

IMPACT EVALUATION OF NU'S PLAN-IT WISE ENERGY PROGRAM

Final Results

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- Simulating program impacts with NU-PRISM
- Conclusions

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- PWEP All-in Rates
- Estimation of Demand Equations
- Enrollment Survey Results

I. EXECUTIVE SUMMARY

NU's Plan-it Wise Energy Program (PWEP) began to call critical peak days in June 1, 2009 and ran through August 31, 2009

- The pre-treatment period covered May 2009
- ♦ 10 event days were called during the pilot period

Around 2,200 residential and small C&I customers were exposed to time-varying rates during the pilot period

 1,114 residential and 1,123 small C&I customers were enrolled in the program as of August 2009

Summer 2009 was a *relatively mild* summer

NU tested the impact of different rate structures in conjunction with several different technologies

PWEP tested three different rate structures with two levels of prices for each, yielding a total of six different price levels:

- Time-of-Use (TOU)
 - Low and High levels were tested
- Peak Time Pricing (PTP)
 - Low and High levels were tested
- Peak Time Rebate (PTR)
 - Low and High levels were tested

NU also tested the effectiveness of several different technologies in the pilot

Technologies tested in the pilot program include:

- Smart thermostat
- ♦ A/C switch
- Energy orb
- In-home display (IHD)

The effectiveness of the technologies were tested by enabling certain customers with one of these technology options and comparing their load profiles with those of other customers who did not have these enabling technologies

There are three main steps in our impact evaluation approach



Step 1- Construct "master analysis dataset" merging different pieces of data (i.e., interval data, weather data, customer characteristics, pricing information, etc.)

Step 2- Estimate demand models and calculate price elasticities that are specific to the NU customers

Step 3- Generate NU-PRISM model and calculate demand response impacts

We calculate PWEP impacts using the NU-PRISM model



Demand Impact Results-*Residential*

		RE	SIDENTIAL - AVI	ERAGE CUSTOM	IER	
	PTP_HI	PTP_HI_ORB	PTP_HI_TECH	PTP_LO	PTP_LO_ORB	PTP_LO_TECH
Critical Days - Peak (% of original consumption)	-16.1%	-16.1%	-23.3%	-10.2%	-10.2%	-15.1%
Critical Days - Off-Peak (% of original consumption)	1.9%	1.9%	4.3%	1.5%	1.5%	3.2%
Non-Critical Days - Peak (% of original consumption)	0.5%	0.5%	0.5%	0.2%	0.2%	0.2%
Non-Critical Days - Off-Peak (% of original consumption)	0.5%	0.5%	0.5%	0.2%	0.2%	0.2%
Total Change in Consumption (%/month)	0.2%	0.2%	0.3%	0.1%	0.1%	0.1%

		RE	SIDENTIAL - AVE	ERAGE CUSTON	IER	
	PTR_HI	PTR_HI_ORB	PTR_HI_TECH	PTR_LO	PTR_LO PTR_LO_ORB	
Critical Days - Peak (% of original consumption)	-10.9%	-10.9%	-17.8%	-7.0%	-7.0%	-11.8%
Critical Days - Off-Peak (% of original consumption)	-0.1%	-0.1%	2.3%	0.3%	0.3%	2.0%
Non-Critical Days - Peak (% of original consumption)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Non-Critical Days - Off-Peak (% of original consumption)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Total Change in Consumption (%/month)	-0.3%	-0.3%	-0.2%	-0.2%	-0.2%	-0.1%

		RE	SIDENTIAL - AVI	ERAGE CUSTOM	IER	
	TOU_HI	TOU_HI_ORB	TOU_HI_TECH	TOU_LO	TOU_LO_ORB	TOU_LO_TECH
Peak (% of original consumption)	-3.1%	-3.1%	-3.1%	-1.6%	-1.6%	-1.6%
Off-Peak (% of original consumption)	1.1%	1.1%	1.1%	0.6%	0.6%	0.6%
Total Change in Consumption (%/month)	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%

Demand response impact summary, Residential LO



Demand response impact summary, Residential HI



PWEP Results- *Residential Customers*

- TOU customers reduced their critical peak period usage by 1.6 to 3.1 percent
- **PTR** customers reduced their critical peak period usage by 7.0 to 17.8 percent
- **PTP** customers reduced their critical peak period usage by **10.2 to 23.3** percent
- **Presence of ORB or IHDs** does not have a statistically significant incremental effect for any of the PTP, PTR, and TOU groups
- **Presence of A/C switch or thermostat** increases the impacts for PTP and PTR groups whereas it does not have a statistically significant incremental effect for the TOU group
- As a result of the programs, total monthly consumption *increases* by about 0.2 percent for the PTP program and *decreases* by about 0.2 percent for PTR and TOU programs

Demand Impact Results- *Small* C&I

		CO	MMERCIAL - AV	ERAGE CUSTON	1ER	
	PTP_HI	PTP_HI_ORB	PTP_HI_TECH	PTP_LO	PTP_LO_ORB	PTP_LO_TECH
Critical Days - Peak (% of original consumption)	-2.8%	-2.8%	-7.2%	-1.7%	-1.7%	-4.6%
Critical Days - Off-Peak (% of original consumption)	1.0%	1.0%	2.7%	0.7%	0.7%	1.7%
Non-Critical Days - Peak (% of original consumption)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Non-Critical Days - Off-Peak (% of original consumption)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Total Change in Consumption (%/month)	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%

		CO	MMERCIAL - AV	ERAGE CUSTON	/IER	
	PTR_HI	PTR_HI_ORB	PTR_HI_TECH	PTR_LO	PTR_LO_ORB	PTR_LO_TECH
Critical Days - Peak (% of original consumption)	0.0%	0.0%	-4.1%	0.0%	0.0%	-2.7%
Critical Days - Off-Peak (% of original consumption)	0.0%	0.0%	1.5%	0.0%	0.0%	1.0%
Non-Critical Days - Peak (% of original consumption)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Non-Critical Days - Off-Peak (% of original consumption)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Total Change in Consumption (%/month)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

		CO	MMERCIAL - AV	ERAGE CUSTON	AER	
	TOU_HI	TOU_HI_ORB	TOU_HI_TECH	TOU_LO	TOU_LO_ORB	TOU_LO_TECH
Peak (% of original consumption)	0.0%	0.0%	-	0.0%	0.0%	-
Off-Peak (% of original consumption)	0.0%	0.0%	-	0.0%	0.0%	-
Total Change in Consumption (%/month)	0.0%	0.0%	-	0.0%	0.0%	-

Demand response impact summary, Small C&I HI/LO



PWEP Results- *Small* C&I Customers

- **TOU** customers did not respond to the TOU programs in a statistically significant fashion
- **PTR** customers reduced their critical peak period usage by **2.7 to 4.1** percent
- **PTP** customers reduced their critical peak period usage by **1.7 to 7.2** percent
- **Presence of ORB or IHDs** does not have a statistically significant incremental effect for any of the PTP, PTR, and TOU customers
- **Presence of thermostat** increased the responsiveness of PTP and PTR customers, whereas it did not have a statistically significant incremental effect for TOU customers
- **Total monthly consumption** does not change in response to the time-varying rates

Comparison of PWEP residential demand response impacts to those from other pilots



Conclusions

- PWEP residential and small C&I customers responded to dynamic rates in spite of relatively mild summer conditions
 - Residential customer impacts vary with the rate type and the existence of enabling technologies and range from 1.6 to 23.3 percent
 - Small C&I customer impacts also vary with the rate type and the existence of enabling technologies and range from 1.7 to 7.2 percent
- Residential customer demand response impacts compare favorably to those from other pilots
- Small C&I customers were less price-responsive compared to the residential customers consistent with the evidence in the literature
- PWEP customers (both residential and small C&I) were not much responsive to the TOU rates possibly due to very long peak period duration (8 hours)

Conclusions (Cont'd)

- Existence of ORB did not increase the extent of price responsiveness in any of the program types tested in the PWEP
- Existence of A/C switch or thermostat increased the extent of price responsiveness in all programs but the TOU program for both customer classes
- PTR and TOU residential programs led to a small decrease in total monthly consumption whereas PTP residential program led to a small increase
- Small C&I customers did not change their total monthly usage during PWEP

II. A CLOSER LOOK AT PWEP

NU's Plan-it Wise Energy Program (PWEP) began to call critical peak days in June 1, 2009 and ran through August 31, 2009

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Technologies tested in the pilot program include:

- Smart thermostat
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- Energy orb
- In-home display (IHD)

