PowerCentsDC™ Program
Final Report

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Prepared by eMeter Strategic Consulting for the Smart Meter Pilot Program, Inc.

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Chris King
Program Manager
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Executive Summary

Background and Unique Nature of the PowerCentsDC Program

In 2007, the Smart Meter Pilot Program, Inc. (SMPPI) initiated PowerCentsDC to test the reactions and impacts on consumer behavior of smart prices, smart meters, and smart thermostats in the District of Columbia. In July 2008, nearly 900 residential customers across the District began receiving electricity with one of three price plans for supply service: Critical Peak Pricing (CPP), Critical Peak Rebate (CPR), or Hourly Pricing (HP). Each customer received a smart meter that records power usage every hour, and those with a central air conditioner were offered a smart thermostat that automatically reduces air conditioning usage when power prices are high.

The PowerCentsDC program is unique among dynamic pricing pilots for several reasons:

- It was designed and is governed by a diverse group of stakeholders;
- It was conceived by the jurisdiction's statutory consumer advocate and funded by electric utility shareholders;
- It tested the response of residential consumers to three different pricing structures and multiple energy information feedback channels in one jurisdiction; and
- Customers with limited-income were specifically recruited to test their responsiveness to dynamic pricing.

Final Report

This final report covers the design, operation, and analysis of the summers of 2008 and 2009 and winter of 2008-9.[1] Data collection began in spring 2008 and continued through the final customer survey in February 2010. Participants enrolled in PowerCentsDC price plans were billed on those prices from July 2008 through October 2009. This report contains the following information:

- The response of customers to recruitment for participation in the program;
- The extent to which each dynamic pricing plan induced a reduction in peak demand; and
- Consumer attitudes toward dynamic pricing and receiving detailed energy information.

The program's ambitious goals included assessing the response of different subgroups to three types of dynamic prices (Exhibit 1) for both regular and all-electric customers; analyzing differences for households with smart thermostats; determining whether consumers would participate in the program, how much they would reduce peak demand, and how much money they would save; and determining the same results for consumers with limited income.

[1] - The Interim Report covered the summer of 2008 and winter of 2008-9: http://www.powercentsdc.org/ESC%2009-11-02%20PCDC%20Interim%20Report%20FINAL.pdf

Dynamic Prices

Critical peak pricing charges different prices for the 60 or so hours of the year when the electricity system is stressed and/or energy market prices are high. For PowerCentsDC, critical peak events lasted four hours and were declared 15 days per year, 3 in winter and 12 in summer[2]. CPP and CPR participants were notified by telephone, email or text messages the evening before each event. HP participants paid prices based on wholesale market prices and were notified before any day in which prices exceeded a high-price threshold.

Price Plan	Description	Example Prices per kWh	High Price/Rebate Event Hours
CPP	Slight discount during 8700 hours per year; much higher price during critical peaks (60 hours per year)	Critical peak: about 75¢; most times: 10.9¢	2 pm-6 pm summer weekdays (12 events per summer); 6 am-8 am and 6 pm-8 pm winter weekdays (3 events per winter)
CPR	Rebates earned for reduction below baseline during critical peaks	Rebate: about -75¢; most times: 11¢	Same as for CPP
HP	Prices change hourly, following wholesale prices	Range from 1¢ to 37¢	High prices typically occur on summer weekday afternoons and winter mornings/evenings

Exhibit 1: Description of PowerCentsDC prices that include both discounts and premium prices.

Customer Participation

Candidate participants were randomly selected across the District to allow participation by all wards. Each randomly selected customer received an offer to participate in a single, pre-assigned price plan: CPP, CPR, or HP. About 900 customers volunteered, with an average response of 6.6%; those with limited income responded at a rate of 7.6%. About 400 smart meters were installed on randomly selected non-participants to provide a control group.

Operations

Prior to live billing under PowerCentsDC prices, participants received an education package, including a pricing leaflet, conservation brochure, and refrigerator magnet displaying the critical peak hours and contact information. Upon commencement of the program, participants began to receive new bills, along with monthly graphical Electric Usage Reports displaying daily usage by price and informational inserts.

Demand Response Results

Professor Frank Wolak of Stanford University performed the analysis. Peak demand reductions were determined by comparing the treatment group of participants with the control group of customers remaining on existing Standard Offer Service (SOS) prices. Only results with a confidence level of 90% or greater are included in this report. The results are summarized below, with detailed results shown in Appendix B, including confidence levels.

[2] - There were only six event days in the shortened summer of 2008.

The results reported here are for the entire program and thus overlap with results previously reported in the Interim Report. Some peak demand reductions reported here differ from those in the Interim Report, though generally not materially. Two reasons account for the differences. First, the final analysis necessarily utilized a larger dataset, with 16 months of data rather than the 8 months of data used for the Interim Report. Second, the final report included more thorough preparation of the data prior to analysis, mainly through an audit process to verify and validate data used for each individual bill and participant in the program.

The winter data for customers with smart thermostats was excluded, because the thermostats "cycled" heat pumps, with the unexpected result of increasing consumption. This can be corrected through different programming of the thermostats.

Peak Reduction by Pricing Plan and Customer Type

The results show that consumers reduce peak summer electricity demand consistently when given a price signal. The statistically valid peak reductions by price plan are shown below in Exhibit 2. The lower reductions for HP may be explained by two factors: the high prices were not as high as for CPP or as the rebate for CPR, and the HP customers had declining average prices over time, due to changes in market conditions.

Price Plan	Peak Reduction – Summer	Peak Reduction – Winter
CPP	34%	13%
CPR	13%	5%
HP	4%	2%

Exhibit 2: Average peak reductions during critical peak events; population weighted average.

Customers with Limited Income

Customers with limited-income participated only in the CPR plan. A comparison of their peak demand reductions to those of other customers on the CPR price plan shows only a slight difference between the two groups, on average, as seen in Exhibit 3. Preliminary results for summer 2008 showed customers with limited-incomehaving a greater peak reduction than other customers, but this was not borne out in the complete dataset. [3]

Price Plan	Regular Income Customers	Customers with Limited Income
CPR	13%	11%

Exhibit 3: Customers with limited income exhibited similar average peak reductions.

Effect of Higher Temperatures

Higher summer temperatures resulted in greater peak demand reductions for CPP and CPR participants, with estimated peak demand reductions shown in Exhibit 4.

[3] - For details see Wolak, Frank. *An Experimental Comparison of Critical Peak and Hourly Pricing: the PowerCentsDC Program,* Preliminary Draft, March 13, 2010.

Price Plan	Peak Reduction	
	At 85°F	At 97°F
CPP	26%	43%
CPR	8%	20%
HP	3%	3%

Exhibit 4: Most peak demand reductions INCREASE as temperatures go up.

Smart Thermostats – Summer

PowerCentsDC participants with smart thermostats had the benefit of automatic responses to summer critical peak events, provided their air conditioner was operating at the time of the critical peak event. This automated response significantly increased summer demand reductions for CPP and CPR participants.

	No Smart Thermostat			With Smart Thermostat		
Customer Type	CPP	CPR	HP	CPP	CPR	HP
Regular (R)	29%	11%	(n/s)	49%	17%	10%
All Electric (AE)	22%	6%	10%	51%	24%	-2%

Exhibit 5: Peak reductions during summer events for customers without and with smart thermostats. Results not statistically valid at the 90% level are denoted by "n/s"; most results are valid at the 99% level. Appendix B provides the detailed significance level for each result presented in the report.

Customer Bill Impacts

PowerCentsDC smart prices were designed to be revenue neutral; therefore, on average, customers that did not change their behavior would pay the same amount as under SOS, and any bill savings would be the result of load shifting. However, for HP participants, wholesale prices fell due to the 2008 economic downturn, increasing HP participants' savings. These savings resulted from these participants taking the risk of paying hourly pricing set in wholesale markets.

The prices were designed to be revenue neutral over 12 months. Over 12 months, CPP and CPR participants saved an average of 3.4% monthly on their electric bills, or $3.44 per month compared to Standard Offer Service. Over 91% of CPP and CPR participants paid less on the smart prices, with 80% having bills between 10% less and 0% less on PowerCentsDC prices. All HP participants saved on the program.

Price Group	Average Bill SOS	Average Bill PowerCentsDC	Dollar Savings	Percent Savings
CPP	$101.26	$99.70	$1.56	2%
CPR	$99.66	$95.07	$4.59	5%
HP	$110.44	$77.42	$43.02	39%

Exhibit 6: Over 91% of CPP and CPR participants saved on PowerCentsDC prices.

Focus Groups

Prior to recruitment of participants, focus groups were conducted to assess consumer preferences. Most focus group attendees liked the smart price concepts, strongly preferring

the critical peak rebate price plan for its simplicity and no-risk aspects. They also liked having the program approved by the Public Service Commission.

Customer Surveys

Following completion of the collection of billing data in November 2009, both participants and control customers were surveyed. The detailed results are provided in Appendices C and D. Some highlights were as follows:

- Over 74% of participants were satisfied with the program, and only 6% were dissatisfied;
- Over 93% of participants who expressed a preference preferred PowerCentsDC pricing over Pepco's default Standard Offer Service pricing;
- About 89% of participants would recommend PowerCentsDC to their friends and family;
- The main motivation for participation was saving money (73%), followed by reducing emissions (34%), exploring Smart Grids (33%), and assisting policymakers (32%); and
- Participants' most common peak demand reduction measure was avoiding use of appliances (60%), with nearly as many reducing air conditioning consumption (59%).

Control customers were surveyed as well. They were asked their preferences for receiving energy usage, cost, and emissions information. The results are shown in Exhibit 7.

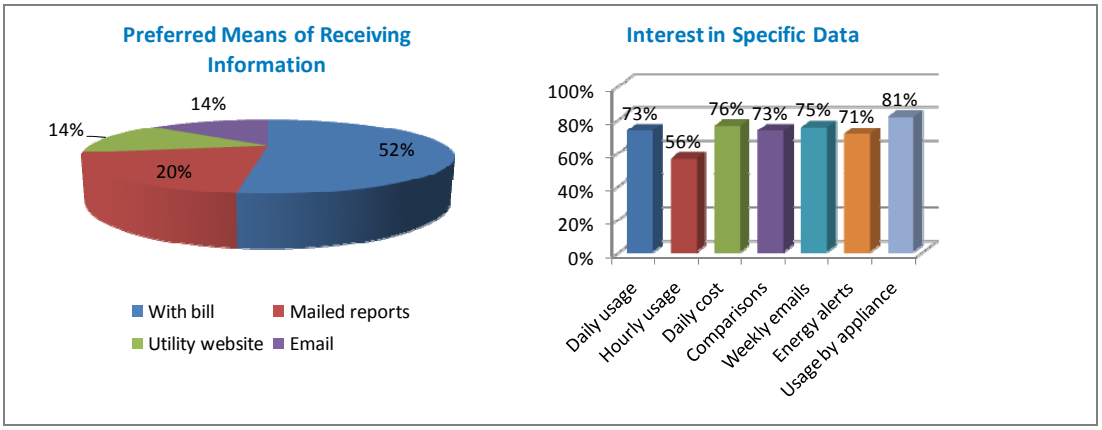

Exhibit 7: Almost 86% of survey respondents preferred to receive their data via mail or email.

Conclusions

The results of PowerCentsDC suggest the following:

- Consistent with other pilots, PowerCentsDC showed that consumers reduced summer peak usage in response to dynamic prices, energy information, and automated control;
- CPP prices led to the greatest peak demand reductions;
- CPR prices were most popular;
- Customers with limited-income customers signed up at higher rates than others, reduced peak very slightly less than others, and saved money on the program;
- Summer peak reductions were greater than winter, implying more discretionary load;
- Automated response via smart thermostats increased the reduction; and
- The vast majority of participants saved money, even with revenue neutral prices.

1 Introduction

This report summarizes the design, operation and outcomes of the PowerCentsDC pilot program undertaken by the Smart Meter Pilot Program, Inc. (SMPPI). PowerCentsDC tested the reactions and impacts on consumer behavior of three different smart prices:

- Critical Peak Prices (CPP[4])
- Critical Peak Rebates (CPR[5])
- Hourly Prices (HP)

The pilot was initiated in mid-2007 with customer recruitment, and recruited participants were placed on the smart prices in mid-2008. Data collection began in spring 2008 and continued through the final customer survey in February 2010. Participants enrolled in the PowerCentsDC price plans were billed on those prices from July 2008 through October 2009.

Outcomes were measured through the quantitative analysis of demand response. Preliminary qualitative feedback was garnered from focus groups conducted prior to the start of program billing.

1.1 Background

In the PJM[6] Region of the United States, as in other organized electricity markets, wholesale electricity prices vary each hour as electricity supply and demand conditions change. When temperatures are very high or very low, power use increases significantly as electricity consumption for cooling or electric heating increases. During these times, power supplies may be limited, thereby increasing wholesale market electric prices. Unexpected generation, transmission, and distribution equipment failure may constrain energy supply at any time, thereby driving prices up. Additionally, markets such as PJM have separate market structures for capacity with values for demand response or generation resources that are available to meet peak demand.

PowerCentsDC provided consumers with electricity pricing plans based on changing wholesale costs that enabled consumers to save money by altering their consumption of electricity. Conventional electric meters do not provide customers with all the information needed to effectively manage their consumption. Conventional meters record only total consumption, much like a car's odometer records total miles. Such meters do not record the time at which electricity is used, so the price of electricity to consumers with such meters cannot reflect the variations in wholesale prices. If the electric rates paid by consumers were to reflect the fact that wholesale electricity market prices vary, then

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[4] - Critical Peak Prices are also known as Peak Day Prices.

[5] - Critical Peak Rebates are also known as Peak Time Rebates.

[6] - PJM is short for PJM Interconnection, the regional wholesale market serving all or parts of 13 states and the District of Columbia, including Illinois, Pennsylvania, New Jersey, and Maryland.

consumers could choose to reduce consumption during the highest cost hours and potentially lessen their electricity bills accordingly.

Importantly, simple dynamic rates, such as CPP and CPR prices, are an effective means of reflecting wholesale prices. There is no need for hourly prices to have effective dynamic rates, though hourly prices may be attractive on a voluntary basis to some customers.

PowerCentsDC is an advanced or "smart" metering project through which selected District of Columbia residential customers in all eight wards have been provided the opportunity to control their electric bills and potentially save money. It is sponsored by Smart Meter Pilot Program, Inc. (SMPPI), a non-profit corporation created through a Pepco merger settlement agreement and approved by the District of Columbia Public Service Commission on May 1, 2002. Under the terms of the Settlement Agreement, Pepco agreed to contribute $2 million in shareholder funds to fund a smart meter pilot program in the District of Columbia.

