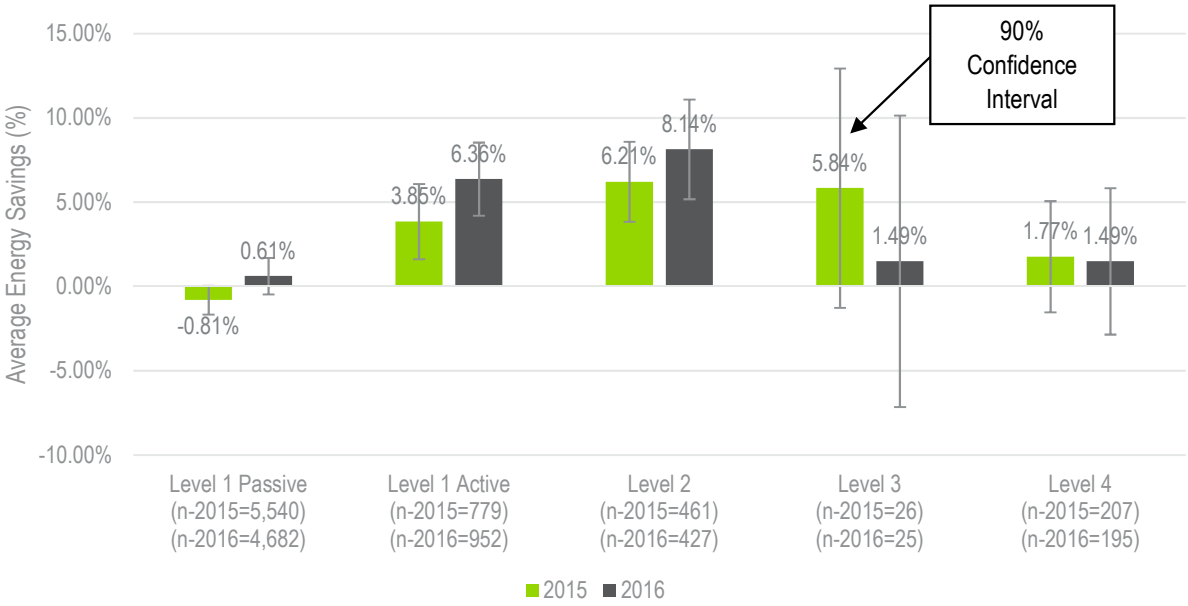
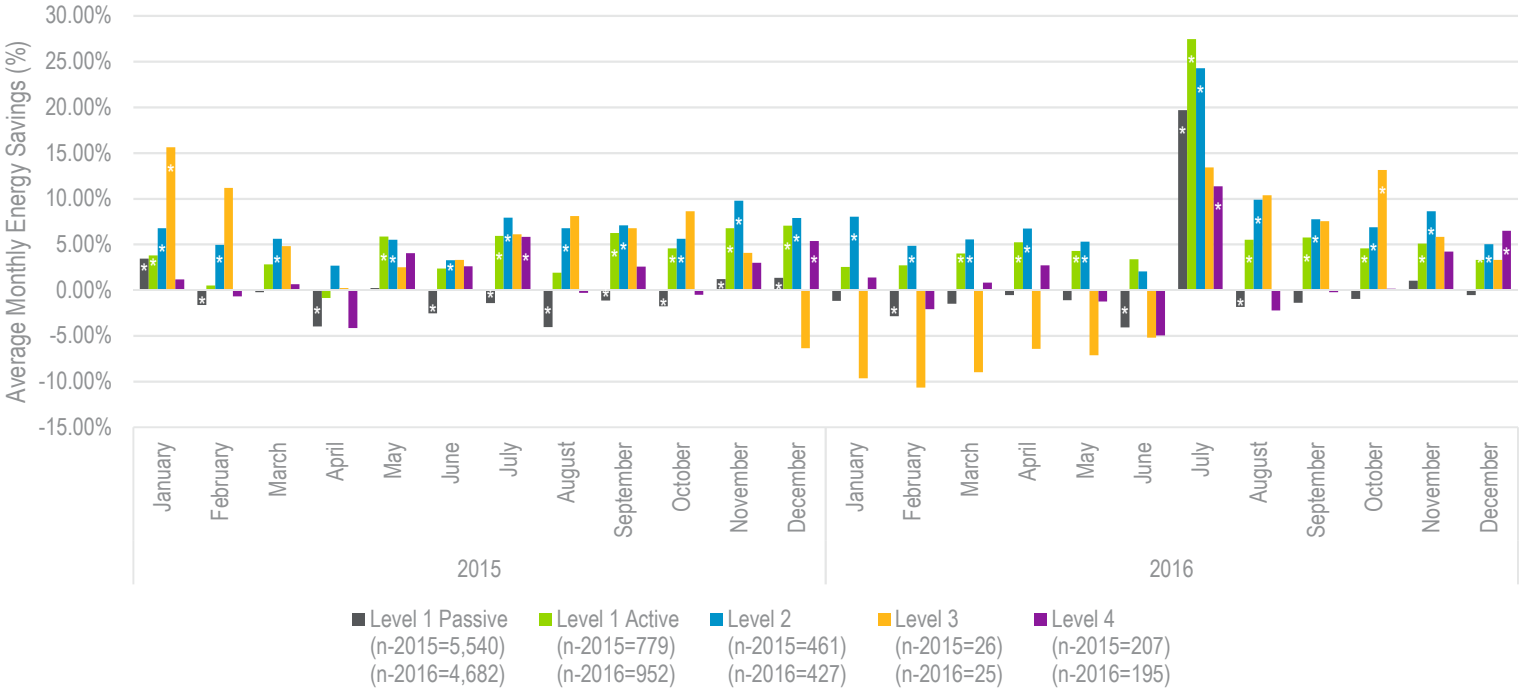
Figure 3-12. Average Energy Impacts for CPP Customers by Technology Level



Source: Navigant analysis
Note: n refers to the number of customers used in this particular analysis, not the total number of customers in each technology/price group.

Energy savings by month and year for each technology level are shown in Figure 3-13. This shows that for most of the groups there were energy savings in almost every month. Level 3 customers showed negative savings in the first half of 2016, but this group was very small (only 25 customers) and these estimates were not statistically significant. Notably July, August, and September of both years, which cover the period when the summer Peak Events were being called, showed energy savings for almost all of the active customers (and the few negative estimates were not statistically significant). Energy savings for all of the groups spiked considerably in July 2016, which may have occurred because that month had 11 events (8 events was the next highest in a single month, occurring in both August 2016 and July 2015). Active customers in Level 1 and Level 2 had significant savings in most of the months of the Pilot. There were not obvious seasonal patterns in energy savings across the five CPP customer groups.

Figure 3-13. Average Monthly Energy Impacts for CPP Customers by Technology Level



Source: Navigant analysis
Note: White asterisks (*) indicate statistical significance at the 90% confidence level. n refers to the number of customers used in this particular analysis, not the total number of customers in each technology/price group.

Navigant examined the billing data from July 2016 thoroughly to ensure that the spike in savings in that month was not driven by an error in the data. Navigant did find that participant usage dipped in that month compared to the matched controls' usage. However, there was no evidence suggesting that the dip was due to erroneous data as opposed to an actual drop in usage, i.e. energy savings.[86]

Navigant attempted to break down the energy impacts by demographic subgroups but the sample sizes were simply too small to draw any conclusions.

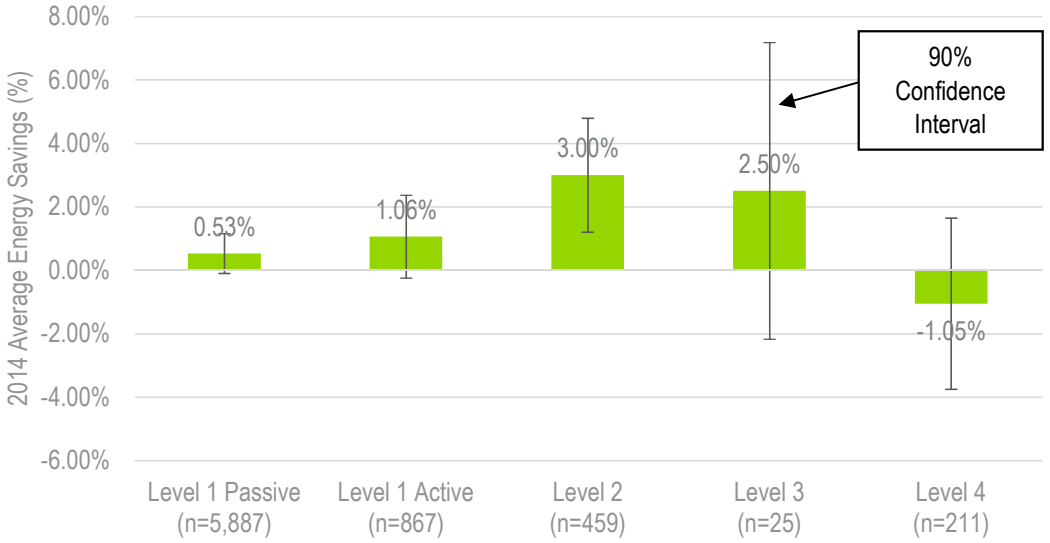
3.2.2 2014 Impacts

Figure 3-14 shows the energy savings from the Pilot in 2014 with 90% confidence intervals. In 2014, only the information portion of the Pilot was in effect—i.e., customers knew the Pilot was coming and technologies were available for those who wanted them. However, there were no price changes or Peak Events. Energy savings were statistically significant at the 90% level for Level 2 CPP customers, who saved 3.00%. Savings were positive, but statistically insignificant, for active and passive Level 1

[86] There was not a drop in the number of customers or observations recorded in this month. Additionally, there was not an increase in observations of zero or negative usage for participants, nor was there a spike in high outliers for matched controls. Finally, usage was not outside the bounds of recorded usage: from 2014 to 2016 average monthly usage ranged from 16 to 26 kWh per day, usage for participants in July 2016 was 18 kWh per day while usage for matched controls was 22 kWh per day.

customers and for Level 3 customers, and negative, but statistically insignificant for Level 4 customers. For passive customers in Level 1 the savings were too small to see a statistically significant effect, and for the other three groups the relatively small sample sizes for billing analysis contributed to the statistical insignificance of the effects.

Figure 3-14. Energy Savings in 2014 by Technology/Price Group



Source: Navigant analysis
Note: n refers to the number of customers used in this particular analysis, not the total number of customers in each technology/price group.

3.3 Bill Savings

Navigant calculated bill savings separately for Pilot participants on the CPP and PTR rates. To estimate the monthly bill impacts of the Pilot for CPP customers, Navigant calculated the bill amount using actual usage under the Smart Rewards TOU pricing rates and the counter-factual bill amount in absence of the Pilot using counter-factual usage under the Basic Rate. Counter-factual usage accounted for the energy savings estimated in Navigant's analysis. For PTR customers, the bill savings were due to the rebates paid by National Grid during Peak Events since these customers were not on the TOU rate. The rebate was calculated by subtracting the actual electricity consumed during Peak Events from the counter-factual consumption during Peak Events (defined as average usage during the ten prior non-holiday, non-Conservation Day weekdays after accounting for a day-of adjustment to capture weather differences, time of event, pre-cooling, etc.) and multiplying by the rebate amount in cents per kWh. These methods are detailed in APPENDIX A.

Table 3-7 shows savings for CPP and PTR customers in both years of the Pilot with the Peak Event hours that were actually called (135 in 2015 and 139 in 2016) and if the maximum of 175 Peak Event hours had been called (based on the average savings per event hour). Considering the actual number of Peak Events called, customers on both rates saved less in 2016 than in 2015 but the drop was more pronounced for CPP customers. The reduction in 2016 compared to 2015 occurred despite the increase in energy savings for CPP customers. Increases in energy savings do not necessarily produce increases in bill savings because of the high price during Peak Events. For example, the highest energy savings

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occurred in July 2016, but that did not produce high bill savings in that month because eleven Peak Events were called, increasing bills for many customers. If 175 Peak Event hours had been called, PTR customers would have earned more savings in rebates but CPP customers would have had slightly lower bill savings as their bills would increase due to more hours being charged at the higher Peak Event period rate.

Table 3-7. Bill Savings by Price Plan

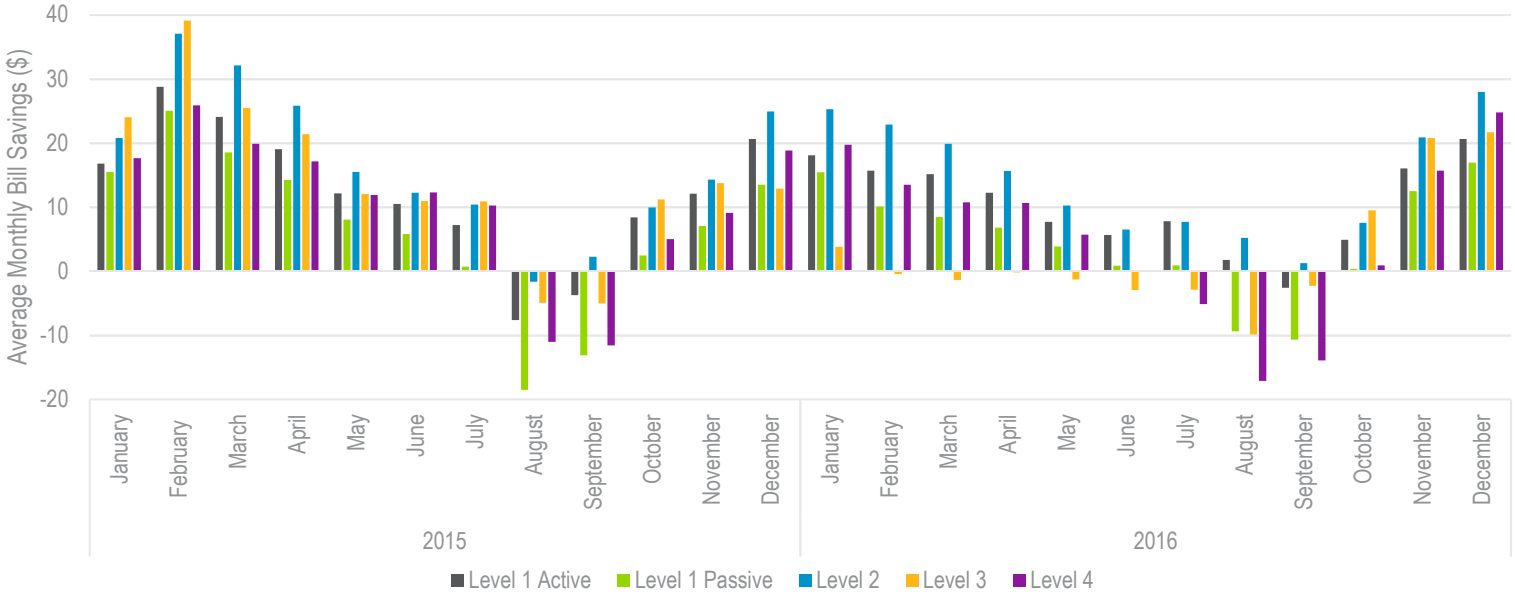
	2015		2016	
	With 135 Peak Event Hours	With 175 Peak Event Hours	With 139 Peak Event Hours	With 175 Peak Event Hours
CPP	$146	$142	$90	$87
PTR	$20	$26	$19	$25

Source: Navigant analysis

3.3.1 CPP Customers

Figure 3-15 shows the average bill savings by month and year for CPP customers. The month of each bill is defined as the last day of the billing period. This means that on average bills in each month contain an equal number of days in the current month and the previous month, for example bills in May reflect usage in the second half of April and the first half of May. On average across technologies, bill savings were highest in February 2015, which reflects January and February 2015 usage, when customers were still adjusting to the new TOU rate. Customers' bills went up in August and September of each year, reflecting usage in July, August, and September, which is expected since July and August were when the majority of the Peak Events were called in each year. Savings followed a similar pattern in both years, peaking in winter (through December, January, and February) and bottoming out during the summer months with Peak Events.

Figure 3-15. Average Bill Savings for CPP Customers



Source: Navigant analysis

Average per-customer bill savings are shown by year in Table 3-8. Savings were lower for each group in 2016 than in 2015. This occurred partially because the difference between the Basic Rate and the CPP rates fell in 2016 compared to 2015. In the summer of 2015 the CPP peak period rate was 0.40¢ less than the Basic Rate and the off-peak rate was 1.94¢ less, whereas in the summer of 2016 the peak period rate was 0.34¢ less than the Basic Rate and the off-peak rate was 1.66¢ less. The price during Peak Events fell from 34.29¢ more than the Basic Rate in 2015 to 29.33¢ more in 2016.

Table 3-8. Bill Savings for CPP Customers by Technology Group

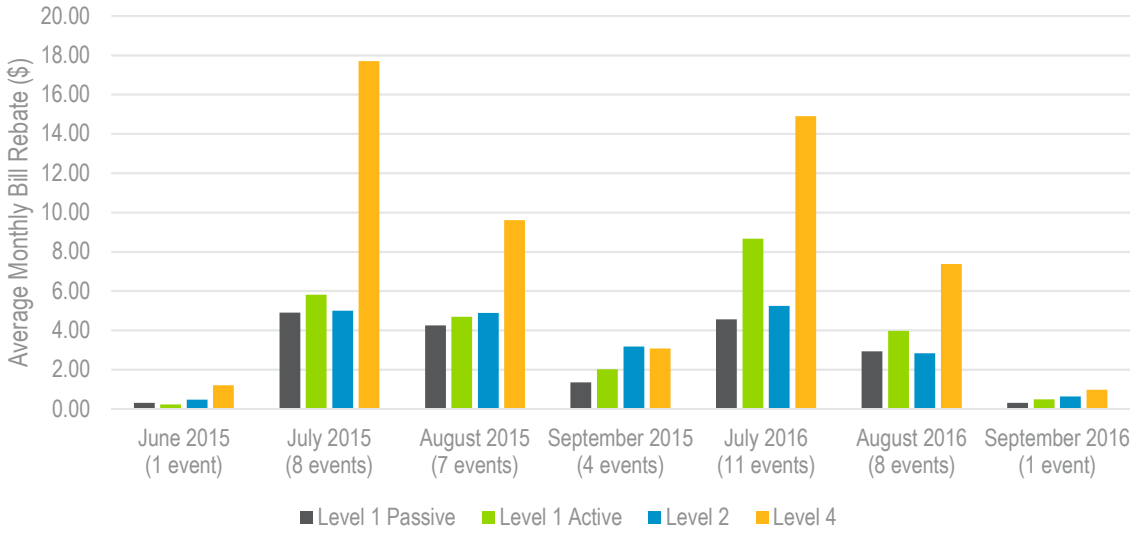
	2015	2016
Level 1 Passive	$79	$56
Level 1 Active	$148	$123
Level 2	$204	$171
Level 3	$172	$35
Level 4	$125	$66

Source: Navigant analysis

3.3.2 PTR Customers

The bill savings for PTR customers came from the monthly rebates earned during Peak Events.[87] Figure 3-16 shows the average bill rebates by month and year for PTR customers. The average total rebate for events called during the summer of 2015 was $10.80 and the average for 2016 was lower at $7.80. Table 3-9 shows the average savings per event in each year.

Figure 3-16. Average Bill Rebates for PTR Customers



Source: Navigant analysis

[87] Energy savings were neither expected nor found for PTR customers and thus changes in usage outside of Peak Events do not enter into our calculations of bill savings.

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Table 3-9. Rebate Paid per Event for PTR Customers by Technology Group

	2015	2016
Level 1 Passive	$0.54	$0.39
Level 1 Active	$0.64	$0.66
Level 2	$0.68	$0.44
Level 4	$1.58	$1.16

Source: Navigant analysis

3.3.3 Arrearage Analysis

As a complement to the bill savings analysis, the evaluation team calculated credit and collection results for Pilot participants and other customers in Worcester. Comparisons between the two groups included the following metrics:

- End of Pilot arrears balances and customer counts for 30/60/90+ day periods;
- End of Pilot arrears balances and customer counts for accounts flagged as medical or life support, and therefore not subject to disconnections;
- Disconnection service history before and during the Pilot; and,
- Uncollectible account history before and during the Pilot.

Navigant found that the Pilot did not have a large impact on any of these four metrics. Overall compared to Worcester customers not in the Pilot, a smaller portion of the Pilot participants had disconnections or uncollectible balances. However, this was true in 2014, before the Pilot began, as well as during the Pilot in 2015 and 2016. A similar percentage of customers within and outside of the Pilot had arrears balances. The average dollar amounts per customer with arrears, disconnects, or uncollectible balances were also similar for Pilot and non-Pilot customers. Tables showing analysis of each of these metrics are presented in APPENDIX B.

3.4 Load Shifting

The regressions from which Navigant estimated Peak Event impacts, which covered June to September of each year, also included coefficients to estimate three types of load shifting:

1. **Load shifting around Peak Events,** including pre-cooling, wherein customers change their energy usage before a Peak Event, and snapback, wherein customers change their energy usage after a Peak Event. In 2015, evidence of pre-cooling in the Pilot was not found and thus pre-cooling was left out of the final regression specification. However, some customers did report using pre-cooling as a strategy to save energy in the surveys, especially in 2016 (see Figure 4-17).
2. **Load-shifting from weekdays to weekends**.
3. **Non-event peak impacts,** in which customers shift usage on weekdays that are not Conservation Days from peak to off-peak hours.

Snapback was estimated for each Peak Event while the other two types of load shifting ware estimated on average for each summer.

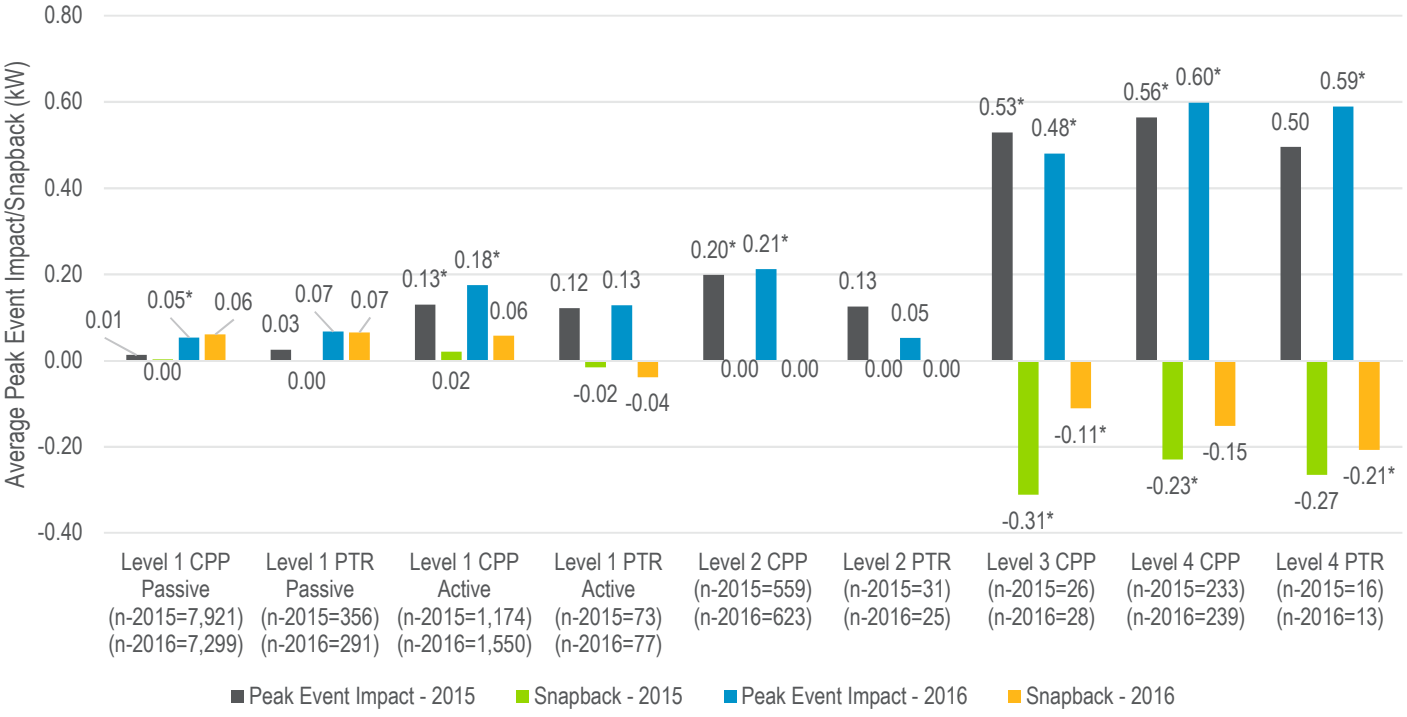
CPP customers were expected to exhibit all three types of load shifting as they were on a TOU rate and thus had an incentive to be price-conscious and shift usage to lower-cost times of the day and week, i.e. off-peak hours and weekends. Load shifting contributed to bill savings for CPP customers. PTR customers may exhibit load shifting around Peak Events as they could earn money back if they reduce usage during Peak Events hours, but they did not have a strong incentive to shift loads from weekdays to weekends or from peak to off-peak hours on days that were not Conservation Days as they were not charged a TOU rate. Overall, Navigant found that each type of load shifting was: (1) small compared to the Peak Event impact, (2) mostly larger for CPP than PTR customers as expected, and (3) mostly larger for customers with higher levels of technology.

Statistically significant load shifting effects were not found for commercial customers in any of the three categories, thus the following subsections focus on residential customer impacts.

3.4.1 Snapback

Figure 3-17 shows the average Peak Event impact and snapback for each residential technology/price group. The overall result is that for this Pilot snapback was not very prominent.

Figure 3-17. Snapback Compared to Peak Event Impacts



Source: Navigant analysis
Note: Negative values for snapback in this graph indicate an increase in usage in the hours after peak events. An asterisk (*) indicates that the majority of the event or snapback hours throughout the summer were statistically significant for the indicated group. Also, n refers to the number of customers used in this particular analysis, not the total number of customers in each technology/price group.

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For Level 1 and 2 customers in both price groups there was hardly any snapback in either year. In fact, for Level 2 customers in both price groups there was no snapback found for any of the Peak Events. For Level 1 customers, Navigant actually found that customers continued to save electricity even after the Peak Event had ended. This may be evidence that these customers, who have no enabling technologies, were making changes during events that they did not stop immediately at the end of the event. This phenomenon can be seen in the graphs provided in Appendix F.

Snapback was more prominent for Level 3 and Level 4 customers. For these groups, snapback was slightly lower in 2016 than in 2015 which could be due to increased awareness of and familiarity with the Pilot in the second year. The disparity in snapback across the different technology levels was almost certainly driven by PCTs which Level 3 and 4 customers had, but Level 1 and 2 customers did not. The smart thermostats were adjusted remotely by National Grid during Peak Event hours and then returned to the user-defined temperature once the Peak Event ended. The snapback observed for customers with these thermostats was likely from the HVAC system working hard to cool the home after running less than usual during Peak Event hours.

Even for Level 3 and 4 customers where significant snapback was observed it was relatively small in magnitude and short in length. On average for Level 3 and 4 customers, the snapback was about half the magnitude of the Peak Event impact. Additionally, snapback generally lasted less than two hours, which is fairly short, especially given the long length of the Peak Events. Tables with snapback for each Peak Event are provided in APPENDIX B.

3.4.2 Weekday to Weekend Load Shifting

CPP customers had an incentive to shift their usage from weekdays to weekends in order to avoid paying the higher peak time rate that ran from 8 a.m. to 8 p.m. on weekdays. PTR customers may have had an incentive to shift usage to weekends when Peak Events were being run during the week, but the incentive was much smaller as they were not charged the TOU rate. Additionally, the Pilot may have caused them to form habits which involved shifting their energy intensive activities to times when Peak Events would definitely not be called.

Figure 3-18 shows the average Peak Event impact and the average shift of usage from weekdays to weekends for each residential technology/price group in each summer (June to September) of the Pilot. For CPP customers some load shifting to weekends was observed for each technology level. The magnitude of the shifting was relatively similar across the two years of the Pilot. PTR customers did not exhibit a statistically significant load shift at any technology level. The disparity in weekday to weekend load shifting between the two rates is not surprising given the different incentives for customers on each rate discussed in the previous paragraph.

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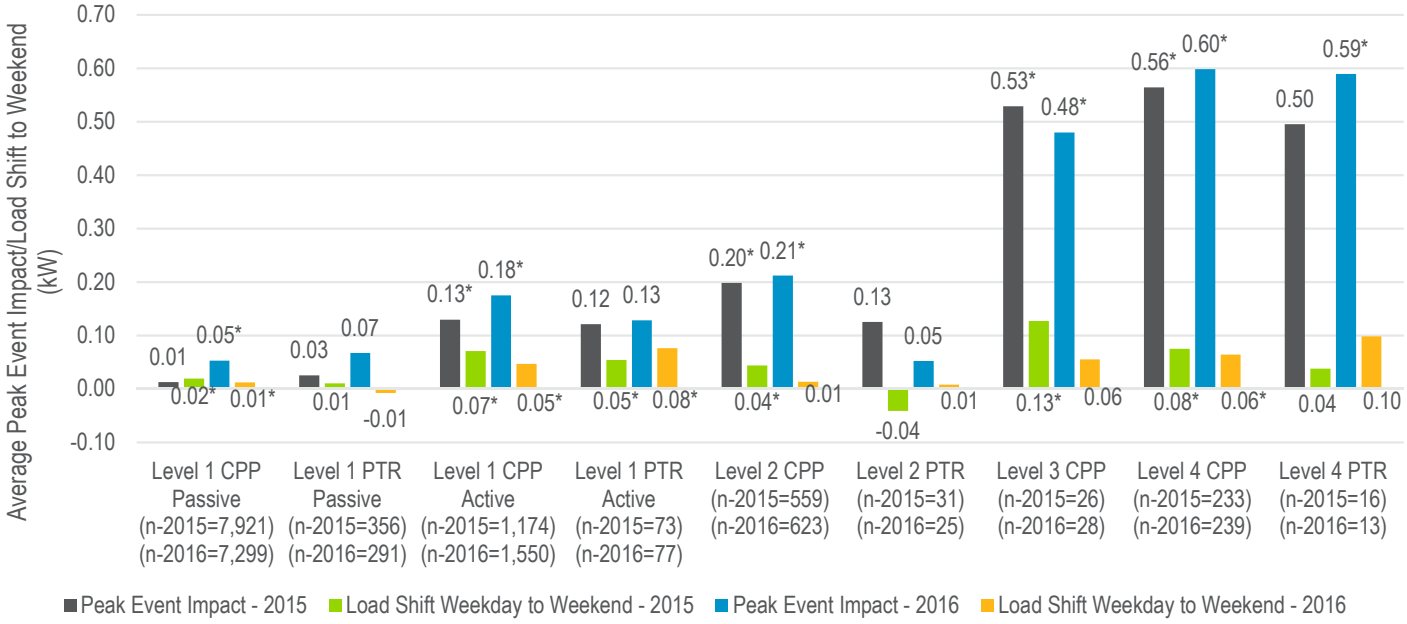
Figure 3-18. Weekday to Weekend Load Shifting Compared to Peak Event Impacts



Source: Navigant analysis
Note: Positive numbers for load shift in this graph indicate a decrease in weekday usage and an increase in weekend usage. An asterisk (*) indicates that the majority of the hours throughout the summer were statistically significant for the indicated group. Also, n refers to the number of customers used in this particular analysis, not the total number of customers in each technology/price group.