The effectiveness of the technologies were tested by enabling certain customers with one of these technology options and comparing their load profiles with those of other customers who did not have these enabling technologies

The PWEP contained a total of 44 treatment cells

Program Cell Type	Residential	Commercial
PTP_HI	\checkmark	\checkmark
PTP_HI_switch	\checkmark	\checkmark
PTP_HI_thermostat	\checkmark	\checkmark
PTP_HI_orb	\checkmark	\checkmark
PTP_LOW	\checkmark	\checkmark
PTP_LOW_switch	\checkmark	\checkmark
PTP_LOW_thermostat	\checkmark	\checkmark
PTP_LOW_orb	\checkmark	\checkmark
PTR_HI	\checkmark	\checkmark
PTR_HI_switch	\checkmark	\checkmark
PTR_HI_thermostat	\checkmark	\checkmark
PTR_HI_orb	\checkmark	\checkmark
PTR_LOW	\checkmark	\checkmark
PTR_LOW_switch	\checkmark	\checkmark
PTR_LOW_thermostat	\checkmark	\checkmark
PTR_LOW_orb	\checkmark	\checkmark
TOU_HI	\checkmark	\checkmark
TOU_HI_thermostat	\checkmark	NA
TOU_HI_ihd	\checkmark	NA
TOU_HI_orb	\checkmark	\checkmark
TOU_LOW	\checkmark	\checkmark
TOU_LOW_thermostat	\checkmark	NA
TOU_LOW_ihd	\checkmark	NA
TOU_LOW_orb	\checkmark	\checkmark
Total Number of Cells	24	20

Enrollment Statistics as of August 2009

Residential											
	PTP HI	PTP LO	PTR HI	PTR LO	TOU HI	TOU LO	Treatment Group	Control Group	TOTAL		
TOTAL	183	188	189	193	183	178	1,114	137	1,251		
NO TECH	98	104	100	108	90	98	598	0	-		
ТЕСН	85	84	89	85	93	80	516	0	-		
ORB & IHD*	43	48	43	44	66	63	307	0	-		
Thermostat & Switch**	42	36	46	41	27	17	209	0	-		

Enrollment Statistics as of August 2009

Notes:

* IHD applies to TOU rate only.

** Switch does not apply to TOU rate.

C&I									
	PTP HI	PTP LO	PTR HI	PTR LO	TOU HI	TOU LO	Treatment Group	Control Group	TOTAL
TOTAL	176	185	197	185	185	195	1,123	63	1,186
NO TECH	93	97	102	98	93	100	583	0	-
ТЕСН	83	88	95	87	92	95	540	0	-
ORB	56	52	57	57	92	95	409	0	-
Thermostat & Switch*	27	36	38	30	0	0	131	0	-

Notes:

* Switch does not apply to TOU rate.

Our impact evaluation methodology follows three main steps



Step 1- Construct "master analysis dataset" merging different pieces of data (i.e., interval data, weather data, customer characteristics, pricing information, etc.)

Step 2- Estimate demand models and calculate price elasticities that are specific to NU customers

Step 3- Generate NU-PRISM model and calculate demand response impacts

Step 1- Construct Master Analysis Dataset



Step 2- Estimation of Demand Equations

In order to predict consumption under new rate designs, we estimate a constant elasticity of substitution (CES) demand system that consists of two equations:

- Substitution Equation models changes in load shape caused by changing peak-to-off peak prices
- Daily Equation models changes in daily average consumption caused by changing daily prices

Using elasticities estimated by this system of two equations, we predict consumption by rate period

Estimated Substitution Equations

	RESI	DENTIAL	SM	ALL C&I
	TOU & Control	PTP/PTR & Control	TOU & Control	PTP/PTR & Control
VARIABLES	resid	resid	c&i	c&i
thi diff	-0.002	0.001	0.006**	0 004**
un_un	(0.199)	(0.353)	(0,000)	(0.004)
thi diffxiune	0.002	0.000	-0.005	0.003
un_annsjane	(0.357)	(0.877)	(0.155)	(0.052)
thi diffxiuly	0.011**	0.009**	-0.005	0.004*
	(0.000)	(0.000)	(0.215)	(0.022)
thi diffxaug	0.017**	0.009**	0.006	0.011**
	(0.000)	(0.000)	(0.072)	(0.000)
TreatCustomer	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)
TreatCustomerxTreatPeriod	-0.077**	-0.067**	-0.051*	0.031
	(0.000)	(0.000)	(0.042)	(0.215)
In price ratioxthi diff	-0.010*	-0.017**	0.006	-0.003*
<u> </u>	(0.016)	(0.000)	(0.259)	(0.032)
In price ratioxthi diff PTR		0.006*	i de la companya de l	0.003*
		(0.024)		(0.048)
In price ratioxthi diff ORB	0.005	0.006	0.009	0.002
	(0.376)	(0.057)	(0.177)	(0.387)
In_price_ratioxthi_diff_TECH	-0.006	-0.010**	0.000	-0.005*
	(0.466)	(0.009)	(.)	(0.044)
june	0.050**	0.079**	0.069**	-0.003
	(0.006)	(0.000)	(0.004)	(0.911)
july	0.022	0.062**	0.084**	0.014
	(0.289)	(0.001)	(0.000)	(0.599)
aug	0.023	0.016	0.037	-0.030
	(0.261)	(0.399)	(0.112)	(0.266)
weekend	0.073**	0.085**	-0.259**	-0.326**
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.099**	-0.009	0.293**	0.280**
	(0.000)	(0.328)	(0.000)	(0.000)
Observations	59669	102384	52692	96555
R-squared	0.012	0.013	0.071	0.097
Number of customer	498	890	440	799
Number of studyid				
Robust p-values in parentheses				
** p<0.01, * p<0.05				
		00		The R.
		20		I he Dri

Estimated Daily Equations

	RESI	DENTIAL	SMALL C&I			
VARIABLES	TOU & Control resid	PTP/PTR & Control resid	TOU & Control c&i	PTP/PTR & Control c&i		
1	0.208	0.001	0.012	0 470**		
In_thi	-0.208	0.001	-0.012	0.4/8**		
to definitions	(0.1/8)	(0.983)	(0.991)	(0.000)		
In_thixjune	1.168**	1.060**	0.229*	$(0.42)^{**}$		
	(0.000)	(0.000)	(0.021)	(0.000)		
in_thixjuly	2.58/**	2.758**	0.874**	1.098**		
1 .1 .	(0.000)	(0.000)	(0.000)	(0.000)		
In_thixaug	3.102**	3.022**	1.019**	1.005**		
	(0.000)	(0.000)	(0.000)	(0.000)		
TreatCustomer	0.000	0.000	0.000	0.000		
	(.)	(.)	(.)	(.)		
TreatCustomerxTreatPeriod	-0.043	-0.016	0.046	0.042		
	(0.194)	(0.562)	(0.393)	(0.209)		
ln_pricexln_thi	-0.107	-0.006*	-0.359	0.004		
	(0.214)	(0.016)	(0.580)	(0.437)		
ln_pricexln_thi_PTR		0.007		-0.003		
		(0.098)		(0.656)		
n_pricexln_thi_ORB			-0.040	0.005		
			(0.734)	(0.504)		
n_pricexln_thi_TECH				0.013		
				(0.082)		
june	-4.789**	-4.347**	-0.992*	-1.805**		
	(0.000)	(0.000)	(0.017)	(0.000)		
uly	-10.697**	-11.422**	-3.643**	-4.588**		
	(0.000)	(0.000)	(0.000)	(0.000)		
aug	-12.801**	-12.472**	-4.233**	-4.166**		
	(0.000)	(0.000)	(0.000)	(0.000)		
weekend	0.032**	0.022**	-0.478**	-0.491**		
	(0.000)	(0.000)	(0.000)	(0.000)		
Constant	-0.440	-0.580**	-2.099**	-1.443**		
	(0.064)	(0.002)	(0.000)	(0.000)		
Observations	60564	108145	53112	97421		
R-squared	0.161	0.173	0.183	0.199		
Number of customer						
Number of studvid	498	890	443	806		
Robust p-values in parentheses ** p<0.01, * p<0.05		~~ ~				

Elasticities implied by the demand equations

We estimate two price elasticities that are specific to the NU population

Substitution elasticity measures the change in load shape caused by changing peak-to-off peak prices

• Percent change in the ratio of peak to off-peak consumption when there is one percent change in the ratio of peak to off-peak prices

Daily (price) elasticity measures the change in daily energy consumption caused by changing daily prices