As a result of the settlement agreement, SMPPI was formed to implement and administer PowerCentsDC. The SMPPI Board includes representatives from the District of Columbia Office of the People's Counsel (OPC), the District of Columbia Public Service Commission (PSC), the District of Columbia Consumer Utility Board (CUB), the International Brotherhood of Electrical Workers Local 1900 (IBEW), and the Potomac Electric Power Company (Pepco).

1.2 Project Summary

The PowerCentsDC project was the first program in the electric utility industry to test the response of residential customers to three different innovative pricing plans under one program: Hourly Pricing, Critical Peak Pricing, and Critical Peak Rebate (also known as Peak-Time Rebate). Through these pricing plans, customers may save on their bills by reducing electricity use when their prices are high. These times are known as "critical peak hours" (under the project, 60 hours each year) and "critical peak days" (15 per year). Customer changes in electricity demand during these times are known as "demand response." PowerCentsDC combined this innovative pricing with innovative consumer energy information feedback and automated, "smart" air conditioner control.

While customer participation was voluntary, the project design was carefully developed to ensure that the evaluated results are statistically representative. To facilitate a statistically valid analysis, for rate design purposes, and to avoid interference with the competitive retail supply market, participation was limited to customers receiving Standard Offer Service (SOS) from Pepco.

Participating customers received a free special "smart meter" installation for their home, which measures the customer's electricity use at hourly intervals and sends the data wirelessly to a third party billing vendor.[7] The vendor used these data to calculate

[7] - The meter selected by SMPPI also has the capability of providing other system benefits such as remote meter reading, outage detection and voltage monitoring information, but was not used for these purposes in the pilot program.

customers' bills based on the PowerCentsDC tariff and to provide participants with a report, mailed with their bill each month, depicting their electricity consumption during the month.

About a third of the project participants – those with central air conditioning that wanted one – received a free "smart thermostat" that reduced central air conditioner compressor use in response to receipt of a utility radio-controlled signal during high priced periods; provided customer messages; and, when programmed, automatically reduced electricity use of air conditioners or central heating systems during selected hours.

1.3 Pilot Objectives

While strongly emphasizing innovation, PowerCentsDC was also designed to provide pragmatic, actionable results. Specifically, the project was designed to provide statistically valid results that could be extrapolated to the entire District of Columbia residential population.

The project measures five primary items:

1) customer reduction in electricity consumption during peak times;
2) customer changes in overall consumption;
3) customer satisfaction with different pricing plans and technologies;
4) usefulness of the selected technologies; and
5) value of presenting additional pricing information to customers.

Following the project's completion, policymakers will have information to begin assessing the cost-effectiveness of these residential pricing and technology options.

1.4 Other Pricing Pilots

PowerCentsDC is one of several smart meter pilots conducted by utilities across the United States and worldwide. In November 2008, a research article summarized these as follows:

> …this article summarizes the results of several second-wave dynamic pricing experiments that have been carried out in the U.S., Canada, France, and Australia. Our review of these pilots reveals that dynamic electricity pricing programs are effective in reducing electricity usage for residential customers. In general, CPP programs supported with enabling technologies result in the largest reductions in load. However, CPP programs alone (without an enabling technology) also achieve significant reductions in load... the combination of dynamic prices with enabling technologies appears to be the most effective program design for reducing electricity usage during high-priced periods.[8]

However, none of the pilots conducted previously include the comparison of CPP, CPR, and HP in a single residential population; the effect of smart thermostats on these three plans; nor the reaction of customers with limited income to these specific options.

[8] - A. Faruqui and S. Sergici, "Household Response to Dynamic Pricing of Electricity. A Survey of Seventeen Pricing Experiments." November 2008.

2 Price Design

Three different commodity price structures were tested in the PowerCentsDC program:

- Critical Peak Price (CPP)
- Critical Peak Rebate (CPR)
- Hourly Price (HP)

Participant usage on these three price plans was compared with the usage of customers in a fourth "control" group who also had smart meters but remained on Standard Offer Service prices.

The three smart price structures were designed to be as revenue neutral as possible relative to Standard Offer Service. This was defined such that a participant whose electricity use was distributed across the hours in the same way as the average for all residential consumers in the District would pay approximately the same bill on all three plans as on SOS prices in the absence of any change in usage. This revenue neutral approach is the same design used in the California Statewide Pricing Pilot, the Ontario Smart Price Pilot, and the Baltimore Gas and Electric Smart Energy Pricing Pilot. By controlling for total bill amounts prior to demand response to the prices, the revenue neutral design permits a more accurate comparison of the demand response effects associated with the three price plans tested.

The three smart price plans tested in the pilot are described in more detail below.

2.1 Tiered Prices for Control Group

The Pepco residential Standard Offer Service prices in the District of Columbia have two or three tiers, depending on the individual customer's tariff, so that the price per unit increases as a customer uses more electricity. Most customers have two price tiers; some have three. The thresholds at which the prices increase vary by season and customer rate schedule (e.g. R, AE, RAD, and RAD-AE).

One rationale for tiered pricing is to provide a price signal to consumers to conserve.

The table below summarizes the tiered prices, using rounded numbers and not including certain details, such as minimum monthly bills and customer charges. These prices are approximate total prices and include generation, transmission, and distribution charges.

Price Plan	Summary	Tier 1 Size (kWh)	Tier 1 Price per kWh	Tier 2 kWh	Tier 2 Price	Tier 3 kWh	Tier 3 Price
R	Applies to most residential customers	0-400	12.9¢	401+	14.7¢	–	–
AE	Residential customers with electric heating	0-400	12.8¢	401+	14.7¢	–	–
RAD	Customers with limited income	0-400	5.4¢	401+	14.8¢	–	–
RAD-AE	Limited-income with electric heating	0-400	5.4¢	401-700	12.3¢	701+	14.6¢

Exhibit 8: Standard Offer Service prices rounded to nearest tenth of a cent; summer 2008.

2.2 Critical Peak Pricing

Under CPP, customers faced two prices: 1) critical peak prices, and 2) prices for all other hours. Critical peak prices were in effect for four hours on critical peak days, of which there were 15 each year. During the summer (June 1 to September 30), there were 12 critical peak days, and during the winter (November 1 to February 28) there were 3 critical peak days.

The critical peak hours occurred between 2 p.m. to 6 p.m. in the summer and between 6 a.m. to 8 a.m. and between 6 p.m. to 8 p.m. during the winter. Critical peak "events" were called by the project implementation contractor in summer when forecast high temperatures for the next day were at or above a threshold level approved by the SMPPI Board of Directors. In winter, the project implementation team focused on the forecast low temperature for the next day. The summer threshold was 90 degrees and the winter threshold was 18 degrees.

Customers were notified of these events the day before, by 5 p.m., via their choice(s) of an automated phone call, email, text page, and/or smart thermostat notification. Prices during the 60 critical peak hours each year were substantially higher than conventional SOS rates but were offset by lower prices during the remaining 8,700 hours of the year.

The resulting prices are shown below. Summer 2009 prices differed as a result of a change in the SOS price, but the relationship between different price tiers was similar.

Price Plan	Summer Tier 1	Summer Tier 2	Summer Tier 1 Critical Peak	Summer Tier 2 Critical Peak	Winter Tier 1	Winter Tier 2	Winter Tier 1 Critical Peak	Winter Tier 2 Critical Peak
R	12.3¢	14.1¢	77.1¢	78.9¢	11.7¢	12.6¢	72.2¢	73.1¢
AE	12.3¢	14.2¢	75.1¢	76.9¢	11.6¢	12.1¢	70.2¢	70.7¢

Exhibit 9: Critical Peak Prices rounded to nearest tenth of a cent; summer 2008 and winter 2008-9.

The CPP represents about a five-fold increase over the SOS price. Critical peak prices occurred for four hours on critical peak days only.

2.3 Critical Peak Rebate

PowerCentsDC also tested the impacts of a Critical Peak Rebate (CPR) pricing structure (sometimes called Peak Time Rebate). In contrast to the CPP, the CPR provided a refund to participants for reductions below their "baseline" usage during the critical peak hours. The CPR electricity prices were the same as Standard Offer Service prices, so the initial bill amount was exactly the same as an SOS bill. Then, if the customer earned a rebate, that amount was subtracted for purposes of computing the customer's bill. The concept is similar to programs that have been offered to large commercial and industrial customers for many years, known as "curtailable" rate programs.

The rebate was calculated by multiplying the reduced consumption, measured in kilowatt-hours, by the rebate amount per kilowatt-hour. Customer consumption reduction was calculated using the following method: consumption during the critical peak event was subtracted from the customer's baseline consumption (see below); the difference was the consumption reduction.

Also, because the incentive during the critical peak hours consisted of a rebate, there was no adjustment to the SOS price in effect throughout the year. On average, a participant making no change in response to the critical peak events paid the same bill on SOS plus CPR as they did if they were paying only SOS prices.

Like CPP events, Critical Peak rebates were in effect only when critical events were declared (15 per year, comprising 12 summer and 3 winter events).

2.3.1 Baseline Determination

For a participant to receive a rebate, his or her consumption had to be below a baseline. The higher the baseline, the easier it was for a participant to earn a rebate (i.e., use an amount of electricity less than the baseline amount). The baseline methodology was developed by reviewing other baseline methodologies used for other residential CPR programs, as well as baselines used for large commercial consumer curtailable programs. Baseline methods considered were the following:

- PJM: Usage for the same hours in the three highest of the ten previous non-event, non-holiday weekdays; alternative baseline calculations are permissible under the PJM demand response tariff;
- New York Independent System Operator: Five highest of the ten previous non-event, non-holiday weekdays;
- Anaheim Public Utilities: Three highest non-event, non-holiday weekdays in the first half of summer; and
- San Diego Gas & Electric (SDG&E): Average of previous five non-event, non-holiday weekdays.

One consideration for PowerCentsDC was whether there should be a weather adjustment. The team analyzed data for 2005 from a similar Anaheim pilot and determined that, on average, usage by control group consumers during critical peak periods was 23% higher than for the same hours of similar weekdays. In other words, this data showed that the starting point for determining a load reduction should be 23% above the similar-day average, giving the customer a fairer opportunity to earn a rebate. The PowerCentsDC design accounted for this difference through the use of the three highest days in the billing month rather than establishing a weather-based multiplier.

Another consideration was customer ability to manipulate the baseline. Unlike the previous days method, the team recommended a method that would not allow customers to know which days would be used to determine the baseline. .

The result was a baseline that was the average of the three highest non-event usage amounts on similar days (non-holiday weekdays) during the billing month. For example, the baseline for the August billing month (which might be, for example, for August 10 to September 9), was calculated based on the three highest non-event usage amounts for non-holiday weekdays during the August billing month.

2.3.2 CPR Rebates

The resulting CPR rebate amounts are shown below, with minus signs reflecting that the amounts are rebates per kWh. Note that the winter rebate amounts are significantly lower than the summer amounts.

Price Plan	Summer 2008 Critical Peak Rebate per kWh	Winter 2008-9 Critical Peak Rebate per kWh	Summer 2009 Critical Peak Rebate per kWh
R	-66¢	-36¢	-76¢
AE	-67¢	-38¢	-77¢
RAD	-83¢	-53¢	-165¢
RAD-AE	-89¢	-63¢	-165¢

Exhibit 10: Critical Peak Rebates rounded to nearest tenth of a cent; energy prices in effect during all hours were unchanged from SOS prices (see Exhibit 1).

2.4 Critical Peak Trigger

The team considered two approaches for triggering critical peak events. The first was to dispatch based on prices in the PJM wholesale market. This would allow events to occur consistent with the highest wholesale prices. Unfortunately, PJM prices are difficult to predict, and predictability within a range is necessary to ration the 15 annual critical peak event days. To solve this problem, SMPPI used a weather trigger for critical peak events.

A weather trigger is commonly used in such programs. The trigger is calculated based on historical data to determine how many times a particular temperature was exceeded (on the high side in summer, low side in winter). The team reviewed historical data for the past five years and selected temperatures which would be expected to provide an appropriate number of critical peak events in at least four of the past five years. A conservative approach

was taken in selecting the trigger temperatures to balance the need to ration event days, but also to ensure adequate data would be available for analysis.

The trigger temperatures selected were 90°F in summer and 18°F in winter.

2.5 Hourly Pricing

Under HP, electricity prices varied hourly. The prices were set the day ahead, based on the prices in the "day-ahead" wholesale market, which is the regional power market operated by the PJM Interconnection. Prices were posted on the project website, www.PowerCentsDC.org, for access by HP participants and were also available by calling a toll-free number. Prices were displayed in real-time on smart thermostats for those customers who elected to use them. Based on wholesale market trends at the beginning of the program, HP prices were expected to exceed Standard Offer Service prices only about one-third of the time within a year, with lower prices the remainder of the time.

During the actual program, however, rapidly falling wholesale prices caused average prices to fall for PowerCentsDC HP participants and increased their savings significantly. SMPPI adjusted the prices quarterly, so the falling prices were accounted for, but they continued to fall. From an economic perspective, by taking the risk of paying hourly pricing set in the wholesale markets, HP participants enjoyed significant savings as wholesale prices dropped in response to falling oil prices and reduced overall demand for electricity caused by the recession that began in September 2008. Notably, this meant that even without changing consumption patterns, HP participants experienced bill savings.

HP participants were notified when prices are "high," as determined by a threshold approved by the SMPPI Board. The purpose was to enable participants to focus on those few hours when prices are significantly above average. The target was to have notifications for about 15 days a year, to keep the notifications parallel to the critical peak events. The notifications were by voicemail, email, or text message, at the customer's option, and smart thermostats automatically reduced air conditioning load during high price events.

The threshold for high hourly prices for the report period was 23 cents per kWh. In addition, because wholesale prices dropped so much when the recession took effect in September 2008, HP customers were later given "courtesy" notices when hourly prices exceeded 15 cents per kWh. Notifications were given for a total of 22 days between July 2008 and October 2009, compared with 24 critical peak event days.

The distribution of hourly prices from July 2008 to October 2009 is shown below.