3.4.3 Non-Event Peak Impacts

CPP customers had an incentive to shift their usage from peak hours to off-peak hours, even in the absence of a Conservation Day, since electricity was cheaper for them during off-peak (8 pm to 8 am) hours. PTR customers had no monetary incentive to shift usage to off-peak hours on days that were not Conservation Days, but the Pilot may have caused them to form habits which involved shifting their energy intensive activities to times when Peak Events would definitely not be called.

Figure 3-19 shows the average Peak Event impacts and the average non-event peak impacts for each residential technology/price group for each year. For CPP customers there were non-event peak impacts at each technology level in both years, although they were generally smaller in 2016 than in 2015. Level 4 customers on the PTR rate showed non-event peak impacts of practical significance in 2015, but the effect dissipated in 2016.

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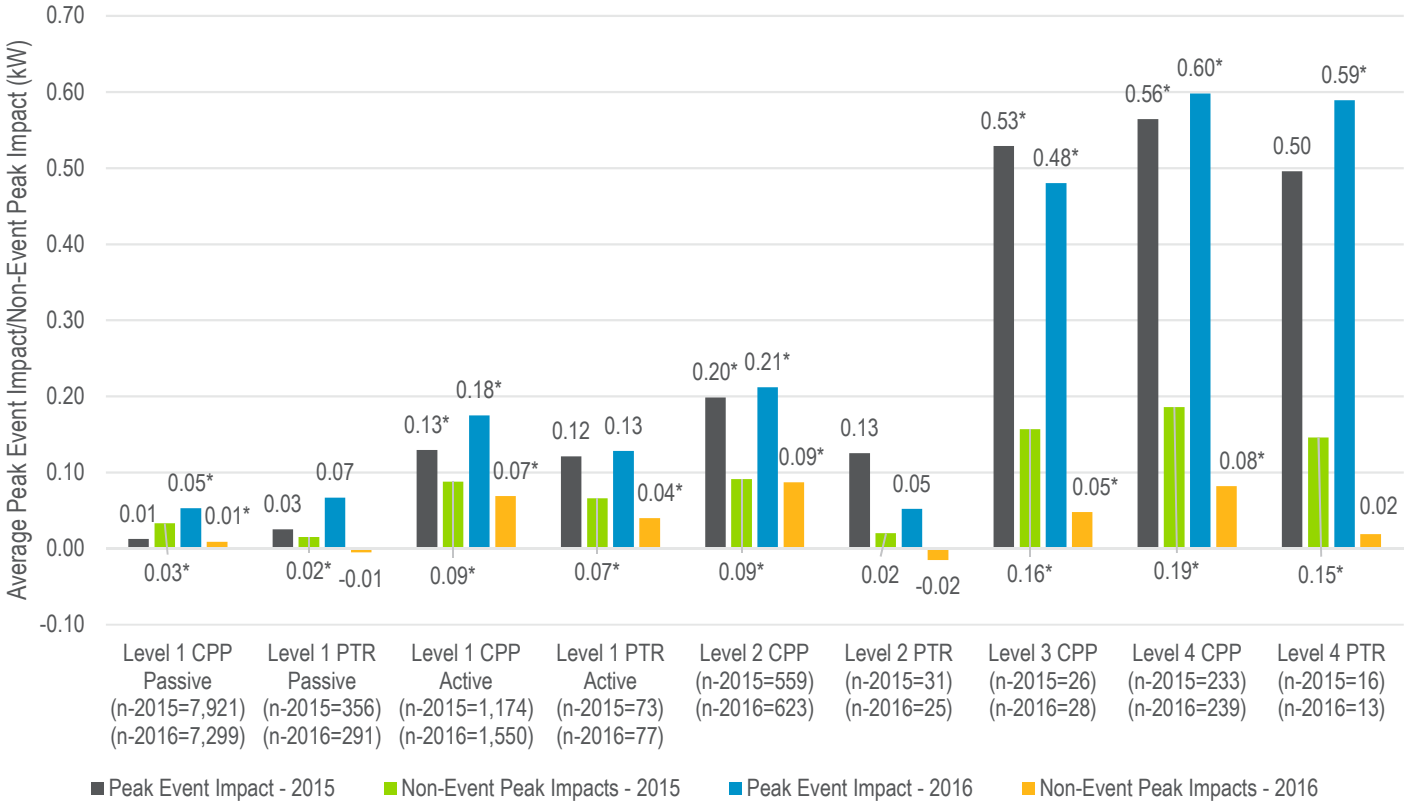
Figure 3-19. Non-Event Peak Impacts Compared to Peak Event Impacts



Source: Navigant analysis
Note: Positive numbers for non-event peak impacts indicate savings during peak hours that were not also Peak Events. An asterisk (*) indicates that the majority of the event hours throughout the summer were statistically significant for the indicated group. Also, n refers to the number of customers used in this particular analysis, not the total number of customers in each technology/price group.

For CPP customers the non-event peak impacts were almost always smaller than the Peak Event impacts. In particular, for the three groups with PCTs the magnitude of the non-event peak impacts was small compared to the Peak Event impacts; the non-event peak impacts for these groups were always less than one-third of the Peak Event impacts.

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4. CUSTOMER EXPERIENCE ASSESSMENT

National Grid based its Smart Energy Solutions evaluation plan for customer experience on the *Common Evaluation Framework's* research questions. The customer experience evaluation focused on these key areas:

- How well did customers understand the Pilot's purpose and its impact on their electric use and bills?
- How did customers interact with the technologies? Were the technologies informative? Did they lead to taking conserving and efficiency actions?
- How well did customers understand the rate choices and 12-month bill protection?
- Why did customers stay in or opt out of the program? What were the critical factors in those decisions?
- What age, income, or other demographic characteristics were important to understanding customer reaction to and participation in the Pilot?[88]

In order to assess customer experience, Navigant relied upon a combination of customer surveys, interviews, and focus groups, as noted in Section 1.2. Although entry into the program was on an opt-out basis, Smart Energy Solutions actually contained a number of opt-out and opt-in decision/action points, as described in Section 1.2.2. Thus, marketing, education, satisfaction, and lessons learned were assessed for each program aspect. APPENDIX C contains a detailed discussion of each customer experience evaluation activity.

4.1 Participation Drivers

Before and throughout the Pilot, National Grid provided information to customers in the Pilot area that emphasized the pricing and no-cost technology options available to them.

4.1.1 Most Customers Accepted the AMI Meter

The first customer decision point occurred when National Grid installed smart meters. While customers had the option to decline the meter, 95% of meters were installed; only about 5% of the eligible 15,000 customers in the Pilot program area declined the meter. According to the meter opt-out survey, most of the customers who declined the meter appeared to do so because they had no interest in participating in the Pilot. Customers who declined the smart meter expressed a variety of reasons, primarily confusion, indifference, health and safety issues, concerns about electricity costs, and data security and privacy concerns, as shown in Figure 4-1. Twenty-two customers provided "generic" reasons for declining the meter, which were divided between 13 saying they "don't think I will benefit from this" and 9 simply saying

[88] Navigant identified low-income customers using the R2 rate. Many of the surveys also collected self-reported data to capture customers whose income was at or below 200% of the federal poverty levels and 60% of the area median income. In 2015, Navigant found that the survey results did not vary based on which definition of low income was used; therefore, the R2 rate definition was used in the analyses throughout this report.

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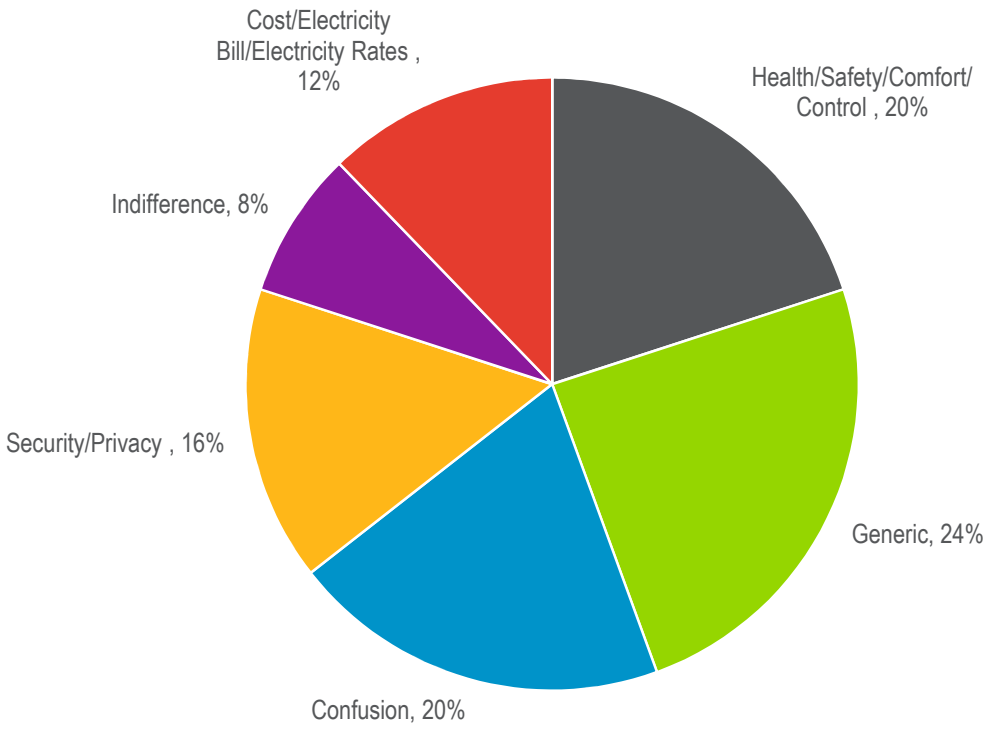
"I don't want this."

Figure 4-1. Categorical Reasons for Declining a Meter

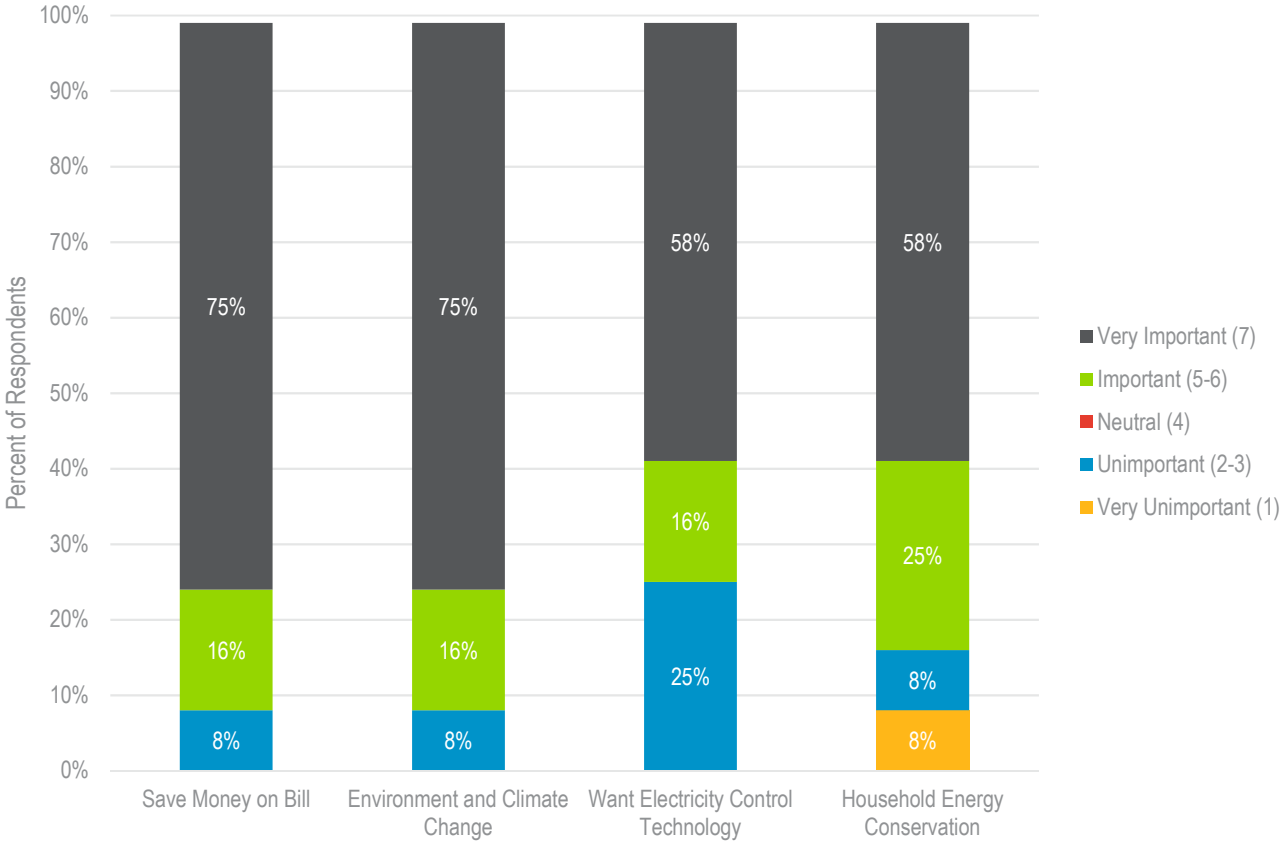


Source: Navigant analysis of meter decline survey (N=70)

4.1.2 Motives for Pilot Participation

In the pre-pilot survey, customers were asked to rate the importance of the following motives to participate in the Pilot: saving money on their electricity bills, the environment and climate change, receiving control technologies, and household energy conservation. As summarized in Figure 4-2, participants most often rated saving money on their electricity bill and protecting the environment as "very important" reasons for participating in the Pilot (75% for both motivations).

Figure 4-2. Customer Motivations for Pilot Participation, as Expressed in the Pre-Pilot Survey

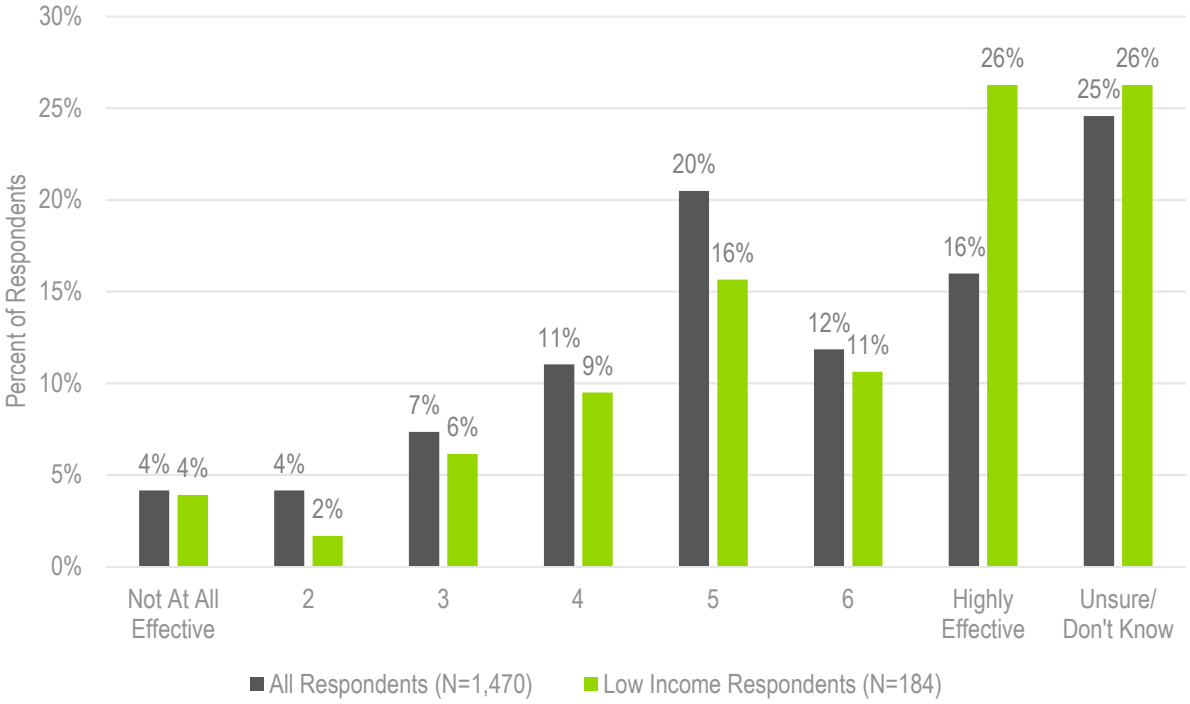


Source: Navigant analysis of pre-pilot survey (N=1,478)
Note: No survey participants provided a neutral response.

4.1.3 Low-Income Customers' Perceived Ability to Adjust Electricity Usage was High

There was concern, before the Pilot started, that low-income participants would not be able to shift their usage to take advantage of lower rates in non-peak hours. However, when asked about their expectations, more of these participants expected that they would be "highly effective" at shifting usage than other participants did (Figure 4-3).

Figure 4-3. Pre-Pilot Perceived Ability of Low-Income Participants to Adjust Energy Usage



Source: Navigant analysis of pre-pilot survey (N=1,470)

As shown in Figure 4-4, when surveyed at the end of the Pilot, low-income customers again rated their ability to manage their electricity higher than all respondents on either the CPP or PTR price plan. However, within the focus groups (as discussed further in Section 4.2.7) low-income customers sometimes indicated taking extreme actions to save energy during events, such as shutting off their room AC entirely, and said that their actual options for controlling electricity use during events were often quite limited. Overall, PTR respondents rated their ability to manage their electricity usage slightly lower than CPP respondents, which makes sense as customers with a low ability to manage electricity would be more likely to switch to the PTR rate to avoid the high Peak Event rate on the CPP plan.

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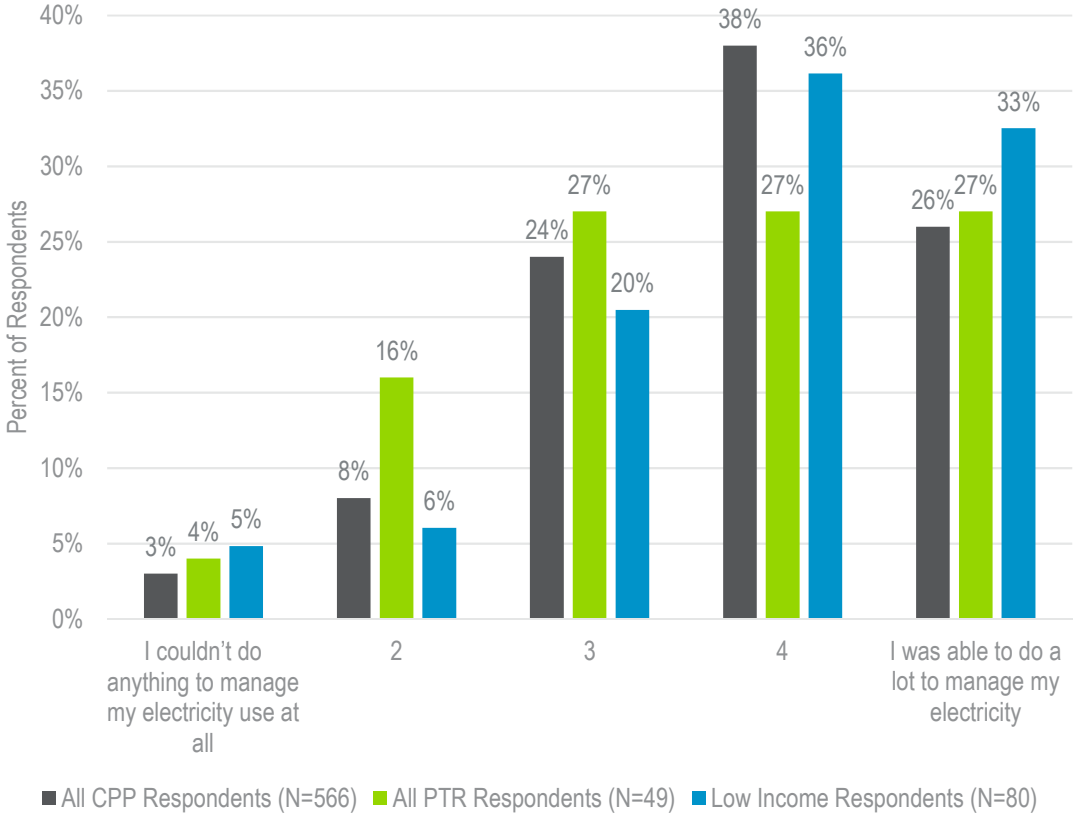
Figure 4-4. Reported Ability of Low-Income Customers to Manage Electricity Use at End of Pilot



Source: Navigant analysis of end of pilot survey (N=615)

4.2 Participant Awareness, Engagement, Satisfaction

National Grid provided extensive information to customers about the program, rates, technologies, and bill protection before and during the Pilot, as shown in Chapter 2. During the pre-pilot survey, customers expressed motivation to save money and confidence that they could shift their electricity usage. In the surveys of all residential customers and focus groups with low-income customers conducted throughout the Pilot, many customers in all demographic segments indicated a desire for more information about the rates and technologies, personalized conservation tips, additional means of communication about the events, and more insights into savings. After the first summer, National Grid adapted the Pilot based on feedback from customers; for example, National Grid expanded and highlighted the options to personalize event notifications in 2016 compared to 2015 based on customer complaints about the timing and channel of the notifications. The Company also continued to send regular mailings and emails throughout the Pilot to keep customers informed and motivated.

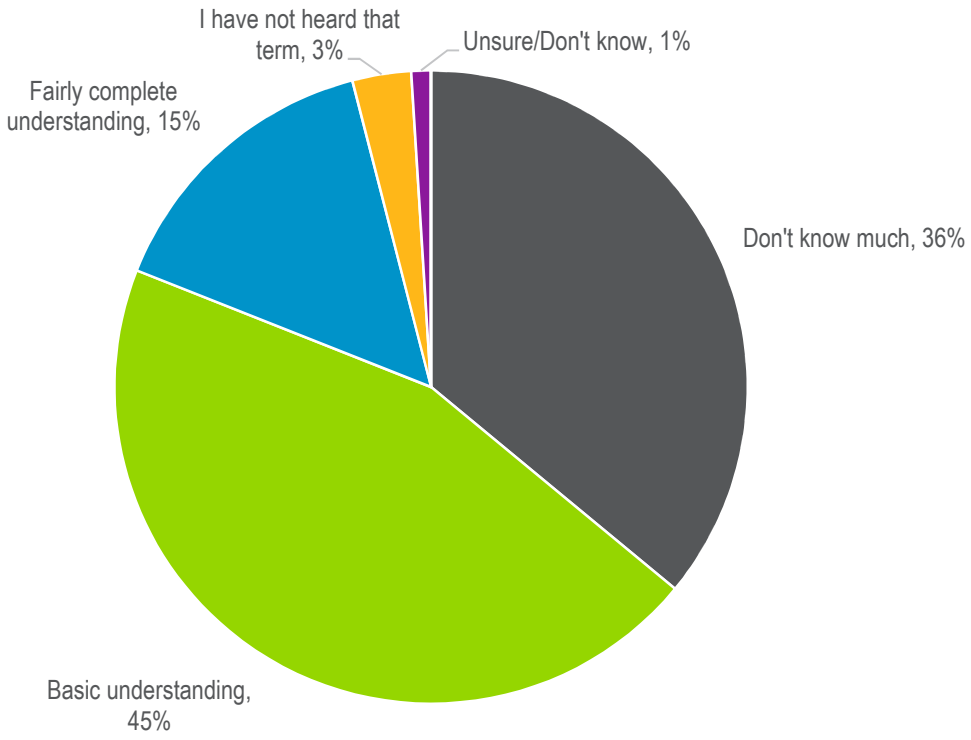
4.2.1 Rate Awareness and Understanding Increased over Time

Participant knowledge and understanding of the program rates was an important aspect of the Pilot. National Grid offered both CPP and PTR options to customers in order to provide flexibility in the program. At face value, customers might prefer the PTR rate over the CPP rate as the CPP rate charges

customers a higher rate during Peak Events. The utility industry typically perceives that the advantage of PTR over CPP for customers is that it provides a rebate due to conservation during Peak Events but does not increase the rate, such that a customer's bill decreases in the short run.[89] However, due to National Grid's CPP rate design, which charged a lower rate than the Basic Rate for at least 335 days (the utility could hold up to 30 Peak Events per year), if customers shifted their usage they would most likely save more money annually on the CPP rate than on the PTR rate. Additionally, customers on the CPP rate were offered bill protection in which they were given a credit at the end of the year if their expenditures exceeded what they would have spent if they had been on the Basic Rate, thus mitigating the risk of the CPP rate. Most customers remained on CPP and did not actively elect either plan. The majority of National Grid customers who contacted the utility to select a rate chose the CPP rate over the PTR rate.

In the initial pre-pilot survey conducted in 2014, 8% of customers said that they had heard of the CPP rate. Of the customers who had heard of the rate, 15% of them "ha[d] a fairly complete understanding of what it means" and 46% "ha[d] a basic understanding of what it means", as shown in Figure 4-5. A few customers may have been confused about the rate, as 3% of these customers said they had never heard of the new rate, when asked how well they understood it.

Figure 4-5. Customer Pre-Pilot Knowledge of the CPP Rate

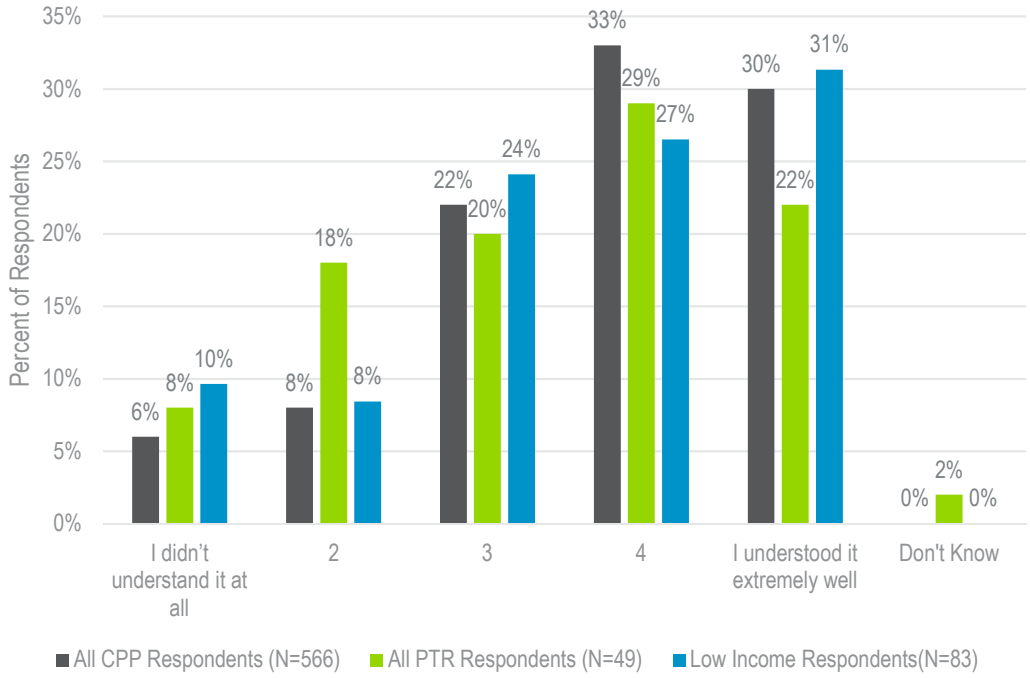


Source: Navigant analysis of pre-pilot survey (N=118)

[89] The Regulatory Assistance Project. *Time-Varying and Dynamic Rate Design.* July 2012.

By the time the end of pilot survey was administered (October 2016), almost all customers (97%) were aware of the Pilot and the rate they were on. Additionally, the majority of customers on both price plans, including those with low incomes, indicated that they had a good understanding of their pricing plan (rating their understanding as a 4 or 5 on a 5-point scale), as shown in Figure 4-6.