 Percent change in the daily average consumption when there is one percent change in the daily average price

Our regression results show that price-responsiveness increases with the hotter weather

This implies that the customers are more price-responsive on hotter event days compared to the milder event days

Summer of 2009 was a *relatively mild* summer

- Especially event days in June and July were not typical events in terms of THI values
- August event days were more representative of typical event days, but still were not as hot and humid as it had been during the past summers

For this reason, we evaluated our elasticity terms using the average weather on "August event days"

Event Day Weather Characteristics, Bradley Weather Station

ID	CPP Date	Minimum THI	Average THI	Maximum THI	Average Peak THI	Average OffPeak THI	THI_DIFF	LN_THI	Maximum Drybulb	Average Drybulb	Minimum Drybulb
CPP Day 1	6/25/2009	65.30	69.87	74.70	74.09	69.03	5.06	4.25	80.00	71.88	64.00
CPP Day 2	7/9/2009	58.90	62.20	66.25	65.65	61.51	4.14	4.13	69.00	61.71	56.00
CPP Day 3	7/16/2009	65.45	69.73	76.20	75.14	68.65	6.49	4.24	82.00	71.67	65.00
CPP Day 4	7/17/2009	63.05	70.20	76.70	75.11	69.22	5.90	4.25	84.00	72.17	61.00
CPP Day 5	7/29/2009	71.10	73.62	77.00	75.05	73.34	1.71	4.30	82.00	75.88	72.00
CPP Day 6	7/30/2009	68.05	73.05	77.80	77.39	72.19	5.20	4.29	86.00	76.63	69.00
Average (CPP1-CPP6)	-		69.78		73.74	68.99	4.75	4.24		71.65	
CPP Day 7	8/4/2009	62.65	70.79	76.85	76.61	69.62	6.99	4.26	85.00	74.08	61.00
CPP Day 8	8/5/2009	62.75	72.72	79.00	77.19	71.82	5.37	4.29	86.00	76.33	63.00
CPP Day 9	8/11/2009	68.25	74.79	79.65	79.04	73.94	5.10	4.31	89.00	79.54	69.00
CPP Day 10	8/18/2009	69.60	75.43	80.70	80.11	74.49	5.63	4.32	92.00	80.83	70.00
Average (CPP7-CPP10)	-	-	73.43	-	78.24	72.47	5.77	4.30		77.70	

Summary Statistics of Weather Terms for Event Days, NON-TOU, Bradley

Summary Statistics of Weather Terms for TOU, Bradley

ID	CPP Date	Minimum THI	Average THI	Maximum THI	Average Peak THI	Average OffPeak THI	THI_DIFF	LN_THI	Maximum Drybulb	Average Drybulb	Minimum Drybulb
JUNE		45.35	64.81	76.40	67.98 71.40	63.23	4.75	4.17	86.00	65.29	39.00
Average (JUN-JULY)	-	33.33	66.39	/8.55	/1.40	00.23	4.96	4.22 4.20	87.00	67.54	51.00
AUGUST		56.80	70.25	82.35	74.00	68.38	5.62	4.25	94.00	72.94	54.00
Average (AUGUST)	-	-	70.25	-	74.00	68.38	5.62	4.25		72.94	

Event Day Weather Characteristics, White Plains Weather Station

ID	CPP Date	Minimum THI	Average THI	Maximum THI	Average Peak THI	Average OffPeak THI	THI_DIFF	LN_THI	Maximum Drybulb	Average Drybulb	Minimum Drybulb
CPP Day 1	6/25/2009	64.35	68.11	73.20	72.36	67.26	5.10	4.22	78.00	69.46	63.00
CPP Day 2	7/9/2009	59.45	62.65	67.00	65.99	61.99	4.00	4.14	70.00	62.46	57.00
CPP Day 3	7/16/2009	65.75	71.20	76.55	76.00	70.24	5.77	4.27	83.00	74.58	66.00
CPP Day 4	7/17/2009	65.85	71.63	76.35	74.68	71.02	3.66	4.27	83.00	74.33	65.00
CPP Day 5	7/29/2009	68.65	71.48	76.45	72.78	71.22	1.55	4.27	81.00	72.88	69.00
CPP Day 6	7/30/2009	69.00	72.79	77.45	76.40	72.07	4.33	4.29	85.00	76.38	70.00
Average (CPP1-CPP6)	-		69.64		73.03	68.96	4.07	4.24		71.68	
CPP Day 7	8/4/2009	64.90	70.82	75.90	75.11	69.96	5.16	4.26	84.00	73.83	64.00
CPP Day 8	8/5/2009	66.85	72.87	77.85	75.70	72.31	3.39	4.29	85.00	76.38	69.00
CPP Day 9	8/11/2009	69.95	73.62	77.65	76.91	72.96	3.96	4.30	85.00	77.67	71.00
CPP Day 10	8/18/2009	69.70	74.73	79.15	78.19	74.04	4.15	4.31	88.00	79.67	72.00
Average (CPP7-CPP10)	-	-	73.01	-	76.48	72.32	4.16	4.29		76.89	

Summary Statistics of Weather Terms for Event Days, NON-TOU, White Plains

Summary Statistics of Weather Terms for TOU, White Plains

ID	CPP Date	Minimum THI	Average THI	Maximum THI	Average Peak THI	Average OffPeak THI	THI_DIFF	LN_THI	Maximum Drybulb	Average Drybulb	Minimum Drybulb
JUNE JULY		46.65 56.95	64.40 67.96	75.30 78.25	66.86 70.94	63.18 66.48	3.69 4.46	4.17 4.22	82.00 85.00	64.55 70.08	41.00 54.00
Average (JUN-JULY)	-		66.18				4.07	4.19		67.31	
AUGUST		56.80	70.21	81.00	73.04	68.79	4.25	4.25	91.00	72.78	54.00
Average (AUGUST)	-	-	70.21	-	73.04	68.79	4.25	4.25		72.78	

PWEP customers were linked to two weather stations: Bradley and White Plains Weather Stations

For the purposes of elasticity calculations and impact estimations, we calculated the weighted average weather terms using Bradley and White Plains weather data

• We use the distribution of the treatment customers to these weather stations as weights in this calculation

	Bradley	White Plains
Residential	36.36%	63.64%
Small C&I	64.11%	35.89%

Distribution of Treatment Customers to Weather Stations

We calculated separate weather variables for TOU and non-TOU programs due to the different peak and off-peak durations

Bradley THI values were consistently higher than that of White Plains

	Brad	ley	White Plains			
	thi_diff	ln_thi	thi_diff	ln_thi		
TOU (June-July)	4.96	4.20	4.07	4.19		
TOU (August only)	5.62	4.25	4.25	4.25		
Non_TOU (June-July)	4.75	4.24	4.07	4.24		
Non_TOU (August only)	5.77	4.30	4.16	4.29		

Summary Weather Characteristics by Program Type, Month, and Weather Station

August Weather Characteristics Weighted by Customer Distribution to the Weather Stations

	ТО	U	Non-TOU		
	thi_diff	ln_thi	thi_diff	ln_thi	
Residential	4.75	4.25	4.75	4.29	
Small C&I	5.13	4.25	5.19	4.29	

Residential Elasticity Estimates

We calculated elasticity terms based on June-July and August event-day weather conditions

Electicity Type	TOU		РТР		PTR	R
Elasticity Type	June-July	August	June-July	August	June-July	August
		Substitu	tion Elasticity Estin	nates		
Price Only	-0.044	-0.047	-0.073	-0.081	-0.047	-0.052
Price + ORB	-0.044	-0.047	-0.073	-0.081	-0.047	-0.052
Price + TECH	-0.044	-0.047	-0.117	-0.128	-0.091	-0.100
		Daily	Elasticity Estimate	25		
Price Only	0.000	0.000	-0.025	-0.026	-0.025	-0.026
Price + ORB	0.000	0.000	-0.025	-0.026	-0.025	-0.026
Price + TECH	0.000	0.000	-0.025	-0.026	-0.025	-0.026

Elasticity Estimates- Residential Customers

Residential elasticity terms are higher based on a more representative August weather data

- PTP customers were found to be more price responsive compared to the PTR and TOU customers
- **PTR customers** were found to be more price responsive compared to the TOU customers
- Incremental effect from ORB was not statistically significant for any of the TOU, PTP, and PTR programs
- Incremental effect from TECH was statistically significant for the PTP and PTR programs, but not for the TOU program
- PTP and PTR customers exhibited some daily price responsiveness, whereas TOU customers did not