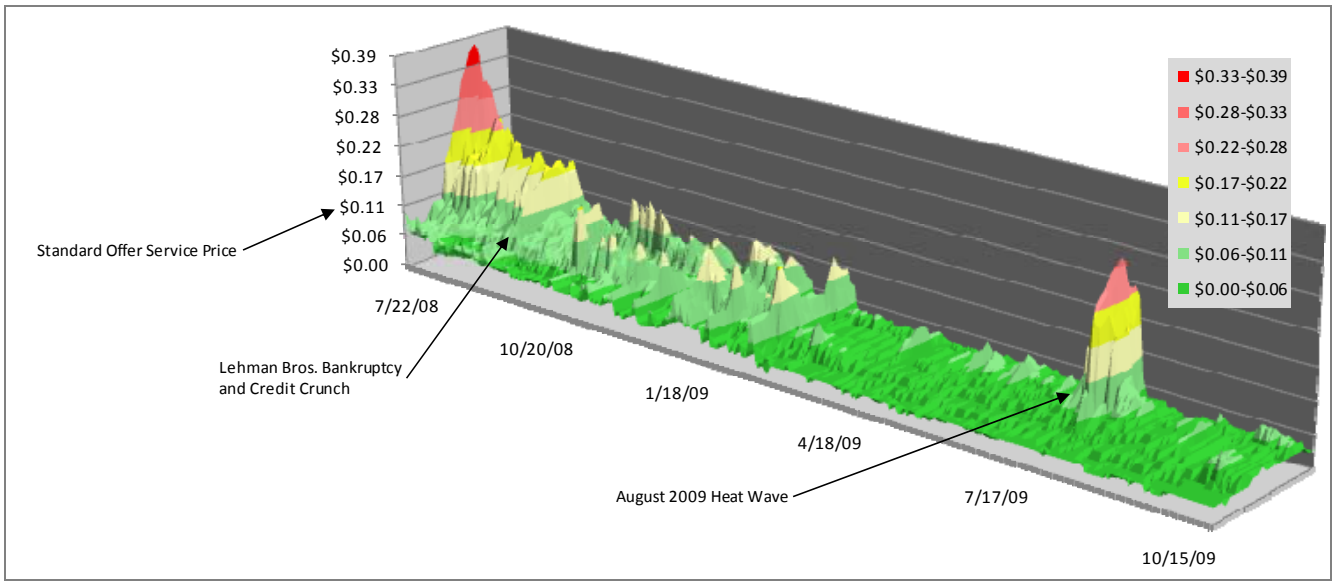


Exhibit 11: Hourly prices for PowerCentsDC HP customers from July 2008 to October 2009 followed PJM wholesale prices; during hours in green, HP prices were lower than SOS prices.

The observed drop in wholesale and, thus, HP customer prices made it difficult to evaluate customer response to the HP prices. HP prices are already more difficult, because they change every hour, creating complexity in the analysis. The falling prices reduce customer bills, which lowers the incentive to reduce peak load as well. These complexities explain in large part the difficulty of determining statistically valid load responses in the HP customer group.

3 Participant Population

The basic concept of the PowerCentsDC program was to have two groups of customers: participants and control customers. Invited voluntary participants were placed on a pre-assigned smart price plan, received a smart meter, and were offered a smart thermostat if they had central air conditioning. Control customers received a smart meter and were treated in the same way that Pepco customers generally were treated; these customers remained on their current SOS price and continued using electricity as they would normally. Electricity consumption for the two groups was compared using standard statistical techniques, by an independent outside expert, to determine the effects of the tariffs and equipment on electricity consumption of participants.

3.1 Customer Participation

All treatment and control participants were Standard Offer Service consumers.

3.1.1 Treatment Group

Candidate participants were randomly selected from all eight wards of the District of Columbia. Participants were recruited for the three treatment pricing plans:

- Critical Peak Pricing (CPP)
- Critical Peak Rebate (CPR)
- Hourly Pricing (HP)

Participants were segregated by price structure. The participants were recruited independently and were not informed of the price plans offered to other customers. There were four customer types in the program: residential (R), all-electric (AE), residential aid discount (RAD) for customers with limited-income residential aid discount all-electric (RAD-AE) for customers with limited income. Participants were recruited at random, with additional participants recruited in the RAD, and RAD-AE groups to obtain sample sizes that would be sufficiently large to be statistically valid.

Recruitment was undertaken via direct mail, using a letter branded by PowerCentsDC. The initial letter notified customers that they "have been selected as a participant." However, customers were not included in the pilot unless they returned the confirmation form included in the recruitment mailing. One reason confirmation was needed was to provide the correct telephone number or email address for critical peak event notifications.

3.1.2 Control Group

The control group was selected randomly from the residential population of the District of Columbia served by Standard Offer Service and paying SOS prices. Control customers were not aware of the program and received neither notifications nor any other information about the program (other than what they might see in the press or by visiting the website).

3.2 Recruitment Results

Candidate participants were randomly selected across the District of Columbia to allow participation by all demographic and income groups. Each randomly selected customer received a single offer to one of the three price options: CPP, CPR, or HP.

3.2.1 Participation Rates

The response rate to recruitment was similar to other pilot programs, with an average response rate of 6.6%. CPR customers volunteered at a rate higher than CPP and HP customers. As in other programs, CPP and HP participants were offered a "thank you" payment (in this case, $100) for participation. These participants received a $50 "up front" incentive and a $50 "thank you" incentive at the conclusion of the pilot. Because a customer's bill could only remain the same or go down on CPR, no thank you payment was provided to CPR customers. (CPR customers were, however, provided with a $25 "thank you" payment for completing the participant survey.)

The recruitment results are shown below (RAD signifies limited-income). The 95% confidence interval allows comparison of two different groups, for example R and RAD. To do so, we take the lower limit of the RAD interval (6.82%) and compare it to the upper limit of the R interval (6.55%). Because 6.82% is higher than 6.55%, we have 95% statistical confidence that in a large-scale recruitment, the RAD response (customers with limited income) will be higher than R (regular income), just as it was in this recruitment of only a small proportion of the total customers in the District.

As seen in Exhibit 12, customers with limited-income volunteered at a rate higher than regular customers, and the difference is statistically valid.

Customer Type	Recruitment Response	95% Confidence Interval	Population Weight	Regular vs. Limited-income
R	6.2%	+/- 0.35%	73.2%	6.4%
AE	7.2%	+/-0.64%	19.1%	
RAD (limited income)	8.0%	+/-1.18%	5.7%	7.6%
RAD-AE (limited income)	6.4%	+/-1.46%	1.9%	
Weighted Average	**6.6%**			

Exhibit 12: Recruitment results by customer type.

Customer Type	Recruitment Response	95% Confidence Interval
CPP	6.5%	+/- 0.52%
CPR	7.4%	+/-0.49%
HP	5.5%	+/-0.49%
Weighted Average	**6.6%**	

Exhibit 13: Recruitment results by price plan offered.

3.2.2 Geographic Distribution

The District, like other areas of the nation, includes an important population of customers with limited income. The Board ensured that all such customers had an equal opportunity to participate. To protect these consumers from risk, they were recruited only for the no-risk CPR plan. The graphic below shows the distribution of participants throughout the District of Columbia.

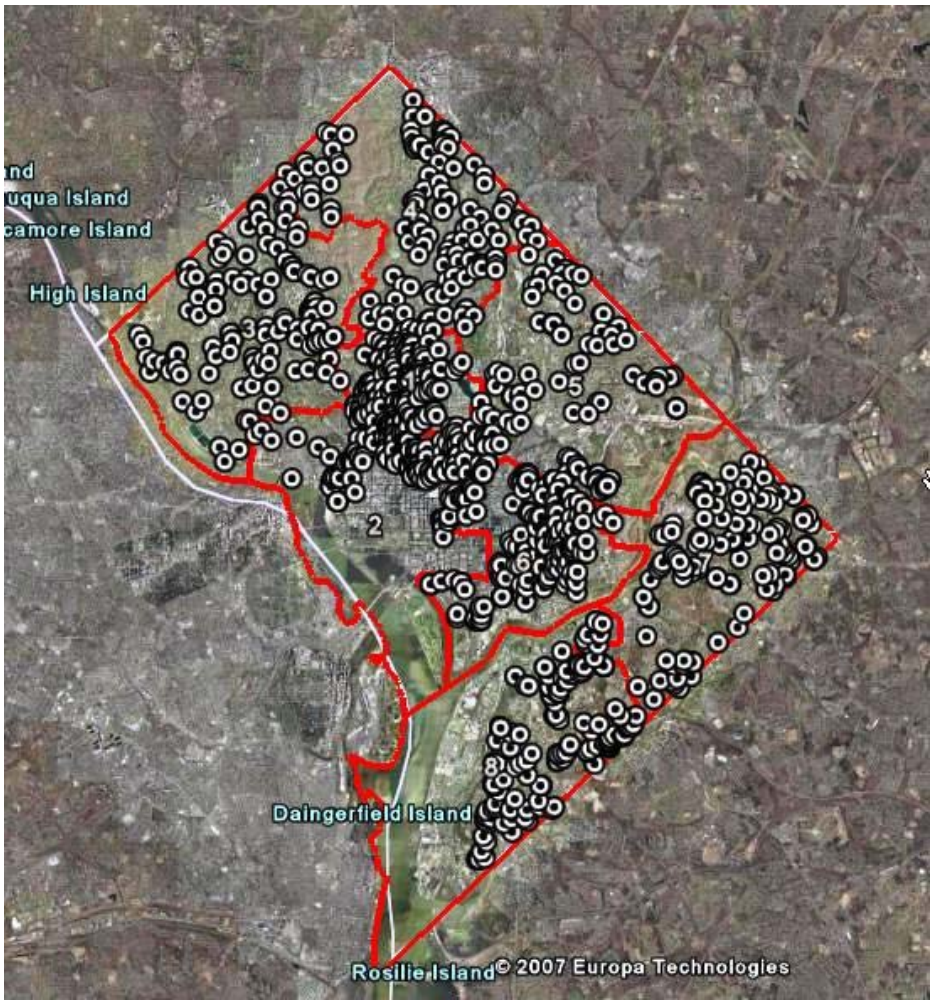


Exhibit 14: Distribution of PowerCentsDC program participants; District and Ward boundaries in orange.

The final result of recruitment was participation by approximately 900 customers in the three price plans, and the statistical results verified that there was no self-selection bias (see Section 5 below). An additional approximately 400 meters were installed on other randomly selected customers to provide a statistical control group for the analysis. Other than having their meters replaced, control group customers were not affected by the program in any way, and they remained on their existing rate plans.

3.2.3 Participants in Analysis Sample

The customers in the analysis are summarized in the table below. There are two reasons for the low number of participants with limited income. First, consumers with limited-income

are a minority of the District's population, with only 7.6% qualifying for RAD rates. Second, there was a delay of about a year between customer recruitment and the program start-up due to the timing of receipt of necessary regulatory approvals. During this delay, many customers with limited income changed premises, thereby dropping out of the program, or no longer qualified for RAD rates. Therefore, customers with limited income appear to have a higher exit rate than other customers, and the available sample for analysis was smaller.

The sample numbers shown here differ slightly from those in the Interim Report.[9] Two reasons account for the differences. First, the final analysis utilized 16 months of data rather than the 8 months of data used for the Interim Report. Second, the final report included more thorough preparation of the data prior to analysis, mainly through an audit process to verify and validate data used for each individual bill and participant in the program.

Customer Type	CPP	CPR	HP
Regular (R)	175	202	175
All Electric (AE)	58	62	56
Regular Limited-income (RAD)	–	36	–
All Electric Limited-income (RAD-AE)	–	18	–

Exhibit 15: PowerCentsDC participant population used in analysis.

3.3 Control Group

To create the control group, customers were selected in a stratified random sample from throughout the District of Columbia. The sample was stratified according to the four basic tariff groups:

- Regular (R)
- All Electric (AE)
- Regular Limited-income (RAD)
- All Electric Limited-income (RAD-AE)

Similarly to the treatment group, the sample numbers below differ slightly from those reported in the interim report and for the same reasons. The final distribution of control customers is shown below.

	Control Customers
Regular (R)	128
All Electric (AE)	97
Regular Limited-income (RAD)	94
All Electric Limited-income (RAD-AE)	59

Exhibit 16: PowerCentsDC control group population used in analysis.

9 - http://www.powercentsdc.org/ESC%2009-11-02%20PCDC%20Interim%20Report%20FINAL.pdf

4 Pilot Operation

This section describes the basic operational details of the pilot, including participant communication approaches, billing approach, critical peak notifications and participant support.

4.1 Participant Recruitment Materials

The recruitment packages consisted of the following:

- *Cover Letter*: Provided a brief introduction to the pilot, described key features, and informed eligible participants how to confirm participation.
- *Brochure*: Provided an explanation of all the key features of the program, including the operation of the smart prices and the equipment involved, including the smart meters and smart thermostats.
- *Confirmation Form*: When signed, this form confirmed the customer's participation.

There were three versions of the Letter and Brochure; one per price group. Sample recruitment materials are included in Appendix A.

4.2 Customer Education and Energy Information Feedback

PowerCentsDC provided a broad set of educational and informational materials, including up-front education in the form of in-person meetings, a welcome package, printed reports, and a consumer engagement website.

4.2.1 In Person Meetings

PowerCentsDC included the unusual step of in-person group meetings for the program participants. These meetings were held approximately two weeks before live billing began for participants. All of the participants were invited to a two-hour, evening session at Pepco's headquarters in downtown Washington, D.C., near a Metro station for easy access (parking is also readily accessible in the evenings).

Three sessions were held; one each for CPP, CPR, and HP price plan participants. The meetings were separate so that the information could be tailored for each price plan and so participants would not be confused by receiving information about different plans. Also, the pilot's intent was that participants focus on their own plans. Approximately 20 to 25 percent of the participants attended one of the meetings.

4.2.2 Welcome Package

Initial participant education, beyond the material in the recruitment package, focused on a package mailed to each eligible participant approximately two weeks prior to "going live" on the PowerCentsDC smart prices. This confirmation mailing included the following:

- *Cover Letter*: Confirmed that the participant was enrolled under the assigned rate plan.
- *Refrigerator magnet:* Provided a reminder of the key program features, such as critical peak hours and how to get customer service. (See Exhibit 17.)
- *Electricity conservation brochure*: provided a variety of conservation tips for electricity consumers that could be used during peak times or anytime.