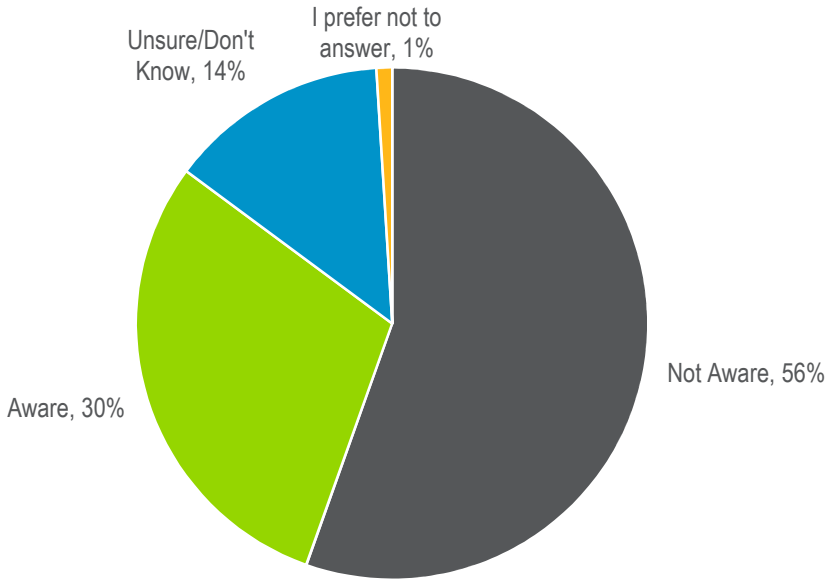
Figure 4-6. Customer Understanding of the Pilot Pricing Plan



Source: Navigant analysis of 2016 end of pilot survey (N=615)

Although customers understood the rate that they were on, most (56%) were not aware they had the option to switch pricing plans (see Figure 4-7). This lack of awareness may have contributed to the higher than expected retention of customers on the Pilot's default CPP rate. The lack of awareness occurred despite the fact that National Grid provided a lot of information about both rates, starting with an official welcome kit. National Grid provided examples of participant bills to customers to illustrate the differences between the two rates. The Company continued to provide information to explain that there were many variables determining the impact of use on cost, particularly during Peak Events, throughout the Pilot.

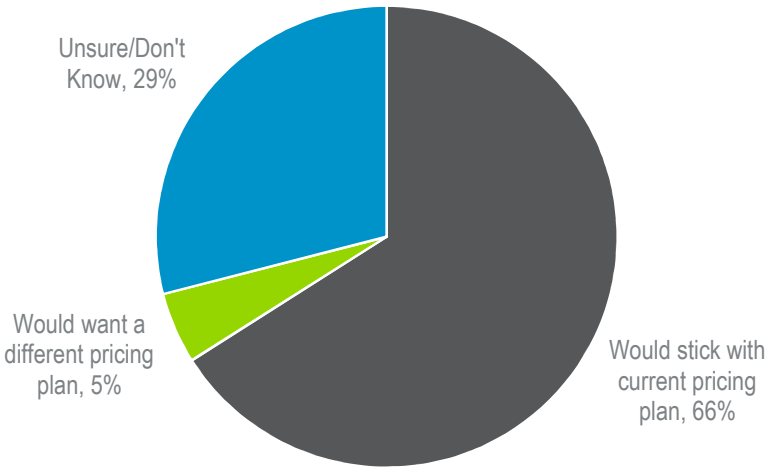
Figure 4-7. Customer Awareness of Ability to Switch Pricing Plans



Source: Navigant analysis of 2016 end of pilot survey (N=615)

Despite not realizing that they could switch price plans, most customers (66%) indicated that they would want to continue with their current price plan if they continued to be enrolled in the Pilot (Figure 4-8). Additionally, only 5% of customers said that they would want to switch to a different pricing plan. This indicates that customers were generally happy with the rate they were on and may not have been seeking options to switch, contributing to the low awareness of switching.

Figure 4-8. Customers' Interest in Continuing with Current Pricing Plan



Source: Navigant analysis of 2016 end of pilot survey (N=615)

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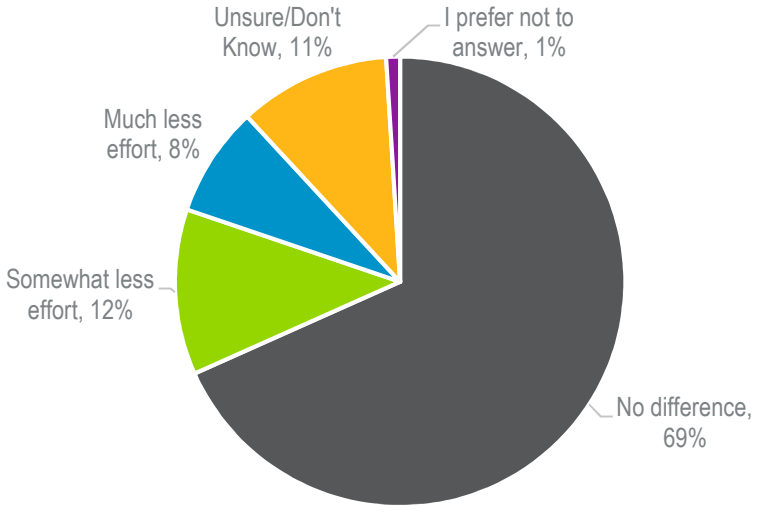
4.2.2 Customers Exhibited Mixed Awareness and Understanding of Program Features

At the end of the Pilot, customers were surveyed about their awareness and understanding of various features of the program. Survey questions focused on the bill protection available on the CPP rate, the technology packages, and the rewards platform that was added in 2016.

Bill Protection

At the end of the Pilot, almost half of the customers on the CPP rate (40%) said that they were aware of the bill protection feature. However, over two-thirds of those who knew about it said that the feature made no difference in their efforts to manage their electricity use. This means that most CPP customers likely did not reduce their energy savings behaviors because they knew they would get bill protection at the end of the year anyway. Approximately 20% of the CPP participants did say that knowing about bill protection led them to put "somewhat less" or "much less" effort into saving energy. To explore this further Navigant matched the survey results to the usage data and examined the Peak Event impacts for active customers in Level 1 CPP who said they were aware or unaware of the bill protection feature.[90] This analysis did not reveal statistically significant differences in impacts and neither group had consistently higher or lower impacts than the other, supporting the conclusion that bill protection awareness did not influence customers' actions in the Pilot.

Figure 4-9. Effect of Bill Protection on Customers' Efforts to Manage Electricity



Source: Navigant analysis of 2016 end of pilot survey (N=229)

[90] We examined active customers in Level 1 CPP because this group contained the largest number of customers who answered this question. In this group, there were 71 customers who were aware of bill protection and 101 who were unaware.

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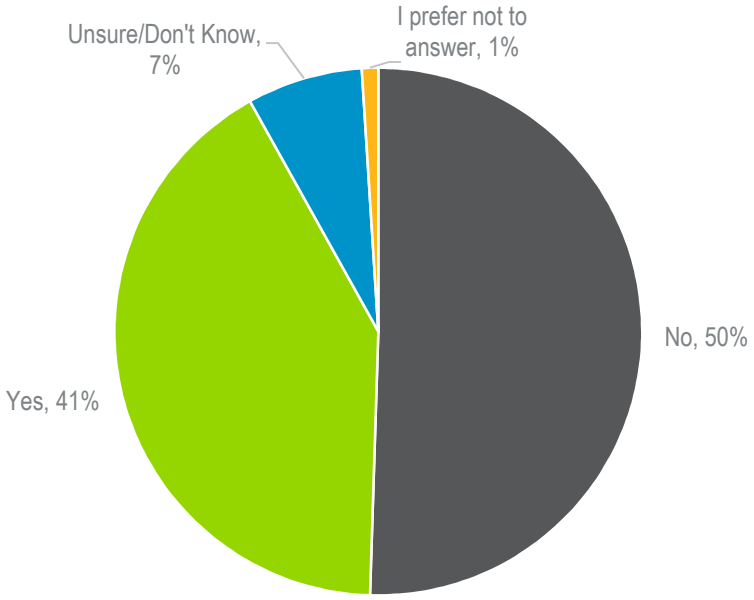
Technology

Approximately 40% of the customers in Level 1, i.e., those who did not opt to receive the free Pilot technologies, were aware that the technologies were available (see Figure 4-10); the relatively low awareness occurred despite heavy promotion of the technologies. Many of those who were aware of the technology offerings chose not to opt into the technologies for reasons that indicated they did not see the benefit of the technology to them and thus expressed a lack of interest in it.[91] Additionally, several customers mentioned they could not install the technology as they were not the homeowner. This complication for renters was also reflected in the reasons reported by customers who wanted one of the technology packages but had to cancel their install (see Figure 2-10).

Figure 4-10. Customer Awareness of Free In-Home Technologies



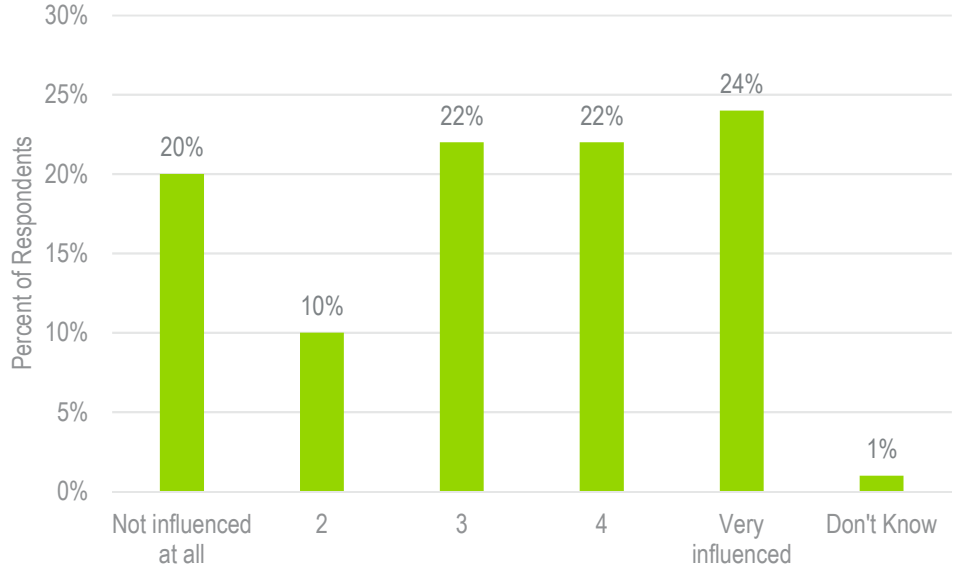
Source: Navigant analysis of 2016 end of pilot survey (N=379)

Rewards Platform

By the time of the End of Pilot survey (October 2016), 67% of customers reported awareness of the rewards platform launched in February 2016. As demonstrated in Figure 4-11, the rewards platform seemed to have varied influence on customers' efforts to save electricity. About half reported that the rewards platform had considerable influence on their efforts, while half reported little to moderate influence. There was an increase in the number of active participants in Level 1 in 2016 compared to 2015 and the increase may be partially attributable to increased traffic to the web portal because of the rewards platform. In 2016, 1,042 customers redeemed points in the rewards platform to receive 2,219 gift cards.

[91] Response options included "Too much bother", "I didn't think about it", "I wasn't sure what it would do", and "I didn't think it would help."

Figure 4-11. Reported Influence of Rewards Platform on Energy Efficient Actions



Source: Navigant analysis of 2016 end of pilot survey (N=428)

4.2.3 Rate Enrollment and Retention Rates On Par with Opt-Out Recruitment Methods

The majority of time-based rate pilots around the country are based on an opt-in recruitment model, in which customers volunteer to participate. By definition, opt-in customers are motivated to participate in a dynamic rate pilot. Customers who participate in opt-in programs tend to be enthusiastic early adopters and not likely to drop out of a program they signed up for.

Smart Energy Solutions is unusual because it is an opt-out program, which requires customers to contact the utility to opt out of the pricing program. Opt-out program design is a relatively new industry concept. Opt-out programs capture all customers, many of whom may follow "default bias", which means that they tend towards the default offering rather than accepting alternative offerings. Industry understanding at this time is that retention rates are similar for opt-in and opt-out programs.[92]

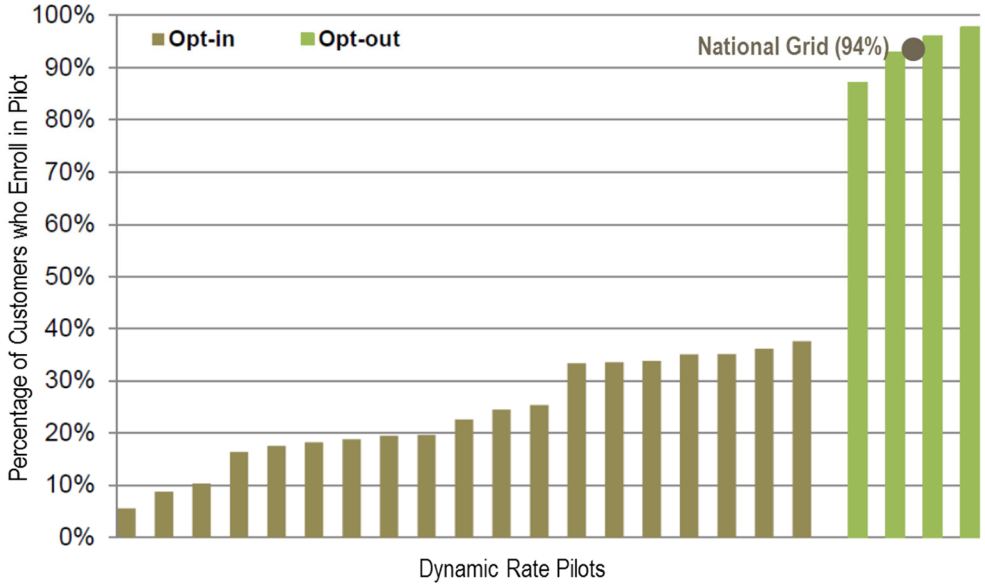
The CPP and PTR rates went live in January 2015 and had been in effect for two years at the end of 2016. As shown in Figure 4-12, National Grid's residential enrollment rates were high compared to opt-in recruitment rates and were on par with typical opt-out recruitment rates. Customer enrollment is the percentage of customers, as of January 2015 when the Pilot rates went live, in the Pilot area who had a meter and had not yet opted out. Over time, customer retention reflects how many customers remain in the Pilot rather than dropping out.[93] As shown in Figure 4-13, National Grid's retention rates for residential

[92] Cappers, P., H. Liesel, R. Scheer. *American Recovery and Reinvestment Act of 2009: Interim report on customer acceptance, retention, and response to time-based rates from the consumer behavior studies*. LBNL-183029. June 2015.

[93] The retention rate considers only those customers who actually dropped out of the Pilot and excludes those who moved or switched to a competitive supplier, which could have happened for any number of reasons unrelated to the Pilot.

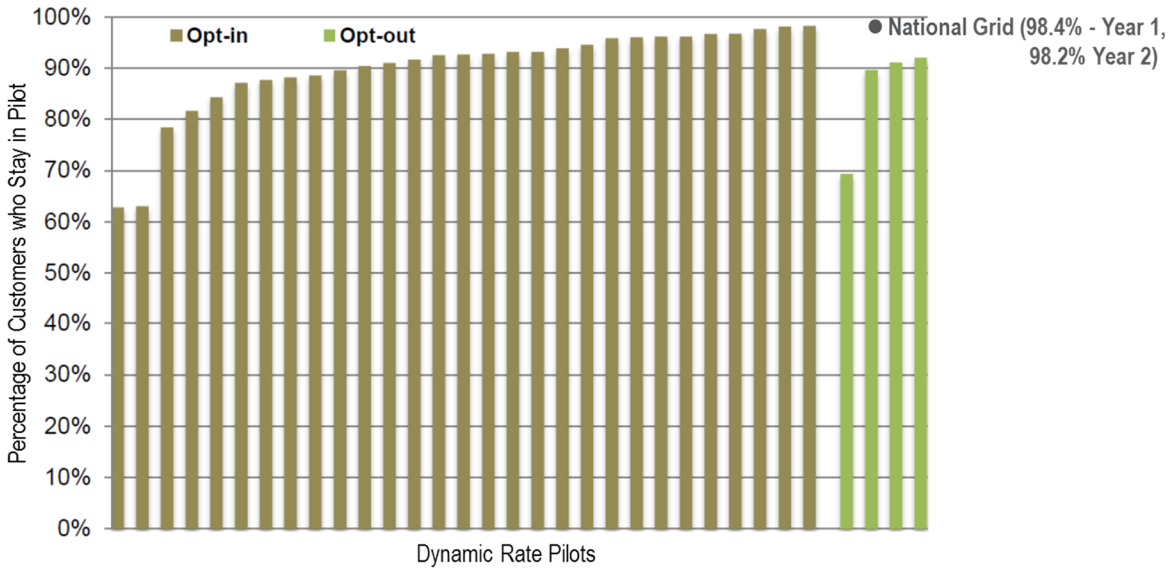
customers were higher than one-year retention rates for other opt-out rate pilot programs, even after two years of the Pilot. In fact, the Pilot had hardly any drop outs from the first year to the second year, making the first and second year retention rates virtually identical.

Figure 4-12. Customer Enrollment Rates Based on Opt-In vs. Opt-Out Recruitment



Source: Lawrence Berkeley National Laboratory and Navigant analysis
Note: Each bar represents a utility that has offered a dynamic rate to its customers.

Figure 4-13. Customer Retention Rate Based on Whether the Utility Used Opt-In or Opt-Out Recruitment



Source: Lawrence Berkeley National Laboratory and Navigant analysis
Note: Each bar represents a utility that has offered a dynamic rate to its customers.

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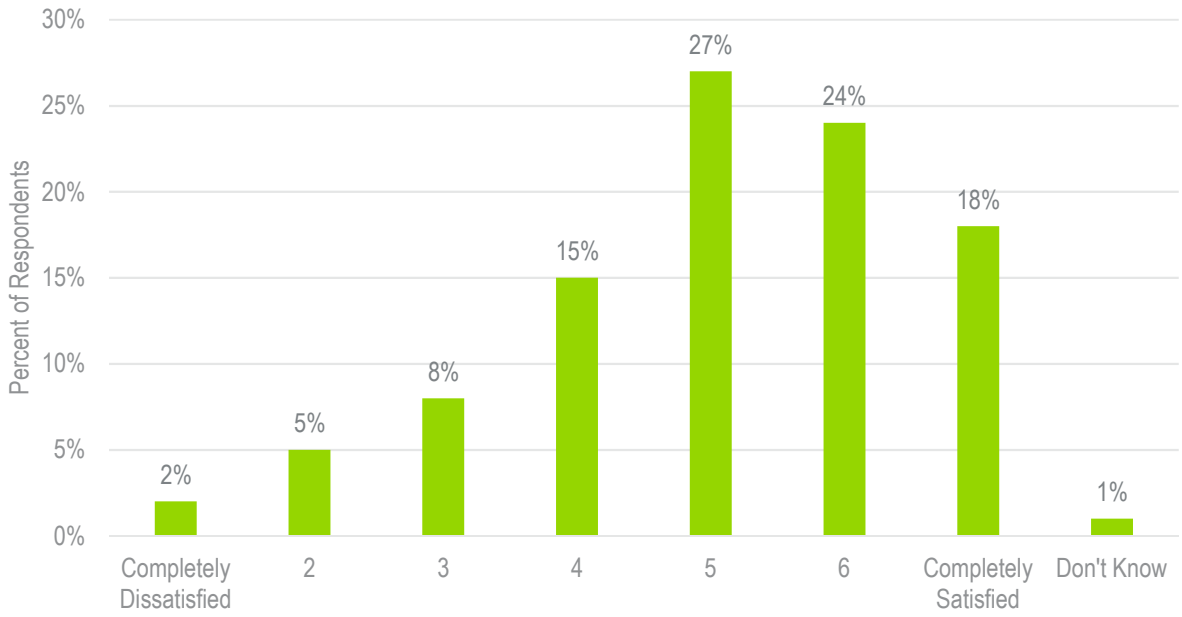
4.2.4 Strong Customer Satisfaction with Program

At the end of the Pilot, as shown in Figure 4-14, 69% of customers indicated a strong level of satisfaction with the Pilot (rating it at least a 5 on a 7-point scale). The weighted average satisfaction rating was 5.06. This was similar to satisfaction after the first year in the Pilot when 72% of customers reported being "very satisfied" or "somewhat satisfied" with the Pilot on a 3-category scale.[94]

Figure 4-14. Participant Overall Satisfaction with Smart Energy Solutions



Source: Navigant analysis of 2016 end of pilot survey (N=615)

As described in the next several paragraphs, the Pilot's satisfaction rating was in line with the satisfaction achieved by several similar demand response pilots implemented by other utilities. In comparing satisfaction with Smart Energy Solutions to similar demand response programs, it is worth reiterating that Smart Energy Solutions is an opt-out program while the comparison programs are opt-in. Participants in opt-in programs chose to enroll and are thus expected to have a higher level of satisfaction than opt-out participants who are enrolled automatically. Satisfaction that is similar to opt-in programs in an opt-out program is commendable.

The Pilot's satisfaction rating was similar to customer feedback to NSTAR's[95] 2012-2013 pilot, undertaken in compliance with Section 85 of the GCA. NSTAR pilot customers were asked to rate the program on a 5-point scale (5 = very positive, 1=very negative, and 3 is neutral); the average rating was 4.0.[96] When translated to the 7-point Smart Energy Solutions scale, NSTAR's satisfaction would have been 5.6 out of 7, which is comparable to the 5.06 out of 7 for Smart Energy Solutions.

[94] The scale was changed from the first to the second year of the Pilot to better align with DPU requirements.

[95] NSTAR is now called Eversource Energy.

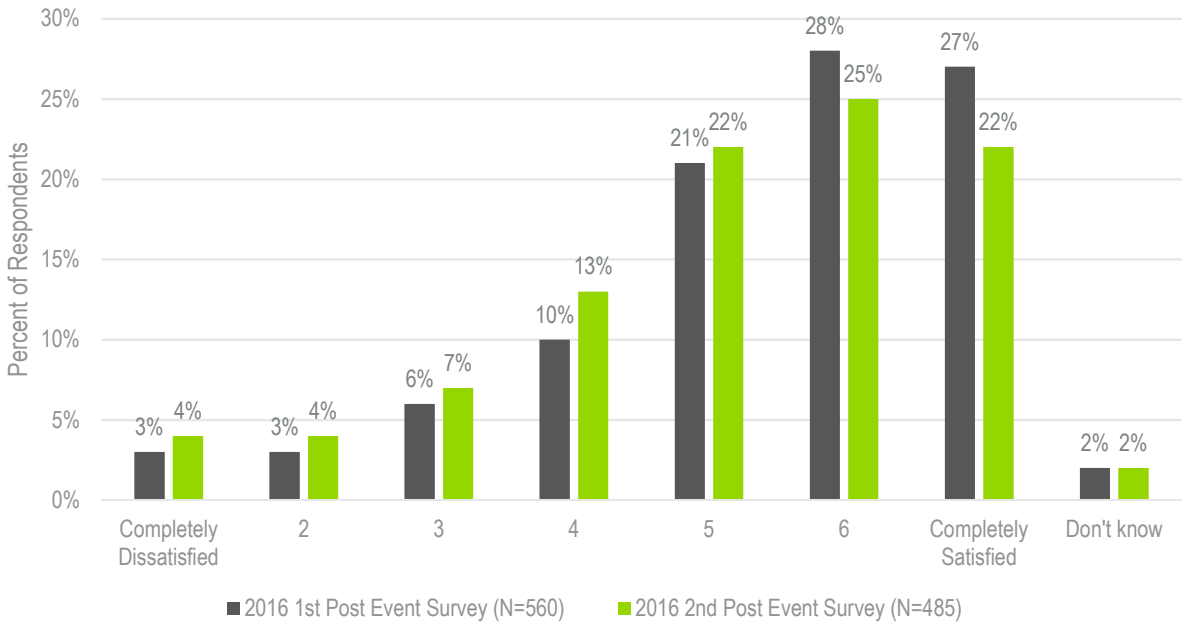
[96] Navigant. *NSTAR Smart Grid Pilot Final Technical Report: AMR Based Dynamic Pricing*. DE-OE0000292. Prepared for U.S. Department of Energy on behalf of NSTAR Gas and Electric Corporation. August 2014.

DTE conducted an opt-in pricing pilot that had a TOU/CPP price plan and included technology offerings very similar to Smart Energy Solutions'. By the end of DTE's pilot, 86% of customers rated their pilot at least a 6 on a 10-point scale.[97] Translated to the 7-point Smart Energy Solutions scale, 86% of customers rated the program at least a 4.2 out of 7 which is comparable to the 84% of Smart Energy Solutions customers that rated the Pilot at least a 4 out of 7.

MN Power held an opt-in demand response pilot that used a TOU/CPP rate but did not include technologies. The satisfaction for MN Power's program averaged 5.6 – 6.1 out of 10 across the three customer groups included.[98] When translated to a 7-point scale, the average satisfaction ranged from 3.9 – 4.3 out of 7. This is slightly lower than the average satisfaction for Level 1 customers in Smart Energy Solutions (who also had no in-home technology) at the end of the Pilot, which was 4.94 out of 7.

Satisfaction with Smart Energy Solutions was also measured in each post event survey. In 2016, the first post event survey occurred on July 7th, which was the second event in a two-day series, and the second post event survey occurred on July 28th, which was the fourth event in a four-day series. The satisfaction across these two surveys did not change significantly as shown in Figure 4-15.[99] In the first survey, 76% of customers rated the Pilot at least a 5 and in the second, 69% did the same. Since the second post event survey was done after a long series of back-to-back Peak Events, these results indicate that satisfaction did not suffer significantly due to the consecutive day Peak Events.

Figure 4-15. Participant Satisfaction with Smart Energy Solutions in 2016 Post Event Surveys



Source: Navigant analysis of 2016 post event surveys (N=560, N=485)

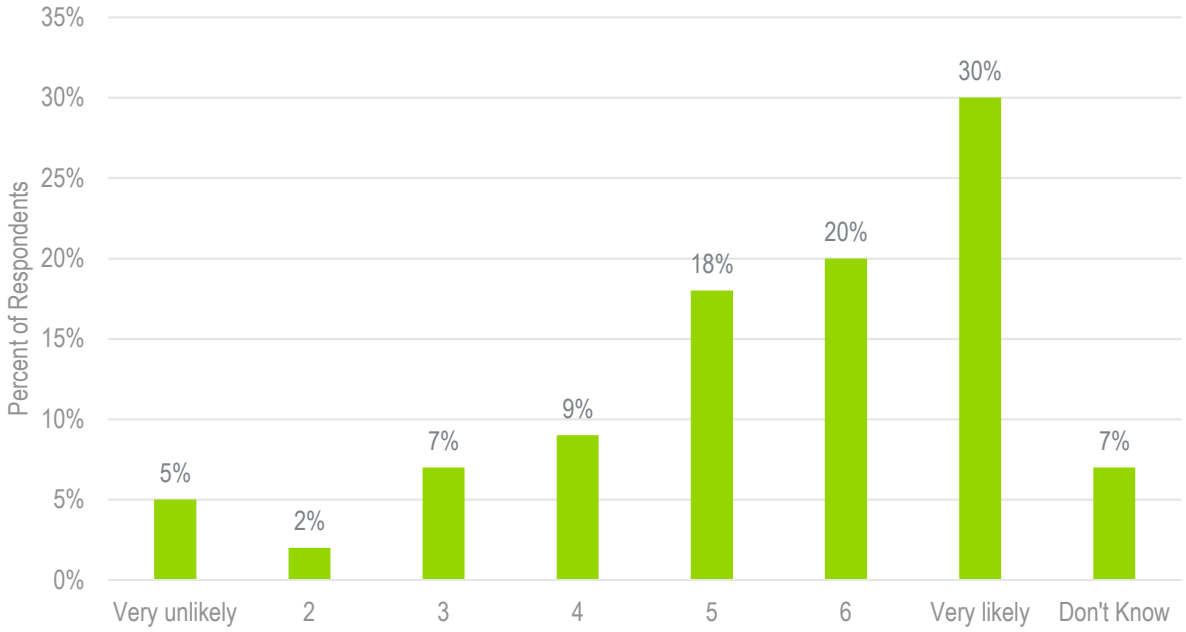
[97] See Cappers, P., H. Liesel, R. Scheer. 2015.

[98] Ibid.

[99] Comparisons to the 2015 post event surveys are not included because the satisfaction questions were changed from a 3 to a 7-point scale to better align with DPU requirements.

Further confirming the strong satisfaction results, over two-thirds of respondents indicated that they would like to continue with the Pilot if it were extended with the same conditions (Figure 4-16). Almost one-third of the customers (30%) indicated that their likelihood of continuing was a 7 on a 7-point scale.

Figure 4-16. Customer's Likelihood to Continue with Smart Energy Solutions

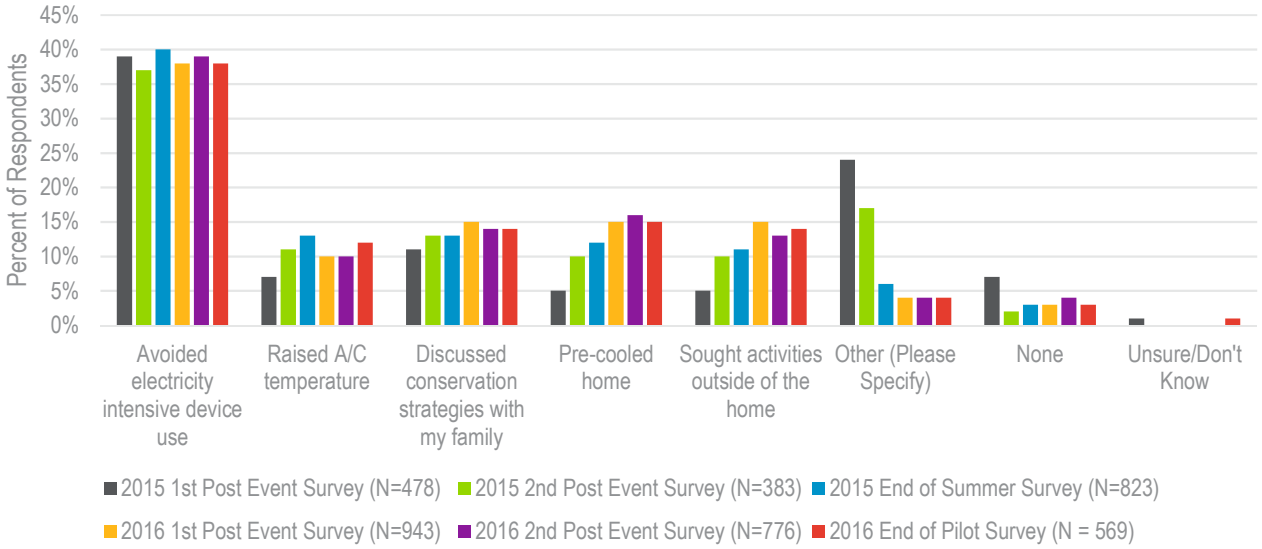


Source: Navigant analysis of 2016 end of pilot survey (N=615)

4.2.5 Customers Changed Electricity Usage and Behavior

Throughout the Pilot, as shown in Figure 4-17, many customers reported that they took actions to change their electricity usage during Peak Events. The most frequent reported action taken, across all the surveys, was to reduce the usage of electricity-intensive devices. Customers also reduced their AC usage, discussed conservation strategies with their families, pre-cooled their homes, and sought activities outside the home during Peak Events. Family discussions, pre-cooling, and leaving home all increased in frequency from the first summer of the Pilot to the second. The number of customers who took actions to reduce their electricity usage during Peak Events increased throughout the Pilot's first summer, reflecting customers' behavioral change and learning. The increased level seen at the end of 2015 was maintained through the Pilot's second summer.