Small C&I Elasticity Estimates

Elasticity Type	TOU		РТР		PTR	
	June-July	August	June-July	August	June-July	August
		Substitu	tion Elasticity Estim	ates		
Price Only	0.000	0.000	-0.014	-0.016	0.000	0.000
Price + ORB	0.000	0.000	-0.014	-0.016	0.000	0.000
Price + TECH	0.000	0.000	-0.036	-0.042	-0.023	-0.026
		Daily	Elasticity Estimates	5		
Price Only	0.000	0.000	0.000	0.000	0.000	0.000
Price + ORB	0.000	0.000	0.000	0.000	0.000	0.000
Price + TECH	0.000	0.000	0.000	0.000	0.000	0.000

Elasticity Estimates-Small C&I Customers
Small C&I elasticity terms are also higher based on a more representative August data

- TOU customers did not respond to dynamic prices in a statistically significant way
- PTP customers responded to prices w/o any enabling technologies, whereas PTR customers did not
- PTP and PTR customers both responded to prices when prices are accompanied w/ enabling technologies
- Incremental effect from ORB was not statistically significant for any of the PTP and PTR programs
- None of the PTP, PTR, and TOU customers exhibited daily price responsiveness

Comparison of NU residential customer elasticities to those estimated in California (SPP), Maryland (BGE) and New Jersey (PSE&G)

Comparison of N	NU Elasticities to BGH	E, SPP and PSE&G I	Elasticities
Program	Enabling Technology	Substitution Elasticity	Daily Elasticity
	СА		
Price Only	No	-0.12	-0.03
Price + ET	Yes	-0.32	-0.06
	BGE		
Price Only	No	-0.096	-0.039
Price + ORB	Yes	-0.136	-0.039
Price + ET_ORB	Yes	-0.180	-0.039
	PSE&G	r r	
Price Only	No	-0.066	-
Price + ET	Yes	-0.125	-
	NU		
Price Only	No	-0.081	-0.026
Price + ORB	Yes	-0.081	-0.026
Price + ET_ORB	Yes	-0.128	-0.026

Note:

1- PSE&G "Price Only"elasticity is the average of elasticities from myPower Sense customers with CAC (-0.069) and without CAC (-0.063). "Price + ET" refers to the elasticity estimated from the myPower Connection program.

2- SPP "Price Only" elasticity is estimated from the CPP-F program. "Price + ET" is estimated from the CPP-V/Track C program. All the Track C customers had smart thermostats

3- BGE elasticities are based on average CPP day weather

4- CA SPP elasticities are adjusted to BGE CAC saturation

5- NU elasticities are based on PTP residential customers.

Comparison of residential substitution elasticities across PTP type programs



Step 3- Generate NU-PRISM and calculate PWEP DR Impacts

We follow these steps to generate NU-PRISM and calculate PWEP demand response impact estimates:

- 1. Convert unbundled rate a customer would pay under the current rate design into an "all-in" rate
- 2. Identify the all-in rate this customer would pay if they participated in the PWEP
- 3. Calibrate the PRISM model to the estimated NU elasticities and the typical NU residential and small C&I customer load profiles and obtain NU-PRISM
- 4. Calculate PWEP demand response impacts using NU-PRISM

Using NU-PRISM, we calculate demand response to the rate designs tested in the PWEP

PRISM algorithm calculates DR impacts in four steps:

- 1. Predict the daily energy use from the daily equation
- 2. Predict the shares of consumption in the peak and off-peak periods under the new rates from the substitution equation
- 3. Apply these shares to the predicted daily energy use
- 4. Calculate electricity consumption by rate period. Other PRISM metrics include:
 - Percent change in peak and off-peak consumption on critical days
 - Percent change in peak and off-peak consumption on non-critical days
 - Percent change in total monthly consumption

PRISM impacts are presented for the average NU residential and small C&I customers

Typical NU customer load profiles are based on 2009 average class load profiles

Typical Customer Load (kWh per hour), PTP/PTR, Residential

	CPF	P Days	Non-CPP Days		
	Peak	Off-Peak	Peak	Off-Peak	
Average Customer	1.54	1.18	1.24	1.01	

Note: Weekends and holidays are included in the off-peak averages.

Typical Customer Load (kWh per hour), PTP/PTR, C&I

	CPP	^o Days	Non-CPP Days		
	Peak	Off-Peak	Peak	Off-Peak	
Average Customer	10.18	7.09	9.30	6.01	

Note: Weekends and holidays are included in the off-peak averages.

Typical Customer Load (kWh per hour), TOU, Residential

	Peak	Off-Peak
Average Customer	1.29	0.98

Note: Weekends and holidays are included in the off-peak averages.

Typical Customer Load (kWh per hour), TOU, C&I

	Peak	Off-Peak
Average Customer	8.95	5.80

Note: Weekends and holidays are included in the off-peak averages.

Demand Impact Results-*Residential*

		RE	SIDENTIAL - AVI	ERAGE CUSTOM	IER	
	PTP_HI	PTP_HI_ORB	PTP_HI_TECH	PTP_LO	PTP_LO_ORB	PTP_LO_TECH
Critical Days - Peak (% of original consumption)	-16.1%	-16.1%	-23.3%	-10.2%	-10.2%	-15.1%
Critical Days - Off-Peak (% of original consumption)	1.9%	1.9%	4.3%	1.5%	1.5%	3.2%
Non-Critical Days - Peak (% of original consumption)	0.5%	0.5%	0.5%	0.2%	0.2%	0.2%
Non-Critical Days - Off-Peak (% of original consumption)	0.5%	0.5%	0.5%	0.2%	0.2%	0.2%
Total Change in Consumption (%/month)	0.2%	0.2%	0.3%	0.1%	0.1%	0.1%

		RE	SIDENTIAL - AVI	ERAGE CUSTON	1ER	
	PTR_HI	PTR_HI_ORB	PTR_HI_TECH	PTR_LO	PTR_LO_ORB	PTR_LO_TECH
Critical Days - Peak (% of original consumption)	-10.9%	-10.9%	-17.8%	-7.0%	-7.0%	-11.8%
Critical Days - Off-Peak (% of original consumption)	-0.1%	-0.1%	2.3%	0.3%	0.3%	2.0%
Non-Critical Days - Peak (% of original consumption)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Non-Critical Days - Off-Peak (% of original consumption)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Total Change in Consumption (%/month)	-0.3%	-0.3%	-0.2%	-0.2%	-0.2%	-0.1%

		RE	SIDENTIAL - AVI	ERAGE CUSTON	IER	
	TOU_HI	TOU_HI_ORB	TOU_HI_TECH	TOU_LO	TOU_LO_ORB	TOU_LO_TECH
Peak (% of original consumption)	-3.1%	-3.1%	-3.1%	-1.6%	-1.6%	-1.6%
Off-Peak (% of original consumption)	1.1%	1.1%	1.1%	0.6%	0.6%	0.6%
Total Change in Consumption (%/month)	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%

PWEP Results- *Residential Customers*

- TOU customers reduced their critical peak period usage by 1.6 to 3.1 percent
- **PTR** customers reduced their critical peak period usage by 7.0 to 17.8 percent
- **PTP** customers reduced their critical peak period usage by **10.2 to 23.3** percent
- **Presence of ORB or IHDs** does not have a statistically significant incremental effect for any of the PTP, PTR, and TOU groups
- **Presence of A/C switch or thermostat** increases the impacts for PTP and PTR groups whereas it does not have a statistically significant incremental effect for the TOU group
- As a result of the programs, total monthly consumption *increases* by about 0.2 percent for the PTP program and *decreases* by about 0.2 percent for PTR and TOU programs

Demand Impact Results- *Small* C&I

		CO	MMERCIAL - AV	ERAGE CUSTON	1ER	
	PTP_HI	PTP_HI_ORB	PTP_HI_TECH	PTP_LO	PTP_LO_ORB	PTP_LO_TECH
Critical Days - Peak (% of original consumption)	-2.8%	-2.8%	-7.2%	-1.7%	-1.7%	-4.6%
Critical Days - Off-Peak (% of original consumption)	1.0%	1.0%	2.7%	0.7%	0.7%	1.7%
Non-Critical Days - Peak (% of original consumption)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Non-Critical Days - Off-Peak (% of original consumption)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Total Change in Consumption (%/month)	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%