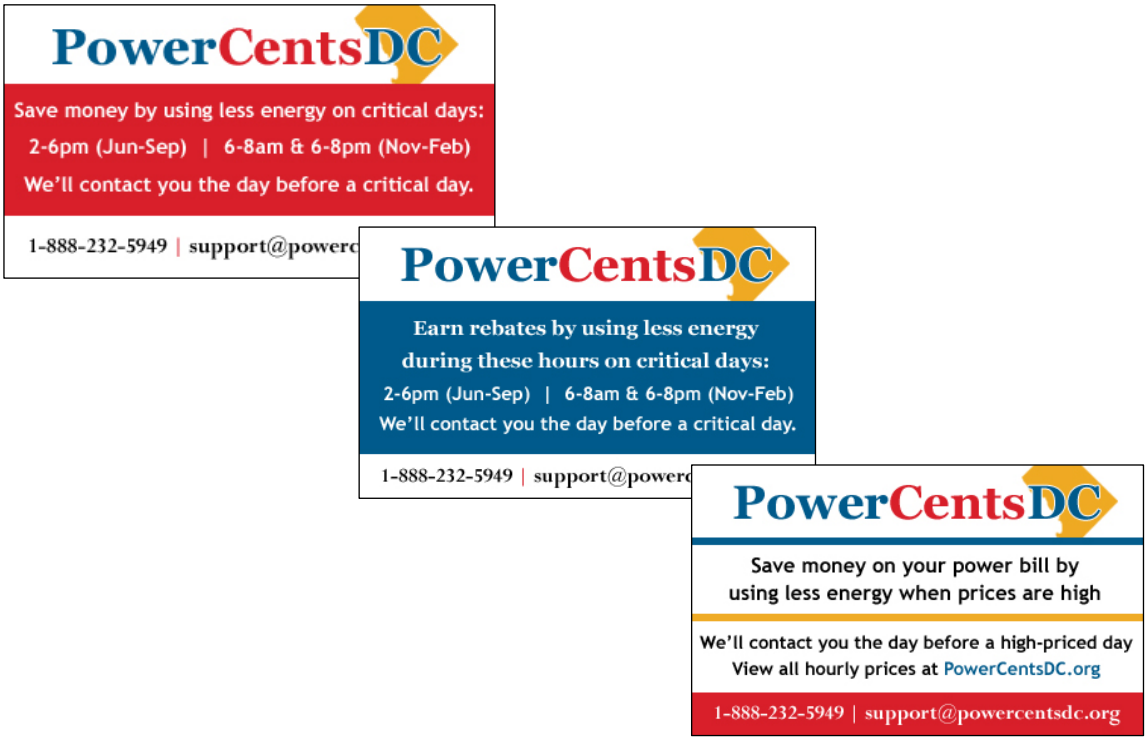


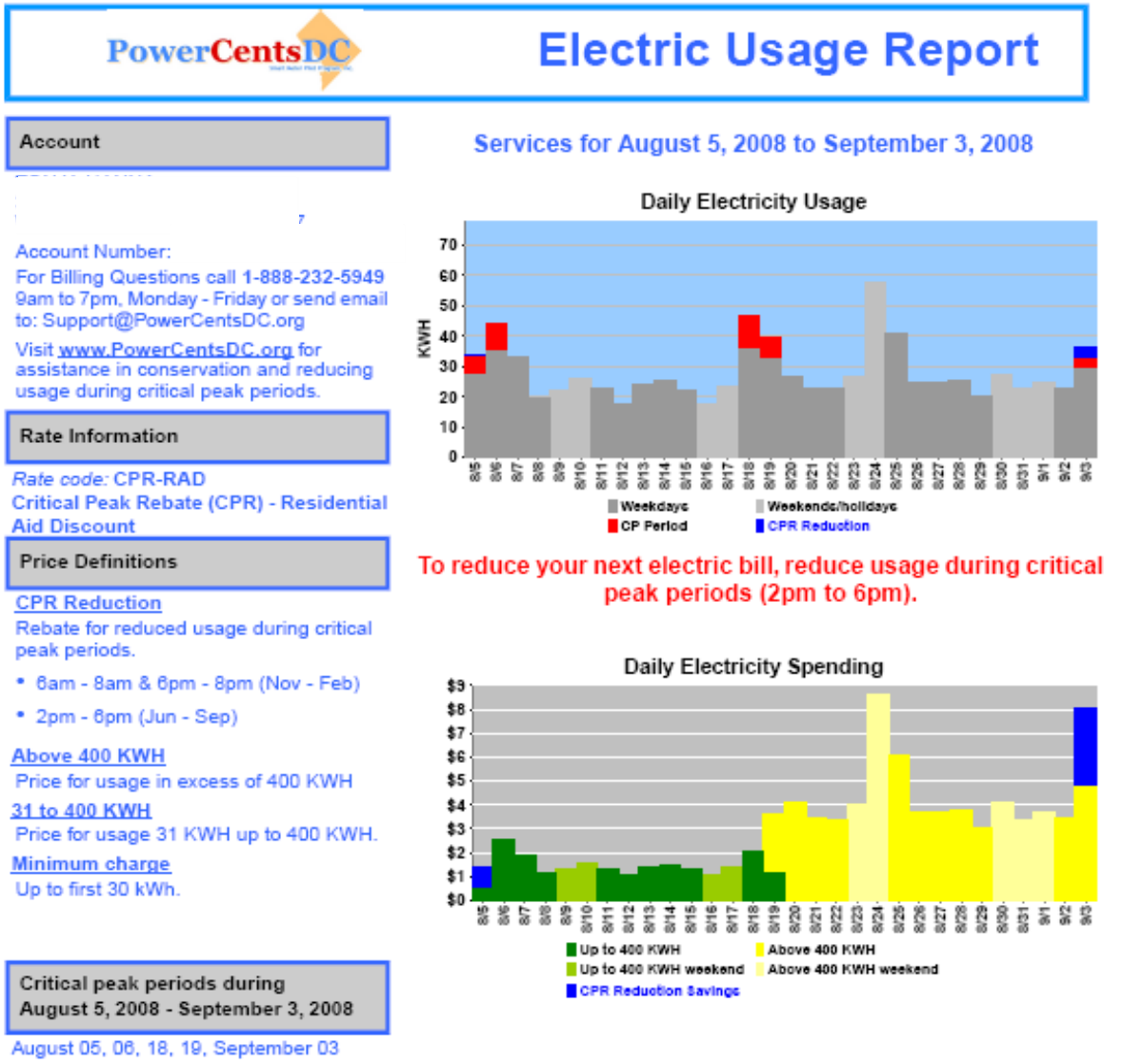
Exhibit 17: Refrigerator magnets provided to all participants per their rate plan; CPP, CPR, and HP, respectively.

4.2.3 Electric Usage Reports

Most importantly, each customer received a detailed customized energy usage report in his or her monthly bills called the "Electric Usage Report." The detailed report showed, day by day, how much electricity the customer used and how much the usage cost each day. The exhibit below shows a sample report for an actual participant. This usage report was provided along with customers' bills beginning when billing under the new rates began.

From feedback received in customer service calls, participants seemed to focus on the two charts on the right-hand side of the report. The upper chart shows daily usage. Weekends are a lighter shade to make them stand out. Usage during critical peak hours is highlighted in red. For CPR participants, the quantity used in the rebate calculation was shown in blue.

The lower chart shows daily spending. It also includes lighter shading for weekends. The different colors correspond to different prices in effect at the time: green is Tier 1 prices, yellow is Tier 2, and blue is the rebate amount for CPR customers. For CPP customers, the spending during critical peak periods was shown in red.



PowerCentsDC

Electric Usage Report

Account

Account Number:
For Billing Questions call 1-888-232-5949 9am to 7pm, Monday - Friday or send email to: Support@PowerCentsDC.org

Visit www.PowerCentsDC.org for assistance in conservation and reducing usage during critical peak periods.

Rate Information

Rate code: CPR-RAD
Critical Peak Rebate (CPR) - Residential Aid Discount

Price Definitions

CPR Reduction
Rebate for reduced usage during critical peak periods.

- 6am - 8am & 6pm - 8pm (Nov - Feb)
- 2pm - 6pm (Jun - Sep)

Above 400 KWH
Price for usage in excess of 400 KWH

31 to 400 KWH
Price for usage 31 KWH up to 400 KWH.

Minimum charge
Up to first 30 kWh.

Critical peak periods during August 5, 2008 - September 3, 2008

August 05, 06, 18, 19, September 03

Services for August 5, 2008 to September 3, 2008

Daily Electricity Usage

To reduce your next electric bill, reduce usage during critical peak periods (2pm to 6pm).

Daily Electricity Spending

Electric Bill Summary

	Services for Aug 5 to Sep 3 Price level	KWH Used	Per KWH	Generation Services per KWH		Distribution Services per KWH**		Transmission Services per KWH		Current Charges this period
CPP Reduction		-5.12	-$0.83	-$0.83000	-$4.25					-$4.25
Usage	Above 400 KWH	434.76	$0.14	$0.10825	$47.06	$0.02850	$12.39	$0.00413	$1.80	$61.25
	31 to 400 KWH	370.00	$0.05	$0.04429	$16.39	$0.00151	$0.56	$0.00079	$0.29	$17.24
	Energy charge	804.76			$59.20		$12.95		$2.09	$74.24
	Minimum charge	up to first 30			$1.69		$0.19		$0.05	$1.93
	*Other charges****	834.76					$5.88			$5.88
	Total Charges	835			$60.89		$19.02		$2.14	$82.05

* Totals may not add up due to rounding. ** Average price per KWH *** This may be displayed as multiple lines on the bill.

Exhibit 18: Sample of Electric Usage Reports provided monthly to all participants; the left panel of the statements differ slightly to reflect the differences between CPP, CPR and HP prices.

4.2.4 Seasonal Bill Inserts

Beginning in November 2008, participants received PowerCentsDC-specific bill inserts that were different each month. These were tailored to highlight specific savings opportunities

related to the season and to leverage seasonal holidays. Air conditioning and dehumidifiers are examples of appliances discussed in summer inserts, while holiday lighting is an example from the winter. An example is shown below.

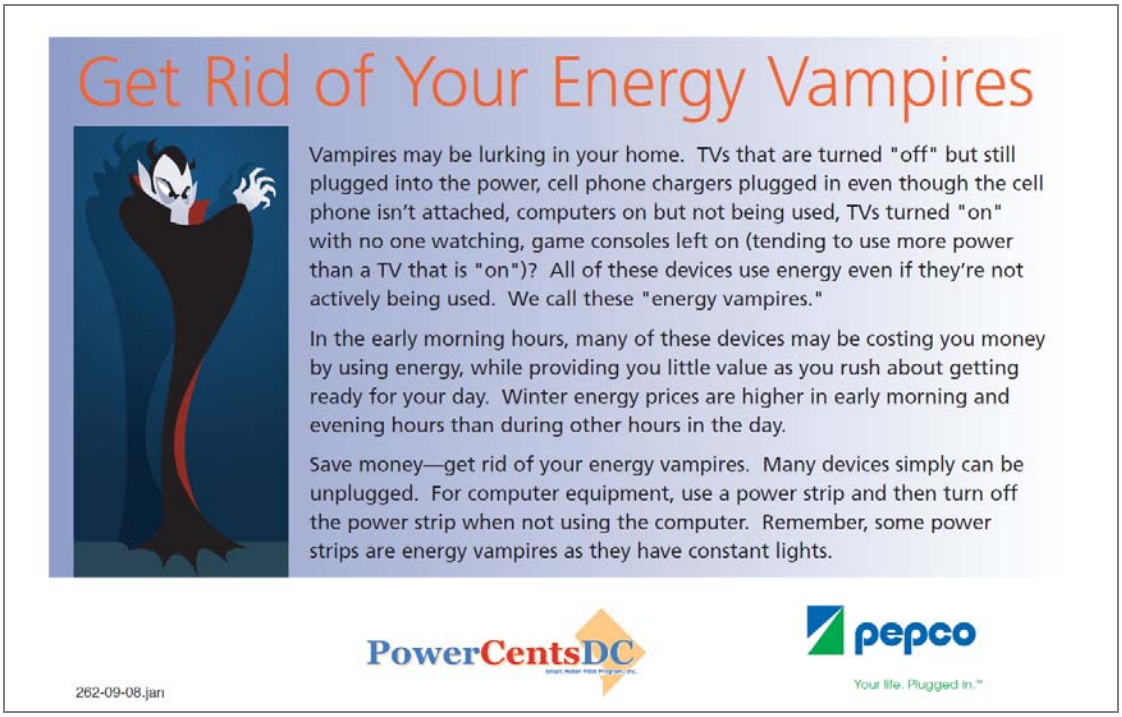


Exhibit 19: Sample of monthly bill inserts provided to PowerCentsDC participants.

4.2.5 Consumer Website

PowerCentsDC provided a website for participants and others to obtain information about the program. The initial website included basic program information, energy savings tips, and hourly prices for HP participants.

The hourly prices were updated automatically each day by obtaining the day-ahead PJM wholesale market prices from the PJM website, applying the PSC-approved tariff calculations, and updating the PowerCentsDC website. Customers were able to view hourly prices going back to the beginning of the program and could download them to an Excel spreadsheet if desired. Hourly prices were posted in the late afternoon each day for electricity to be delivered the following day.

For the second summer of the program, the website was expanded through the addition of consumer engagement software. This software allowed participants to log in and view their individual hourly data. The data could also be viewed in different time periods: hourly information over the course of a day, daily information over the course of a billing period (month), and monthly information over the course of a year.

The dashboard page of the consumer engagement element of the website is shown below.

Exhibit 20: PowerCentsDC consumer engagement software.

4.3 Incentive Approach

As an incentive to enroll, CPP and HP participants received a "thank you payment" of $100. Specifically, $50 was provided up front, with $50 paid upon completion of the pilot.

Such an incentive was consistent with incentive payments of $75 to $100 made in similar pilots. Numerous researchers have concluded that the incentive does not present an issue when analyzing the effect of prices on pilot participants. The reason is that the incentive payment is a fixed externality; participants receive credit for the $100 by participating. Any savings or losses on their smart prices do not change the fact that they receive the incentive payment. Thus, participants are just as motivated to reduce peak demand after receiving the payment as they would be without it.

4.4 Billing

Participants were billed on their normal monthly billing cycles. Each participant received a Pepco bill as they did on Standard Offer Service (SOS), plus the energy usage report. Other than the smart prices, the usage reports, and PowerCentsDC-specific bill inserts, participant bills and payments were treated the same as for other SOS customers.

4.5 Smart Meters and Thermostats

All participants in PowerCentsDC received a free smart meter. Approximately one-third of participants with central air conditioning or central electric heating selected the option to receive a free smart thermostat.