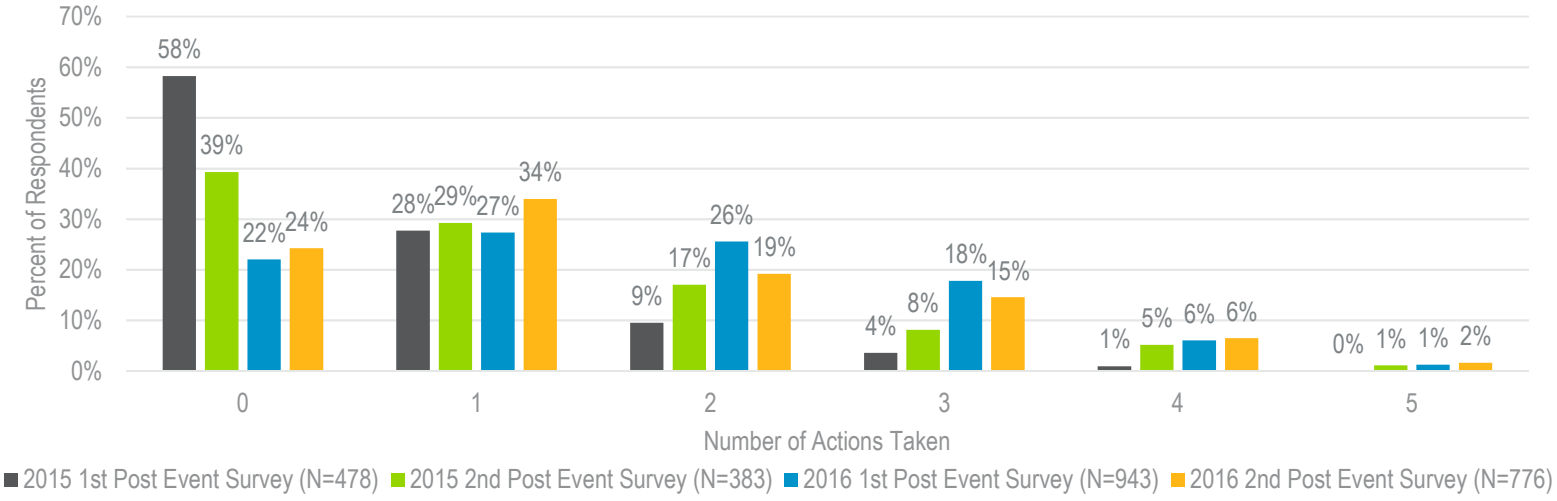
Figure 4-17. Actions Customers Took to Reduce Electricity Usage on Conservation Days



Source: Navigant analysis of post event surveys (N=527, N=270, N=943, N=776), 2015 end of summer survey (N=406), and 2016 end of pilot survey (N=569)

Navigant aggregated the number of actions customers indicated taking in the post event surveys to look at the intensity of actions across the two summers of the Pilot. The number of actions was counted from the survey, so certain actions were aggregated together. For example, “Avoided electricity intensive device use” was counted as one action, although customers may have changed their usage of several distinct devices. As shown in Figure 4-18, compared to the first summer of the Pilot, in the second summer fewer individuals took no actions to reduce their electricity usage during a Conservation Day and the average number of actions taken increased from 2.25 to 3.72.

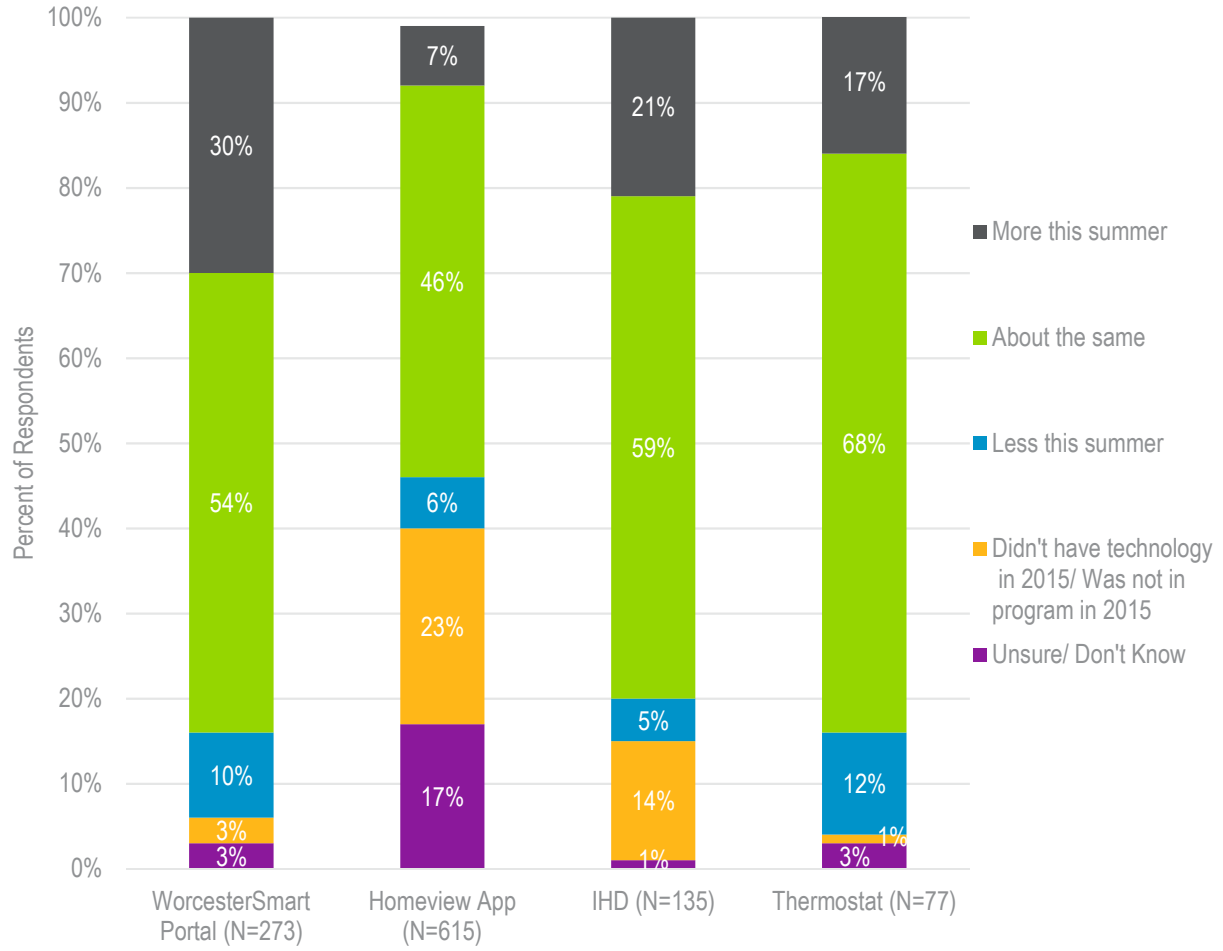
Figure 4-18. Reported Number of Actions Taken during Peak Events



Source: Navigant analysis of post event surveys (N=527, N=270, N=943, N=776)

As shown in Figure 4-19, most customers did not change the frequency with which they viewed the WorcesterSmart web portal (54%), the Homeview App (46%), their IHD (59%), or their smart thermostat (68%) through the two summers of the Pilot. The IHD and the web portal were the two technologies that had the largest increase in usage from 2015 to 2016; 21% of customers reported viewing their IHD more frequently and 30% reported viewing the web portal more frequently in 2016 than 2015. Very few customers reported viewing each technology less in 2016 than in 2015. These results suggest that the value of these technologies remained steady throughout the duration of the Pilot.

Figure 4-19. Change in Customer Viewing of Technology in the Second Summer Compared to the First



Source: Navigant analysis of 2016 end of pilot survey (N=615)

4.2.6 Customers Believed they Reduced Summer Electricity Usage and Noticed Summer Bill Increase

As discussed in Section 4.1.2, two of the major motivations of customers who enrolled in Smart Energy Solutions were to explore technologies that could help them reduce electricity usage and to save money on their electricity bills. Customers provided insight into their perceived savings and conservation in the end of pilot survey. Most customers perceived a change in their electricity usage during the two years of

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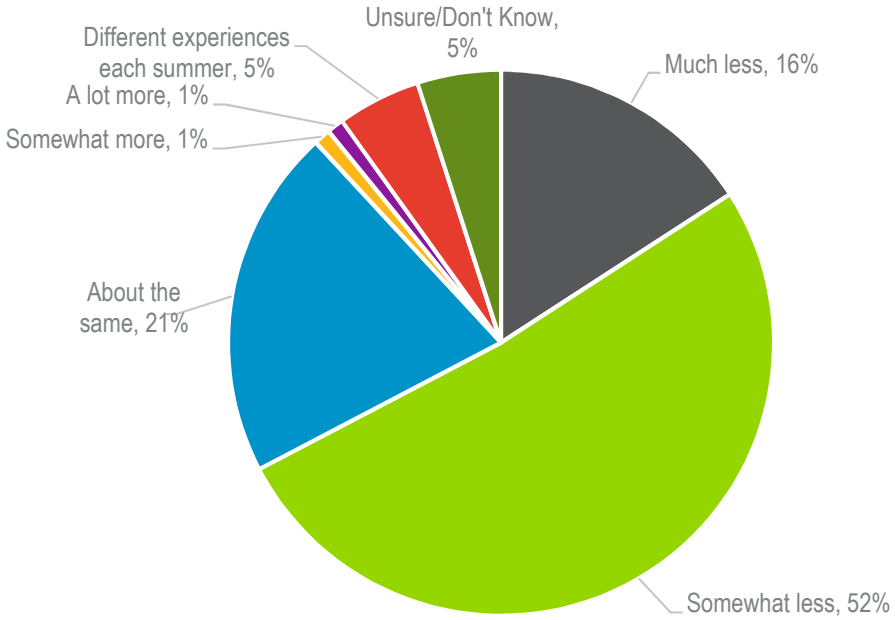
the Pilot compared to a normal summer. The majority of customers (68%) believed they reduced their electricity usage at least "somewhat" (see Figure 4-20).

Figure 4-20. Customer Perceived Change in Summer 2015 & 2016 Electricity Usage Compared to a Normal Summer



Source: Navigant analysis of 2016 end of pilot survey (N=615)

Forty percent of customers believed their summer bills decreased during the Pilot, 26% said they stayed the same, and 16% believed their summer bills increased during the Pilot (see Figure 4-21). Seven percent of customers felt they had different experiences with their bills each summer of the Pilot. As demonstrated in Figure 4-22, the majority of customers (53%) believed that Smart Energy Solutions was largely responsible for the changes in their electric bill, rating the effect of the Pilot at least a 4 on a 5-point scale. The finding that many customers said their summer bills increased was not surprising, as the CPP rate was designed to save customers money over the course of the year to balance out possible increases in summer months due to Peak Events. The Peak Event rates were in effect for over 130 hours in each summer, so the average customer spent more on electricity during summer months than in pre-pilot summers. Customers noticed this increase. However, they saved during the rest of the year because the Pilot rates were lower than the Basic Rate on non-Conservation Days. It is actually surprising that 40% said their bills decreased when the bill savings analysis clearly shows bill increases in the summer months (see Figure 3-15).

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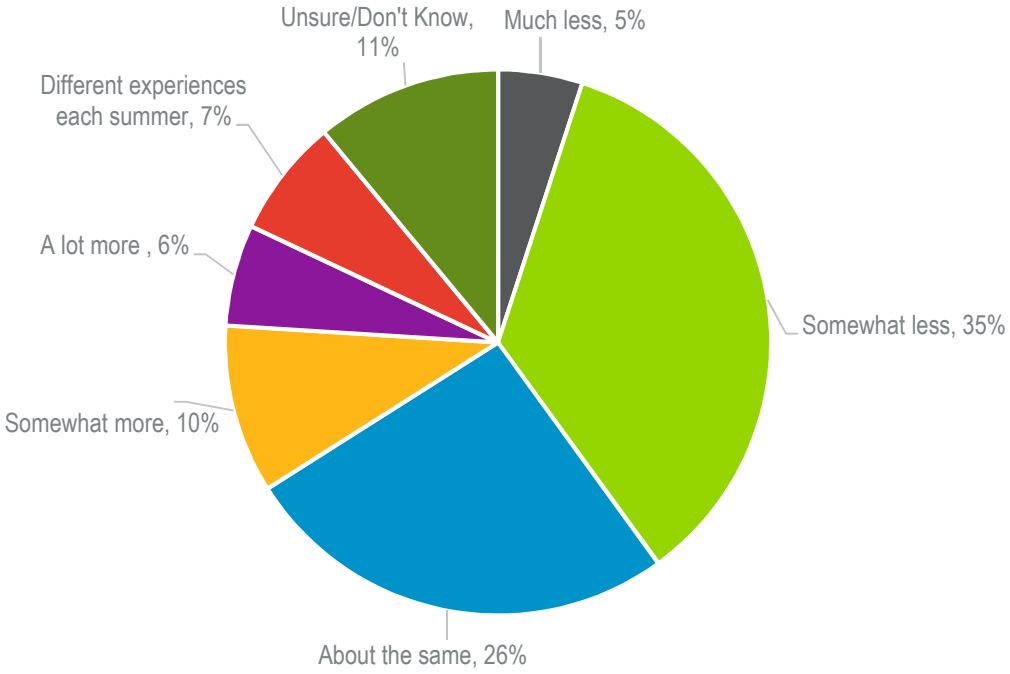
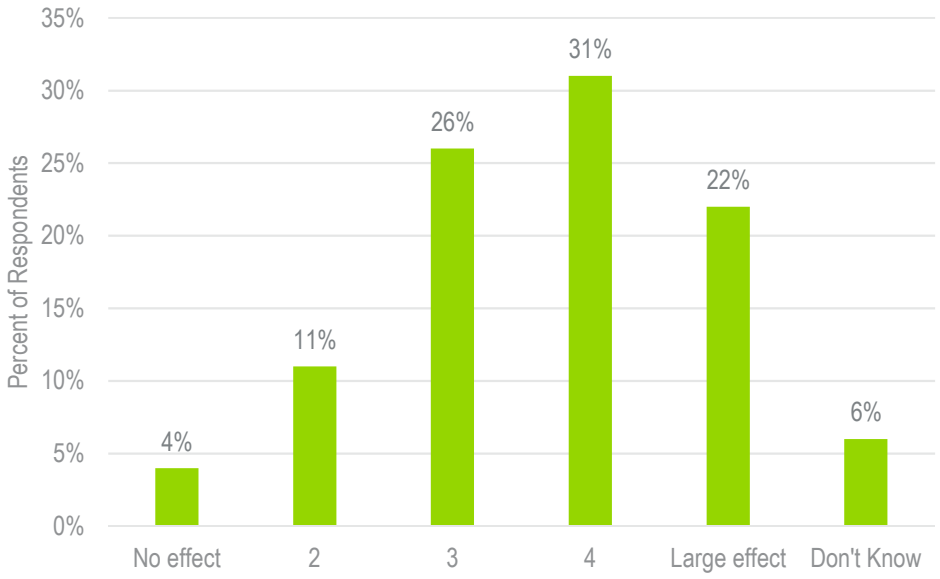
Figure 4-21. Customer-Perceived Change in Summer 2015 & 2016 Electric Bill Compared to a Normal Summer



Source: Navigant analysis of 2016 end of pilot survey (N=615)

Figure 4-22. Customer Perception of Effect of Pilot on Bill



Source: Navigant analysis of 2016 end of pilot survey (N=385)

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4.2.7 Low-Income Customers were Positive about the Pilot but Need Targeted Outreach

Low-income customers who participated in focus groups were not significantly different from other customers in their behaviors. They were quite aware of events and they were knowledgeable about the WorcesterSmart portal and the rewards platform. They took care to educate household members about reducing their energy use during events, found activities outside their homes, and limited air conditioning usage (which was primarily window AC). However, we learned from the focus groups that knowledge about the most effective energy conserving behaviors was sometimes limited. These customers were not aware of energy efficiency programs offered by National Grid or available through organizations such as Worcester Community Action. They understood how the CPP rate worked but often didn't know they had the option to switch to the PTR rate, which may have suited some of them better. They felt their options to conserve further were constrained either because they had already taken all the measures they could think of for their daily use or had elderly, ill or limited mobility household members or pets who needed cooled environments. Finally, in response to the back-to-back events that occurred in 2016, some participants said they essentially 'gave up' trying to conserve by the third day.

Even though focus group participants felt there were challenges, their overall reaction to the program was positive. Participants liked the ability to take more control of their electricity use and were very interested in the program technologies, though very few were aware of the technology options before the focus group. The findings suggest three areas for National Grid to tailor outreach for low-income participants:

- Outreach and education about the program rates, perhaps including a template to help participants decide which rate makes the most sense for their particular living situation;
- Outreach and education about the available technologies and how to get the most impact from them; and,
- Outreach on applicable energy efficiency programs that provide assistance with home improvements such as air sealing, insulation, appliances, and heating and cooling equipment.

4.2.8 Commercial Customers were Difficult to Identify and Engage

Small commercial customers are a 'difficult to serve' group in energy efficiency programs, and that was found to be the case in Smart Energy Solutions as well. Commercial customers were included in the Pilot area and were identified by their rates (G1 and G2). In attempting to recruit small commercial customers for evaluation activities, Navigant found that in many cases the customer account was limited to common area lighting or similar uses in rental buildings, making true small commercial accounts difficult to identify.

Most commercial customers were unresponsive to attempts to recruit them to focus groups and interviews. Navigant was able to complete five pre-pilot interviews in the spring of 2014 and four in-person or telephone interviews at the end of the 2015 summer. Almost every small commercial customer interviewed had only a general knowledge of and little interest in the Pilot and said they paid very little attention to it. The typical response was that they needed to run their businesses and did not see how they could adjust electricity usage without having some negative impact on their business. The single exception was a retail food service business customer who was both knowledgeable and enthusiastic about the program. He said he actively adjusted his usage during Peak Event hours and believed he benefitted substantially.

Given the responses, further work with small business customers would greatly benefit from active outreach tailored to their needs, possibly through a well-informed customer like the one cited above and/or through local business organizations, stressing the benefits and techniques of actively managing electricity use under either the CPP or PTR rate.

4.2.9 Customers Provided Feedback Throughout the Pilot to Improve Smart Energy Solutions

According to all of Navigant's customer engagement research, participants were aware of Conservation Days. They also acknowledged the multiple communications that they received about Conservation Days and Peak Events. Customers had the option to select their notification preferences for events. They could be notified of events by National Grid one day prior to, and/or the day of, a Peak Event via a combination of telephone, email, text, notification on IHDs, and the web portal.

As part of the Company's "listen, test, learn" approach, customer feedback was sought out and National Grid took actions to improve the customer experience based upon the feedback they received. Some customer feedback in 2015 demonstrated that customers lacked understanding about the program, and in 2016 National Grid increased information and education to meet customers' needs. As shown in Figure 4-23, which summarizes feedback from across the surveys, participants were aware that efforts should be made to conserve electricity during critical Peak Event hours and most participants were diligent in adjusting their energy use and practices to minimize usage. Based on feedback provided via the surveys and focus groups, customers wanted personalized conservation tips, transparency in bill calculations, additional information about the pricing plans to aid them in making the right rate choice, and information about technologies that could help them further reduce electricity usage (Figure 4-23). National Grid responded to this feedback in various ways, such as by creating the Energy Signatures and rewards platform in 2016 (see Section 2.3.2). Customers also desired more advance notice about Peak Events, which implies not having a clear understanding of how far in advance National Grid can confirm an event will be called.

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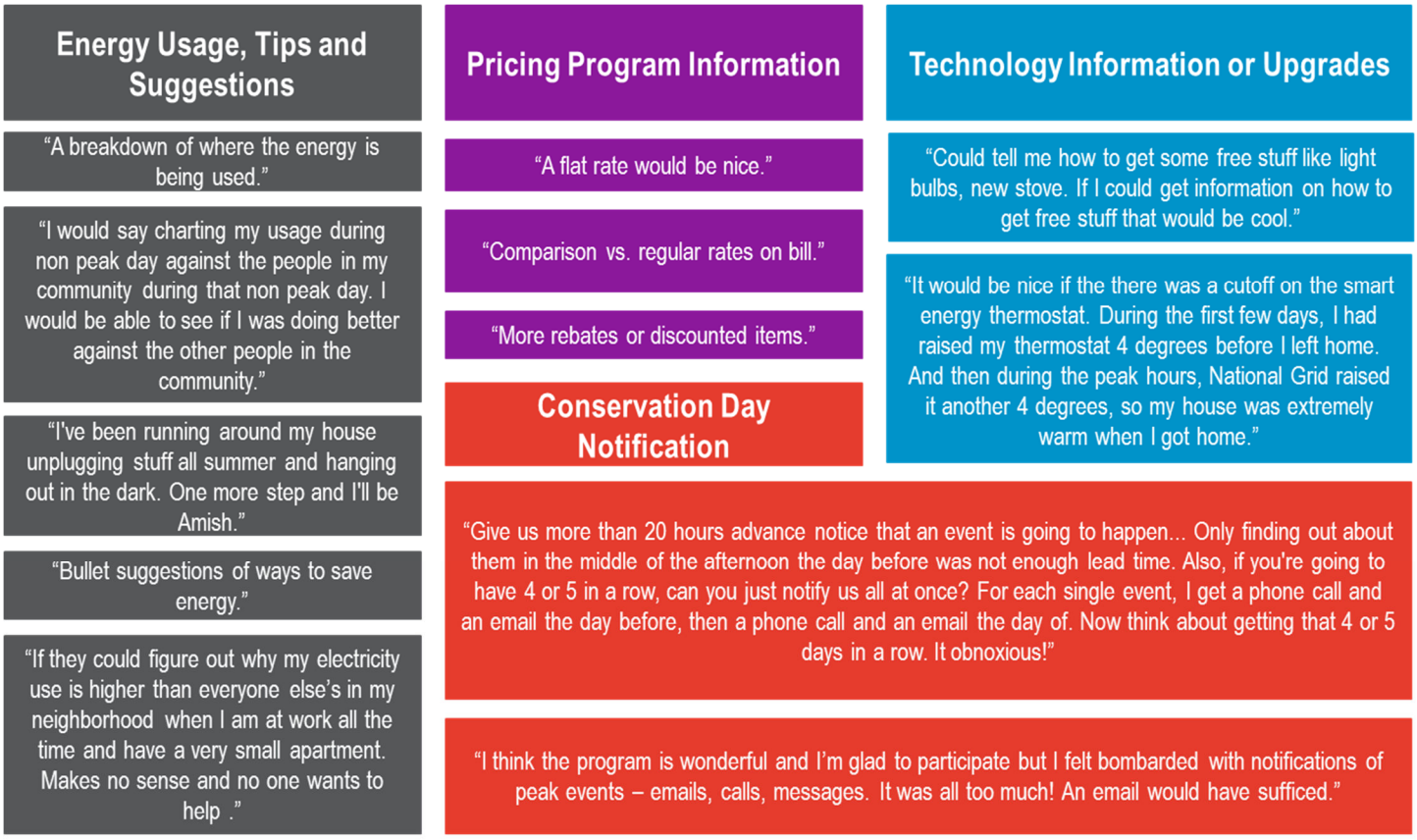
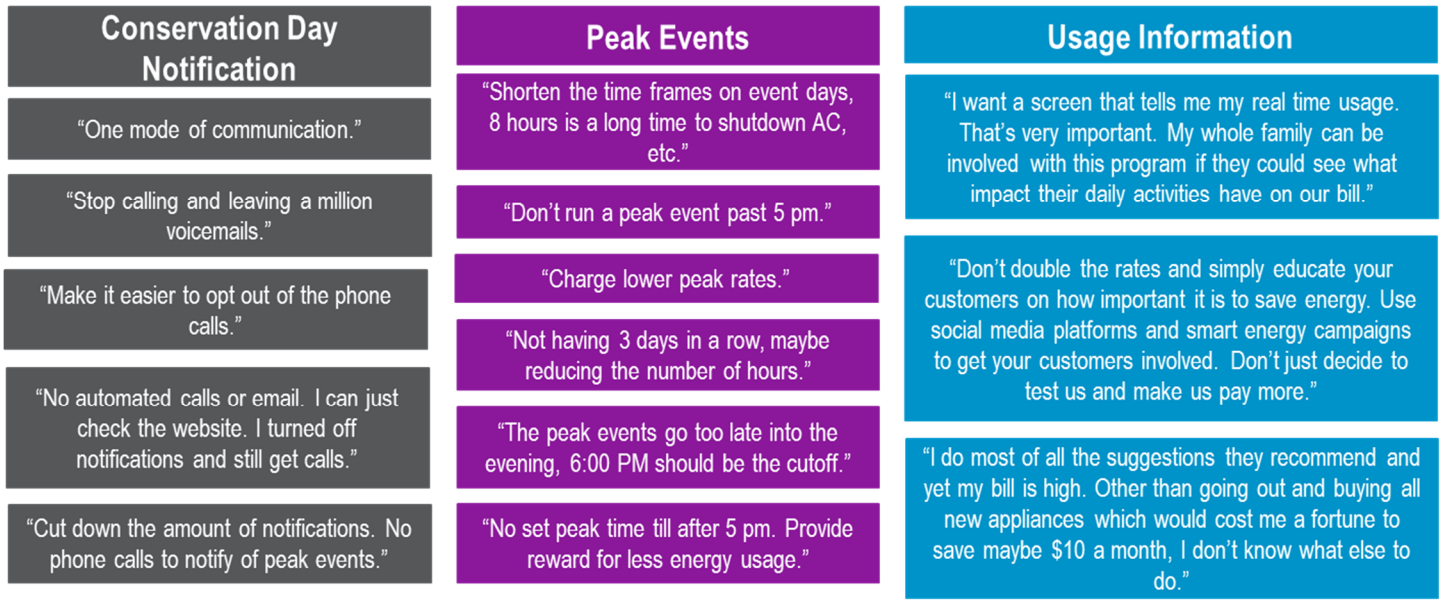
Figure 4-23. Additional Information Customers Would Like About Smart Energy Solutions



Source: Navigant analysis of 2015 end of summer survey, 2016 post event surveys, and 2016 end of pilot survey

In addition to wanting more specific information about the program, customers had several requests for National Grid to improve Smart Energy Solutions in both 2015 and 2016. As shown in Figure 4-24, customers wanted lower rates, shorter Peak Event timeframes, fewer Peak Events, and additional information about their usage. In 2015, customers stated their preference for text or email notifications over phone calls and voicemails and National Grid made adjustments. While these comments were critical, they show that customers were aware of and engaged with the Pilot. As discussed in Section 4.2.4, 69% of customers rated their satisfaction at least a 5 on a 7-point scale. Feedback is part of National Grid's "listen, test, learn" approach, and serves as the basis for adjustments to the Pilot that will improve customer experience.

Figure 4-24. Customer Recommendations to Improve Smart Energy Solutions



Source: Navigant analysis of 2015 end of summer survey and 2016 end of pilot survey

As shown in Figure 4-25, customers also expressed positive feedback over the course of the Pilot emphasizing that they appreciated that the Pilot helped save them money and electricity and was an avenue for them to help the environment. Customers liked that the WorcesterSmart portal provided them with information that allowed them to conserve electricity, such as tips on which appliances to avoid using during Peak Events and how much electricity they were able to save on past Conservations Days. Customers with the IHD mentioned that the frame was useful in reminding them of conservation hours and informing them of their real-time electricity usage and real time prices.