		CO	MMERCIAL - AV	ERAGE CUSTON	AER	
	PTR_HI	PTR_HI_ORB	PTR_HI_TECH	PTR_LO	PTR_LO_ORB	PTR_LO_TECH
Critical Days - Peak (% of original consumption)	0.0%	0.0%	-4.1%	0.0%	0.0%	-2.7%
Critical Days - Off-Peak (% of original consumption)	0.0%	0.0%	1.5%	0.0%	0.0%	1.0%
Non-Critical Days - Peak (% of original consumption)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Non-Critical Days - Off-Peak (% of original consumption)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Total Change in Consumption (%/month)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

		COMMERCIAL - AVERAGE CUSTOMER TOU_HI TOU_HI_ORB TOU_HI_TECH TOU_LO TOU_LO ORB TOU_LO_TECH 0.0% 0.0% - 0.0% 0.0% - - 0.0% 0.0% - 0.0% 0.0% - -						
	TOU_HI	TOU_HI_ORB	TOU_HI_TECH	TOU_LO	TOU_LO_ORB	TOU_LO_TECH		
Peak (% of original consumption)	0.0%	0.0%	-	0.0%	0.0%	-		
Off-Peak (% of original consumption)	0.0%	0.0%	-	0.0%	0.0%	-		
Total Change in Consumption (%/month)	0.0%	0.0%	-	0.0%	0.0%	-		

PWEP Results- *Small* C&I Customers

- **TOU** customers did not respond to the TOU programs in a statistically significant fashion
- **PTR** customers reduced their critical peak period usage by **2.7 to 4.1** percent
- **PTP** customers reduced their critical peak period usage by **1.7 to 7.2** percent
- **Presence of ORB or IHDs** does not have a statistically significant incremental effect for any of the PTP, PTR, and TOU customers
- **Presence of thermostat** increased the responsiveness of PTP and PTR customers, whereas it did not have a statistically significant incremental effect for TOU customers
- Total monthly consumption does not change in response to the time-varying rates

Demand response impact summary, Residential LO



Demand response impact summary, Residential HI



Demand response impact summary, Small C&I HI/LO



III- APPENDIX

1- Load Profile Comparison: Control vs. Treatment

We analyzed control and treatment group load profiles in the pretreatment and treatment periods

- We constructed typical-day load profiles for each month by averaging the load values for control and treatment customers by hour
- We also reviewed the detailed summary statistics of the daily load data
- Our comparisons revealed that the load profiles of treatment and control customers were comparable to a large extent in the pretreatment and treatment periods
 - Any remaining differences is accounted for the difference-indifferences terms in the demand models

Load profile comparison- Control vs. Treatment Group Small C&I



Mean Comparison Test - May



Mean Comparison Test - June

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Con	f. Interval]	Group	Obs	Mean	Std. Err.	Std. Dev.	195% Co	onf. J
Control	24	4.749	0.285	1.398	4.159	5.340	Control	24	5 001	0 332	1 628	4 314	_
Treatment	24	3.938	0.298	1.459	3.322	4.554	Treatment	24	4 244	0.332	1.657	3 545	
Combined	48	4.344	0.212	1.472	3.916	4.771	Combined	48	4.623	0.241	1.669	4.138	
Δ		0.811	0.413		-0.019	1.642	Δ		0.757	0.474		-0.198	
$\Delta = \text{mean} (\text{Co} \text{H0: } \Delta = 0, \text{H})$	ntrol) - mea IA: ∆ ≠ 0	n Treatment)		Pr(T > t) = Outcome: D	= 0.055 o Not Reject 1	t = 1.966 H0	$\Delta = \text{mean} (\text{Co} \mathbf{H0}: \Delta = 0, \mathbf{H0})$	ntrol) - mea IA: ∆ ≠ 0	n Treatment)		Pr(T > t) = Outcome : D	= 0.117 10 Not Rejec	t = t H0:
													_

[95% Conf. Interval]

5.689

4.944

5.107

1.711

t = 1.596

Load profile comparison- Control vs. Treatment Group Small C&I (Cont'd)



Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Co	nf. Interval]
Control	24	5.630	0.425	2.080	4.752	6.508
Treatment	24	4.688	0.387	1.896	3.888	5.489
Combined	48	5.159	0.292	2.026	4.571	5.747
Δ		0.942	0.575		-0.215	2.098
$\Delta = \text{mean} (\text{Co} \text{H0: } \Delta = 0, \text{H})$	ntrol) - meaı IA: ∆≠0	n Treatment)		Pr(T > t) = Outcome: De	= 0.108 o Not Reject	t = 1.639 t H0

Mean Comparison Test - July



Mean Comparison Test - August

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Co	nf. Interval]
Control	24	5.740	0.448	2.195	4.813	6.667
Treatment	24	5.249	0.436	2.136	4.347	6.151
Combined	48	5.494	0.311	2.157	4.868	6.121
Δ		0.491	0.625		-0.768	1.749
$\Delta = \text{mean} (\text{Co} \text{H0: } \Delta = 0, \text{H})$	introl) - mean $\mathbf{IA:} \Delta \neq 0$	n Treatment)		Pr(T > t) = Outcome: De	= 0.437 o Not Reject	t = 0.785 t H0

Load profile comparison- Control vs. Treatment Group Small C&I (Cont'd)

	0	Control		
	Percentiles	Smallest		
1%	0.1	0.1		
5%	0.5	0.2		
10%	0.9	0.3	Obs	63
25%	20.3	0.5	Sum of Wgt.	63
50%	52.2		Mean	116.4
		Largest	Std. Dev.	235.8
75%	103.2	475.6		
90%	214.8	591.1	Variance	55611.2
95%	475.6	767.9	Skewness	4.5
99%	1593.9	1593.9	Kurtosis	26.6
	 	astmant		
		eatment		
	Percentiles	Smallest		
1%	Percentiles 0.7	Smallest 0.0		
1% 5%	Percentiles 0.7 3.4	<i>Smallest</i> 0.0 0.0		
1% 5% 10%	Percentiles 0.7 3.4 6.4	Smallest 0.0 0.0 0.1	Obs	1,123
1% 5% 10% 25%	Percentiles 0.7 3.4 6.4 15.2	Smallest 0.0 0.0 0.1 0.2	Obs Sum of Wgt.	1,122
1% 5% 10% 25% 50%	Percentiles 0.7 3.4 6.4 15.2 38.5	Smallest 0.0 0.0 0.1 0.2	Obs Sum of Wgt. Mean	1,123 1,123 100.6
1% 5% 10% 25% 50%	Percentiles 0.7 3.4 6.4 15.2 38.5	Smallest 0.0 0.0 0.1 0.2	Obs Sum of Wgt. Mean Std. Dev.	1,123 1,123 100.6 189.8
1% 5% 10% 25% 50% 75%	Percentiles 0.7 3.4 6.4 15.2 38.5 99.8	Smallest 0.0 0.0 0.1 0.2 Largest 1468.1	Obs Sum of Wgt. Mean Std. Dev.	1,123 1,123 100.6 189.8
1% 5% 10% 25% 50% 75% 90%	Percentiles 0.7 3.4 6.4 15.2 38.5 99.8 237.4	Smallest 0.0 0.1 0.2 Largest 1468.1 1589.6	Obs Sum of Wgt. Mean Std. Dev. Variance	1,123 1,123 100.6 189.8 36026.1

n ... C C . 001

The Brattle Group

31.9

1960.3 Kurtosis

987.8

99%

Load profile comparison- Control vs. Treatment Group *Residential*



Mean Comparison Test - May



Mean Comparison Test - June

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Co	nf. Interval]	Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Co	nf. Interval]
Control	24	0.858	0.038	0.185	0.780	0.936	Control	24	0.915	0.042	0.205	0.829	1.002
Treatment	24	0.714	0.038	0.184	0.637	0.792	Treatment	24	0.752	0.038	0.185	0.674	0.830
Combined	48	0.786	0.028	0.197	0.729	0.843	Combined	48	0.833	0.030	0.210	0.772	0.894
Δ		0.143	0.053		0.036	0.251	Δ		0.163	0.056		0.050	0.277
$\Delta = \text{mean} (CoH0: \Delta = 0, 1)$	ontrol) - me HA: ∆ ≠ 0	an Treatment)	Pr(T > t) = Outcome : Re	0.010 ject H0	t = 2.691	$\Delta = \text{mean} (CoH0: \Delta = 0, \Box$	ontrol) - me HA: ∆ ≠ 0	ean Treatmen	t)	Pr(T > t) = Outcome : Re	= 0.006 eject H0	t = 2.898