The smart meters recorded electricity use hourly and transmitted it to the data center every day after midnight via a wireless communications link. Also, the smart meters had the capability to detect outages and the capability of sending a signal to the utility shortly after the power goes out. Because the communications link was always in operation, Pepco could read the meter and could monitor to see if power is on at the meter at any time. These functionalities were not tested as part of this pilot program. To provide radio coverage for the entire District, four radio transmitter towers were used. The smart meters have an LCD display so customers can read the meter locally as well (see Exhibit 21).

Exhibit 21: Smart meter and smart thermostat provided to PowerCentsDC participants.

The smart thermostats contained a wireless receiver inside. During critical peak events, the thermostat was sent a message so that less air conditioning or electric heating was used during the event. Unfortunately, in winter cycling feature of the thermostats was used rather than temperature setback, with the result that back-up resistance heaters turned on – which, in turn, increased consumption. Clearly temperature setback during winter months is the preferred approach for central heat pump systems. .

4.6 IT Architecture

The IT system implemented for PowerCentsDC supported all of the program activities, from consumer marketing and enrollment through billing and final load impact analysis. The IT platform was installed and operated remotely, with a simple interface to Pepco's billing system to minimize costs and impacts on Pepco's systems while allowing implementation of the wide range of features and dynamic prices that were utilized in the pilot.

Among others, the PowerCentsDC IT system provided the following functions:

- *Marketing*: Identification of target customers, production of mailing lists, and tracking of recruitment activities.
- *Enrollment*: Customer enrollment in the program via website, email, and telephone, with tracking of participants and participant status.
- *Meter and Thermostat Tracking*: Tracking of locations for meter and thermostat installations, including installation and operational status.
- *Ongoing Data Communications and Management*: Retrieval of hourly interval usage data; validation, editing, and estimation of meter data; storage of meter data for use in final program analysis; sending of daily month-to-date usage and cost, and real-time price, to smart thermostats; and integration with the program website.
- *Demand Response Events:* Event initiation; notification of participants by email, SMS, or automated phone call; tracking of customer responses to notifications; notification of billing system; and sending of control signals to smart thermostats.
- *Billing and Customer Support:* Monthly bill calculation for CPP, CPR, and HP customers; daily bill calculation for customers with smart thermostats; and support access for customer service representatives responding to participant emails and phone calls.
- *Consumer Engagement Software:* Online presentment of usage and cost data for program participants, including email and SMS notifications.

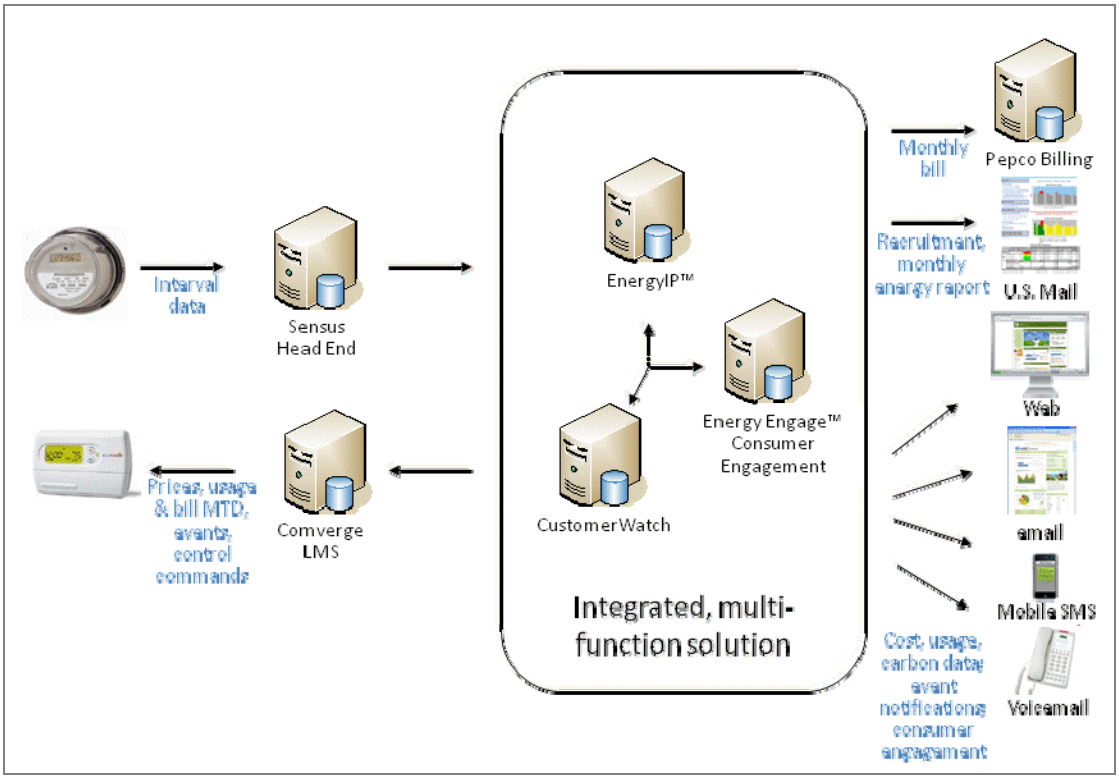


Exhibit 22: The PowerCentsDC IT Architecture provided an integrated, multi-function solution.

4.7 Critical Peak Events

Critical peak events were called for CPP and CPR customers. To assist in responding to hourly prices, HP customers received day-ahead notifications of high-price "events" as well.

4.7.1 Critical Peak Notification

At the time of enrollment, participants indicated their preference for their method of receiving automated notification of critical peak events by phone, e-mail, and/or text messages (on cell phones). Notifications are delivered on the day before a critical peak event, usually in the afternoon, no later than 5:00 pm. The notification technology allows for verification that the messages are delivered – though not necessarily listened to (phone message) or read (email).

Some participants asked for more than one mode of notification; they were provided with multiple options for their convenience.

Critical peak notification success rates are typically between 95% and 98%. If an automated phone message is picked up by the receiver, whether it is an answering machine or a live person, the message is considered to be delivered. If an e-mail is not bounced back or otherwise marked as "undeliverable," it is considered successfully delivered.

Anecdotal feedback received from customers calling or emailing customer support indicates that participants were generally satisfied with the mode of day-ahead e-mail or phone notification they had chosen. Some had to work out their filtering process for unwanted phone calls, but this was not a significant barrier to participating in the critical peak test group.

4.7.2 Summer 2008 Critical Peak Events

During the shortened 2008 summer period of the pilot, six critical peak events were called based on day-ahead forecasts that exceeded the thresholds. The first event was not called until August 5, 2008, because customers did not go onto the PowerCentsDC prices until July 22, 2008. Actual temperatures on the event days are provided below. Recall that the summer critical peak hours were 2 p.m. to 6 p.m.

Critical Peak Day	Actual Max Temp (°F)	Time of High Temp
Tuesday, August 5	86	1:00 pm
Wednesday, August 6	94	4:00 pm
Monday, August 18	93	4:00 pm
Tuesday, August 19	94	4:00 pm
Wednesday, September 3	95	3:00 pm
Friday, September 4	95	4:00 pm

Exhibit 23: Actual temperature of summertime critical peak events against a forecast temperature trigger of 90°F.

On August 5, 2008, the actual maximum temperature reached only 86 in spite of being forecast to be 90 degrees.

4.7.3 Summer 2009 Critical Peak Events

During the 2009 summer period of the pilot, 12 critical peak events were called.

Critical Peak Day	Actual Max Temp (°F)	Time of High Temp
Thursday, June 25	87	4:00 pm
Wednesday, July 15	87	4:00 pm
Thursday, July 16	95	4:00 pm
Wednesday, July 22	89	4:00 pm
Tuesday, July 28	91	4:00 pm
Thursday, July 30	86	4:00 pm
Tuesday, August 4	90	4:00 pm
Monday, August 10	96	4:00 pm
Monday, August 17	90	4:00 pm
Tuesday, August 18	93	3:00 pm
Tuesday, September 15	83	3:00 pm
Thursday, September 24	85	2:00 pm

Exhibit 24: Actual temperature of summertime critical peak events against a forecast temperature trigger of 90°F.

As seen in Exhibit 24, several events were called at temperatures below the target threshold of 90 degrees. The reason was the moderate weather. The project team wanted to be sure to call all 12 events. First, the rates were designed for 12 summer events. Second, the team wanted the data for use in the load impact analysis.

Since the summer 2008 and 2009 temperatures were moderate compared to previous summers (the previous five years were analyzed to establish the critical peak dispatch threshold), most of the events represented situations just slightly over the threshold values; in several cases, the actual temperature was below the day-ahead forecast and the threshold. This is significant because other pilots have found that less load shifting occurs on moderate days in comparison to extreme temperature days, a result also confirmed in this program.

4.7.4 Winter Critical Peak Events

Three critical peak events were called in winter based on a day-ahead forecast of below 18°F.

Critical Peak Day	Actual Min Temp (°F)	Time of Low Temp	Mean Temp during Critical Peak (°F)
Thursday, January 15	17.1	11:00 pm	22.9
Friday, January 16	10.9	5 am/11 pm	12.5
Wednesday, February 4	23.0	11:00 pm	28.0

Exhibit 25: Actual temperature characteristics of declared wintertime critical peak events against a temperature trigger of 18°F.

Only January 16 was extremely cold during the critical peak hours.

4.8 Participant Support

The implementation team provided both telephone and email support for participants. The phone support was staffed from 9:00 am – 6:00 pm Washington D.C. time.

A minority of participants used the e-mail support feature of the project to resolve issues related to their participation. These participants had questions regarding metering, critical peak times, and minor changes to their billing information. Where appropriate, inquiries were forwarded to a contact at Pepco to be addressed.

The PowerCentsDC telephone support line received approximately 800 calls and voice messages from July 2008 through February 2009 – roughly one call per participant (though many calls were from other customers who called during the enrollment period). About 700 of the calls were directly related to PowerCentsDC, with most of these inquiries during the start-up phase of the project. The remaining calls were not related to PowerCentsDC; they were questions about the participants' regular Pepco service or calls from non-participants who wanted to know about smart metering in general.

Phone support logs indicate that callers were knowledgeable about and involved in the management of their electricity usage. Numerous callers articulated to the phone support staff that they were using their participation in the program and their access to smart meter data as a way to gain more control over their energy usage.

5 Demand Response Impacts

This final report covers the design, operation, and analysis of the summers of 2008 and 2009 and winter of 2008-9 (the Interim Report, issued in November 2009, covered the summer of 2008 and winter of 2008-9). Data collection began in spring 2008 and continued through the final customer survey that ended in February 2010. Participants enrolled in the PowerCentsDC special pricing were billed on those prices from July 22, 2008 through October 31, 2009. This report includes the following:

- The response of customers to recruitment for participation in the program;
- The extent to which various dynamic pricing structures cause a reduction in peak demand; and
- Consumer attitudes toward dynamic pricing and receiving detailed energy information.

5.1 Demand Response Impacts

The analysis of demand response was performed by Professor Frank Wolak of Stanford University. Peak demand reductions were determined by comparing the treatment group of participants with the control group of customers remaining on existing Standard Offer Service (SOS) prices. Only results with a confidence level of 90% or greater are included in this report. The results are summarized below, with detailed results shown in Appendix B, including the confidence level of each.

The results reported here are for the entire program and thus overlap with results previously reported in the Interim Report. Some peak demand reductions reported here differ from those in the Interim Report, though generally not materially. Two reasons account for the differences. First, the final analysis necessarily relied upon a larger dataset, with 16 months of data rather than the 8 months of data used for the Interim Report. Second, the final report included more thorough preparation of the data prior to analysis, mainly through an audit process to verify and validate data used for each individual bill and participant in the program.

The winter data for customers with smart thermostats was excluded. This is because the thermostats "cycled" heat pumps, with the result that back-up resistance heaters turned on – which, in turn, increased consumption.

Most results are statistically valid at the 99% level or better (those results in the tables below that are not statistically valid at the 90% level are denoted by "n/s").

5.1.1 Analytical Model

To analyze the load reductions during peak and critical peak times, a nonparametric conditional mean estimation framework was used. The framework used customer-level fixed effects and day-of-sample fixed effects.

The fixed effects approach uses a separate intercept term for each customer to control for effects that are unique to that customer and relatively constant over the time period being examined. The unique effects of the stable, but unmeasured, characteristics of each customer are their "fixed effects" from which this method takes its name. These fixed effects are held constant. The fixed effects nature of the model means the model does not need to include unchanging customer characteristics such as house size, appliances, etc.

Controlling for fixed effects controls the amount of variance (noise) the analysis model is faced with, since each customer has a different initial electricity consumption pattern, a different response to weather, and a different change in consumption pattern in response to smart prices. This approach provides for a much closer fit to the data than most models, because individual responsiveness is incorporated and accounted for. In fact, for the PowerCentsDC analysis, a separate fixed effect is estimated for every hour of data for every customer.

This approach has worked well in estimating the impacts of other residential demand response programs such as the California Statewide Pricing Pilot, the Idaho Power critical peak pricing pilot, the Sacramento Municipal Utility District air conditioning direct load control program, and the Ontario Smart Price Pilot.

More details on the model and full results can be found in Appendix B.

5.1.2 Representativeness of Control and Treatment Groups

The goal of the pilot program was to develop results that can be extrapolated to the District population. This requires that both the control and treatment groups be sufficiently large and drawn at random. The control group was selected by first stratifying the customers into the R, AE, RAD, and RAD-AE groups. Second, within each stratum, random numbers were assigned to residential customers throughout the District. Third, customers were then selected sequentially until each sample was complete. The size of the control groups was verified by Dr. Wolak prior to selection. Once control customers were identified through the randomization process, smart meters were installed at each residence. Accordingly, the control samples, being randomly drawn and sufficiently sized, are representative of the District population as a whole for each stratum.

To verify that the treatment groups are also representative samples of the population, a comparison of the treatment and control groups was performed for the pre-treatment period. The smart meters were installed, on average, at least two months prior to customers being placed on PowerCentsDC prices. A comparison was made of the mean hourly consumption throughout the day for the treatment customers versus control customers for the pre-treatment period.