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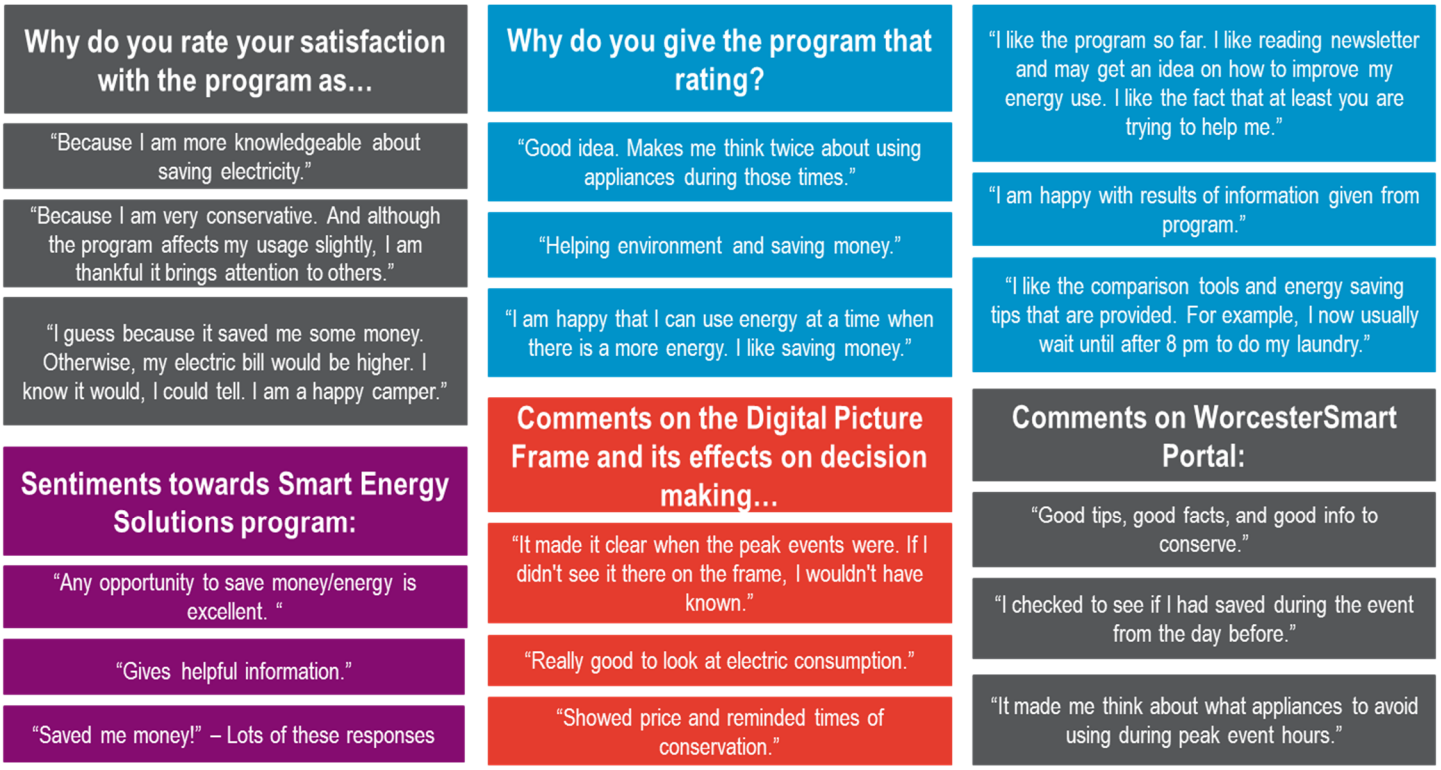
Figure 4-25. Customer's Positive Feedback on Smart Energy Solutions



Source: Navigant analysis of 2015 & 2016 post event surveys, 2015 end of summer survey, and 2016 end of pilot survey

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5. LESSONS LEARNED FROM PROGRAM IMPLEMENTATION STAFF

National Grid identified lessons learned from the Pilot through meetings with members of National Grid's implementation team. This process captured key learnings, including aspects that worked well and also opportunities identified during Pilot implementation. Lessons learned that are relevant to the customer-facing evaluation discussed in this report were identified in the following areas:

- Advanced Metering Infrastructure (AMI)
- Billing
- Outreach and Education
- Customer Service
- Peak Events
- In-Home Technology Installation

5.1 Advanced Metering Infrastructure

National Grid found that the opt-out approach to the Pilot was instrumental in simplifying the planning, scheduling, communication, and initial technology successes, including the Early Field Trial. The opt-out model allowed National Grid to plan the solution around the idea that most customers would stay in the program. This allowed the design of the RF Mesh solution (a wireless mesh network) to include all meter locations, facilitating a hybrid and integrated environment using a combination of RF Mesh and a small population of cellular meters. National Grid enabled a mixture of data collection time frames in an effort to identify the optimal frequency (e.g., 5- or 15-minute intervals) to support customer desires or deliver advanced analytics and asset management value.

National Grid identified the need to perform a more thorough business process impact and analysis effort to ensure the myriad of customer scenarios can be supported by any chosen solution. Some of the business processes that needed to be examined included meter installations and exchanges, billing, bill presentation, presentation of data on the web, and integration of new suppliers into the process.

5.2 Billing

National Grid was able to successfully support a wide variety of billing scenarios, under both current tariffs and Smart Grid tariffs, using AMI meter data. National Grid delivered a solution that leveraged existing customer billing capabilities and incorporated changes to support the new billing process using energy intervals and a tiered pricing structure based on time of use. This required minimal changes to the existing bill format. National Grid has been delivering the new billing capabilities since January 2015.

The approach used for bill presentation would have benefited from a more flexible and innovative bill design. Representing the energy and bill savings as well as the TOU pricing aspects on the customer bill each month would have created greater transparency and understanding for the customer, as well as promoting awareness of the value and benefits that many customers realized through participating in the Pilot. Revision of the bill presentation was not pursued because of the complexity of changing the bill

format in National Grid's customer billing system and the Pilot timeline. In lieu of presenting savings on the bill itself, customers' savings were communicated from time to time in the monthly reports.

5.3 Outreach and Education

Extensive outreach and education were critical to creating awareness and interest among customers and motivating them to participate actively in the Pilot. National Grid was highly focused on achieving a positive customer experience while meeting all the pilot requirements and delivering on National Grid's Outreach and Education (O&E) Plan. From the beginning, National Grid found that carefully planned outreach and education efforts and application of the "listen, test and learn" approach created synergistic value. For example, the Green to Growth Summit informed National Grid's O&E Plan and how it sought to connect with customers. National Grid and leaders from the City of Worcester worked closely on all aspects of the Pilot and sought to properly address concerns raised in the various public forums. As the Pilot moved into the implementation phase, the opt-out design simplified communications and outreach and allowed National Grid to remain focused within the Pilot area. By delivering information and capabilities to customers in a phased manner, National Grid was able to build awareness and understanding in a focused and well-articulated manner, which supported a more positive customer experience.

Several aspects of the O&E efforts stood out as supporting the success of the Pilot in meeting its goals. The Sustainability Hub grew from a concept created by the stakeholders participating in the Green to Growth Summit. With well over 8,000 visitors since it opened, the Hub has been a place where customers, the community and interested stakeholders can learn about the program and how a smarter grid will deliver greater choice, control, and convenience. As demonstrated by this evaluation, the WorcesterSmart web portal was more successful than expected in driving peak demand reductions. National Grid would continue to highlight a web portal or similar information-provision resource in future efforts as a key tool enabling customers to learn and take action. The findings that most customers understand their pricing plan at least reasonably well, and that most would choose to stay on the CPP rate if the program were to continue (see Figure 4-6 and Figure 4-8), support that the outreach and education efforts have been successful in helping customers to embrace these changes in the ways they use and value energy.

National Grid identified a need for more personalized information and insights for Pilot customers. The monthly paper reports sent to all customers included comparative information, but providing customers with more specific and tangible advice and suggestions on how they can save within the Pilot would add considerable value. Towards this end, National Grid has been developing "Energy Signatures" that can help customers identify their patterns of daily energy use and ways to save based upon those patterns (see Section 2.3.2).

5.4 Customer Service

Providing access to dedicated support services and the Sustainability Hub allowed customers to receive quick access to information and resolution of issues. The use of dedicated personnel to support customers was critical to helping customers with any questions or concerns that arose. These dedicated personnel were well-versed in the fine details of the program, and this made it easier for the customer to access timely assistance. This group consisted of dedicated call center representatives, tier 2 support through the project team, and vendor support, including one-on-one training provided as part of

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the in-home technology installation process. Personalized support and instruction were also provided to Pilot participants who visited the Sustainability Hub. As of the end of 2016, over 8,200 customers had visited the Sustainability Hub and it was mentioned by many customers as a useful source of information alongside direct mail, the Smart Energy Solutions website, and National Grid's Customer Contact Center (see Figure 2-15). A survey administered by the Sustainability Hub also found that customers ranked the Hub highly as a source of information (see APPENDIX C).

Improving access to the web portal would have enhanced customers' access to online customer support resources. The process of signing up for the web portal could have been faster, more intuitive and streamlined. In addition, having the web portal available when meters were installed would have helped to maintain interest and engagement with the Pilot in the time before technologies were installed and pricing plans went into effect. In the future, a better design and flow for all customer web-based transactions and interactions, in concert with standard controls and security concerns, would support higher levels of customer engagement.

5.5 Peak Events

Optimizing peak event communications by providing and promoting communication options, and customizing peak event characteristics to make participation easier for customers, supported the achievement of higher participation and savings levels in the second year. The demand response program was successful in Year 1, and Year 2 saw improvements in impacts and customer engagement. In Year 1, National Grid organized a test Peak Event prior to the summer to engage customers in the process and refresh their memory, so they would be prepared for the first real Peak Event. Upon hearing from some customers that the Conservation Day communications were excessive, National Grid adjusted the default notification process and also promoted the availability of communication personalization options to participants. Calling or logging in to the web portal in order to log their communication preferences provided an opportunity for customers to become engaged in the process. National Grid also responded to customer feedback in Year 2 by making adjustments to Peak Event start and end times and thermostat offsets in order to facilitate participation.

Additional customer education could contribute to further improvement in Peak Events. Survey results indicated that some customers did not understand why and how Peak Events were called, and additional education could help customers understand, for example, why Peak Events could not be called several days in advance and why they tended to occur on the hottest days. In addition, the evaluation determined that customers with in-home technology saved more than those without any technologies apart from web portal access. Promoting the savings opportunities created by embracing technologies could help more customers take the step of signing up for technologies and increasing their participation in the program.

5.6 In-Home Technology Installation

The installation and customer education process received positive feedback from customers. National Grid received very positive feedback from customers about the process of installing home energy management technologies in their homes. The training provided in relation to operation of the technologies was also very well received. Trial installations in the homes of early adopters and "friendly" installs were valuable in National Grid's efforts to design the process, to validate the amount of time required for installation, and to identify some potential issues that might be encountered.

National Grid observed, however, that a number of customers seemed to lose interest in installing in-home technologies after they had completed the initial online or paper-based technology enrollment process. In order to address this phenomenon, more detailed information about the actual installation process could be provided to customers. For example, customers who rent their home should receive the information needed to understand that they are responsible for obtaining the landlord's permission before a visit can be scheduled. Similarly, customers should understand that the installation process requires that a technician enter the home, rather than performing the work outdoors or in a basement. Clearly stating the available installation times is also important. Finally, the education process should inform customers that there may be additional obstacles to installation that can only be identified when the installer is on site, such as construction, the location of the AMI meter relative to the in–home technologies, and meter vaults.

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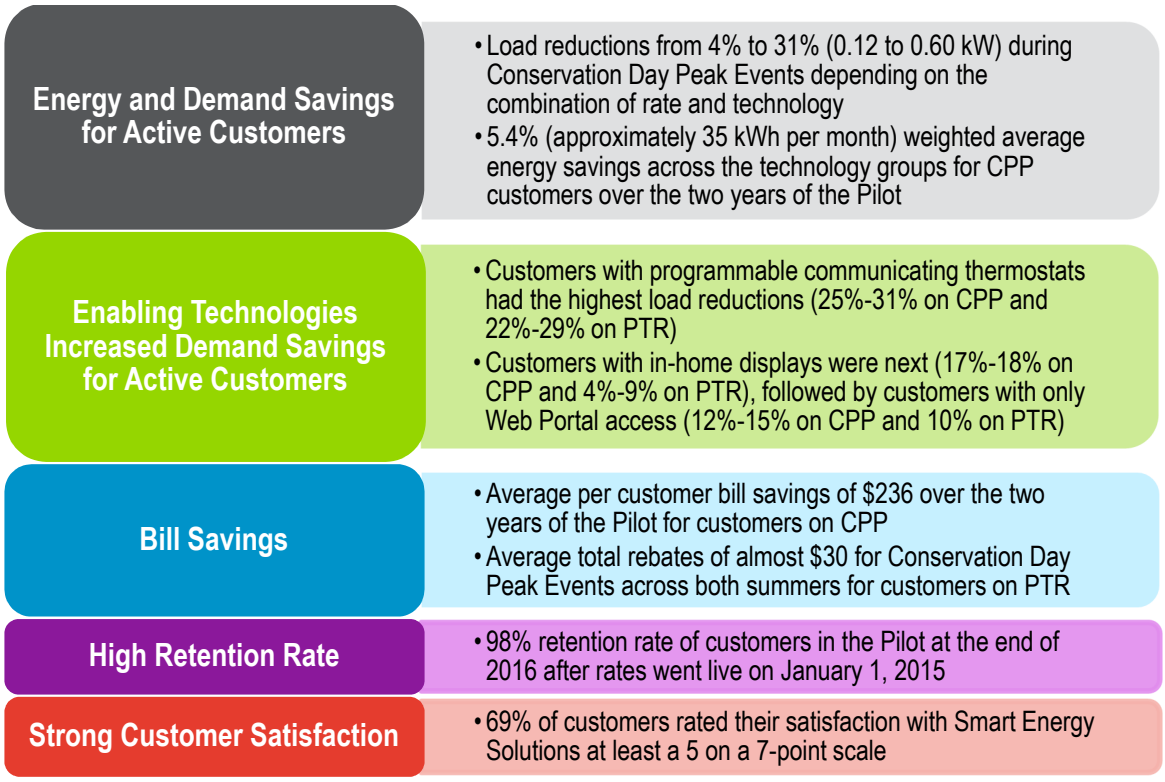
6. KEY FINDINGS AND LEARNINGS

6.1 Key Evaluation Findings

National Grid's Pilot was an innovative smart grid pilot combining deployment of advanced meters, customer-facing technologies, and TOU rates that ran through the end of 2016. National Grid filed for a two-year extension of the Pilot in 2016 and the DPU approved an interim extension that extends the Pilot until a final decision is reached in 2017. The Pilot also includes advanced distribution grid-side technologies which are the subject of a separate report.[100] This evaluation, conducted by Navigant, covers Pilot activities through the end of 2016. Key findings from this evaluation are shown in Figure 6-1.

Figure 6-1. Key Findings from Evaluation of Smart Energy Solutions



Source: Navigant analysis
Note: CPP refers to Critical Peak Pricing and PTR refers to Peak Time Rebate.

6.2 Key Learnings from Smart Energy Solutions

Before and throughout the Pilot, National Grid implemented a "listen, test, learn" approach that is based on "on the ground" conversations and reflections on the Pilot. This feedback, combined with learning,

[100] National Grid. *Interim Grid-Facing Evaluation Report*, March 31, 2016.

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leads to continuous improvement. National Grid conducted extensive program marketing in the lead-up to initiating meter installations, the first phase of the program. These activities included convening a public summit to discuss the proposed program, development of brochures explaining the program, and establishment of the staffed, physical Sustainability Hub within the Pilot program area. National Grid also partnered with local schools to offer Energy Ambassador internships at the Sustainability Hub. Clark University offered annual internships, and Worcester Polytechnic Institute created a student Sustainability Ambassador program. Ambassadors host Sustainability Hub tours and attend outreach events to educate customers throughout the community. Presenting the personal side of the Company is the backbone of "listen, test, learn", and is the inspiration for sending National Grid employees and Ambassadors into the community. It is also the basis for hosting visitors at the Sustainability Hub for the dual purpose of educating customers and listening to their concerns and feedback.

Several broad themes emerged regarding customer response to the Pilot design and implementation: Impacts for active customers (17% peak load reduction and 5.4% average load reduction over the two years of the Pilot) met the goals established through Section 85 of the GCA, and the majority of customers were satisfied with the Pilot. Figure 6-2 summarizes key learnings from the two years of Smart Energy Solutions.

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Figure 6-2. Key Learnings from Smart Energy Solutions

Smart Energy Solutions shows the viability of opt-out design.

- The program enrolled ~11,000 participants, which is many more than could have been recruited in an opt-in design.
- The retention rate after two years was 98%, which is higher than many comparable opt-in programs.
- Program satisfaction was strong, with 69% of participants rating the Pilot at least a 5 on a 7-point scale.

It is important to choose the default options in an opt-out program carefully.

- Smart Energy Solutions defaulted customers onto the CPP rate and web portal, with no additional in-home technology.
- Approximately 95% of customers were still on the default price plan and 90% on the default technology level after the two years of the Pilot.
- Although satisfaction was strong, "default bias" is likely to be a factor in customers staying on the default enrollment options in the opt-out design.

Long Peak Events and Peak Events called on consecutive days did not significantly affect savings or satisfaction.

- Despite calling more Peak Events (including on consecutive days) and longer Peak Events than similar programs, Smart Energy Solutions acheived similar satisfaction and savings.
- However, some customers did express a desire for shorter events ending earlier in the evening.

In-home devices increased demand savings, but much of the total savings were acheived with just a web portal.

- Customers with in-home devices had significantly higher demand savings (up to 31%) than those without any technology (up to 15%).
- Customers without technology who visited the program web portal saved approximately twice as much in the second year of the Pilot as those who did not visit the web portal (this may be attributable to differences in motivation as well as to the web portal itself).
- Customers without technology made up 90% of the participants in the Pilot and approximately 70% of the total Peak Event savings.
- Customers with IHDs saved the most energy, followed by those with web portal access only. Those with PCTs had higher demand savings but lower energy savings.

Customers on the CPP rate saved more than those on the PTR rate.

- At each technology level, active customers on the CPP rate saved more than those on the PTR rate.
- Passive customers saved more on the PTR rate, but that could be due to a slightly higher level of engagement since they had to opt in to the PTR rate.
- The motivations to save on the CPP rate are greater than for the PTR rate, as on the CPP rate customers face higher bills if they don't save.

The PTR rate may be more appropriate than the CPP rate for those on fixed budgets or with health issues.

- Although the CPP rate saves money over the course of the year, bills do increase for many customers in the summer, potentially making the PTR rate a better choice for customers on a fixed or limited income.
- Additionally for those who have a limited ability to reduce their energy usage (because of elderly, ill, or limited mobility household members, pets who need cooler temperatures, electric medical equipment, etc.) the PTR rate may be more appropriate.

Information needs to be provided multiple times via multiple channels.

- Despite a plethora of communication from National Grid, half of customers without technology did not know it was available, and of the 40% who knew it was available, many did not understand the benefits.
- Additionally, many customers (56%) did not realize they had the option to switch price plans.
- Based on the focus groups, low-income customers had low awareness of the rates and technologies despite the high potential benefits to this group.

Customers want options to personalize notifications.

- Customers cited issues with the amount and methods of Conservation Day notifications in 2015, and responded well to additional promotion and simplification of personalization options in 2016.

Source: Navigant analysis

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APPENDIX A. IMPACT ASSESSMENT METHODOLOGY

Navigant evaluated energy, demand, and bill impacts from the Pilot using regression analysis of monthly bills and hourly customer loads, respectively, using anonymized customer data from National Grid. Energy and demand impacts were estimated by technology/price group. On the residential side, a single regression was estimated for each group when the number of customers in the group was large enough, or combined regressions with dummies were used to separate the effect for each group individually if there were too few customers. Navigant also estimated impacts by demographic subgroup as the data allowed, i.e., when there were enough customers in a given subgroup to estimate savings via regression analysis. On the commercial side, a pooled regression was run for G1 commercial customers on the CPP rate in Level 1 and single customer regressions were run for all other commercial customers.

A.1 Peak Event Impacts

Navigant used an *ex-post* model to estimate demand impacts, which included variables to control for temperature, humidity, intra-seasonal, intra-weekly and intra-daily (i.e., hourly) seasonality, and the build-up of heat in the home over 4- and 24-hour periods.[101] The model included additional controls for the way that the relationship between demand and temperature can vary by month and for the possibly non-linear manner in which heat build-up may affect household demand.

The impacts and snapback were estimated using a battery of dummy variables that were specific to each unique Conservation Day, hour of day combination. In effect, the model ascribes all event- and snapback hour variation in demand from the baseline to the event (or the snapback). Navigant also explored the possibility of pre-cooling but did not find significant evidence of its existence, and therefore pre-cooling was left out of the final model specification.

For each technology/price group over the period from 8 a.m. to 10 p.m. from June through September of 2014 and the year being estimated (either 2015 or 2016) the regression model in Equation A-1 was estimated. This equation shows the exact model used in 2015 and a very similar model was used in 2016. In 2015, Navigant estimated the model using quarter-hourly data and then aggregated impacts to the hourly level. In 2016, Navigant aggregated the data to the hourly level first and then ran the regression at that level, thus the quarter-hour dummies were changed to hour dummies (which was the only change for the 2016 regression model). This aggregation to the hourly level was made to simplify the calculation of standard errors and was not expected to impact the savings estimates. Navigant tested both methods in 2016 and, as expected, found that the change did not have a statistically significant impact on the coefficient estimates.

[101] In the original scope of work, Navigant proposed matching from the load research customers to construct the baseline usage, as opposed to the within subject method that was ultimately used. However, the load research group only consisted of about 200 customers and thus was not large enough to match from.

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Equation A-1. *Ex-post* Regression Model to Estimate Demand Savings

$$
\begin{aligned}
y_{k,t} = \alpha_k &+ \sum_{i=1}^{55} \beta_i^h \cdot qh_{i,t} + \sum_{s=1}^{S=22} \sum_{i=1}^{55} \beta_{i,s}^e \cdot qh_{i,t} \cdot e_{s,t} + \sum_{s=1}^{S=22} \sum_{r=1}^{R=20} \beta_{s,r}^s \cdot qh_{i,t} \cdot s_{s,r,t} + \sum_{i=1}^{55} \beta_i^{CDH} \cdot qh_{i,t} \cdot CDH65_t + \sum_{i=1}^{55} \beta_i^{HDH} \cdot qh_{i,t} \cdot HDH65_t \\
&+ \sum_{i=1}^{55} \beta_i^{THI} \cdot qh_{i,t} \cdot THI_t + \sum_{i=1}^{55} \beta_i^{THI_{15}} \cdot qh_{i,t} \cdot THI\_lag15_t + \sum_{i=1}^{55} \beta_i^{THI_{30}} \cdot qh_{i,t} \cdot THI\_lag30_t + \sum_{i=1}^{55} \beta_i^{THI_{45}} \cdot qh_{i,t} \cdot THI\_lag45_t \\
&+ \sum_{i=1}^{55} \beta_i^{THI_{60}} \cdot qh_{i,t} \cdot THI\_lag60_t + \sum_{i=1}^{55} \beta_i^{CDTH} \cdot qh_{i,t} \cdot CDH65_t \cdot THI_t + \sum_{i=1}^{55} \beta_i^{MA24CD} \cdot qh_{i,t} \cdot MA24\_CDH65_t \\
&+ \sum_{i=1}^{55} \beta_i^{MA24CDTH} \cdot qh_{i,t} \cdot MA24\_CDH65_t \cdot THI_t + \sum_{i=1}^{55} \beta_i^{MA4CD} \cdot qh_{i,t} \cdot MA4\_CDH65_t \\
&+ \sum_{i=1}^{55} \beta_i^{MA4CDTH} \cdot qh_{i,t} \cdot MA4\_CDH65_t \cdot THI_t + \sum_{i=1}^{55} \beta_i^{RH} \cdot qh_{i,t} \cdot RH_t + \sum_{i=1}^{55} \sum_{d=1}^{7} \beta_d^{DoW} \cdot qh_{i,t} \cdot DoW_{d,t} \\
&+ \sum_{i=1}^{55} \sum_{m=6}^{M=9} \beta_m^{Month} \cdot qh_{i,t} \cdot Month_{m,t} + \sum_{i=1}^{55} \sum_{m=6}^{M=9} \beta_m^{MonthCDH} \cdot qh_{i,t} \cdot Month_{m,t} \cdot CDH_t \\
&+ \sum_{i=1}^{55} \sum_{m=6}^{M=9} \beta_m^{MonthTHI} \cdot qh_{i,t} \cdot Month_{m,t} \cdot THI_t + \sum_{i=1}^{55} \beta_i^{pmMA24CD2} \cdot pm_{i,t} \cdot MA24\_CDH65_t^2 \\
&+ \sum_{i=1}^{55} \beta_i^{pmMA24CD2TH} \cdot pm_{i,t} \cdot MA24\_CDH65_t^2 \cdot THI_t + \sum_{i=1}^{55} \beta_i^{pmMA4CD2} \cdot pm_{i,t} \cdot MA4\_CDH65_t^2 \\
&+ \sum_{i=1}^{55} \beta_i^{pmMA4CD2TH} \cdot pm_{i,t} \cdot MA4\_CDH65_t^2 \cdot THI_t + \sum_{i=1}^{55} \beta_i^{peak} qh_{i,t} \cdot peakhour\_evtyr_t + \sum_{i=1}^{55} \sum_{d=1}^{7} \beta_d^{weekend} qh_{i,t} \cdot weekend\_evtyr_{d,t} \\
&+ \varepsilon_t
\end{aligned}
$$

Where:

$y_{k,t}$	=	The average kWh usage of household *k* in quarter-hour *t*.
$qh_{i,t}$	=	A dummy variable equal to one if *i* is equal to the quarter-hour defined by *t*. For example, if quarter-hour *t* were 12-12:15 p.m. then $h_{17,t}$ would equal one and $h_{1,t}$ to $h_{16,t}$ and $h_{18,t}$ to $h_{55,t}$ would all be equal to zero.[102]
$e_{s,t}$	=	A dummy variable equal to one if there is a Peak Event taking place in quarter-hour *t* on event day *s* (one of the 40 Peak Event days) and zero otherwise.
$s_{s,r,t}$	=	A dummy variable intended to capture the effect of snapback in the period following the end of the event period. The *r*-th dummy is equal to one if period *t* is the *r*-th period following the end of a Peak Event and the event in quarter-hour *t* corresponds to event *s*. Note that snapback is modeled only within the same day as the event, thus the highest value attained by *R* was 20 (for the events ending at 5 p.m.), and the lowest was 8 (for the events that ended at 8 p.m.).
$CDH65_t$	=	Cooling degree hours observed in quarter-hour *t* – base is 65°F.
$HDH65_t$	=	Heating degree hours observed in quarter-hour *t* – base is 65°F.
THI_t	=	Temperature humidity index in quarter-hour *t*.
$MA24\_CDH65_t$	=	Cooling degree hours calculated based on a 24-hour moving average of temperatures leading up to quarter-hour *t*. This variable helps capture the effect

[102] Recall that only hours between 8 a.m. and 10 p.m. were included in the regression.

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		on demand of heat build-up during periods of extended high temperatures.
$MA4\_CDH65_t$	=	Cooling degree hours calculated based on a 4-hour moving average of temperatures leading up to quarter-hour *t*. This variable helps capture the effect on demand of heat build-up during short periods of high temperatures followed by precipitous drops in temperature such as during a storm.
$MA4\_THI_t$	=	Temperature humidity index calculated based on a 24-hour moving average of the temperature humidity index leading up to quarter-hour *t*. This variable helps capture the effect on demand of heat build-up during short periods of high temperatures followed by precipitous drops in temperature such as during a storm.
RH_t	=	Relative humidity of quarter-hour *t*.
$DoW_{d,t}$	=	A dummy variable equal to one if quarter-hour *t* falls in the day of the week indicated by subscript *d*. A value of *d* of 1 indicates a Sunday, and a value of 7 indicates a Saturday.
$Month_{m,t}$	=	A dummy variable equal to one if quarter-hour *t* falls in month *m*, and zero otherwise. Note that only the months of June through September are included in the estimation sample.
$CDD65_t$	=	Cooling degree days observed on the day in which quarter-hour *t* falls – base is 65°F.
$pm_{it,}$	=	A dummy variable equal to one if quarter-hour *t* falls between noon and 9 p.m.
$peakhour\_evtyr_t$	=	A dummy variable equal to one if quarter-hour *t* falls during a peak hour, 8 a.m. to 8 p.m., in the event year (2015 or 2016). This variable captures the effect of the Smart Rewards Pricing on usage during non-event peak hours.
$weekend\_evtyr_{d,t}$	=	A dummy variable equal to one if quarter-hour *t* falls on a weekend in the event year (2015 or 2016). This variable captures the effect of the pricing scheme and the Peak Events on weekend usage, for example, weekend usage might go up if customers shift loads to the weekend to avoid the higher weekend day and Peak Event pricing.

Each regression creates an estimated fitted average per-participant baseline for every day included in the regression. In 2015, the regression in Equation A-1 was estimated using energy usage (kWh) over 15 minute periods which was then aggregated to the hour to get demand (kW) impacts. In 2016, hourly demand data (kW) was used directly in the regression.

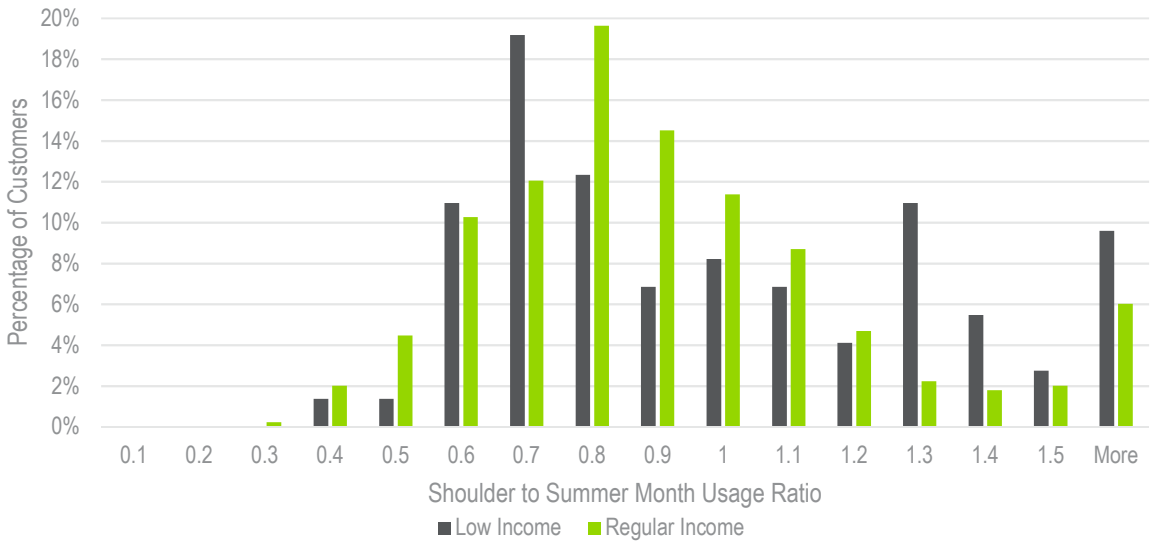
In 2015, the evaluation team estimated a day-of adjustment for each event day by subtracting actual usage from the fitted usage for the time from 8 a.m. until the start of the event. The day-of adjustment was subtracted from fitted usage for the entire day to create an adjusted fitted baseline. Demand savings were calculated by subtracting actual usage from the adjusted fitted baseline in each time period of the event. In 2016, the day-of adjustment was removed to simplify the calculation of standard errors. Navigant found that the day-of adjustment was minimal and did not have a statistically significant effect on the savings estimate.