Load profile comparison- Control vs. Treatment Group *Residential (Cont'd)*



Mean	Comparison	Test - July	
Mean	Comparison	Test - July	

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Co	nf. Interval]
Control	24	1.087	0.051	0.251	0.981	1.193
Treatment	24	0.898	0.044	0.215	0.807	0.989
Combined	48	0.993	0.036	0.250	0.920	1.065
Δ		0.189	0.067		0.053	0.325
$\Delta = \text{mean} (CoH0: \Delta = 0, 1$	ontrol) - me HA: ∆≠0	an Treatment)	Pr(T > t) = Outcome : Re	0.007 ject H0	t = 2.806



Mean Comparison Test - Augu

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Co	onf. Interval]
Control	24	1.347	0.068	0.331	1.207	1.487
Treatment	24	1.107	0.056	0.273	0.992	1.222
Combined	48	1.227	0.047	0.324	1.133	1.321
Δ		0.240	0.088		0.064	0.416
$\Delta = \text{mean} (C)$ H0: $\Delta = 0$,	ontrol) - me HA: ∆ ≠ 0	an Treatment	:)	Pr(T > t) = Outcome: Re	0.009 ject H0	t = 2.744

Load profile comparison- Control vs. Treatment Group Residential (Cont'd)

	С	ontrol		
	Percentiles	Smallest		
1%	5.3	3.8		
5%	6.0	5.3		
10%	7.9	5.3	Obs	137
25%	14.3	5.4	Sum of Wgt.	137
50%	20.8		Mean	24.8
		Largest	Std. Dev.	15.6
75%	31.8	67.4		
90%	46.7	68.3	Variance	243.7
95%	59.1	73.4	Skewness	1.3
00%	72.4			
9970	/3.4	80.5	Kurtosis	4.6
3770	73.4 Tre	80.5 eatment	Kurtosis	4.6
9970	73.4 Tre Percentiles	80.5 eatment Smallest	Kurtosis	4.6
1%	73.4 Tre <u>Percentiles</u> 1.7	80.5 eatment Smallest 0.0	Kurtosis	4.6
1% 5%	73.4 Tre Percentiles 1.7 4.2	80.5 eatment <u>Smallest</u> 0.0 0.2	Kurtosis	4.6
1% 5% 10%	73.4 Tre Percentiles 1.7 4.2 6.1	80.5 eatment <u>Smallest</u> 0.0 0.2 0.2	<i>Kurtosis</i> Obs	1,114
1% 5% 10% 25%	73.4 Tre <u>Percentiles</u> 1.7 4.2 6.1 10.3	80.5 eatment Smallest 0.0 0.2 0.2 0.3	Kurtosis Obs Sum of Wgt.	1,114 1,114
1% 5% 10% 25%	73.4 Tre <u>Percentiles</u> 1.7 4.2 6.1 10.3 17.8	80.5 eatment <u>Smallest</u> 0.0 0.2 0.2 0.3	Kurtosis Obs Sum of Wgt. Mean	4.6 1,114 1,114 21.0
1% 5% 10% 25% 50%	73.4 Tre <u>Percentiles</u> 1.7 4.2 6.1 10.3 17.8	80.5 eatment Smallest 0.0 0.2 0.2 0.3	Kurtosis Obs Sum of Wgt. Mean Std. Dev	1,114 1,114 21.0 14 7
1% 5% 10% 25% 50%	73.4 Tre <u>Percentiles</u> 1.7 4.2 6.1 10.3 17.8 27 1	80.5 eatment Smallest 0.0 0.2 0.2 0.3 Largest 85.2	Kurtosis Obs Sum of Wgt. Mean Std. Dev.	1,114 1,114 21.0 14.7
1% 5% 10% 25% 50% 75% 90%	73.4 Tre <u>Percentiles</u> 1.7 4.2 6.1 10.3 17.8 27.1 39.8	80.5 eatment <u>Smallest</u> 0.0 0.2 0.2 0.3 <u>Largest</u> 85.2 90.2	Kurtosis Obs Sum of Wgt. Mean Std. Dev. Variance	4.6 1,114 1,114 21.0 14.7 2164
1% 5% 10% 25% 50% 75% 90% 95%	73.4 Tre <u>Percentiles</u> 1.7 4.2 6.1 10.3 17.8 27.1 39.8 48.6	80.5 eatment <u>Smallest</u> 0.0 0.2 0.2 0.3 <u>Largest</u> 85.2 90.2 98.2	Kurtosis Obs Sum of Wgt. Mean Std. Dev. Variance Skewness	4.6 1,114 1,114 21.0 14.7 216.4 1.6

Descendilog Commonwood A Daily I and Daviday

PWEP tested three different rate structures with two levels of prices for each

 PWEP rates were implemented as adjustments to the existing tariff rates

	Total Tariff Rate		Delta to Tari	iff for PTP	РТР	Rate	Delta to T	Tariff for OU	TOU	Rate	Delta to Tari	iff for PTR	PTR	Rate
Rate Schedule	(\$/kWh)	Period	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
C & L (Data 20 & 25)	0 125	Peak	0.650	1.601	0.775	1.726	0.069	0.138	0.194	0.263	0.650	1.601	0.775	1.726
C & 1 (Rate 30 & 35) = 0.12;	0.125	0.125 Off Peak	-0.020	-0.049	0.105	0.076	-0.031	-0.062	0.094	0.063	0.000	0.000	0.000	0.000
Desidential (Date 1 & 5)	0 122	Peak	0.655	1.614	0.778	1.736	0.071	0.142	0.193	0.265	0.655	1.614	0.777	1.736
Kesidential (Kate 1 & 3)	0.122	Off Peak	-0.015	-0.036	0.108	0.086	-0.029	-0.058	0.093	0.065	0.000	0.000	0.000	0.000

PWEP Rates- Generation Component

Notes:

[1] Total Tariff Rate is the sum of generation service tariff rate and FMCC generation charge (\$/kWh). The values shown in the table are for June 2009.

[2] "Delta to Tariff" columns represents the adjustments that should be made to the total tariff rates to obtain the "generation service" component of the pilot program rates. PTP, PTR, and TOU rates shown in this table exclude non-generation charges. In other words, these rates are not all-in rates.

We calculated all-in rates by summing up the "generation" and "non-generation" components of the rates

We calculated the all-in rates following the steps below:

- Identify the generation (and also time-varying) component of the rates
- Identify the non-generation component (i.e., customer charges, distribution, transmission, renewable charge, etc.)
- Sum up generation and non-generation components to come up with the all-in rate

Note that under the PTR rate design, consumption has a cost equal to the current rate plus the foregone rebate amount, which represents the same opportunity cost to the customer as the CPP rate design

PWEP All-in Rates (\$/kWh)- *Residential*

	June	Rate 1 July-August	R June	ate 5 July-August	Weighted Average
Control	0.201	0.201	0.202	0.202	0.201
TOU_HI_PEAK	0.344	0.343	0.344	0.344	0.343
TOU_HI_OPEAK	0.144	0.143	0.144	0.144	0.143
TOU_LO_PEAK	0.273	0.272	0.273	0.273	0.272
TOU_LO_OPEAK	0.173	0.172	0.173	0.173	0.172
PTP_HI_PEAK	1.815	1.814	1.815	1.816	1.815
PTP_HI_OPEAK	0.165	0.164	0.165	0.166	0.165
PTP_LO_PEAK	0.857	0.856	0.857	0.857	0.856
PTP_LO_OPEAK	0.187	0.186	0.187	0.187	0.186
PTR_HI_PEAK	1.815	1.815	1.816	1.816	1.815
PTR_HI_OPEAK	0.201	0.201	0.202	0.202	0.201
PTR_LO_PEAK	0.856	0.856	0.857	0.857	0.856
PTR_LO_OPEAK	0.201	0.201	0.202	0.202	0.201

All-in Residential Rates - NU

Note: Rates are shown for the customers who purchase their power from NU. For customers purchasing their power from 3rd party suppliers, generation charges are 10% lower on average.

Residential TOU All-in Rate (Rate 1)



Residential PTP All-in Rate (Rate 1)



Residential PTR All-in Rate (Rate 1)



PWEP All-in Rates (\$/kWh)- Small C&I

	R June	ate 30 July-August	R: June	ate 35 July-August	Weighted Average
Control	0.203	0.205	0.180	0.181	0.203
TOU_HI_PEAK	0.341	0.342	0.318	0.319	0.341
TOU_HI_OPEAK	0.141	0.142	0.118	0.119	0.141
TOU_LO_PEAK	0.272	0.274	0.249	0.250	0.272
TOU_LO_OPEAK	0.172	0.174	0.149	0.150	0.172
PTP_HI_PEAK	1.805	1.806	1.781	1.782	1.804
PTP_HI_OPEAK	0.155	0.156	0.131	0.132	0.154
PTP_LO_PEAK	0.853	0.855	0.830	0.831	0.853
PTP_LO_OPEAK	0.183	0.185	0.160	0.161	0.183
PTR_HI_PEAK	1.804	1.806	1.781	1.782	1.804
PTR_HI_OPEAK	0.203	0.205	0.180	0.181	0.203
PTR_LO_PEAK	0.853	0.855	0.830	0.831	0.853
PTR_LO_OPEAK	0.203	0.205	0.180	0.181	0.203

All-in Commercial Rates - NU

Note: Rates are shown for the customers who purchase their power from NU. For customers purchasing their power from 3rd party suppliers, generation charges are 10% lower on average.