The difference in mean consumption across hours of the day for the treatment and control group was found not to be statistically different from zero for all four customer subgroups:

R, AE, RAD, and RAD-AE. Thus, the treatment groups are representative samples of the District population, and the statistics show no self-selection bias.[10]

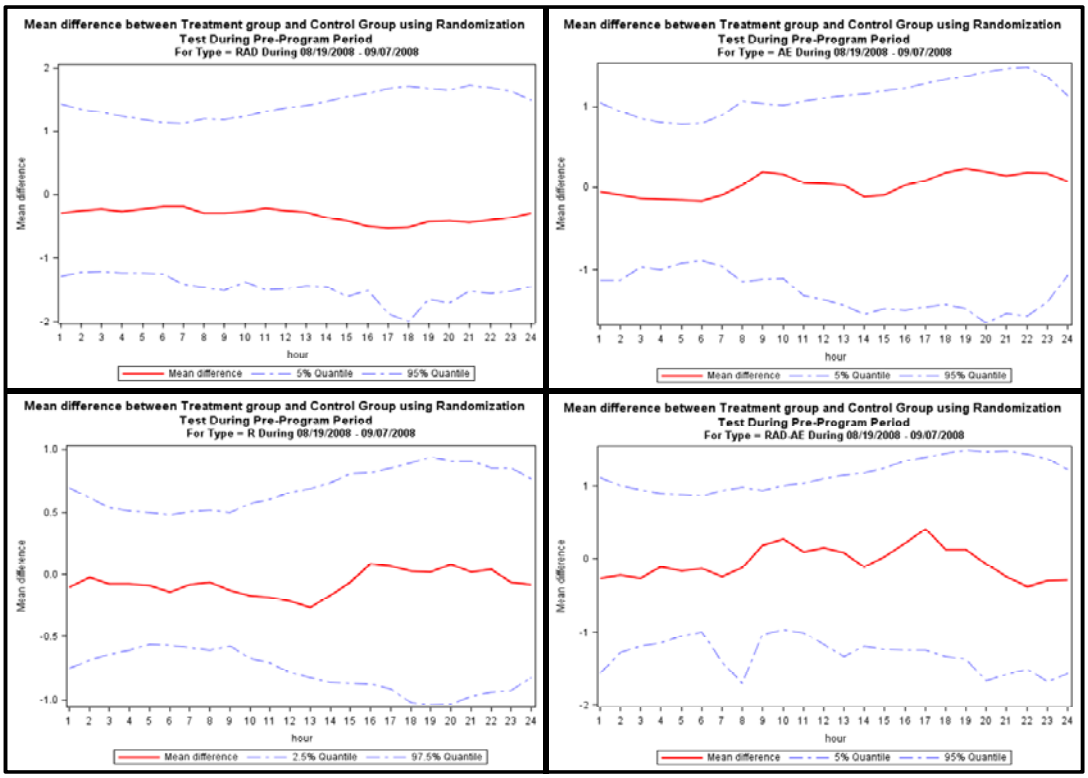


Exhibit 26: The solid red line being between the dotted blue lines at all times shows the control groups are statistically valid for comparison with the PowerCentsDC participant groups.

5.1.3 Peak Reductions by Price Plan

The results show that consumers reduce peak summer electricity demand consistently when given a price signal. The statistically valid peak reductions by price plan and customer type are shown below. The lower reductions for HP may be explained by two factors: the high prices were not as high as for CPP or as the rebate for CPR, and the HP customers had declining average prices.

Price Plan	Peak Reduction – Summer	Peak Reduction – Winter
CPP	34%	13%
CPR	13%	5%
HP	4%	2%

Exhibit 27: Average peak reductions during all critical peak events by season and customer type, weighted by actual population in the District.

The demand reduction results for the different customer types are shown below.

[10] - In statistical language, we cannot reject the null hypothesis of successful randomization of treatment and control groups.

Customer Type	Population Weight	Peak Reduction – Summer CPP	Peak Reduction – Summer CPR	Peak Reduction – Summer HP	Peak Reduction – Winter CPP	Peak Reduction – Winter CPR	Peak Reduction – Winter HP
Regular (R)	73%	34%	13%	3%	12%	7%	(n/s)
All Electric (AE)	19%	33%	12%	6%	13%	(n/s)	13%
Limited-income (RAD)	6%	-	5%	-	-	(n/s)	-
Ltd Income All Electric (RAD-AE)	2%	-	30%	-	-	(n/s)	-

Exhibit 28: Peak reductions during all events.

5.1.4 Temperature Effects

Higher summer temperatures resulted in greater peak demand reductions, with estimated peak demand reductions shown below.

Price Plan	Peak Reduction At 85°F	Peak Reduction At 97°F
CPP	26%	43%
CPR	8%	20%
HP	3%	3%

Exhibit 29: Most peak demand reductions INCREASE as temperatures go up.

5.1.5 Smart Thermostats – Summer

PowerCentsDC participants with smart thermostats had the benefit of automatic responses to summer critical peak events, provided their air conditioner was operating at the time of the critical peak event. This automated response significantly increased summer demand reductions for CPP and CPR participants.

Customer Type	No Smart Thermostat CPP	No Smart Thermostat CPR	No Smart Thermostat HP	With Smart Thermostat CPP	With Smart Thermostat CPR	With Smart Thermostat HP
Regular (R)	29%	11%	(n/s)	49%	17%	10%
All Electric (AE)	22%	6%	10%	51%	24%	-2%

Exhibit 30: Peak reductions during all summer events for customers without and with smart thermostats; the minus sign for HP-AE signifies a demand increase.

During events, customers could override the automatic adjustment or change the settings. In Exhibit 31 shown below, participants responding to the survey indicated that over half of the participants with smart thermostats had overridden the automated response for all pricing plans. However, only 29 percent of CPR participants overrode two or more events while a significantly higher percentage of HP and CPP participants (44 percent) overrode two or more events.

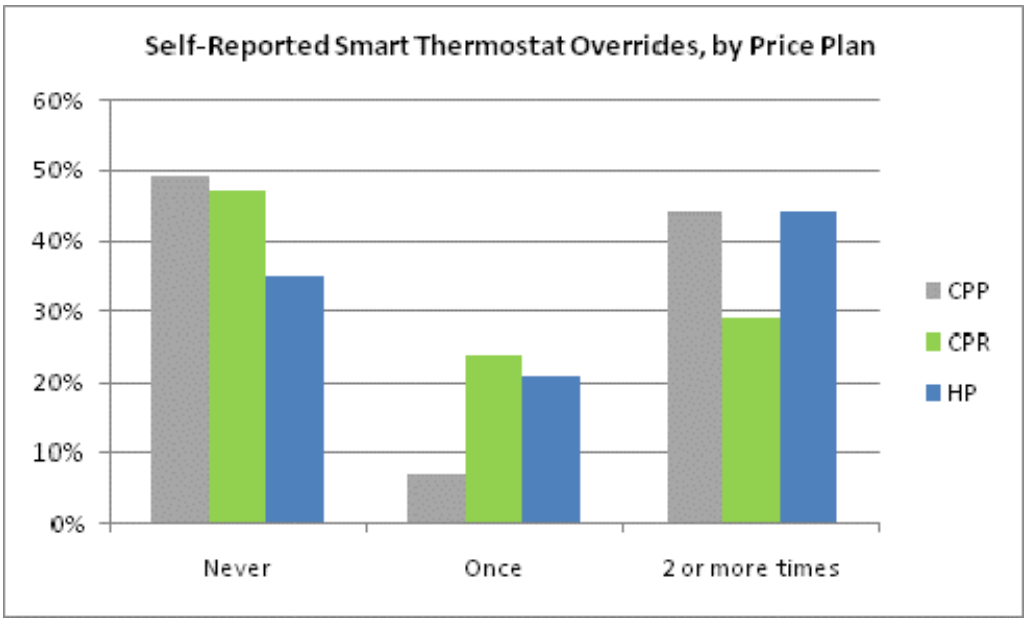


Exhibit 31: CPP customers overrode smart thermostats less often than others.

5.1.6 Peak Reductions by Income Level

Customers with limited-income participated only in the CPR plan. A comparison of their peak demand reductions to those of other customers on the CPR price plan shows only a slight difference between the two groups, on average, as seen in Exhibit 32. Preliminary results for summer 2008 showed customers with limited-income having a greater peak reduction than other customers, but this was not borne out in the complete dataset. [11]

Price Plan	Regular Income Customers	Customers with Limited Income
CPR	13%	11%

Exhibit 32: Average peak reductions during all critical peak events by season and customer type, weighted by actual population in the District.

5.2 Homeowners vs. Renters

The customer survey provided insights into the potential for renters to reduce peak loads as compared to homeowners. While renters own fewer appliances in many categories, they own more electric-intensive appliances in others, particularly cooking and baking. In addition, the survey showed that renters have higher levels of electric water heating. Moreover, renters undertake more high-intensity electricity uses during the peak hours, including clothes washing and drying, cooking, baking, and watching flat screen televisions. The survey data are summarized in Exhibits 33 and 34 below, with details in Appendix D.

[11] - For details see Wolak, Frank. *An Experimental Comparison of Critical Peak and Hourly Pricing: the PowerCentsDC Program,* Preliminary Draft, March 13, 2010.

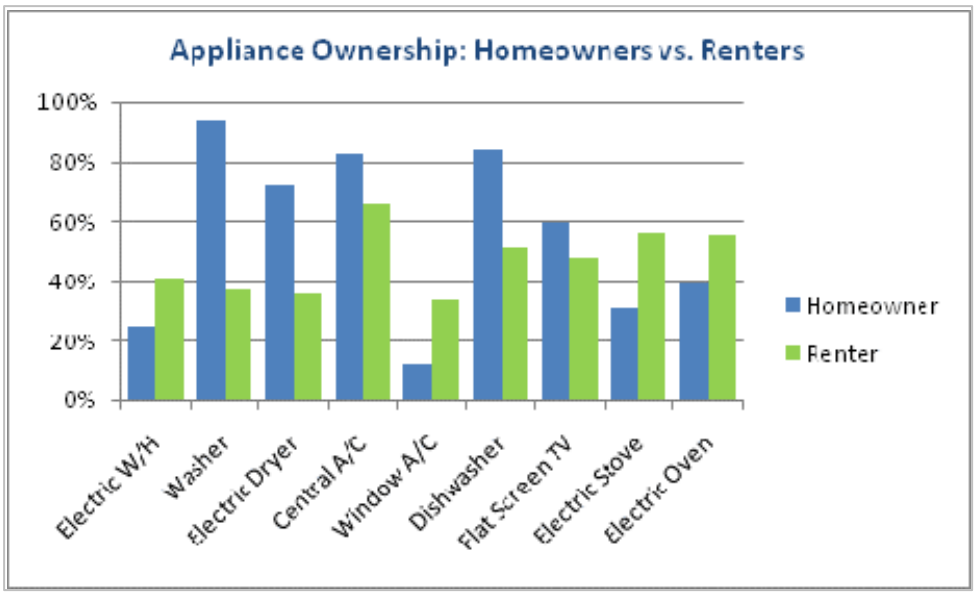


Exhibit 33: Renters own fewer appliances in some areas but more electric-intensive appliances in others, such as cooking.

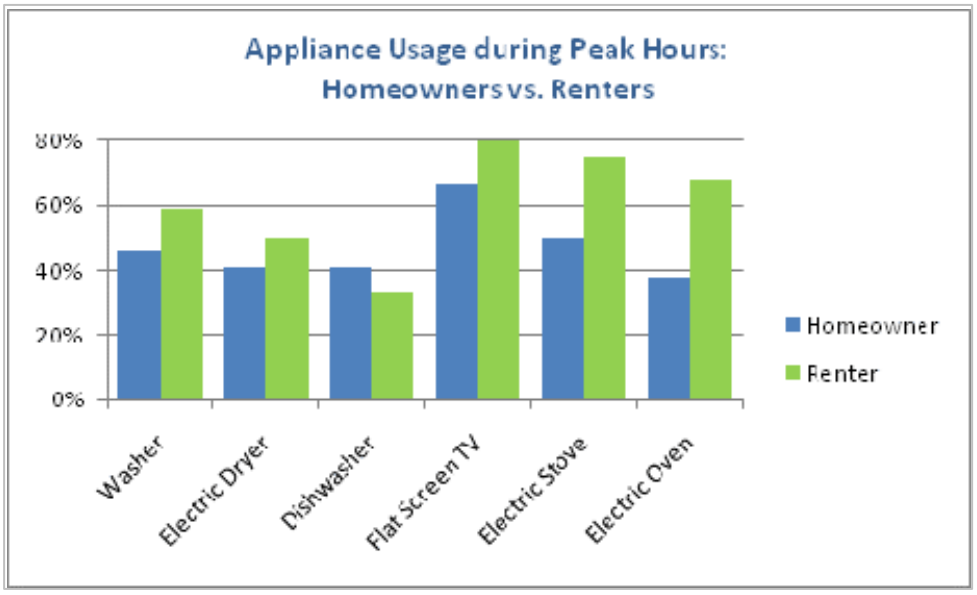


Exhibit 34: Renters use more appliances more often during peak hours.

5.3 Customer Bill Impacts

PowerCentsDC smart prices were designed to be revenue neutral; therefore, on average, customers that did not change their behavior would pay the same amount as under SOS, and any bill savings would be the result of load shifting. For the Hourly Price plan, quarterly adjustments were made to reconcile forecast wholesale prices with actual prices and, therefore, maintain revenue neutrality. However, wholesale prices fell faster than quarterly adjustments for revenue neutrality, causing average prices to fall for HP participants and increasing their savings. By taking the risk of paying hourly prices set by wholesale markets,

the HP participants enjoyed significant savings as wholesale prices dropped in response to falling oil prices and lower overall demand for electricity caused by the recession that began in September 2008.

The rates were designed to be revenue neutral over 12 months. On average, over 12 months, CPP and CPR participants saved 3.4% monthly on their electric bills, or $3.44 per month compared to Standard Offer Service. Over 91% of CPP and CPR participants paid less on the smart prices, with 80% having bills between 10% less and 0% less on PowerCentsDC prices.

Price Group	Average Bill SOS	Average Bill PowerCentsDC	Dollar Savings	Percent Savings
CPP	$101.26	$99.70	$1.56	2%
CPR	$99.66	$95.07	$4.59	5%
HP	$110.44	$77.42	$43.02	39%

Exhibit 35: Over 91% of CPP and CPR participants saved on PowerCentsDC prices.

Conservation effects which lower a participant's usage compared to what it would have been without the PowerCentsDC smart prices and energy information feedback via the energy usage reports are not considered in these results.

Individual savings varied significantly, as seen in the chart. Each dot is the percentage savings for one participant. This chart is for CPP and CPR participants only.