A.2 CAC Penetration

Using 2015 data, Navigant identified customers likely to have CAC in Level 2 CPP by examining the ratio

of shoulder to summer month usage.[103] A customer with CAC is likely to have considerably higher usage in the summer than in the shoulder months; therefore, a lower shoulder to summer month usage ratio indicates a higher likelihood of having CAC. Figure A-1 shows the distribution of the shoulder to summer month usage ratio for low-income and standard-income customers in Level 2 CPP. The percentage of customers with a ratio below 0.9 is 52% for low-income customers and 63% for standard-income customers. This suggests that there may be lower CAC penetration for low-income customers, as a lower percentage of them have a low shoulder to summer month usage ratio.

Figure A-1. Shoulder to Summer Month Usage Ratio for Level 2 CPP Customers by Income Level



Source: Navigant analysis

A.3 Energy Impacts

Navigant estimated the reduction in energy use for 2014, when only the informational portion of the program was in effect, and for 2015 and 2016 when the Pilot's Smart Rewards Pricing was in effect and Peak Events were called during the summer. In order to estimate energy impacts via regression analysis, Navigant drew matched controls from a large pool of non-participant households in ZIP codes near the Worcester area where the Pilot took place.[104] The basic logic of matching is to balance the participant and non-participant samples by matching on the exogenous covariates known to have a high correlation with the outcome variable. Doing so increases the efficiency of the estimate and reduces the potential for model specification bias. Formally, the argument is that if the outcome variable Y is independently distributed conditional on X and D (conditional independence assumption), where X is a set of exogenous variables and D is the program variable, then the analyst can gain some power in the estimate of savings

[103] Navigant chose to use July and August as the summer months and May and October as the shoulder months.

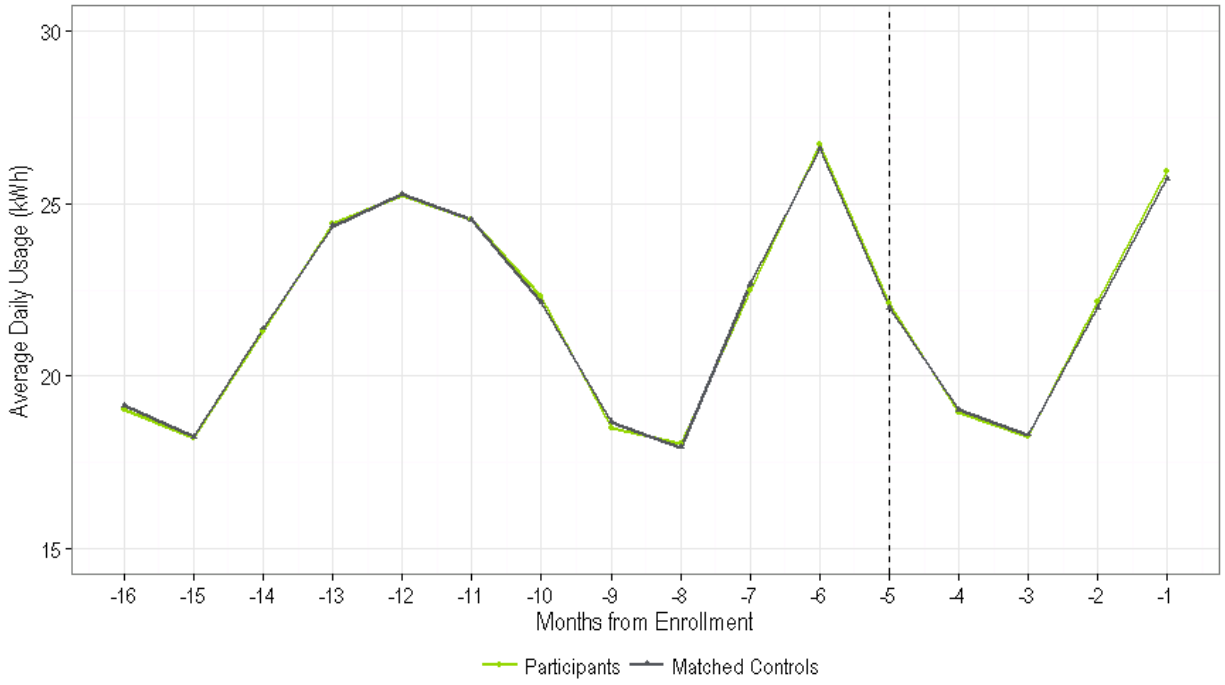
[104] Navigant used households in the following ZIP codes in the pool of non-participants from which to draw matched controls: 01601, 01602, 01603, 01604, 01605, 01606, 01607, 01608, 01609, 01610, 01611, 01501, 01527, 01545, 01505, 01583, 01520, 01612, 01524, 01542, 01537, 01540, 01590, 01519, 01560, 01588, 01534, 01568, 01532, 01581, 01522, 01507, and 01562.

and reduce potential model specification bias by assuring that the distribution of X is the same for treatment and control observations.

In this evaluation, the outcome variable is daily post-program period energy use, and the available exogenous covariate with by far the greatest correlation with this outcome variable is average daily use in the same month of the pre-program period, $PrekWh_{k,t}$, where k indexes the customer and t indexes the month. After drawing matches, the evaluation team ran the regression analysis to further control for any remaining imbalance in the matching on this variable. If, for instance, after matching the participants use slightly more energy on average in the pre-program period than their matches—i.e., they are higher baseline energy users—then including $PrekWh_{k,t}$ as an explanatory variable in a regression model predicting daily energy use during the post-program period prevents this remaining slight difference in baseline energy use from being attributed to the program.

Matches were draw on a 12-month period from September 2012 to August 2013; this left a 4-month test period from September 2013 to December 2013 to see how the matches performed outside of the matching period but before the program started. The expectation is that the participants and their matched controls should have similar usage both during the matching period and during the test period. To ensure that the quality of the matches selected using this method was high, Navigant examined the average usage of the participants and their selected matches in both the matching and test periods as shown in Figure A-2.

Figure A-2. Usage by Participants and Matching Controls in the Matching and Test Periods



Source: Navigant analysis

The development of a matched comparison group is viewed as a useful pre-processing step in a regression analysis to assure that the distributions of the covariates (i.e., the explanatory variables on which the output variable depends) for the treatment group are the same as those for the comparison group that provides the baseline measure of the output variable. This minimizes the possibility of model

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specification bias.

After matches were drawn, energy impacts were estimated for each year and technology/price group using regression analysis of monthly billing data as shown in Equation A-2. For 2014, energy impacts were estimated for the full year. For 2015 and 2016, savings were estimated separately in each month by interacting the participant variable in Equation A-2 with the monthly dummies.

Equation A-2. Post-Program Regression Model to Estimate Energy Savings

$$y_{k,t} = \beta_1 Participant_k + \sum_i \beta_{2i} Month_{i,t} + \sum_i \beta_{3i} Month_{i,t} \cdot PrekWh_{k,t} + \beta_4 cdd_{k,t} + \beta_5 hdd_{k,t} + \varepsilon_{k,t}$$

Where:

$y_{k,t}$	=	The average daily consumption of kWh by household *k* in bill period *t*.
$Participant_k$	=	A dummy variable equal to one if household *k* is a participant in the Pilot, and zero otherwise.
$Month_{i,t}$	=	A dummy variable equal to one when *i* equals *t*, and zero otherwise. In other words this is a monthly fixed effect.
$PrekWh_{k,t}$	=	Household *k*'s average daily consumption of kWh in the same calendar month of the pre-program year (2013) as the calendar month of month *t*.
$cdd_{k,t}$	=	The cooling degree days in bill period t for household *k* – base is 65°F.
$hdd_{k,t}$	=	The heating degree days in bill period t for household *k* – base is 65°F.

In each regression, the coefficient β_1 is the estimate of the reduction in average daily kWh consumption by program participants.

A.4 Bill Savings

CPP Customers

To estimate the monthly bill impacts of the Pilot for CPP customers, Navigant calculated the bill amount using actual usage under the Smart Rewards TOU pricing rates and the counter-factual bill amount using counter-factual usage in the absence of the program under the Basic Rate. Counter-factual usage was estimated using the energy savings estimated in Equation A-2. In cases where the energy savings were not statistically significant at the 90% level, Navigant still used the point estimate of savings to estimate counter-factual usage. In an unbiased regression, the point estimate of savings is a more accurate estimate of savings than zero, even when the point estimate is not statistically significant. Bill savings were calculated by technology level and were split out by income level.[105]

National Grid gave Navigant the actual bill amount paid by each participant in the Pilot; the TOU rates are shown in Table A-1. To estimate the counter-factual bill amount, the evaluation team calculated counter-factual usage in the absence of the program and multiplied it by the Basic Rate shown in Table A-2 to get commodity cost. Navigant then applied the non-commodity charges which were the same for the TOU rate and the Basic Rate. Once the evaluation team knew the bill amount under the program and in the absence of the program, subtraction gave the bill savings. These steps are laid out in Equation A-3.

[105] Low-income customers are given a 25% discount on their entire bill, including both the commodity and non-commodity charges.

Equation A-3. Bill Savings Calculation for CPP Customers

$$Pilot\_Cost = actual\_usage * basic\_rate$$

$$Counter\_Cost = basic\_rate * (actual\_usage * (1 - energy\_savings)) + non\_commodity\_charges$$

$$bill\_savings = Pilot\_Cost - Counter\_Cost$$

Table A-1. Smart Energy Solutions Pricing Rates

Effective for Usage During the Month of:	Residential (R-1, R-2) Rate (cents / kWh) Smart Rewards Pricing			Conservation Day Rebate
	Peak Period	Off-Peak Period	Peak Event Period	
December, 2016	9.369	7.742	45.853	(45.853)
November, 2016	9.369	7.742	45.853	(45.853)
October, 2016	7.744	6.421	37.416	(37.416)
September, 2016	7.702	6.379	37.374	(37.374)
August, 2016	7.702	6.379	37.374	(37.374)
July, 2016	7.702	6.379	37.374	(37.374)
June, 2016	7.702	6.379	37.374	(37.374)
May, 2016	7.702	6.379	37.374	(37.374)
April, 2016	12.463	10.226	62.636	(62.636)
March, 2016	12.463	10.226	62.636	(62.636)
February, 2016	12.463	10.226	62.636	(62.636)
January, 2016	12.463	10.226	62.636	(62.636)
December, 2015	12.463	10.226	62.636	(62.636)
November, 2015	12.463	10.226	62.636	(62.636)
October, 2015	8.859	7.313	43.544	(43.544)
September, 2015	8.859	7.313	43.544	(43.544)
August, 2015	8.859	7.313	43.544	(43.544)
July, 2015	8.859	7.313	43.544	(43.544)
June, 2015	8.859	7.313	43.544	(43.544)
May, 2015	8.859	7.313	43.544	(43.544)
April, 2015	15.537	12.675	79.730	(79.730)
March, 2015	15.537	12.675	79.730	(79.730)
February, 2015	15.537	12.675	79.730	(79.730)
January, 2015	15.537	12.675	79.730	(79.730)

Source: National Grid

Table A-2. Basic Rate

Fixed Price Options	
Effective During the Period of:	Rate (cents / kWh)
11/1/16 – 12/31/16	9.787
10/1/16-10/31/16	8.084
5/1/16 – 9/30/16	8.042
11/1/15 – 4/30/16	13.038
5/1/15 – 10/31/15	9.257
11/1/14 – 4/30/15	16.273

Source: National Grid

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PTR Customers

For PTR customers, the bill savings were due to the rebates paid by National Grid during Peak Events since these customers were not on the TOU rate. This report shows the rebate paid out by the Company for usage reduction during Peak Events. National Grid calculated reduced usage as the difference between metered usage during the Peak Event and "normal" usage, defined as average usage during the ten prior non-holiday, non-Conservation Day weekdays after accounting for a day-of adjustment to capture weather differences, time of event, pre-cooling, etc. The reduction was multiplied by the per-kWh cost of the rebate (see Table A-1) to determine the total rebate due to the customer.[106]

A.5 Load Shifting

In addition to capturing demand savings during a Peak Event, Equation A-1 was also set up to capture snapback after an event, peak savings during times outside of a Peak Event, and evidence of load shifting to weekends.

The coefficient on $qh_{i,t} \cdot s_{s,r,t}$ which is the quarter-hour (or hour in 2016) dummy interacted with the snapback dummy captures whether participants increased usage after the Peak Event relative to what they would have used in the absence of the event. Such snapback would reduce the total demand reduction attributable to the Pilot. A positive coefficient indicates that snapback occurred.

The coefficient on $peakhour\_evtyr_t$ captures the demand reduction during peak hours (8 a.m. to 8 p.m.) in the event year (2015 or 2016) that are not also during Peak Events. A negative coefficient indicates a reduction in usage due to the program. This captures whether the Pilot reduced peak usage when a Peak Event was not called.

The coefficient on $weekend\_evtyr_{d,t}$ captures the change in usage on weekends in the event year (2015 or 2016). This indicates whether participants shifted usage from weekdays which have TOU pricing to weekends which have a flat rate. A positive coefficient indicates that load shifting to the weekend occurred.

[106] Details can be found in: D.P.U. No. 1237, Tariff for Basic Service, September 3, 2014.

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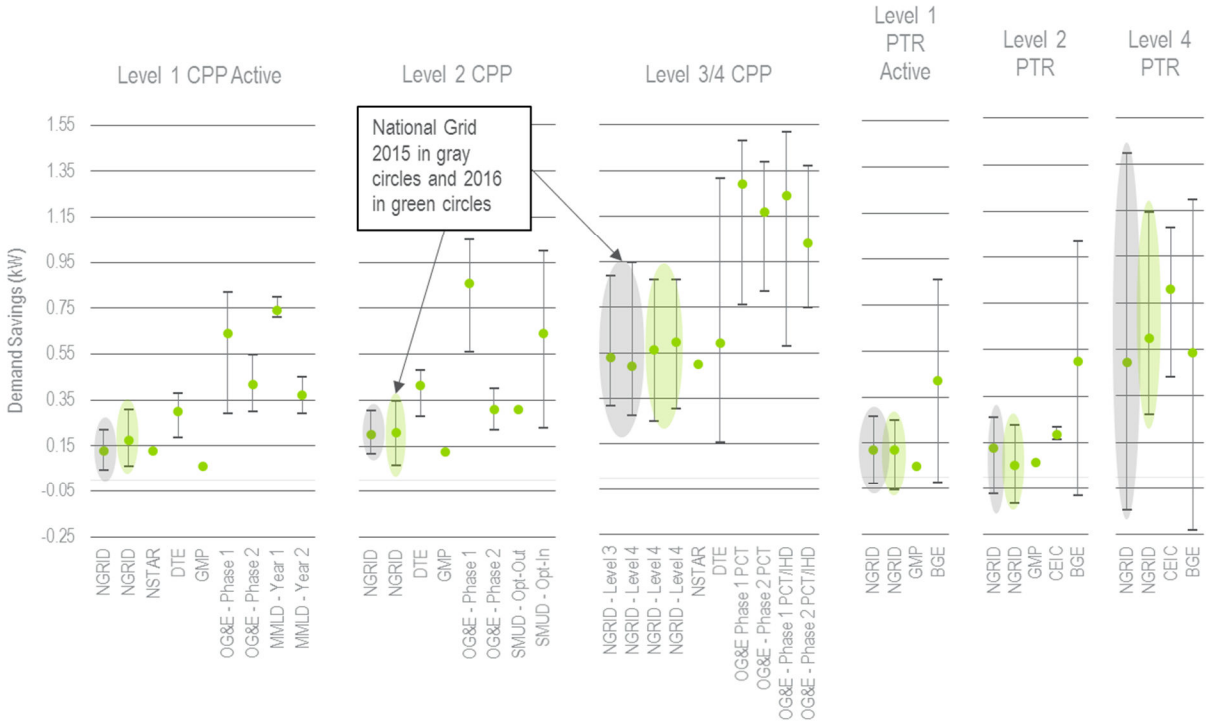
APPENDIX B. ADDITIONAL IMPACT ASSESSMENT RESULTS

B.1 Peak Event and Load Shifting Impacts

Figure B-1 shows comparisons of the Pilot to other utility programs for the absolute impacts during Peak Event hours. The Pilot had slightly lower absolute impacts than the comparison programs for most of the technology/price groups. Combined with the percentage comparisons, this suggests that National Grid has slightly lower baseline usage than most of the comparison utilities. Lower baseline usage among National Grid customers could cause National Grid's total savings to be slightly lower than those for comparable programs even though the percentage savings were the same.

Figure B-1. Peak Event Impacts Absolute Comparison to Other Utilities



Source: Navigant analysis and the Smart Grid Investment Grant program

Figure B-2 shows the average absolute impact for each event for the five CPP customer groups, and Figure B-3 shows the average absolute impact for each event for the four PTR groups. The absolute savings followed the same patterns as the percentage savings, with steady impacts for Levels 1 and 2 in both years and decreasing impacts throughout the summer for Levels 3 and 4 in 2015 and steady impacts in 2016. Absolute impacts for passive customers in Level 1 increased from 2015 to 2016.

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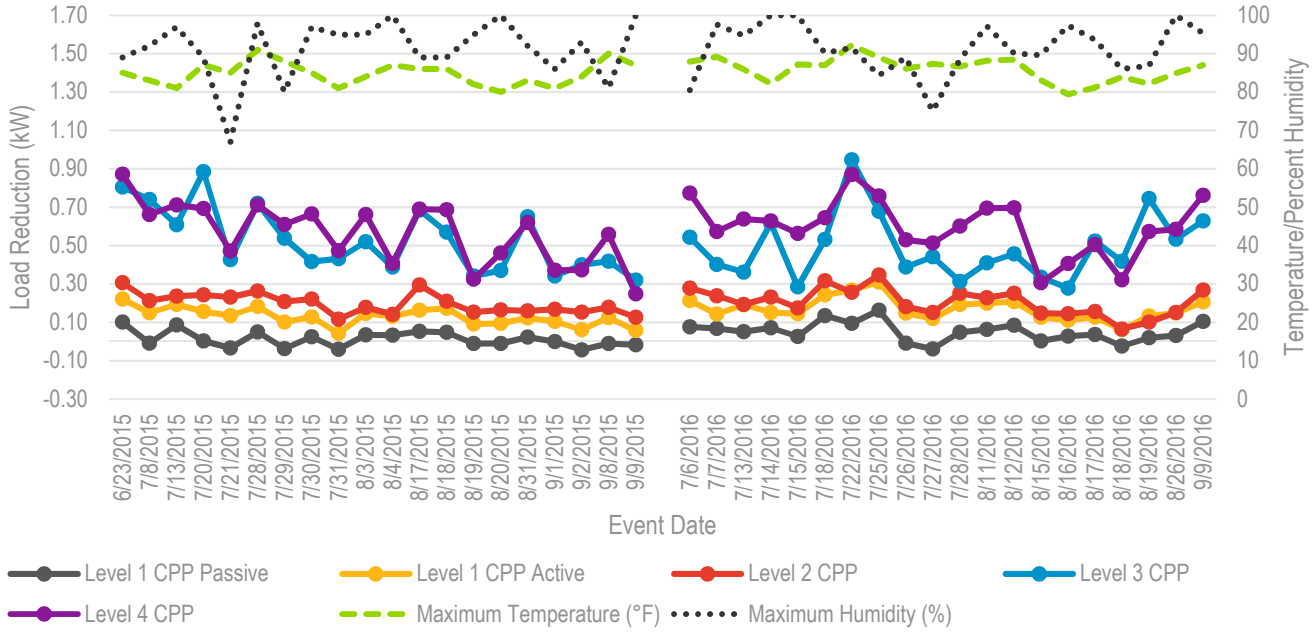
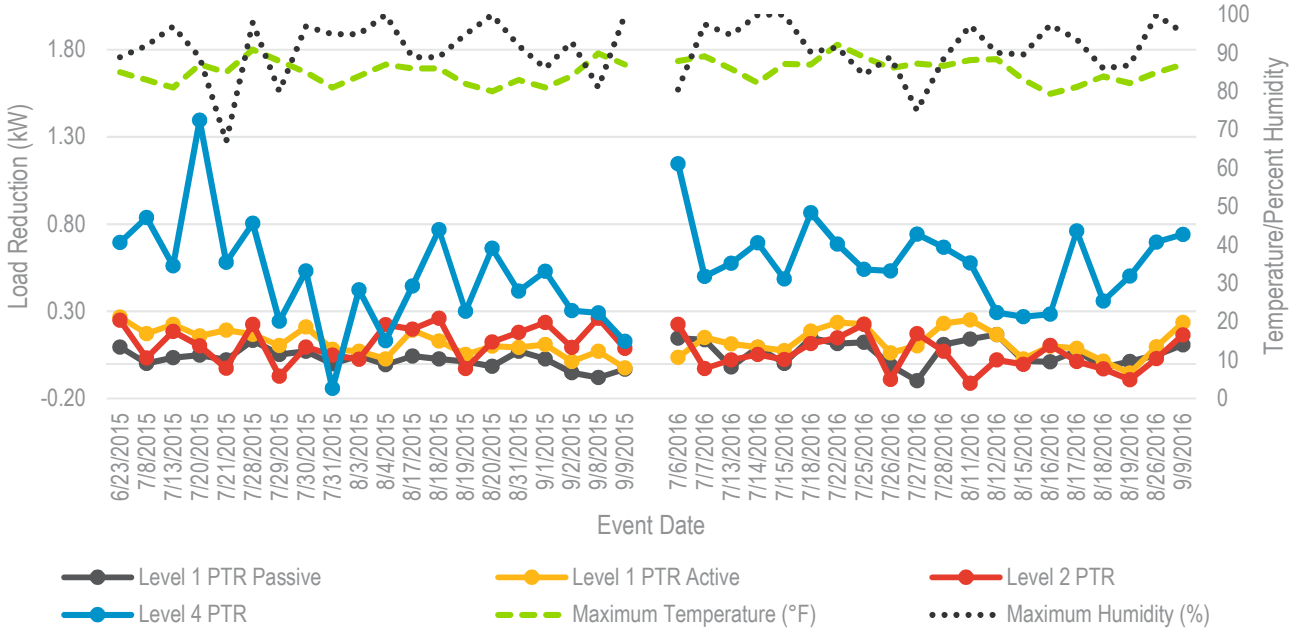
Figure B-2. Absolute Savings for CPP Customers



Source: Navigant analysis

Figure B-3. Absolute Savings for PTR Customers



Source: Navigant analysis
Note: Level 3 PTR is left out as this group only had one customer in 2015 and two in 2016.

Absolute and percentage impacts by technology/price group for each Peak Event in the two summers of

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the Pilot are shown in Table B-1 through Table B-4. Positive values indicate savings, or a decrease in electricity usage, and negative values indicate dissavings, or an increase in electricity usage.

Table B-1. Percentage Demand Impact for each Peak Event by Technology/Price Group (2015)

Event Date	Level 1 CPP Passive		Level 1 CPP Active		Level 1 PTR Passive		Level 1 PTR Active		Level 2 CPP		Level 2 PTR		Level 3 CPP		Level 4 CPP		Level 4 PTR	
June 23rd	9%	*	21%	*	9%	*	23%	*	27%	*	20%		50%	*	48%	*	31%	*
July 8th	-1%		15%	*	0%		15%		21%	*	3%		49%	*	38%	*	40%	*
July 13th	8%	*	19%	*	3%		20%	*	23%	*	16%		40%	*	40%	*	29%	*
July 20th	0%		13%	*	4%		11%		20%	*	8%		45%	*	34%	*	49%	*
July 21st	-3%	*	12%	*	2%		16%	*	21%	*	-2%		26%	*	26%	*	27%	*
July 28th	4%	*	16%	*	12%	*	14%		22%	*	16%		35%	*	35%	*	33%	*
July 29th	-3%	*	9%	*	5%		9%		18%	*	-6%		29%	*	28%	*	10%	
July 30th	2%	*	12%	*	6%		16%	*	19%	*	8%		26%	*	34%	*	26%	*
July 31st	-4%	*	5%		0%		8%		12%	*	5%		32%	*	29%	*	-9%	
August 3rd	3%	*	14%	*	4%		6%		16%	*	2%		33%	*	33%	*	21%	
August 4th	3%	*	13%	*	-1%		3%		14%	*	18%		28%		25%	*	8%	
August 17th	4%	*	14%	*	4%		14%	*	23%	*	15%		33%	*	31%	*	20%	
August 18th	4%	*	14%	*	2%		10%		16%	*	17%		29%	*	30%	*	30%	*
August 19th	-1%		8%	*	1%		4%		13%	*	-2%		20%		17%	*	14%	
August 20th	-1%		9%	*	-2%		8%		15%	*	10%		23%		27%	*	32%	*
August 31st	2%	*	11%	*	6%		7%		14%	*	14%		37%	*	31%	*	22%	
September 1st	0%		11%	*	3%		11%		17%	*	17%		25%		23%	*	28%	*
September 2nd	-4%	*	6%	*	-5%		1%		14%	*	7%		25%	*	20%	*	14%	
September 8th	-1%		10%	*	-7%		5%		15%	*	17%		21%	*	25%	*	13%	
September 9th	-1%		5%	*	-3%		-2%		10%	*	6%		16%		12%	*	6%	
Average	**1%**		**12%**	*	**2%**		**10%**		**17%**	*	**9%**		**31%**	*	**29%**	*	**22%**	

Source: Navigant analysis
Note: An asterisk (*) indicates that the majority of the event hours were statistically significant at the 90% confidence level for the indicated group.

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Table B-2. Percentage Demand Impact for each Peak Event by Technology/Price Group (2016)

Event Date	Level 1 CPP Passive		Level 1 CPP Active		Level 1 PTR Passive		Level 1 PTR Active		Level 2 CPP		Level 2 PTR		Level 3 CPP		Level 4 CPP		Level 4 PTR	
July 6th	6%	*	17%	*	11%	*	3%		23%	*	15%	*	25%	*	33%	*	46%	*
July 7th	6%	*	14%	*	12%	*	13%		23%	*	-2%		26%	*	34%	*	28%	*
July 13th	5%	*	18%	*	-2%		10%		19%	*	2%		21%	*	34%	*	29%	*
July 14th	7%	*	15%	*	8%	*	8%		21%	*	4%		40%	*	37%	*	38%	*
July 15th	2%	*	13%	*	0%		6%		16%	*	2%		15%		28%	*	23%	
July 18th	10%	*	20%	*	11%	*	14%	*	25%	*	8%		26%	*	30%	*	38%	*
July 22nd	7%	*	20%	*	8%	*	16%	*	20%	*	10%		39%	*	34%	*	26%	*
July 25th	11%	*	23%	*	8%	*	15%	*	26%	*	14%		29%	*	31%	*	21%	*
July 26th	-1%		13%	*	-1%		5%		16%	*	-6%		20%	*	25%	*	24%	*
July 27th	-3%	*	10%	*	-8%	*	8%		13%	*	12%		22%	*	24%	*	32%	*
July 28th	4%	*	16%	*	8%	*	17%	*	21%	*	5%		15%		27%	*	29%	*
August 11th	5%	*	15%	*	10%	*	17%	*	18%	*	-7%		17%	*	28%	*	22%	*
August 12th	6%	*	16%	*	11%	*	11%	*	19%	*	1%		20%	*	29%	*	12%	
August 15th	0%		12%	*	1%		2%		13%	*	0%		19%	*	16%	*	14%	
August 16th	3%	*	12%	*	1%		10%		15%	*	9%		20%		27%	*	18%	
August 17th	3%	*	13%	*	7%		8%		16%	*	1%		35%	*	31%	*	44%	*
August 18th	-2%	*	6%	*	-2%		1%		7%	*	-2%		26%	*	18%	*	19%	
August 19th	2%	*	13%	*	1%		-5%		10%	*	-7%		43%	*	31%	*	25%	*
August 26th	3%	*	14%	*	4%		8%		14%	*	2%		29%	*	29%	*	33%	*
September 9th	9%	*	18%	*	9%	*	19%	*	23%	*	11%		32%	*	36%	*	34%	*
Average	**4%**	*	**15%**	*	**5%**		**9%**		**18%**	*	**3%**		**26%**	*	**29%**	*	**28%**	*

Source: Navigant analysis
Note: An asterisk (*) indicates that the majority of the event hours were statistically significant at the 90% confidence level for the indicated group.

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Table B-3. Absolute Demand Impact (kW) for each Peak Event by Technology/Price Group (2015)

Event Date	Level 1 CPP Passive		Level 1 CPP Active		Level 1 PTR Passive		Level 1 PTR Active		Level 2 CPP		Level 2 PTR	Level 3 CPP		Level 4 CPP		Level 4 PTR	
June 23rd	0.101	*	0.222	*	0.267	*	0.095	*	0.307	*	0.250	0.806	*	0.872	*	0.695	*
July 8th	-0.009		0.150	*	0.173		0.002		0.213	*	0.032	0.740	*	0.662	*	0.838	*
July 13th	0.086	*	0.193	*	0.226		0.034	*	0.236	*	0.185	0.609	*	0.712	*	0.561	*
July 20th	0.003		0.157	*	0.159		0.049		0.244	*	0.102	0.886	*	0.694	*	1.396	*
July 21st	-0.034	*	0.135	*	0.193		0.021	*	0.232	*	-0.026	0.426	*	0.472	*	0.581	*
July 28th	0.050	*	0.184	*	0.168	*	0.133		0.264	*	0.225	0.720	*	0.712	*	0.805	*
July 29th	-0.037	*	0.102	*	0.104		0.052		0.208	*	-0.071	0.539	*	0.611	*	0.243	
July 30th	0.025	*	0.129	*	0.210		0.072	*	0.222	*	0.095	0.417	*	0.665	*	0.532	*
July 31st	-0.040	*	0.043		0.083		-0.001		0.117	*	0.050	0.432	*	0.474	*	-0.142	
August 3rd	0.035	*	0.147	*	0.072		0.044		0.178	*	0.026	0.520	*	0.662	*	0.423	
August 4th	0.034	*	0.131	*	0.028		-0.006		0.141	*	0.224	0.388		0.407	*	0.131	
August 17th	0.054	*	0.164	*	0.193		0.043	*	0.295	*	0.198	0.686	*	0.691	*	0.445	
August 18th	0.049	*	0.173	*	0.130		0.028		0.210	*	0.261	0.571	*	0.687	*	0.769	*
August 19th	-0.010		0.091	*	0.052		0.012		0.153	*	-0.028	0.341		0.325	*	0.300	
August 20th	-0.011		0.095	*	0.101		-0.015		0.165	*	0.124	0.370		0.462	*	0.662	*
August 31st	0.023	*	0.124	*	0.093		0.071		0.160	*	0.180	0.650	*	0.621	*	0.416	
September 1st	0.000		0.105	*	0.109		0.027		0.169	*	0.237	0.341		0.372	*	0.530	*
September 2nd	-0.043	*	0.061	*	0.012		-0.051		0.153	*	0.093	0.400	*	0.373	*	0.304	
September 8th	-0.011		0.125	*	0.072		-0.079		0.178	*	0.261	0.419	*	0.559	*	0.292	
September 9th	-0.017		0.058	*	-0.025		-0.031		0.126	*	0.087	0.320		0.249	*	0.129	
Average	**0.012**		**0.129**	*	**0.121**		**0.025**		**0.199**	*	**0.125**	**0.529**	*	**0.564**	*	**0.496**	

Source: Navigant analysis
Note: An asterisk (*) indicates that the majority of the event hours were statistically significant at the 90% confidence level for the indicated group.