Small C&I TOU All-in Rate (Rate 30)



Small C&I PTP All-in Rate (Rate 30)



Small C&I PTR All-in Rate (Rate 30)



Estimation of Demand Equations

In order to predict consumption under new rate designs, we estimate a constant elasticity of substitution (CES) demand system that consists of two equations:

- Substitution Equation models changes in load shape caused by changing peak-to-off peak prices
- Daily Equation models changes in daily average consumption caused by changing daily prices

Using elasticities estimated by this system of two equations, we predict consumption by rate period

We employ fixed effects estimation method to estimate the parameters of the substitution equation

Fixed effects estimation is equivalent to a regression in which each customer has an individual dummy variable that controls for the time invariant characteristics of that customer (e.g., some are larger users and some are smaller users)

 R-squared values from fixed effects models are inherently smaller than those from an equivalent dummy variable regression as fixed effects estimation only represents the amount of time variation in the dependent variable that is explained by the time variation in the explanatory variables

Specification of the Substitution Equation (Presented for the PTP/PTR customers; TOU model is similar)

$$\ln\left(\frac{Peak_kWh}{OffPeak_kWh}\right)_{s} = \alpha_{0} + \alpha_{i}THI_DIFF_{s} + \alpha_{2} \ln\left(\frac{Peak_Price}{OffPeak_Price}\right)_{s} xTHI_DIFF_{s} + \alpha_{3} \ln\left(\frac{Peak_Price}{OffPeak_Price}\right)_{s} xTHI_DIFF_{s} xPTR + \alpha_{4} \ln\left(\frac{Peak_Price}{OffPeak_Price}\right)_{s} xTHI_DIFF_{s} xORB + \alpha_{5} \ln\left(\frac{Peak_Price}{OffPeak_Price}\right)_{s} THI_DIFF_{s} xORB + \alpha_{5} \ln\left(\frac{Peak_Price}{OffPeak_Price}\right)_{s} THI_DIFF_{s} xDRB + \alpha_{5} \ln\left(\frac{Peak_Price}{OffPeak_Price}\right)_{s} THI_DIFF_{s} xORB + \alpha_{5} \ln\left(\frac{Peak_Price}{OffPeak_Price}\right)_{s} THI_DIFF_{s} xTECH + \sum_{i=0}^{5} \beta_{i} D_Month_{k} + \alpha_{5} D_TreatPeriod_{i} + \alpha_{5} D_TreatPeriod_{i} + \alpha_{5} D_TreatPeriod_{i} TeatCustomer_{i} + \alpha_{5} D_TreatPeriod_{i} TeatCustomer_{i} + \sum_{i=1}^{5} \beta_{i} D_Month_{k} + \alpha_{5} D_WEEKEND + v_{i} + u_{s}$$

$$\ln\left(\frac{Peak_KWh}{OffPeak_KWh}\right)_{s} : \text{Logarithm of the ratio of peak to off-peak load for a given day}$$

$$THI_DIFF_{s} : \text{The difference between peak and off-peak THI. THI is defined as follows: THI=0.55 x Drybulb Temperature + 0.20 x Dewpoint + 17.5$$

$$\ln\left(\frac{Peak_Price}{OffPeak_Frice}\right)xTHI_DIFF_{s} : \text{Interaction of ratio of peak to off-peak prices and THI_DIFF for a given day}$$

$$\ln\left(\frac{Peak_Price}{OffPeak_Frice}\right)xTHI_DIFF_{s} xORB : \text{Interaction of ratio of peak to off-peak prices, THI_DIFF and ORB dummy for a given day}$$

$$\ln\left(\frac{Peak_Price}{OffPeak_Frice}\right)xTHI_DIFF_{s} xORB : \text{Interaction of ratio of peak to off-peak prices, THI_DIFF and ORB dummy for a given day}$$

$$\ln\left(\frac{Peak_Price}{OffPeak_Frice}\right)xTHI_DIFF_{s} xORB : \text{Interaction of ratio of peak to off-peak prices, THI_DIFF and ORB dummy for a given day}$$

$$\ln\left(\frac{Peak_Price}{OffPeak_Frice}\right)xTHI_DIFF_{s} xORB : \text{Interaction of ratio of peak to off-peak prices, THI_DIFF and ORB dummy for a given day}$$

$$\ln\left(\frac{Peak_Price}{OffPeak_Frice}\right)xTHI_DIFF_{s} xORB : \text{Interaction of ratio of peak to off-peak prices, THI_DIFF and TECH dummy for a given day}$$

$$\ln\left(\frac{Peak_Price}{OffPeak_Frice}\right)xTHI_DIFF_{s} xORB : \text{Interaction of ratio of peak to off-peak prices}, THI_DIFF and ORB dummy for a given day}$$

$$D_TreatPeriod :Dummy variable$$

Specification of the Daily Equation (Presented for the PTP/PTR customers; TOU model is similar)

 $\ln(kWh)_{i_{l}} = \alpha_{0} + \alpha_{1}\ln(THI)_{i_{k}} + \alpha_{2}\ln(\operatorname{Price})_{i_{l}}x\ln(THI)_{i_{k}} + \alpha_{3}\ln(\operatorname{Price})_{i_{l}}x\ln(THI)_{i_{l}}xPTR + \alpha_{4}\ln(\operatorname{Price})_{i_{l}}x\ln(THI)_{i_{l}}xORB + \alpha_{5}\ln(\operatorname{Price})_{i_{k}}x\ln(THI)_{i_{k}}xTECH + \sum_{k=1}^{6}\delta_{k}(\ln(THI)xD_Month_{k})_{i_{k}} + \alpha_{6}D_TreatPeriod_{i} + \alpha_{7}D_TreatCustomer_{i} + \alpha_{8}D_TreatPeriodxTreatCustomer_{i_{l}} + \sum_{k=1}^{6}\beta_{k}D_Month_{k} + \alpha_{9}D_WEEKEND + v_{i} + u_{i_{k}}$

$\ln(kWh)_{ii}$: Logarithm of the daily average of the hourly load
$\ln(THI)_{ii}$: Logarithm of the daily average of the hourly THI
$\ln(\operatorname{Pr}ice)_{ii} x \ln(THI)_{ii}$: Interaction of price with ln (THI)
$\ln(\operatorname{Pr}ice)_{ii} x \ln(THI)_{ii} x PTR$:Interaction of ln (Price), ln (THI) and PTR dummy for a given day
$\ln(\operatorname{Pr}ice)_{ii} x \ln(THI)_{ii} x ORB$:Interaction of ln (Price), ln (THI) and ORB dummy for a given day
$\ln(\Pr{ice})_{i_i} x \ln(THI)_{i_i} xTECH$:Interaction of ln (Price), ln (THI) and TECH dummy for a given day
$\ln(THI)xD_Month$: Interaction of ln (THI) variable with monthly dummies
D_TreatCustomer	: Dummy variable is equal to 1 when the customer is a treatment customer
D_TreatPeriod	: Dummy variable is equal to 1 when the period is June 2008 through August 31, 2008
$D_TreatPeriodxTreatCustomer$: Interaction of <i>D_TreatPeriod</i> with treatment customer dummy
D_Month_k	: Dummy variable that is equal to 1 when the month is k
D_WEEKEND	: Dummy variable that is equal to 1 on weekends

We also compared treatment and control group customers in terms of their responses to the enrollment survey questions

Evidence from enrollment surveys is limited by the number of treatment and control customers who did not respond to the surveys

- Residential treatment and control group customers are comparable to each other in terms of their answers for most of the questions covered in the survey (i.e., CAC ownership, income and education of the household, etc.)
- Commercial treatment and control group customers are not comparable to each other for most of the questions covered in the survey
A1: Do you plan to remain at this location through August 31, 2009?