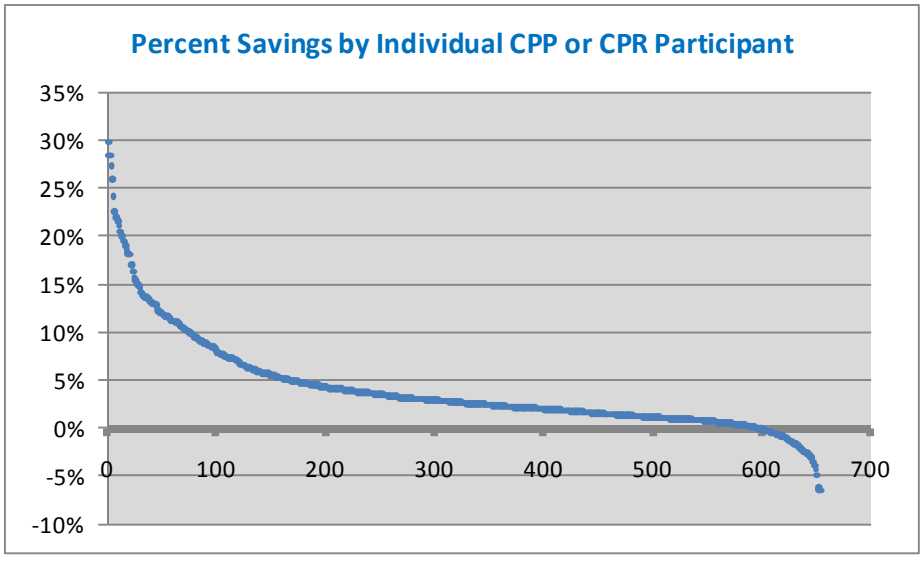


Exhibit 36: Distribution of CPP and CPR participant bill savings on smart prices as a result of peak load reduction. Each dot represents an individual participant's net loss or savings. Those above the 0.0% line paid less on smart prices. The X axis is the customer number, from 1 to about 650.

The chart below shows the number of customers in various savings groups. Again, this chart is for CPP and CPR participants only.

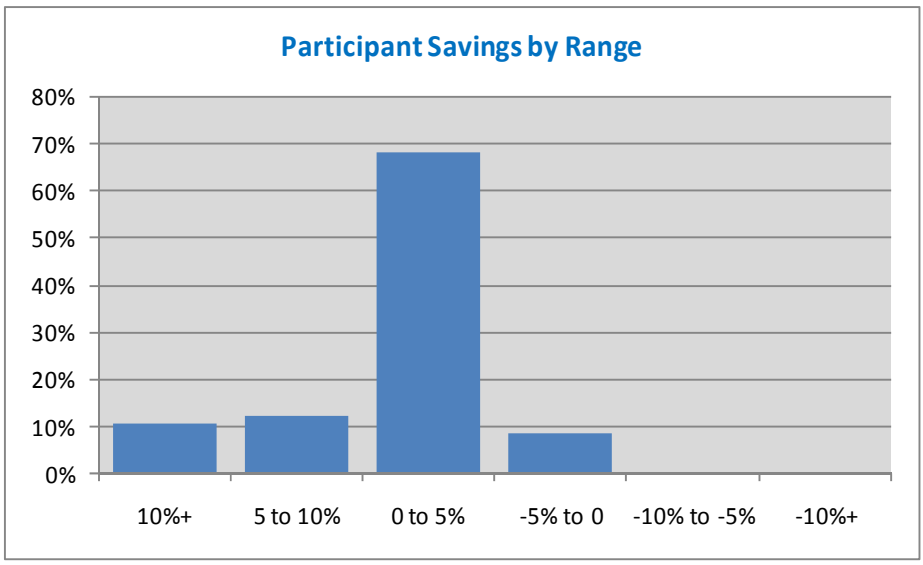


Exhibit 37: Distribution of CPP and CPR participant bill savings by savings band.

The number and timing of the critical peak events is important in maintaining revenue neutrality for CPP. For a full 12 months, 12 summer and 3 winter events are included in the rate design. To ensure a proper analysis, the bill savings analysis used the full 12-month period of November 1, 2008 to October 31, 2009 only. This period included the planned 12 summer and 3 winter events.

In contrast, the number of events does not affect revenue neutrality for CPR or HP customers. For CPR customers, the energy price is the same as for SOS, so it is revenue neutral absent any rebates earned. This makes the number of events independent of revenue neutrality, because revenue neutrality assumes no peak reductions, and therefore no rebates.

For HP customers, there are no critical peak events, so the number of events does not matter for them, either. HP prices are a function solely of wholesale hourly prices.

6 Customer Research

The PowerCentsDC program included customer research. Two methods were used: focus groups and customer surveys. Appendices D and E provide the customer survey results.

Focus Groups

Prior to recruitment of participants, focus groups were conducted to assess consumer preferences. Most focus group attendees liked the smart price concepts, strongly preferring the critical peak rebate price plan for its simplicity and no-risk aspects. They could earn rebates by reducing peak demand but pay no more if they chose not to respond. They also liked having the program approved by the Public Service Commission.

Customer Surveys

Following completion of the collection of billing data in November 2009, both participants and control customers were surveyed. The detailed results are provided in Appendix D. Some highlights were as follows:

- Over 74% of participants were satisfied with the program, and only 6% were dissatisfied;
- Over 93% of participants who expressed a preference preferred PowerCentsDC over Standard Offer Service;
- About 89% of participants would recommend PowerCentsDC to their friends and family;
- The main motive for participation was saving money (73%), followed by reducing emissions (34%), exploring smart grids (33%), and assisting policymakers (32%); and
- Participants' most common peak demand reduction measure was avoiding use of appliances (60%), with nearly as many reducing air conditioning consumption (59%).
- Control customers were asked their preferences for receiving energy usage, cost, and emissions information; most preferred the information be "pushed" as mail or email.

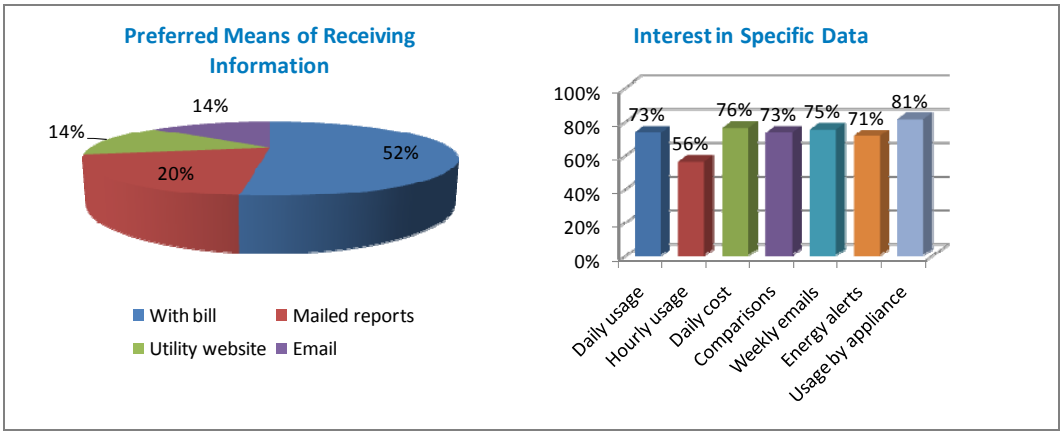


Exhibit 38: Almost 86% of survey respondents preferred to receive their data via mail or email.

7 Conclusion

This report summarizes the design, operation and outcomes of the PowerCentsDC pilot program undertaken by the Smart Meter Pilot Program, Inc. (SMPPI). PowerCentsDC tested the reactions and impacts on consumer behavior of three different smart prices:

- Critical Peak Prices (CPP)
- Critical Peak Rebates (CPR)
- Hourly Prices (HP)

The pilot was initiated in mid-2007 with customer recruitment and recruited participants were placed on the smart prices starting on July 22, 2008 and continued through October 31, 2009.

The results of PowerCentsDC suggest the following:

- Consistent with other pilots, PowerCentsDC showed consumers reduced summer peak demand in response to dynamic prices, energy information, and automated control;
- CPP prices led to the greatest peak demand reductions;
- CPR prices were most popular;
- Customers with limited-income signed up at higher rates than others, reduced peak load less than others, and saved money on the program;
- Summer peak reductions were greater than winter, implying more discretionary load;
- Automated response via smart thermostats increased the reduction; and
- The vast majority of participants saved money, even with revenue neutral prices.

8 Appendix A: Sample Marketing Materials

Appendix A provides samples for the following marketing materials:

- CPP, CPR, and HP recruitment letters
- CPP, CPR, and HP recruitment brochures

PowerCentsDC

Dear Neighbor,

In this time of increasing energy costs, a new program is available to help you better manage your electric bill and provide more information about your energy use.

You are among a select group of District of Columbia residents invited to participate in *PowerCentsDC™*, a new electricity pricing program. The program will run for two years beginning this fall. *PowerCentsDC* is sponsored by a non-profit corporation, SMPPI[1], comprised of Pepco, the DC Public Service Commission, the DC Office of the People's Counsel, the DC Consumer Utility Board, and the International Brotherhood of Electrical Workers.

As a participant, your rate will be changed to a new Critical Peak Pricing (CPP) rate plan. Under this plan, up to 15 days each year will be designated as Critical Peak days. For four hours on only those days, your price will be higher than your current price. At all other times, your price will be lower. The new prices are based on hourly prices in the electric wholesale market. Reducing energy usage when prices are high gives you the power to manage your electric bill, save money, and help the environment.

Participants in the CPP rate plan will receive:

- A $100 incentive for participation – $50 upfront and $50 at the end of the program.
- A free smart thermostat, available on a first come, first served basis, for those with central air-conditioning.
- Monthly billing reports with easy-to-use charts on your daily electricity usage and spending.
- Suggestions for ways to reduce or shift electricity use – and save money.
- Notification of when prices will be high the following day (via text message, email, page and/or phone message).
- A free smart meter that records when electricity is used.

To sign up, return the enclosed enrollment form, visit our website at www.PowerCentsDC.org, or call 1-888-232-5949. The number of participants is limited, so only the first to sign up will have the opportunity to participate.

Your participation will help determine what kind of pricing options will be offered to all customers in the District of Columbia in the future. Pepco will continue to provide you with electric service during your participation. Thank you for your part in helping to manage electricity costs and improving the environment in DC.

Sincerely,

Rick Morgan,
Chairman, SMPPI

[1] Smart Meter Pilot Program, Inc.

pepco CUB

PowerCentsDC

Dear Neighbor,

In this time of increasing energy costs, a new program is available to help you better manage your electric bill and provide more information about your energy use.

You are among a select group of District of Columbia residents invited to participate in *PowerCentsDC*™, a new electricity pricing program. The program will run for two years beginning this fall. *PowerCentsDC* is sponsored by a non-profit corporation, SMPPI[1], comprised of Pepco, the DC Public Service Commission, the DC Office of the People's Counsel, the DC Consumer Utility Board, and the International Brotherhood of Electrical Workers.

As a participant, your rate will be changed to a new Critical Peak Rebate (CPR) rate plan. You may earn a rebate on your electric bill by reducing your electricity use for a short period of time (four hours) on Critical Peak days; PowerCentsDC will designate up to 15 days each year as Critical Peak days. By participating, you can save money and help the environment.

Participants in the CPR rate plan will receive:

- The opportunity to earn rebates on their electric bills.
- A free smart thermostat, available on a first come, first served basis, for those with central air-conditioning.
- Monthly billing reports with easy-to-use charts on your daily electricity usage and spending.
- Suggestions for ways to reduce or shift electricity use – and save money.
- Notification of Critical Peak days the following day (via text message, email, page and/or phone message).
- A free smart meter that records when electricity is used.

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pepco CUB

PowerCentsDC

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You are among a select group of District of Columbia residents invited to participate in *PowerCentsDC*™, a new electricity pricing program. The program will run for two years beginning this fall. *PowerCentsDC* is sponsored by a non-profit corporation, SMPPI[1], comprised of Pepco, the DC Public Service Commission, the DC Office of the People's Counsel, the DC Consumer Utility Board, and the International Brotherhood of Electrical Workers.

As a participant, your rate will be changed to a new Hourly Pricing (HP) rate plan with prices sometimes lower and sometimes higher than your current price. The new prices are based on hourly prices in the electric wholesale market. Reducing energy usage when hourly prices are high gives you the power to manage your electric bill, save money, and help the environment.

Participants in the HP rate plan will receive:

- A $100 incentive for participation – $50 upfront and $50 at the end of the program.
- A free smart thermostat will be available on a first come, first served basis for those with central air-conditioning.
- Monthly billing reports with easy-to-use charts on your daily electricity usage and spending.
- Suggestions for ways to reduce or shift electricity use – and save money.
- Notification of when hourly prices will be unusually high the following day (via text message, email, page and/or phone message).
- A free smart meter that records when electricity is used.

To sign up, return the enclosed enrollment form, visit our website at www.PowerCentsDC.org, or call 1-888-232-5949. The number of participants is limited, so only the first to sign up will have the opportunity to participate.