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Table B-4. Absolute Demand Impact (kW) for each Peak Event by Technology/Price Group (2016)

Event Date	Level 1 CPP Passive		Level 1 CPP Active		Level 1 PTR Passive		Level 1 PTR Active		Level 2 CPP		Level 2 PTR		Level 3 CPP		Level 4 CPP		Level 4 PTR	
July 6th	0.076	*	0.213	*	0.146	*	0.036		0.278	*	0.226		0.544	*	0.773	*	1.146	*
July 7th	0.069	*	0.144	*	0.137	*	0.151		0.239	*	-0.028		0.402	*	0.574	*	0.500	*
July 13th	0.052	*	0.191	*	-0.018		0.114		0.194	*	0.022		0.362	*	0.639	*	0.576	*
July 14th	0.071	*	0.151	*	0.093	*	0.095		0.231	*	0.053		0.617	*	0.628	*	0.694	*
July 15th	0.026	*	0.145	*	0.001		0.075		0.175	*	0.024		0.285		0.564	*	0.486	
July 18th	0.135	*	0.244	*	0.149	*	0.186	*	0.317	*	0.116		0.531	*	0.646	*	0.865	*
July 22nd	0.095	*	0.269	*	0.116	*	0.236	*	0.257	*	0.149		0.947	*	0.871	*	0.686	*
July 25th	0.163	*	0.310	*	0.123	*	0.227	*	0.347	*	0.225		0.679	*	0.758	*	0.541	*
July 26th	-0.008		0.148	*	-0.009		0.062		0.182	*	-0.090		0.388	*	0.530	*	0.532	*
July 27th	-0.039	*	0.120	*	-0.098	*	0.103		0.152	*	0.172		0.442	*	0.513	*	0.742	*
July 28th	0.049	*	0.193	*	0.109	*	0.230	*	0.252	*	0.072		0.313		0.602	*	0.667	*
August 11th	0.064	*	0.200	*	0.141	*	0.251	*	0.228	*	-0.113		0.410	*	0.696	*	0.577	*
August 12th	0.085	*	0.208	*	0.167	*	0.167	*	0.252	*	0.022		0.457	*	0.697	*	0.293	
August 15th	0.003		0.126	*	0.017		0.027		0.148	*	-0.004		0.335	*	0.307	*	0.269	
August 16th	0.029	*	0.112	*	0.010		0.101		0.145	*	0.105		0.278		0.406	*	0.284	
August 17th	0.036	*	0.127	*	0.074	*	0.088		0.157	*	0.012		0.524	*	0.505	*	0.761	*
August 18th	-0.024	*	0.061	*	-0.022		0.014		0.065	*	-0.030		0.419	*	0.322	*	0.360	
August 19th	0.02	*	0.134	*	0.013		-0.054		0.102	*	-0.092		0.745	*	0.574	*	0.502	*
August 26th	0.032	*	0.148	*	0.050	*	0.097		0.152	*	0.029		0.534	*	0.586	*	0.696	*
September 9th	0.105	*	0.206	*	0.107	*	0.236	*	0.269	*	0.164		0.629	*	0.762	*	0.740	*
Average	**0.052**	*	**0.173**	*	**0.065**		**0.122**		**0.207**	*	**0.052**		**0.492**	*	**0.598**	*	**0.596**	*

Source: Navigant analysis
Note: An asterisk (*) indicates that the majority of the event hours were statistically significant at the 90% confidence level for the indicated group.

Absolute snapback impacts by technology/price group for each Peak Event in each summer of the Pilot are shown in Table B-5 and Table B-6. As noted in Section 3.4.1 no snapback was found for Level 2 customers on either rate, thus these groups are left out of the table. Negative values indicate snapback, or an increase in electricity usage subsequent to a Peak Event, and positive values indicate continued lower usage subsequent to a Peak Event.

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Table B-5. Absolute Snapback (kW) for each Peak Event by Technology/Price Group (2015)

Event Date	Level 1 CPP Passive		Level 1 CPP Active		Level 1 PTR Passive		Level 1 PTR Active		Level 3 CPP		Level 4 CPP		Level 4 PTR	
June 23rd	-0.02	*	0.05	*	0.04		0.00		-0.23	*	-0.14	*	0.17	
July 8th	-0.06	*	-0.04	*	0.00		-0.01		-0.42	*	-0.22	*	-0.43	*
July 13th	0.07	*	0.09	*	0.00		0.03		-0.18		0.03		0.03	
July 20th	-0.14	*	0.00		-0.17	*	0.00		-0.42	*	-0.45	*	0.35	
July 21st	-0.09	*	-0.01		0.02		-0.36	*	-0.53	*	-0.36	*	-0.15	
July 28th	0.08	*	0.07	*	0.00		0.00		-0.01		-0.22	*	-0.27	
July 29th	0.00		0.03	*	0.09	*	0.00		-0.55	*	-0.14		-0.12	
July 30th	0.02	*	0.00		0.00		0.00		-0.61	*	-0.18	*	-0.14	
July 31st	-0.04	*	-0.01		-0.08	*	0.00		-0.17		-0.23	*	-0.91	*
August 3rd	0.00		0.07	*	0.00		0.00		-0.43	*	-0.15	*	-0.29	*
August 4th	0.07	*	0.10	*	-0.03	*	0.00		-0.36	*	-0.11	*	-0.16	
August 17th	0.14	*	0.09	*	0.03	*	0.00		0.20		-0.10	*	-0.05	
August 18th	0.05	*	0.04	*	0.05	*	0.00		-0.13		-0.18	*	-0.13	
August 19th	0.00		0.00		0.00		0.00		-0.47	*	-0.30	*	-0.38	*
August 20th	0.01		0.00		0.00		0.00		-0.55	*	-0.22	*	-0.31	
August 31st	0.00		0.00		0.00		0.00		-0.37	*	-0.49	*	-0.50	*
September 1st	-0.02	*	0.00		0.00		0.00		-0.31	*	-0.26	*	0.00	
September 2nd	-0.01		0.00		0.00		0.00		-0.43	*	-0.40	*	-0.61	*
September 8th	0.00		0.02	*	0.00		0.02		-0.15		-0.16	*	-0.69	*
September 9th	0.00		-0.09	*	0.00		0.00		-0.13		-0.34	*	-0.71	*
Average	**0.00**		**0.02**		**0.00**		**-0.02**		**-0.31**	*	**-0.23**	*	**-0.27**	

Source: Navigant analysis
Note: An asterisk (*) indicates that the majority of the event hours were statistically significant at the 90% confidence level for the indicated group.

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Table B-6. Absolute Snapback (kW) for each Peak Event by Technology/Price Group (2016)

Event Date	Level 1 CPP Passive		Level 1 CPP Active		Level 1 PTR Passive		Level 1 PTR Active		Level 3 CPP		Level 4 CPP		Level 4 PTR	
July 6th	0.096	*	0.07	*	0.177	*	0		-0.123		-0.149	*	0.175	
July 7th	0.076	*	0.04	*	0.108	*	0		-0.299	*	-0.14	*	-0.122	
July 13th	0.032	*	0.04	*	0		0		-0.352	*	-0.205	*	-0.251	
July 14th	0.037	*	0.03	*	0		0		0.147		-0.104	*	-0.078	
July 15th	0.083	*	0.11	*	0.135	*	0		-0.071		0.012		0.053	
July 18th	0.108	*	0.07	*	0.152	*	0		0.135		-0.096	*	-0.058	
July 22nd	0.221	*	0.22	*	0.093	*	0		0.289		0.255	*	0.114	
July 25th	0.144	*	0.13	*	0.201	*	0		-0.119		-0.063		-0.301	
July 26th	0.006	*	0.02	*	0		-0.227	*	-0.263	*	-0.35	*	-0.537	*
July 27th	-0.034	*	-0.06	*	0		0		-0.481	*	-0.616	*	-0.703	*
July 28th	0.067	*	0.10	*	0		0		0.021		-0.146	*	-0.619	*
August 11th	0.101	*	0.08	*	0.123	*	0		-0.358	*	-0.019		-0.65	*
August 12th	0.043	*	0.00		0.127	*	0		-0.319	*	-0.136	*	-0.196	
August 15th	0.007	*	-0.03		0		-0.308	*	-0.14		-0.39	*	-0.639	*
August 16th	0.033	*	0.02	*	0		0		-0.249	*	-0.192	*	-0.097	
August 17th	0.094	*	0.10	*	0.127	*	0		-0.061		-0.096	*	-0.28	
August 18th	-0.034	*	0.00		0		0		-0.247	*	-0.373	*	-0.416	*
August 19th	0		0.04	*	0		-0.045	*	0.364	*	-0.132	*	-0.034	
August 26th	0		0.02	*	0		-0.285	*	-0.183		-0.242	*	0.22	
September 9th	0.099	*	0.10	*	0.028	*	0		-0.002		-0.084	*	-0.124	
Average	**0.06**		**0.06**		**0.06**		**-0.04**		**-0.12**	*	**-0.16**		**-0.23**	*

Source: Navigant analysis
Note: An asterisk (*) indicates that the majority of the event hours were statistically significant at the 90% confidence level for the indicated group.

B.2 Arrearages Analysis Tables

Table B-7 through Table B-10 show the results of Navigant's review of credit and collections for Pilot participants versus other Worcester customers. This analysis included review of:

- End of Pilot arrears balances and customer counts for 30/60/90+ day periods;

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- End of Pilot arrears balances and customer counts for accounts flagged as medical or life support, and therefore not subject to disconnections;
- Disconnection service history before and during the Pilot; and,
- Uncollectible account history before and during the Pilot.

Overall compared to Worcester customers not in the Pilot, a smaller portion of the Pilot participants had disconnections or uncollectible balances. However, this was true in 2014, before the Pilot began, as well as during the Pilot in 2015 and 2016. A similar percentage of customers within and outside of the Pilot had arrears balances. The average dollar amounts per customer with arrears, disconnects, or uncollectible balances were also similar for Pilot and non-Pilot customers. Therefore, the Pilot did not appear to have a large impact on any of these metrics.

Table B-7. Arrears Balances for 30/60/90+ Days

	30 Day Arrears	60 Day Arrears	90 and Plus Day Arrears	Total Arrears
Worcester Non-Pilot Customers	$3,595,793	$1,911,086	$11,390,436	$16,897,315
Pilot Participants	$504,055	$272,787	$1,900,085	$2,676,928
	30 Day Arrears - Customer Counts	**60 Day Arrears - Customer Count**	**90 and Plus Day Arrears - Customer Count**	**Total Arrears - Customer Counts**
Worcester Non-Pilot Customers	19,899	12,846	10,412	20,451
Pilot Participants	3,289	1,913	1,507	3,363
	30 Day Arrears -Average Per Customer	**60 Day Arrears - Average Per Customer**	**90 and Plus Day Arrears - Average Per Customer**	**Total Arrears - Average Per Customer**
Worcester Non-Pilot Customers	$181	$149	$1,094	$826
Pilot Participants	$153	$143	$1,261	$796
	30 Day Arrears - Customer Counts as % of Customer Base	**60 Day Arrears - Customer Counts as % of Customer Base**	**90 and Plus Day Arrears - Customer Counts as % of Customer Base**	**Total Arrears - Customer Counts as % of Customer Base**
Worcester Non-Pilot Customers	28%	18%	15%	29%
Pilot Participants	32%	18%	15%	32%

Source: Navigant analysis

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Table B-8. Arrears Balances for Medical and Life Support Accounts

	Total Medical & Life Support Accounts	Accounts with Arrears Balance	Share of Medical & Life Support Accounts with Arrears Balances	Average Arrears Per Account
Worcester Non-Pilot Customers	1,245	885	71%	$4,129
Pilot Participants	155	121	78%	$5,031

Source: Navigant analysis

Table B-9. Disconnection Service History

Year	Worcester Non-Pilot Customers			Pilot Participants		
	Total Number of Customers			Total Number of Customers		
2014	69,029			11,184		
2015	70,090			10,555		
2016	69,915			10,361		
	Number of Disconnected Customers	Total $ Amount in Arrears	Average $ Amount Per Disconnected Customer	Number of Disconnected Customers	Total $ Amount in Arrears	Average $ Amount Per Disconnected Customer
2014	2,536	$3,305,180	$1,303	282	$332,185	$1,178
2015	4,140	$5,327,681	$1,287	314	$372,751	$1,187
2016	4,348	$4,881,481	$1,123	598	$777,486	$1,300
	Percentage of Total Customers Disconnected			Percentage of Total Customers Disconnected		
2014	3.7%			2.5%		
2015	5.9%			3.0%		
2016	6.2%			5.8%		

Source: Navigant analysis

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Table B-10. Uncollectible Account History

Year	Worcester Non-Pilot Customers			Pilot Participants		
	Total Number of Customers			Total Number of Customers		
2014	69,029			11,184		
2015	70,090			10,555		
2016	69,915			10,361		
	Number of Uncollectible Customers	Total $ Amount in Arrears	Average $ Amount Per Uncollectible Customer	Number of Uncollectible Customers	Total $ Amount in Arrears	Average $ Amount Per Uncollectible Customer
2014	4,044	$4,636,522	$1,147	272	$349,719	$1,286
2015	4,411	$5,666,770	$1,285	434	$556,184	$1,282
2016	4,998	$5,810,217	$1,163	617	$788,534	$1,278
	Percentage of Total Customers with Uncollectibles			Percentage of Total Customers with Uncollectibles		
2014	5.9%			2.4%		
2015	6.3%			4.1%		
2016	7.1%			6.0%		

Source: Navigant analysis

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APPENDIX C. DETAILED SURVEY, INTERVIEW, AND FOCUS GROUP RESULTS

Throughout every stage of the Pilot, National Grid sought customer feedback in order to understand customer awareness and experiences with the rates, technologies, and operation of Peak Events. Navigant completed several surveys, interviews, and focus groups, which are summarized in the body of this report. This appendix details customer responses to the following data collection activities:

1. Meter Decline Survey, November 2013
2. Pre-Pilot Survey, February 2014
3. Pre-Pilot Commercial Interviews, April-May 2014
4. Post Installation Survey, April 2014-March 2015
5. Post Event Surveys, June-July 2015 & July-August 2016; End of Summer Survey, September 2015; and End of Pilot Survey, October 2016
6. End of Summer Low-Income Focus Groups, September 2015 & September 2016
7. End of Summer Commercial Interviews, October 2015
8. Opt Out & Drop Out Survey, November 2015 & October 2016

C.1 Meter Decline Survey, November 2013

The rate at which National Grid customers declined to have a smart meter installed (4%) was within the range of full-scale deployments by other utilities, some of which did not initially offer the option to opt out of meter installation (Table C-1). Seventy customers who had actively declined a meter were interviewed by phone in order to understand why they opted out of the meter installation. Customers who did not have an installation completed due to technical problems were not addressed in this survey.

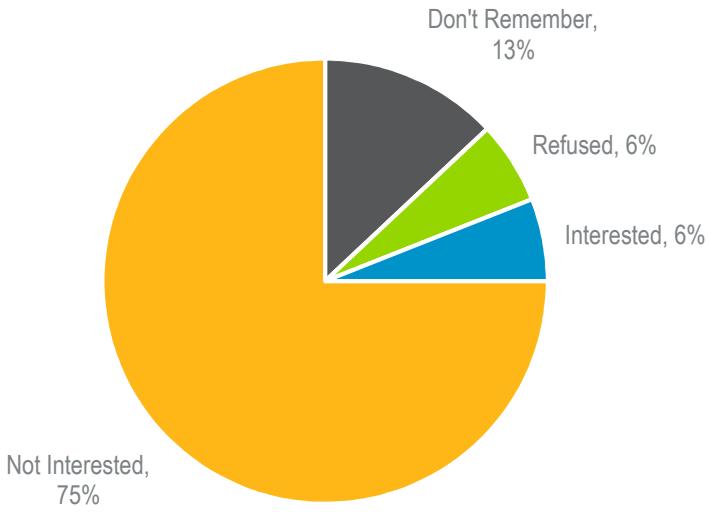
Table C-1. Comparison of Meter Decline Rate to Other Meter Installations

Utility	Total Residential Customers (#)	Opt Out (#)	Percentage Opt Out	Notes on Opt Out
BC Hydro	2,000,000	60,000	3%	Full system deployment
SCE	4,283,836	23,100	1%	Full system deployment
PG&E	5,500,000	42,905	1%	Full system deployment
Central Maine Power	620,000	8,000	1%	Full system deployment
SDG&E	1,249,104	2,227	<1%	Full system deployment

Source: Navigant analysis of the meter decline survey and other utility meter deployments

Customers who declined a meter tended to not have knowledge about the Pilot; as shown in Figure C-1, 75% were not interested in participating in the Pilot at all.

Figure C-1. Desire of Customers who Declined Meter to Participate in Pilot



Source: Navigant analysis of the meter decline survey (N=70)

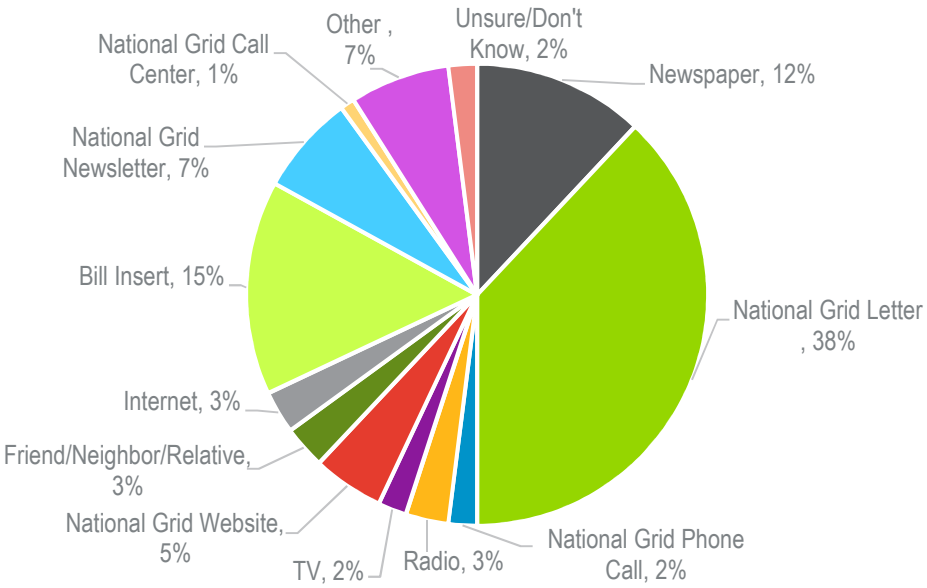
When asked why they declined to have a meter installed, 61% of customers cited only one reason for declining, 31% cited two reasons, and 7% cited three reasons. The single most often cited reason was "I won't benefit from this," followed by health and safety concerns.

C.2 Pre-Pilot Survey, February 2014

The Smart Energy Solutions pre-pilot survey was fielded to potential Pilot participants from January 9, 2014 to February 12, 2014. The survey was available to a total population of 12,823 residential customers through an online survey and in-bound and out-bound phone calls. A total of 1,470 residential customers completed the survey, or approximately 11.5% of the eligible population. The survey contained questions about a wide range of topics including demographic information, Pilot awareness and attitude, end-use appliance information, and energy usage habits. The survey was built upon the pre-pilot survey developed as part of the *Common Evaluation Framework* produced by the Massachusetts Smart Grid Collaborative Technical Subcommittee. With National Grid and DPU approval, some modifications were made to the survey to accommodate the Smart Energy Solutions Pilot.

At the time of the survey, almost 50% of customers surveyed had read, seen, or heard information about Smart Energy Solutions within the previous three months. The most common way that customers had heard about the Pilot was from a National Grid communication (letter or bill insert) (see Figure C-2).

Figure C-2. How Customers Heard of the Pilot

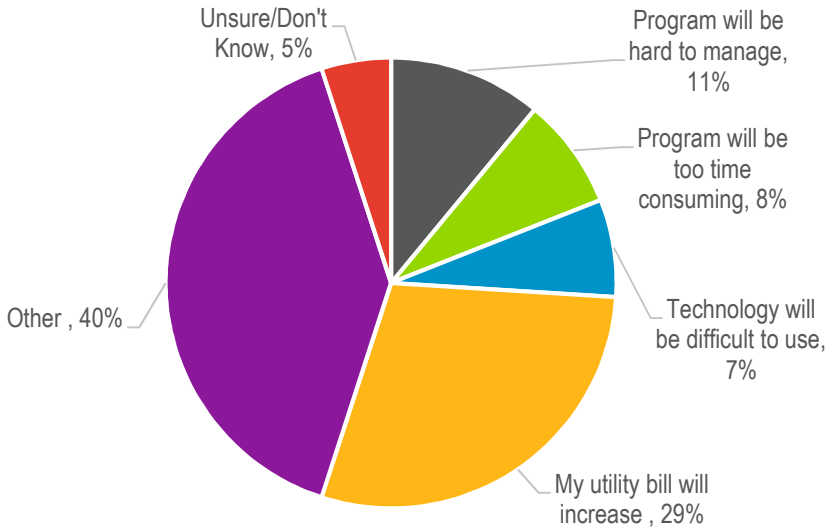


Source: Navigant analysis of pre-pilot survey (N=706)

Within the respondents' verbatim responses, many requested more information about the Pilot. Many respondents across all demographic segments also expressed interest in participating in the Pilot if it could provide them a better way to manage their energy usage and decrease their monthly energy bill.

The majority (53%) of customers did not have any concerns about participating in the Pilot. Of those that did have concerns, the most common was with their bill increasing, as shown in Figure C-3. Verbatim responses showed a similar pattern and are represented in the "Other" category.

Figure C-3. Reasons for Concern with Pilot Participation



Source: Navigant analysis of pre-pilot survey (N=323)

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C.3 Pre-Pilot Commercial Interviews, April-May 2014

Navigant contacted 99 commercial customers in the Pilot area to establish a focus group to discuss their understanding of the Pilot before it began. After five attempts and having only recruited four customers, Navigant decided to interview the customers individually rather than convene a focus group. The interviews provided insight into how much each customer knew about Smart Energy Solutions, how they believed it would affect them, and how much they knew about the Sustainability Hub. The customers represented a variety of services: commercial landlord, construction and real estate development, automotive services, and operations for the City of Worcester. There were no retail sales businesses among the sample.

The evaluation team found that customers appeared to be unaware of the products and services available to them, including technology packages and the Sustainability Hub. Overall, the customers' feedback emphasized their communication desires, including the following:

- **Desire for personal National Grid contact.** Customers said that they would appreciate more personal interactions with National Grid in order to learn about the program. They wanted to receive emails about the program directly from a contact at National Grid and know that they could easily call or email a National Grid employee with questions.
- **Preference for web-based information presentment.** Besides emails, these customers would like to access information about the Pilot online rather than via a smartphone app or IHD.

Although National Grid had not released any information about the program rate before the interviews took place, customers understood the program rates when the evaluation team explained them. Two of the interviewees raised concerns that they could not shift their electricity usage because their business model depends on their using energy-intensive heavy equipment during weekday business hours. The participants' responses suggested that it would be important for National Grid to emphasize how the rate plans may affect commercial as well as residential customers during the Pilot.

C.4 Post Installation Survey, April 2014-March 2015

Navigant completed 241 surveys out of a population of 743 National Grid residential customers who had technologies installed between April 2014 and February 2015. Customers reported strong satisfaction with installation:

- 98% of participants reported that installers appeared at the scheduled day and time
- 90% of participants received the equipment they expected
- 99% of participants received training
- 91% of participants received hands-on demonstrations
- 67% of participants found explanations of how equipment worked "very clear" and 27% found explanations "somewhat clear"
- Verbatim responses indicated some participants were not able to access expected usage/cost data or thought it insufficient for their needs

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C.5 Post Event Survey, June-July 2015 & July-August 2016; End of Summer Survey, September 2015; and End of Pilot Survey, October 2016

Navigant achieved 2,974 completes across four post event surveys and two end of season surveys (Table C-2). The majority of respondents were Level 1 customers, which was not surprising considering most participants have Level 1 technology.

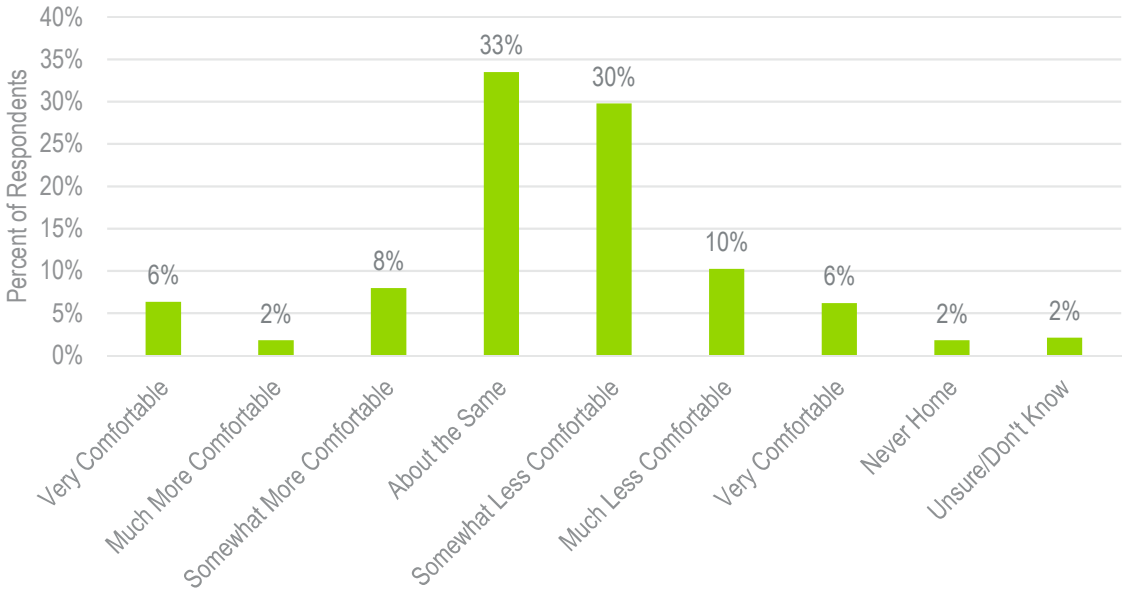
Table C-2. Number of Respondents per Post Event, 2015 End of Summer, and 2016 End of Pilot Survey by Technology Package

Survey	Level 1	Level 2	Level 3	Level 4	Totals
Post Event #1 - June 2015	307	154	10	54	**525**
Post Event #2 - July 2015	167	68	5	30	**270**
End of Summer - September 2015	315	118	7	66	**506**
Post Event #3 - July 2016	377	130	6	50	**563**
Post Event #4 - July 2016	325	112	4	54	**495**
End of Pilot - October 2016	381	144	11	79	**615**

Source: Navigant analysis of post event, 2015 end of summer, and 2016 end of pilot surveys

In comparison to a typical afternoon, participants in the Pilot reported that they were generally equally or less comfortable in their home during the Peak Events, as shown in Figure C-4.