Mean Comparison Test - Question A1

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Co	nf. Interval]
Control	121	2.000	0.000	0.000	2.000	2.000
Treatment	1085	1.987	0.003	0.113	1.980	1.994
Combined	1206	1.988	0.003	0.107	1.982	1.994
Δ		0.013	0.010		-0.007	0.033
$\Delta = \text{mean} (Co H0: \Delta = 0, \Box$	ontrol) - me HA: Δ≠0	an Treatment	.)	Pr(T > t) = Outcome : Do	0.209 Not Reject	t = 1.257 H0

A2: Does customer have central air conditioning within their home? (This does not include window units)



Mean Comparison Test - Question A2

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Co	nf. Interval]
Control	121	1.430	0.045	0.497	1.340	1.519
Treatment	1072	1.432	0.015	0.496	1.402	1.462
Combined	1193	1.432	0.014	0.496	1.404	1.460
Δ		-0.002	0.048		-0.095	0.091
$\Delta = \text{mean (C}$ H0: $\Delta = 0$,	ontrol) - me HA: ∆ ≠ 0	an Treatment		Pr(T > t) = Outcome : Do	0.964 Not Reject	t = -0.045 H0

A3: Does customer own or rent their home?



Mean Comparison Test - Question A3

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Co	nf. Interval]
Control	120	1.950	0.020	0.219	1.910	1.990
Treatment	463	1.765	0.020	0.425	1.726	1.803
Combined	583	1.803	0.016	0.398	1.770	1.835
Δ		0.185	0.040		0.107	0.264
$\Delta = \text{mean} (Co H0: \Delta = 0, \Box$	ontrol) - me HA: ∆ ≠ 0	an Treatment	t)	Pr(T > t) = Outcome : Re	0.000 ject H0	t = 4.624

801: How many square feet of living space is there in the customers' home, including bathrooms, foyers and hallways?



Mean Comparison Test - Question 801

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Co	nf. Interval]
Control	121	1.967	0.082	0.903	1.804	2.129
Treatment	668	2.377	0.060	1.543	2.260	2.495
Combined	789	2.314	0.052	1.471	2.212	2.417
Δ		-0.410	0.145		-0.694	-0.126
$\Delta = \text{mean (Control)} - \text{mean Treatment)}$ H0: $\Delta = 0$, HA: $\Delta \neq 0$)	Pr(T > t) = Outcome : Re	0.005 ject H0	t = -2.837

802: How would you rate your home as being a "green home"?



Mean Comparison Test - Question 802

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Co	nf. Interval]
Control	120	1.175	0.063	0.694	1.050	1.300
Treatment	668	1.034	0.033	0.848	0.970	1.099
Combined	788	1.056	0.029	0.828	0.998	1.114
Δ		0.141	0.082		-0.020	0.302
$\Delta = \text{mean (Column 1)}$ H0: $\Delta = 0$,	ontrol) - me HA: ∆ ≠ 0	an Treatment)	Pr(T > t) = Outcome : Do	0.087 Not Reject	t = 1.714 H0

803: What was the highest level of education completed by the head of household in the customers' home?



Mean Comparison Test - Question 803

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Co	nf. Interval]
Control	121	4.694	0.126	1.383	4.445	4.943
Treatment	668	4.716	0.057	1.464	4.604	4.827
Combined	789	4.712	0.052	1.451	4.611	4.814
Δ		-0.021	0.143		-0.303	0.260
$\Delta = \text{mean} (C)$ H0: $\Delta = 0$,	ontrol) - me HA: ∆ ≠ 0	an Treatment)	Pr(T > t) = Outcome: Do	0.882 Not Reject	t = -0.149 H0

804: Please check the range that best describes the household's total annual income?



Mean Comparison Test - Question 804

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Co	nf. Interval]
Control	121	2.636	0.130	1.432	2.379	2.894
Treatment	667	2.672	0.062	1.609	2.549	2.794
Combined	788	2.666	0.056	1.583	2.556	2.777
Δ		-0.035	0.156		-0.342	0.272
Δ = mean (Control) - mean Treatment) H0: Δ = 0, HA: $\Delta \neq$ 0)	Pr(T > t) = Outcome: Do	0.822 Not Reject	t = -0.226 H0

Distribution of Missing Responses: Control vs Treatment





A1: Do you plan to remain at this location through August 31, 2009?



Mean Comparison Test - Question A1

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Con	f. Interval]
Control	36	2.000	0.000	0.000	2.000	2.000
Treatment	1168	2.000	0.000	0.000	2.000	2.000
Combined	1204	2.000	0.000	0.000	2.000	2.000
Δ		0.000	0.000		0.000	0.000
$\Delta = \text{mean} (\text{Control})$ H0: $\Delta = 0$, H	ntrol) - mear IA: ∆ ≠ 0	n Treatment)		Pr(T > t) = Outcome : Do	Not Reject I	t = H0

A2: Do you have central air conditioning within the space that your business occupies?



Mean Comparison Test - Question A2

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Co	nf. Interval]
Control	36	1.889	0.053	0.319	1.781	1.997
Treatment	1168	1.677	0.014	0.468	1.650	1.704
Combined	1204	1.684	0.013	0.465	1.657	1.710
Δ		0.212	0.079		0.058	0.366
$\Delta = \text{mean (ConH0: } \Delta = 0, H$	$htrol) - mean (A: \Delta \neq 0$	Treatment)		Pr(T > t) = Outcome : Re	= 0.007 eject H0	t = 2.695

A3: Is the central air conditioning system controlled by a Building Automation System or an Energy Management System (a computerized or automated system which controls temperature within the building)?



Mean Comparison Test - Question A3

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Co	nf. Interval]
Control	31	1.419	0.090	0.502	1.235	1.603
Treatment	586	1.328	0.019	0.470	1.290	1.366
Combined	617	1.332	0.019	0.471	1.295	1.370
Δ		0.092	0.087		-0.079	0.262
$\Delta = \text{mean} (\text{Co} \\ \text{H0: } \Delta = 0, \text{ H}$	ntrol) - mear IA: ∆ ≠ 0	Treatment)		Pr(T > t) = Outcome: De	= 0.292 o Not Reject	t = 1.056 t H0

A4: Is the customer participating in another demand response program? (A demand response program is a program that offers incentives to customers for reducing electricity use when demand is high)



Mean Comparison	Test -	Question A4
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Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Co	nf. Interval]
Control	28	1.179	0.074	0.390	1.027	1.330
Treatment	409	1.027	0.008	0.162	1.011	1.043
Combined	437	1.037	0.009	0.188	1.019	1.054
Δ		0.152	0.036		0.081	0.223
$\Delta = \text{mean} (\text{Co} \\ \text{H0: } \Delta = 0, \text{ H}$	ntrol) - mear IA: ∆ ≠ 0	n Treatment)		Pr(T > t) = Outcome : Re	= 0.000 eject H0	t = 4.208

802: What is the square footage of the space that your business occupies at this location?



Mean Comparison Test - Question 802

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
Control	36	3.056	0.195	1.170	2.660	3.451
Treatment	895	2.370	0.039	1.176	2.293	2.447
Combined	931	2.396	0.039	1.183	2.320	2.472
Δ		0.686	0.200		0.293	1.078
Δ = mean (Control) - mean Treatment) H0: Δ = 0, HA: $\Delta \neq 0$				Pr(T > t) = Outcome : Re	t = 3.431	

806: How would you regard your business as a green business?



Mean Comparison Test - Question 806

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
Control	36	0.944	0.149	0.893	0.642	1.246
Treatment	1168	1.195	0.025	0.853	1.146	1.244
Combined	1204	1.188	0.025	0.855	1.139	1.236
Δ		-0.251	0.145		-0.534	0.033
$\Delta = \text{mean (Control)} - \text{mean Treatment)}$ H0: $\Delta = 0$, HA: $\Delta \neq 0$			Pr(T > t) = 0.083 $t = -1.7Outcome: Do Not Reject H0$			

807: Please check the range that best describes the total annual revenue for this business



Mean Comparison Test - Question 807

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
Control	36	4.722	0.404	2.421	3.903	5.542
Treatment	1168	4.518	0.074	2.528	4.373	4.663
Combined	1204	4.524	0.073	2.524	4.381	4.667
Δ		0.204	0.427		-0.634	1.042
$\Delta = \text{mean (Control)} - \text{mean Treatment)}$ H0: $\Delta = 0$, HA: $\Delta \neq 0$			Pr(T > t) = 0.633 Outcome : Do Not Reject		t = 0.478 t H0	

Distribution of Missing Responses: Control vs. Treatment