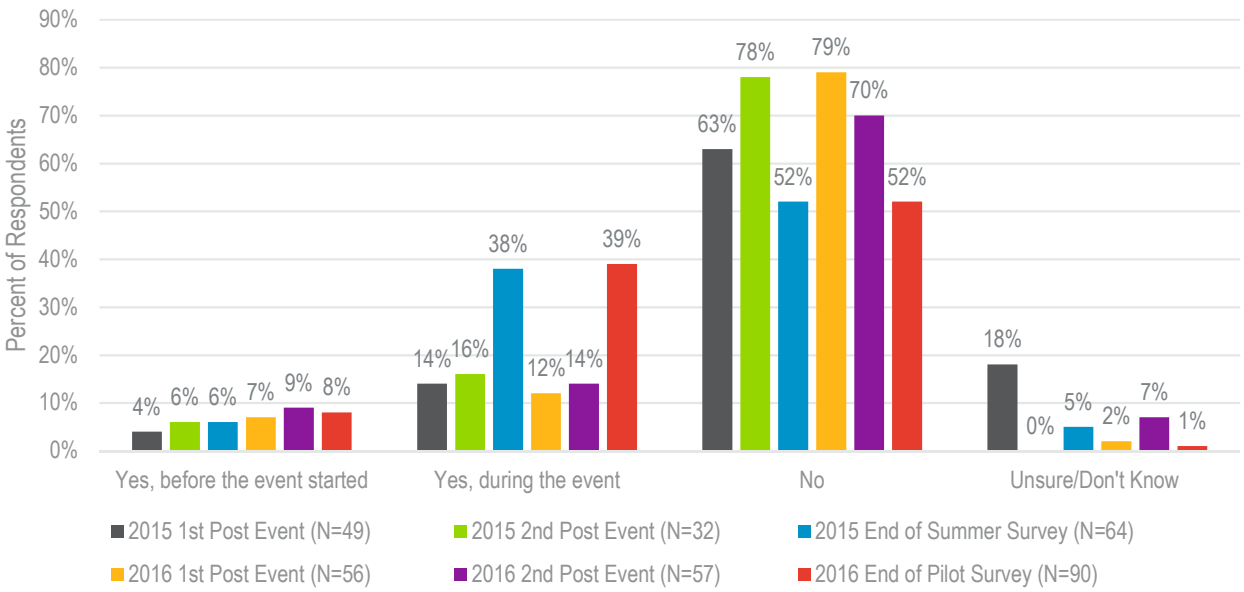
Figure C-4. Comfort during Peak Events Compared to a Typical Afternoon with Similar Temperatures



Source: Navigant analysis of 2016 end of pilot survey (N=615)

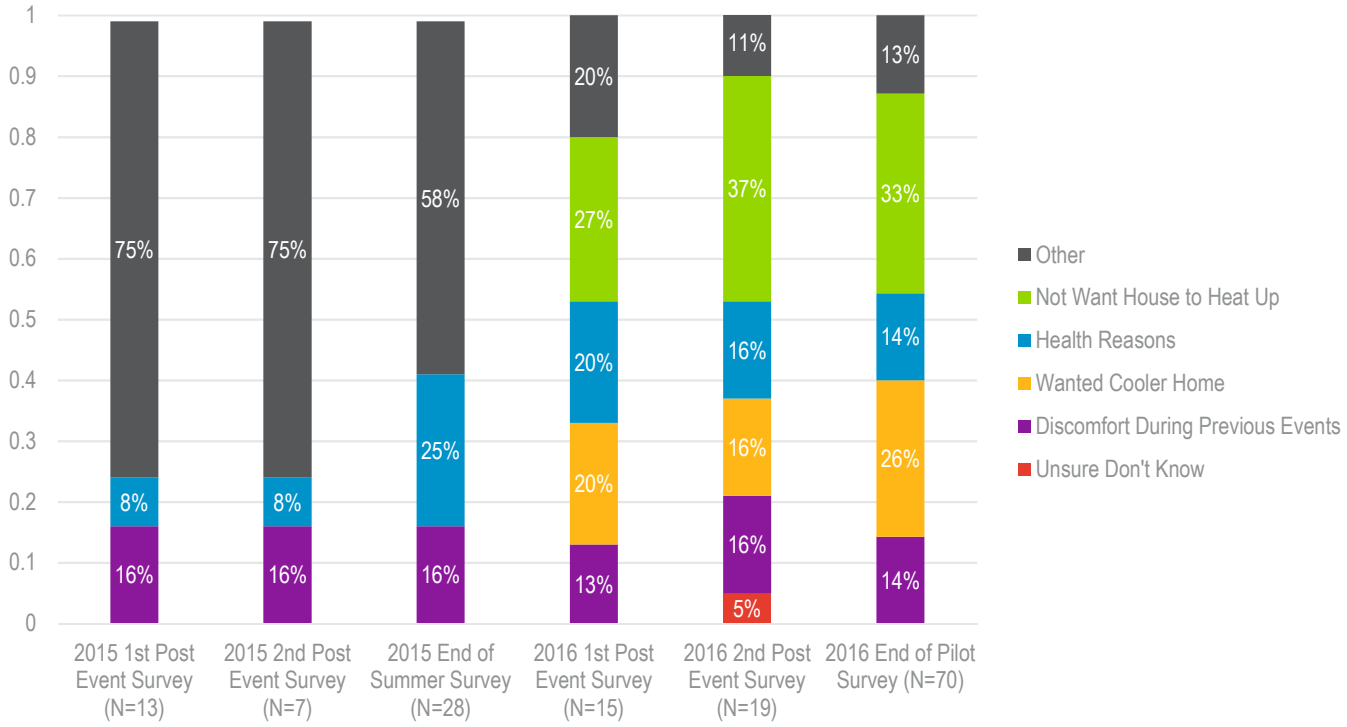
The end of pilot survey asked respondents with a thermostat a series of questions about how they used their thermostat during Peak Events throughout the two summers. In each year as the summer progressed, respondents reported using the override button on their thermostat more frequently (see Figure C-5). In each summer, a little under 40% of customers indicated overriding their thermostat at least once during a Peak Event. As shown in Figure C-6, when asked in the post event and end of season surveys, customers cited comfort and health as reasons for overriding the thermostat adjustment ("Other" responses were primarily about comfort or confirming that there were no other reasons for the override). Nearly two-thirds of thermostat respondents were satisfied with their smart thermostat; few participants (7%) were dissatisfied with the smart thermostat.

Figure C-5. Occurrence of Smart Thermostat Overrides



Source: Navigant analysis of post event (N=49, N=32, N=56, N=57), 2015 end of summer (N=64), and 2016 end of pilot (N=90) surveys

Figure C-6. Reasons for Smart Thermostat Overrides



Source: Navigant analysis of post event (N=13, N=7, N=15, N=19), 2015 end of summer (N=28), and 2016 end of pilot surveys (N=70)

Half of respondents that had a smart plug reported using it during Peak Events in 2015 and 30% reported doing so in 2016. In 2015, those who used their smart plug plugged it into small appliances and electronics (26%), lamps or other light fixtures (8%), refrigerator or freezer (4%)—although National Grid told customers not to use the smart plug for these appliances—room air conditioner or dehumidifier (4%), or other uses (8%). In 2016, those who did not use their smart plug reported that they had forgotten about the Smart Plug (20%), did not understand its purpose (16%), or did not know how to use it (9%). Most customers were satisfied or very satisfied with the smart plug.

C.6 Low-Income Focus Groups

Purpose and Recruitment

To gain a nuanced understanding of how low-income participants perceived and adjusted to the Pilot, Navigant hosted three low-income focus groups: two in 2015 and one in 2016. Using a script developed by Navigant and approved by National Grid and low-income stakeholders, recruiters offered a $150 incentive for participation in a 90-minute discussion with a Navigant moderator. Almost all of the participants in the three groups had technology Level 1, and all but two participants were on the CPP program rate.

In 2015, 22 Pilot participants whose self-reported income was less than or equal to 60% of Massachusetts median income, accounting for household size, took part in the two focus groups.

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In 2016, to reach customers at even lower income levels, Navigant recruited participants whose self-declared income was at or below 200% of federal poverty levels. Although 13 customers agreed to participate, only 6 appeared for the group.[107]

Participants varied in their household composition, including single parents (male and female), single elders, elders with grandchildren, families with one or more people with health problems such as asthma, families with seriously ill members, and one college student.

Focus Group Discussion Topics and Responses

Focus group topics included:

- Energy affordability and options and practices for reducing electricity use;
- Presence of very young, elderly, ill, and disabled household members, or pets during Peak Events;
- Participant awareness of events and responses to them;
- Awareness of program technology and reasons for not signing up;
- Internet access, familiarity, and usage; and,
- Awareness of program rates, bill protection, and ability to initially choose and later switch rates.

Through these three focus groups, low-income customers reported several concerns about participating in the Pilot including:

- Keeping the home cool for homebound parents, members in poor health, babies, and/or pets;
- Electricity expenses and affordability;
- Options for reducing their electricity usage; and
- Desire for more information and transparency about their particular electric usage and bill savings opportunities.

Unsurprisingly, participants expressed considerable concern about electricity cost and affordability. They were positive about the Pilot, engaged, and felt they were able to manage their electricity use; however, in more detailed discussion some said they had few options for making real reductions. They were highly aware of events and most preferred text and email event notifications. However, some expressed the opinion that if they missed a notification or a family member kept the air conditioning running they were being penalized for not cutting back during the event. The two participants on the PTR rate were aware of rebates for conserving electricity but did not understand how the rebates were calculated, even when an explanation was provided.

Participants were not aware of a number of factors that might affect their participation in the Pilot, including rate choices, technology options, and bill protection. All of the groups strongly expressed a

[107] This occurred despite reminder phone calls made the day before the focus group to those who had agreed to participate.

desire for more information and more explanation, such as what sort of rate would provide the lowest cost given their particular circumstances. Despite this, focus group participants were positive about the Pilot overall and showed a willingness to learn and to do as much as they could to take actions that would lower their electric bills.

In all three groups, participants reported taking the maximum measures they could think of to reduce electricity usage during events, even if those actions affected their comfort or feeling of wellbeing. These actions included conversations with family members to impress the importance of taking actions such as playing video games on battery operated handheld devices rather than online or on the television with a video game console. Participants reduced or completely turned off all lighting, clothes and dishwashers, and air conditioning during events, including households who had elderly or sick members. One person reported closing every circuit breaker in the house except for the 20-year-old refrigerator. Many recipients left the home, going to libraries, museums, stores, or any publicly open place that had air conditioning, but for the longer Peak Events that strategy was not always practical, especially around mealtimes. In 2016, which had several back-to-back events, participants expressed weariness by the second or third day and some said they gave up trying at some point. From these actions participants felt they used considerably less electricity but they did not see bill reductions in line with their actions. There was no awareness of bill protection or the net effect of truing up bills on an annual basis. This lack of bill protection awareness was not limited to low-income participants, as demonstrated in surveys.

Participants were very aware of the rewards platform and were positive about it. However, they had little or no awareness of National Grid's energy efficiency programs or programs offered through community groups like Worcester Community Action, although one person was having an old refrigerator replaced, apparently through the Low-Income Retrofit initiative.

Participants had little or no awareness of rate choices at the outset of the Pilot or their ability to switch to the PTR rate. One participant with a chronically ill household member found out about the PTR pricing plan through a call to National Grid customer service and found that the switch made a substantial difference in their bill because they could not do without air conditioning.

Most Level 2 focus group participants were positive in their views about the IHD's, however the great majority of focus group participants were unaware of the technology choices. When participants had an opportunity to see the IHDs in person during the focus groups they were very positive about the technology offerings as tools in managing electricity usage.

C.7 End of Summer Commercial Interviews, October 2015

As there were too few commercial customers in the Pilot area to survey, Navigant interviewed four commercial participants in order to obtain qualitative input about their 2015 summer season experience. National Grid and Navigant identified approximately 275 commercial participants on general service (G1) rates, but the majority were property owner accounts and almost all were on the Critical Peak Pricing (CPP) rate with Level 1 technology. Navigant sought a variety of participants, aiming to talk to customers with Level 2 or higher technology as well as a PTR customer, focusing on retail and office customers. Customers received a $200 honorarium or charity donation for a 30-minute interview. The four interviewed customers were all on the CPP rate with Level 1 technology.

The evaluation team found that the commercial customers interviewed were continuing business as usual and with one exception were not aware of their rate choice within the Pilot. The participants knew about

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the CPP pricing plan but not the PTR pricing plan and knew about the events but were unable to adjust their usage during them.

Given the very low response rates and the amount of effort exerted to recruit just five customers for interviews in 2015, as well as the small number of commercial participants in the Pilot, Navigant did not conduct commercial interviews in 2016.

C.8 Opt Out & Drop Out Surveys, November 2015 & October 2016

Customers could change rates or leave the Pilot at any time. Navigant surveyed these customers on a rolling basis to understand their reasons for "opting out" (*i.e.*, switching from CPP to PTR) or dropping out of the program, based on whether enough customers had dropped out or opted out to have a statistically significant customer pool to survey. Enough customers had dropped out of the program, or switched to the PTR rate by November 2015 to field a survey. Due to the very low rate of opting out and dropping out, a second survey was not fielded until the end of the Pilot in October 2016.

Across both surveys Navigant completed surveys with 42 customers (Table C-3). Six of the PTR respondents dropped out before the Pilot rates-go-live date of January 1, 2015, and the rest dropped out during the Pilot.

Table C-3. Opt Out & Drop Out Customers Surveyed by Technology Package

Technology Package	2015		2016	
	Opt Out	Drop Out	Opt Out	Drop Out
Level 1	5	14	2	6
Level 2	1	6	0	3
Level 3	1	1	0	0
Level 4	1	0	0	2
Total	**8**	**21**	**2**	**11**

Source: Navigant analysis of the opt out and drop out surveys

Survey responses indicated that customers that dropped out of the program felt:

- More information was needed on the Pilot;
- Peak Event hours were inconvenient;
- The Pilot intruded on privacy and personal decision-making;
- The Pilot increased their bills;
- Savings didn't justify the effort; and,
- They could not change electric usage due to equipment they needed to use.

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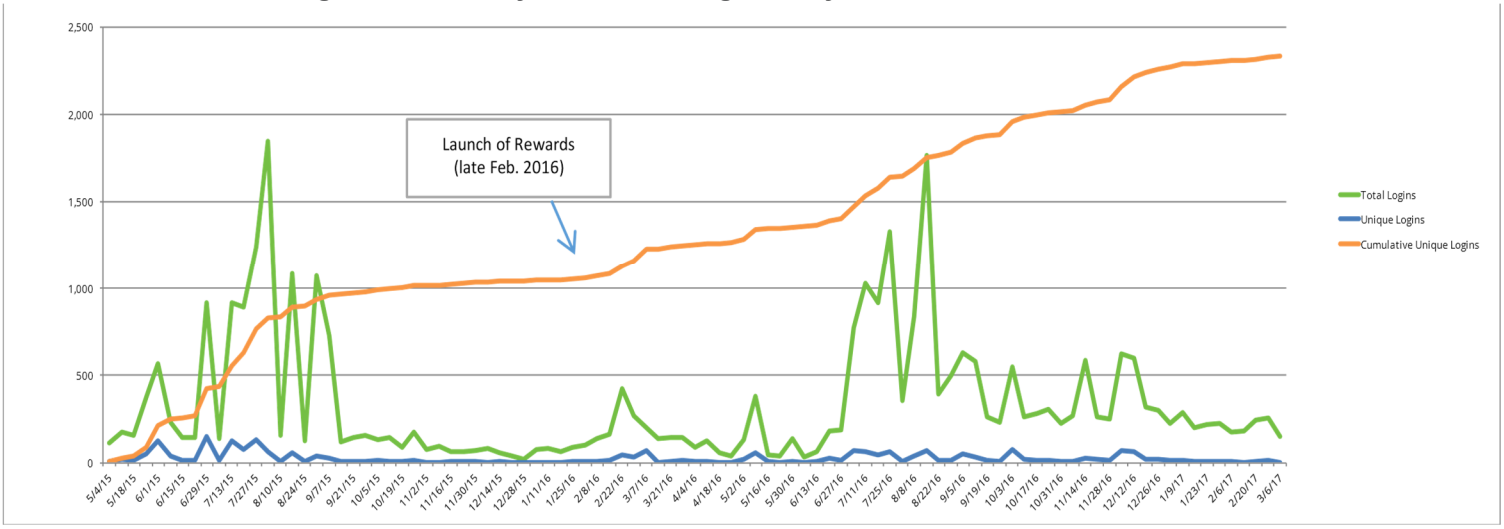
APPENDIX D. REWARDS PLATFORM EFFECTIVENESS

The rewards platform on the WorcesterSmart web portal was launched in February 2016. As of March 2017, over 2,200 rewards had been redeemed by Pilot participants. The following results came from National Grid's internal assessment of the platform's effectiveness.

Web Portal Logins

Since launching the rewards platform, there has been a considerable increase in the total logins to the web portal (Figure D-1). After the launch of the rewards platform, the average weekly login count jumped from 323 (from 5/4/15 to 2/21/16) to 360 (from 2/22/16 to 3/6/17) – an 11.5% increase. While logins spiked after the initial program launch in 2014 and again during the first Peak Event season in 2015, they plateaued following the Pilot's first Peak Event season – until the February 2016 addition of rewards reinvigorated customer interest.

Figure D-1. Weekly Web Portal Logins, May 2015 – March 2017



Source: National Grid
*The "cumulative logins" are cumulative as of this chart's start date (i.e. they exclude unique logins prior to 5/04/2015).

Communication Click-to-Open Rates

Table D-1 details the click-to-open rates (the key measurement for conversion) for Peak Event-related communications in 2015 and 2016. These rates generally improved from 2015 to 2016. For emails sent to customers the day before Peak Events click-to-open rates increased by 18.4%, and for emails sent the day of Peak Events click-to-open rates increased by 9.2%.

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Table D-1. Click-to-Open Rates for Peak Event Emails in 2015 and 2016

	Click-to-Open Rates	
Peak Event Emails Sent	2015	2016
Day Before	5.91%	7.0%
Day Of	8.7%	9.5%
Day After	31.0%	22.6%

Source: National Grid

Program Satisfaction

National Grid also found that the rewards platform positively impacted customer satisfaction. In a survey conducted by National Grid in January and February 2017, 83% of customers rated the value of the rewards feature as a 4 or 5 on a 5-point scale. Ranked among other web portal site and program features (such as Peak Event content, energy-saving tips, and energy insights), the rewards feature received the highest customer satisfaction score. Furthermore, 68% of customers reported that email content relating to rewards and contests helped them to save energy and money in their homes. These survey results suggest that rewards are a significant motivator and driver of site traffic, engagement, and energy savings.

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APPENDIX E. MEDIA COVERAGE OF SMART ENERGY SOLUTIONS

Various media sources have covered Smart Energy Solutions from different points of view. National Grid's "listen, test, learn" approach lends itself to reviewing criticism and praise, and adjusting the Pilot or providing additional information to customers.

The following summarizes a selection of these stories:

Title: A Controversy Erupts in Worcester: All Eyes on Smart Grid Plan

Date: January 30, 2014

Link: http://worcestermag.com/2014/01/30/controversy-erupts-worcester-eyes-smart-grid-plan/20499

Summary: This article, written early in the Pilot—after meter installation was completed and just as technologies and rates were offered, provides coverage of National Grid's cooperation with neighbors to build a communications tower. It details concerns that some customers have about smart meter radio frequency, as well as information National Grid provided about smart meter radio frequency strength in order to educate people about the low health risk posed by smart meters.

Title: National Grid Smart Grid Program Launches Technology Phase

Date: April 1, 2014

Link: http://www.golocalworcester.com/news/national-grid-smart-grid-program-launches-technology-phase

Summary: Released during National Grid's customer technology launch, this article discusses the customer-facing and grid-facing investments covered in the Pilot. It provides detail on the distribution and communication infrastructure investment.

Title: National Grid's Sustainability Hub Gathers Customers and Community

Date: December 16, 2014

Link: http://www.intelligentutility.com/article/14/12/national-grid-s-sustainability-hub-gathers-customers-and-community

Summary: This op-ed by National Grid's VP of Customer Strategy and Engagement, Ed White, summarizes the Sustainability Hub's first year as an educational tool and community space. It highlights events held at the Sustainability Hub, individuals and groups who visit the Hub to learn about the Pilot and sustainability, as well as community groups that use the Hub as a meeting space.

Title: Worcester Smart Grid Up and Running as National Grid Launches Pilot Program

Date: January 15, 2015

Link: http://www.masslive.com/news/worcester/index.ssf/2015/01/worcester_smart_grid_up_and_r.html

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Summary: Written shortly after the Pilot rates went live, this article summarizes rate offerings and describes meters, anticipated customer savings, as well as National Grid's smart grid distribution system investments. It also cites Worcester's diversity as the driver to have the Pilot in Worcester.

Title: National Grid's Smart Energy Solutions Program Adds Interactive Energy Savings Features

Date: April 30, 2015

Link: http://3blmedia.com/News/National-Grids-Smart-Energy-Solutions-Program-Adds-Interactive-Energy-Savings-Features

Summary: Written in the first quarter that Pilot rates went live, this article summarizes the customer portal, IHD, and app, as well as how the Pilot's smart grid investments have reduced outage restoration times.

Title: A year in, Smart Energy program bright idea for most

Date: September 12, 2015

Link: http://www.telegram.com/article/20150912/NEWS/150919656/101448

Summary: This front-page article in the Sunday Worcester Telegram & Gazette documents the positive program experience of multiple customers, as well as presenting results from the first summer of Conservation Days. The article also introduces the natural link between Smart Energy Solutions and National Grid's Grid Modernization Plan that was filed with the DPU in 2015.

Title: CEIVA Energy Technology Powers 20% Additional Savings for National Grid's Smart Energy Solutions Customers

Date: October 12, 2015

Link: http://www.businesswire.com/news/home/20151012005202/en/CEIVA-Energy-Technology-Powers-20-Additional-Savings

Summary: This article, published after customers' first summer on the Pilot rates, summarizes the technologies offered. It highlights customer bill savings and other technologies offered to customers.

Title: Carlos Nouel and Nick Corsetti on Jordan Levy Show

Date: July 15th, 2015

Summary: Carlos Nouel and Nick Corsetti on Jordan Levy radio show to discuss Smart Energy Solutions.

Title: Marcy Reed on Jordan Levy Show

Date: October 15th, 2015

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Summary: Marcy Reed on Jordan Levy radio show, mentions Smart Energy Solutions.

Title: Worcester Habitat for Humanity chapter to dedicate first Veterans Build home today

Date: February 12, 2016

Link: http://www.telegram.com/article/20160212/NEWS/160219927

Summary: This article discusses National Grid's partnership with Habitat for Humanity to provide an energy efficient home to a veteran and his family. As part of Smart Energy Solutions, this home features in-home technology tools and energy efficient washer, dryer, and heating systems.

Title: Worcester smart grid pilot reports $1.25M savings

Date: February 25, 2016

Link: http://www.telegram.com/article/20160225/NEWS/160229460

Summary: This article, written after the first year of the pilot, describes the details of National Grid releasing the results of the first year of the program. The results revealed customers participating in the Pilot saved $1.25 million on their electricity bills, which is equivalent to powering a local library for almost a year. The first year results also highlighted the program's retention customer satisfaction rates. This report tremendously helped National Grid to make improvements for the second year, such as better communication with customers before and during Conservation Days and providing more information on saving energy through the online portal.

Title: National Grid touts success in first-year of Worcester Smart Grid program

Date: March 1st, 2016

Link: http://www.masslive.com/news/worcester/index.ssf/2016/03/national_grid_touts_success_of.html

Summary: This article gives a short explanation of what Smart Energy Solutions is and summarizes the successes of the first year of the program. The successes mentioned include $1.25 million in customer savings, 2,300 Megawatt-hours saved, a 98 percent retention rate, and a 72 percent customer satisfaction rate.

Title: Ed White on Jordan Levy Show

Date: March 14th, 2016

Summary: Ed White on Jordan Levy radio show mentions Smart Energy Solutions.

Title: Smart Grid pilot at $55M and counting

Date: May 23rd, 2016

Link: http://www.wbjournal.com/article/20160523/PRINTEDITION/305209985/smart-grid-pilot-at-55m-and-counting

Summary: This article explains some of the challenges regarding National Grid's budget for the Smart Grid pilot. Planned financial contributions and unexpected cost overruns have resulted in National Grid exceeding the program's initial budget ($45.5M). Consequently, the Massachusetts Attorney General's Office has flagged the pilot with concerns of excess spending and called for an investigation at the end of the pilot. The overrun includes $20 million for investments in distribution systems and $35 million for all program costs, technologies, outreach, and solutions. Costs were unexpectedly high because the original budget assumed community donations that it didn't receive. However, the benefits of the Sustainability Hub and Smart Energy Solutions program have exceeded initial expectations.

Title: Chronicle/Problem Solvers: A House Full of Energy Saving Tips-National Grid's Sustainability Hub in Worcester

Date: June 10th, 2016

Link: http://www.wcvb.com/article/chronicleproblem-solvers-a-house-full-of-energy-saving-tips/8103467

Summary: The local news show "The Chronicle" visited the Sustainability Hub in the summer of 2016 to show how the Sustainability Hub is a resource for energy efficiency and "smart" appliance information. Interviews with staff and interns give tips on how to be more energy efficient, what energy efficient products and appliances are available, and other energy saving ideas and information available at the Hub.

Title: Connected controversies: The NTP cell phone study and wireless electric meters

Date: June 23rd, 2016

Link: https://worcestermag.com/2016/06/23/connected-controversies-ntp-cell-phone-study-wireless-electric-meters/43751

Summary: This article describes the preliminary results of U.S. Department of Health and Human Services' National Toxicology Program's study testing links between cancer and chronic exposure to radiation emitted from wireless devices, including National Grid's smart meters. The results revealed strong evidence that such exposure is associated with certain cancer formation (testing on rodents). Major controversy surrounds the assumption that weak exposures (sub-thermal) are assumed to be safe. Some Worcester residents are in opposition to National Grid's wireless meter pilot because of health risks, privacy, and circulation of the community's energy dollars. The article also highlights how other countries have taken precautions surrounding low intensity, high-frequency electromagnetic fields.

Title: National Grid taps Itron for Massachusetts smart metering plan in grid modernization effort

Date: July 27th, 2016

Link: http://www.utilitydive.com/news/national-grid-taps-itron-for-massachusetts-smart-metering-plan-in-grid-mode/423337/

Summary: This article, appearing in July 2016, discusses National Grid's (NG) decision to use the tech and services company Itron to supply the platform for the Advanced Metering Functionality for its grid

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modernization plan. It highlights National Grid's four proposals, of varying scale, to the Department of Public Utilities (DPU) to meet grid modernization requirements set by state regulators. The decision to use Itron for this next phase of modernization is dependent on DPU approval, and the two companies agreeing to a contract.

Title: National Grid Pursues Smart Energy Solutions Extension

Date: September 1st, 2016

Link:http://www.electricenergyonline.com/detail_news.php?ID=594760&titre=National+Grid+Pursues+Smart+Energy+Solutions+Extension

Summary: This article, written in September 2016, discusses National Grid's plans to extend the Smart Energy Solutions pilot program in Worcester for an additional two years. National Grid recently filed a request to the Department of Public Utilities (DPU) to expand on infrastructure investments, customer engagement and improvements to electric services. The program has also helped inform National Grid's grid modernization in Massachusetts, later filed to the DPU.

Title: Monfredo: How Safe are the Electromagnetic Fields Emitted by Wireless Technology?

Date: September 3rd, 2016

Link: http://www.golocalworcester.com/news/monfredo-how-safe-is-the-electromagnetic-fields-emitted-by-wireless-technol

Summary: This article, posted on the Go Local Worcester website, presents information, research, and opinions that are concerned about the use of technology, specifically Wi-Fi-enabled technology, and its health effects on students and children who are consistently exposed to it. The National Grid pilot program smart meters are briefly mentioned as one of the expanded uses of such technology. The author, who expresses concern about the possible health-risk associated with these technologies, presents scientists, organizations, and countries who have either expressed concern, or taken action, on limiting exposure to Wi-Fi technology and lists suggestions for possible equipment that limits exposure. In the end, the author advocates its readers to do more research on the subject to become better informed.

National Grid Smart Energy Solutions
Meter Decline Survey

INTRODUCTION: My name is _____, and I work for a market research firm called Bellomy Research. We are calling on behalf of National Grid about the Smart Energy Solutions Program. This is not a sales call or a call about a bill.

As you are aware from National Grid's communications, as part of the Smart Energy Solutions Program, National Grid is installing smart electricity meters at many customers' homes. I'm calling you today to follow up on your request to decline a smart meter, and ask you to share your thoughts with us. These questions will take about 5 minutes of your time.

INITIAL: Establish respondent name

1. Am I speaking with _____NAME OF Customer of Record?
    a. Yes _____
    b. No_____ [SKIP TO QUESTION 3]
    c. Refused _____ [SKIP TO QUESTION 3]
2. IF 1≠a: Can we call back at a time when _____ is available? As I said, this will only be a five minute call. (ESTABLISH TIME IF PROVIDED, THANK AND TERMINATE)
    a. Yes _____
    b. No_____
    c. Refused _____

3. What do you remember about the program that was described in the material you received? (DO NOT READ LIST. RECORD ALL MENTIONS.)(RECORD MENTIONS NOT LISTED BELOW UNDER OTHER SPECIFY.)

    a. The program involves "Smart Grid" technologies
    b. Ability to save money on electric bills
    c. Ability to reduce environmental impacts
    d. Program is designed to reduce peak electricity demand
    e. National Grid will know my daily energy use
    f. Other (PLEASE SPECIFY)_____
    g. Refused

4. When you originally received and read the invitation, did you think you would like to participate in this pilot program?

    a. Yes
    b. No
    c. Don't Remember
    d. Refused

5. It's helpful to understand why customers don't want a smart meter installed in their homes. Can you tell us why you declined the meter? (DON'T PROMPT –TAKE MULTIPLE RESPONSES UP TO FOUR RESPONSES)

INTERVIEWER: TAKE THE CLOSEST RESPONSE FOR EACH POSSIBLE ANSWER BELOW

Confusion

a. The materials are too confusing
b. National Grid didn't do a good job explaining what this means to me
c. I don't know what a smart meter is
d. I don't know why you contacted me
e. I haven't seen any information
f. Just confused

Indifference

a. I don't care about my utility
b. I don't care about electricity
c. I don't care
d. I don't like/want change
e. I'm too busy to think about it
f. It's a hassle

Health/Safety/Comfort/Control

a. I'm worried about fire hazards posed by smart meter
b. I don't want National Grid to control my temperature/heating/cooling/appliances
c. I don't want my home to be uncomfortable (temperature)
d. I want to use electricity as I see fit, I don't care about costs
e. I'm worried about EMF
f. I'm worried about radiation
g. I'm concerned for my/my family's/my pet's health
h. I don't want National Grid to interrupt my electricity whenever they want to

Cost/Electricity Bill/Electricity Rates

a. I don't want to pay more for electricity
b. I'm trying to save money
c. I already pay enough for electricity
d. I don't understand how this affects my bills
e. I don't want to be forced onto a dynamic/time-based rate
f. Smart meters are inaccurate and I will be overcharged for electricity
g. The costs might outweigh the benefits

Security/Privacy

a. I don't want people to know how much electricity I use/when I use it
b. I don't want the government/Big Brother to know how much electricity I use/when I use it
c. I don't want National Grid to know how much electricity I use/when I use it
d. I don't want hackers to gain access to my personal information
e. I'm concerned about how my data will be used
f. I'm afraid burglars will know when I'm not home, based on my electricity usage patterns (work, vacation, etc.)
g. I'm afraid of cyber terrorism

Generic

a. I won't benefit from this
b. I don't want a smart meter
c. I'm worried
d. Don't Know
e. Refused

6. Can you tell me a little more about what concerns you?
    a. Open _____
    b. Don't Know_____
    c. Refused _____
7. What could National Grid have done or explained that would make the meter installation more appealing to you?
    a. Open _____
    b. Don't know
    c. Refused
    a.
8. Is there anything else you would like to tell us about your decision to decline the smart meter installation in your home?
    a. Open _____
    b. Don't Know_____
    c. Refused _____

[END QUESTIONS]

Those are all the questions I have. Thank you for your time and assistance to us today.