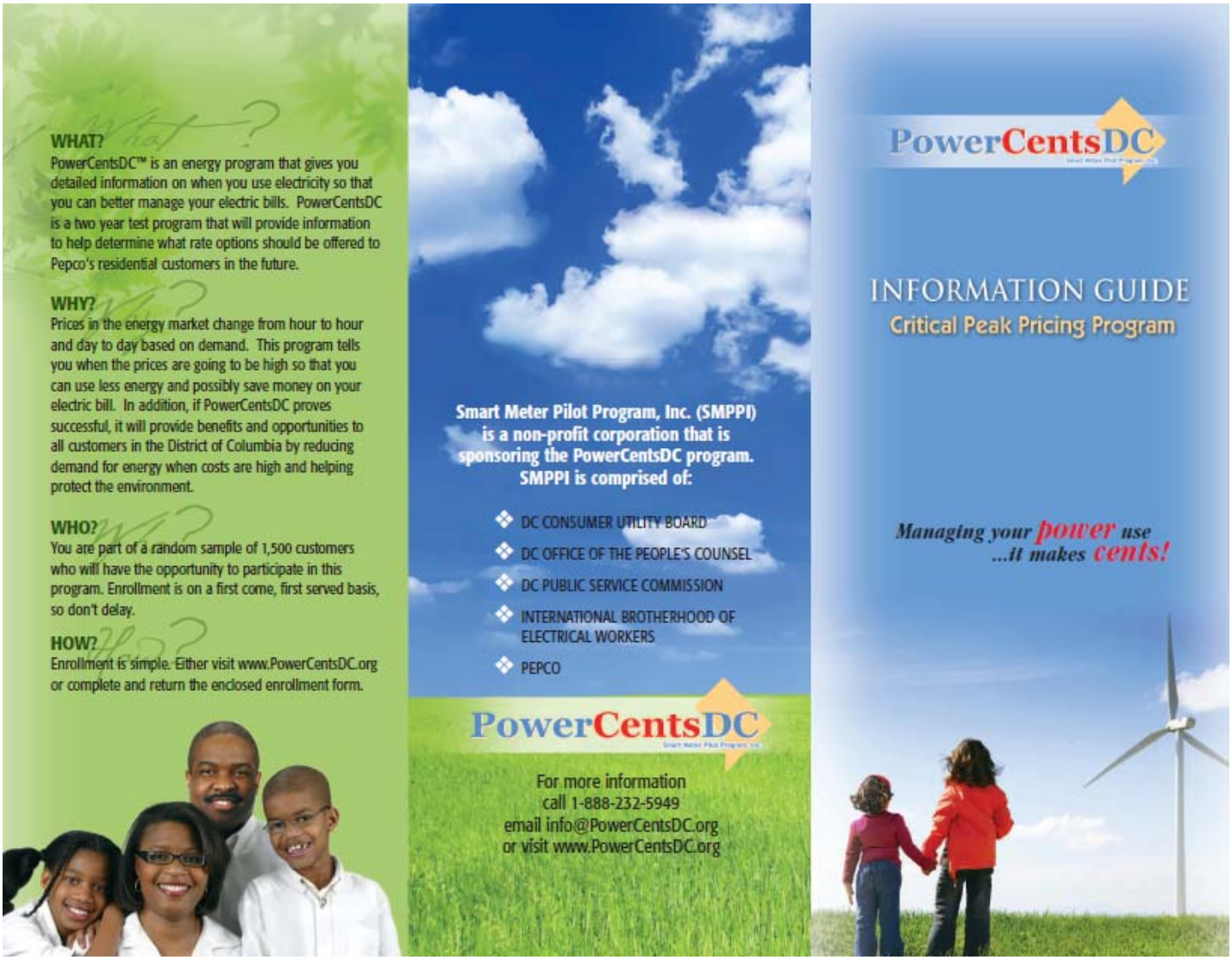
Your participation will help determine what kind of pricing options will be offered to all customers in the District of Columbia in the future. Pepco will continue to provide you with electric service during your participation. Thank you for your part in helping to manage electricity costs and improving the environment in DC.

Sincerely,

Rick Morgan,
Chairman, SMPPI

[1] Smart Meter Pilot Program, Inc.

pepco OPC CUB


WHAT?
PowerCentsDC™ is an energy program that gives you detailed information on when you use electricity so that you can better manage your electric bills. PowerCentsDC is a two year test program that will provide information to help determine what rate options should be offered to Pepco's residential customers in the future.
WHY?
Prices in the energy market change from hour to hour and day to day based on demand. This program tells you when the prices are going to be high so that you can use less energy and possibly save money on your electric bill. In addition, if PowerCentsDC proves successful, it will provide benefits and opportunities to all customers in the District of Columbia by reducing demand for energy when costs are high and helping protect the environment.
WHO?
You are part of a random sample of 1,500 customers who will have the opportunity to participate in this program. Enrollment is on a first come, first served basis, so don't delay.
HOW?
Enrollment is simple. Either visit www.PowerCentsDC.org or complete and return the enclosed enrollment form.
Smart Meter Pilot Program, Inc. (SMPPI) is a non-profit corporation that is sponsoring the PowerCentsDC program. SMPPI is comprised of:
DC CONSUMER UTILITY BOARD
DC OFFICE OF THE PEOPLE'S COUNSEL
DC PUBLIC SERVICE COMMISSION
INTERNATIONAL BROTHERHOOD OF ELECTRICAL WORKERS
PEPCO
PowerCentsDC
For more information
call 1-888-232-5949
email info@PowerCentsDC.org
or visit www.PowerCentsDC.org
PowerCentsDC
INFORMATION GUIDE
Critical Peak Pricing Program
Managing your power use ...it makes cents!

WHAT IS CRITICAL PEAK PRICING?

Under the critical peak pricing rate plan, your electricity price will vary based on the price of electricity in the electric wholesale market. You will be notified a day in advance when critical peak days occur, allowing you to adjust your energy use for the next day.

There will be no more then 15 critical peak days called per year, and you will be asked to reduce your usage for only four hours on these days. Reducing energy consumption when prices are high helps you control your energy bill.

CRITICAL PEAK HOURS DURING 15 PEAK DAYS PER YEAR

SUMMER 2 p.m. - 6 p.m.
WINTER 6 a.m. - 8 a.m. and 6 p.m. - 8 p.m.

WHEN DO HIGH PRICED HOURS OCCUR?

Critical peak days occur most often in July and August when the temperature and humidity are high. They also occur during the winter on very cold days. It is important to note that no more than 60 hours per year will be billed at the critical peak rate. The other 8,700 hours during the year will be priced *lower* than your current rate plan.

HOW WILL I KNOW WHEN PRICES ARE HIGH?

In the event that a critical peak day is called, we will notify you the day ahead by telephone, email, text message, or pager – your choice. Notification for Monday occurs on Friday.

WILL I PAY MORE MONEY IF I DON'T MAKE ANY CHANGES?

You may be able to save money if you pay attention to WHEN you use energy, as well as HOW MUCH. If you make no changes in your energy use you will pay, on average, the same amount over a twelve month period as on the Pepco Standard Offer Service (your current electricity price). Since not all customers are average, if you make no change, you could pay a small amount less over the course of the year, or you could pay a small amount more.

Detailed information provided on how much you are spending each day for electricity.

HOW DO I SAVE MONEY?

You can save money by using less energy when prices are high – during critical peak hours.

HOW CAN I REDUCE ELECTRICITY USE?

You can reduce electricity use during higher priced hours by raising your thermostat in the summer or lowering it in the winter. You may also change the time when you do laundry, turn off lights or other appliances, and schedule errands or shopping so you are out of the house during higher priced hours.

Energy saving tips to help you save money on your electric bill can be found at www.PowerCentsDC.org

COST?

There is no cost to participate in PowerCentsDC. You don't need to buy any special equipment. Pepco will install a "smart meter" at your home that uses advanced technology to measure hourly energy usage. The meter will remain in place at the conclusion of the program.

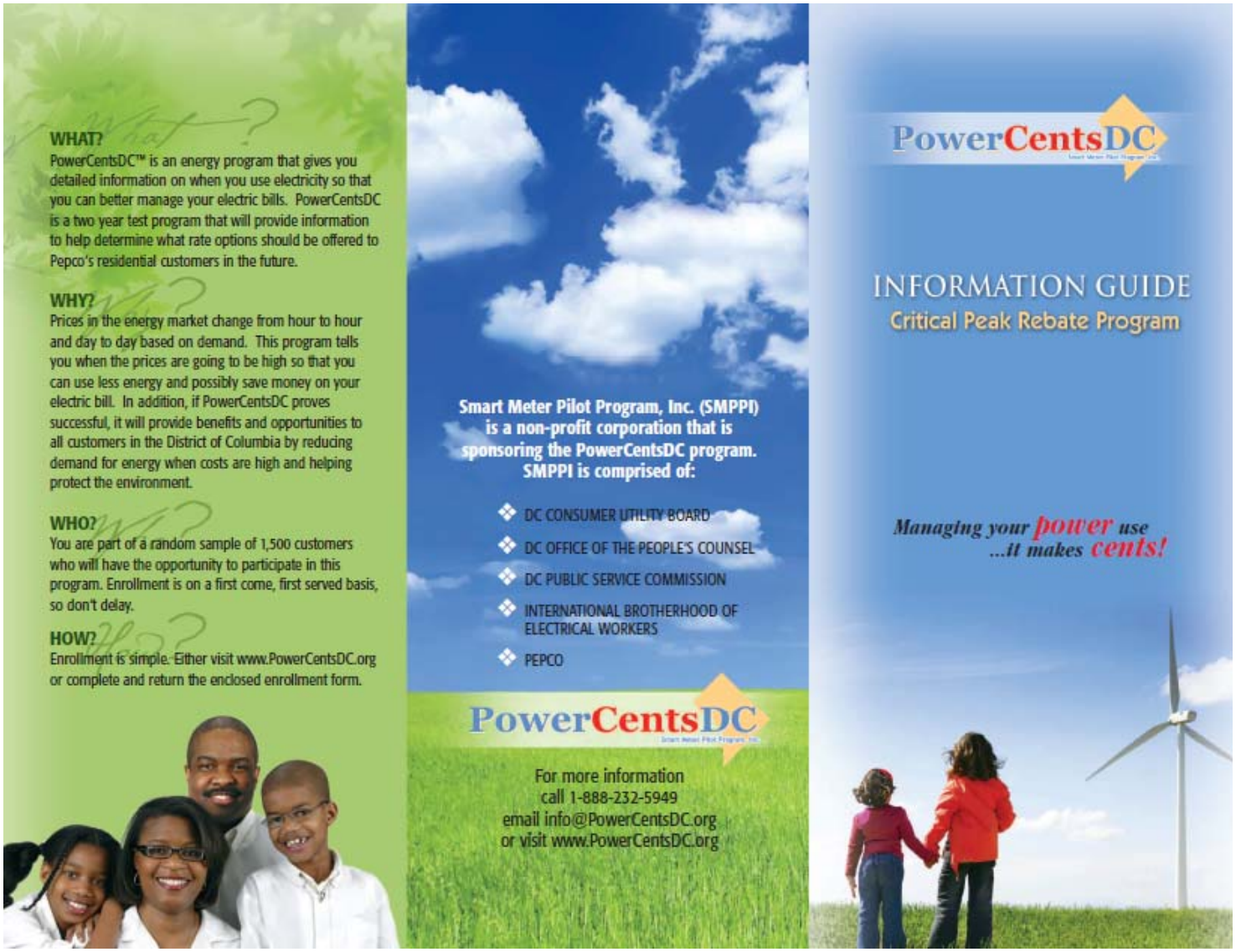
Smart Meter

Also, a limited number of customers with central air-conditioning will be offered a free smart thermostat on a first come, first served basis. The smart thermostat receives a radio signal from Pepco when energy prices are high; reducing the amount of energy consumed by your air-conditioner.

Smart Thermostat

WHEN?

Enrollment begins now. We will confirm your enrollment and provide additional details by letter before the program starts in the fall of 2007.


WHAT?
PowerCentsDC™ is an energy program that gives you detailed information on when you use electricity so that you can better manage your electric bills. PowerCentsDC is a two year test program that will provide information to help determine what rate options should be offered to Pepco's residential customers in the future.
WHY?
Prices in the energy market change from hour to hour and day to day based on demand. This program tells you when the prices are going to be high so that you can use less energy and possibly save money on your electric bill. In addition, if PowerCentsDC proves successful, it will provide benefits and opportunities to all customers in the District of Columbia by reducing demand for energy when costs are high and helping protect the environment.
WHO?
You are part of a random sample of 1,500 customers who will have the opportunity to participate in this program. Enrollment is on a first come, first served basis, so don't delay.
HOW?
Enrollment is simple. Either visit www.PowerCentsDC.org or complete and return the enclosed enrollment form.
Smart Meter Pilot Program, Inc. (SMPPI) is a non-profit corporation that is sponsoring the PowerCentsDC program. SMPPI is comprised of:
DC CONSUMER UTILITY BOARD
DC OFFICE OF THE PEOPLE'S COUNSEL
DC PUBLIC SERVICE COMMISSION
INTERNATIONAL BROTHERHOOD OF ELECTRICAL WORKERS
PEPCO
PowerCentsDC
For more information
call 1-888-232-5949
email info@PowerCentsDC.org
or visit www.PowerCentsDC.org
PowerCentsDC
INFORMATION GUIDE
Critical Peak Rebate Program
Managing your power use ...it makes cents!

WHAT ARE CRITICAL PEAK REBATES?

Under the critical peak rebate rate plan, you are able to earn a rebate for reducing your electric consumption below what you would normally have used during a critical peak period.

WHAT IS A CRITICAL PEAK PERIOD?

Critical peak periods occur when competitive wholesale energy prices are unusually high. Critical peak periods occur most often in July and August when the temperature and humidity are high. They also occur during the winter on very cold days.

Under this program critical peak periods can be called up to fifteen times per year and last for four hours. When called, they will occur as follows:

CRITICAL PEAK HOURS DURING 15 PEAK DAYS PER YEAR

SUMMER 2 p.m. - 6 p.m.
WINTER 6 a.m. - 8 a.m. and 6 p.m. - 8 p.m.

HOW WILL I KNOW WHEN THERE IS A CRITICAL PEAK PERIOD?

In the event that a critical peak period is called, we will notify you the day ahead by telephone, email, text message, or pager – your choice. Notification for Monday occurs on Friday.

WILL I PAY MORE MONEY IF I DON'T MAKE ANY CHANGES IN MY ELECTRIC USAGE?

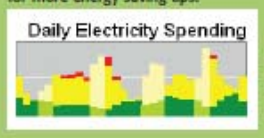
No. This program is designed so that you will not pay more than you pay on your current rate plan.

HOW DO I EARN A REBATE?

You can potentially earn a rebate by lowering your electric consumption during the critical peak period to a level below what you would have normally used during the same time period.

HOW CAN I REDUCE ELECTRICITY USE?

You can reduce electricity use during higher priced hours by raising your thermostat in the summer or lowering it in the winter. You may also change the time when you do laundry, turn off lights or other appliances, and schedule errands or shopping so you are out of the house during higher priced hours. Please visit www.PowerCentsDC.org for more energy saving tips.



Detailed information provided on how much you are spending each day for electricity.

HOW IS MY REBATE CALCULATED?

The rebate is calculated by multiplying the reduced consumption, measured in kilowatt-hours, by the rebate amount per kilowatt-hour.

HOW WILL I RECEIVE MY REBATE?

The rebate will be included on your Pepco bill. An Electric Usage Report will contain specific details about the rebate.

Energy saving tips to help you save money on your electric bill can be found at www.PowerCentsDC.org

COST?

There is no cost to participate in PowerCentsDC. You don't need to buy any special equipment. Pepco will install a "smart meter" at your home that uses advanced technology to measure hourly energy usage. The meter will remain in place at the conclusion of the program.

Smart Meter

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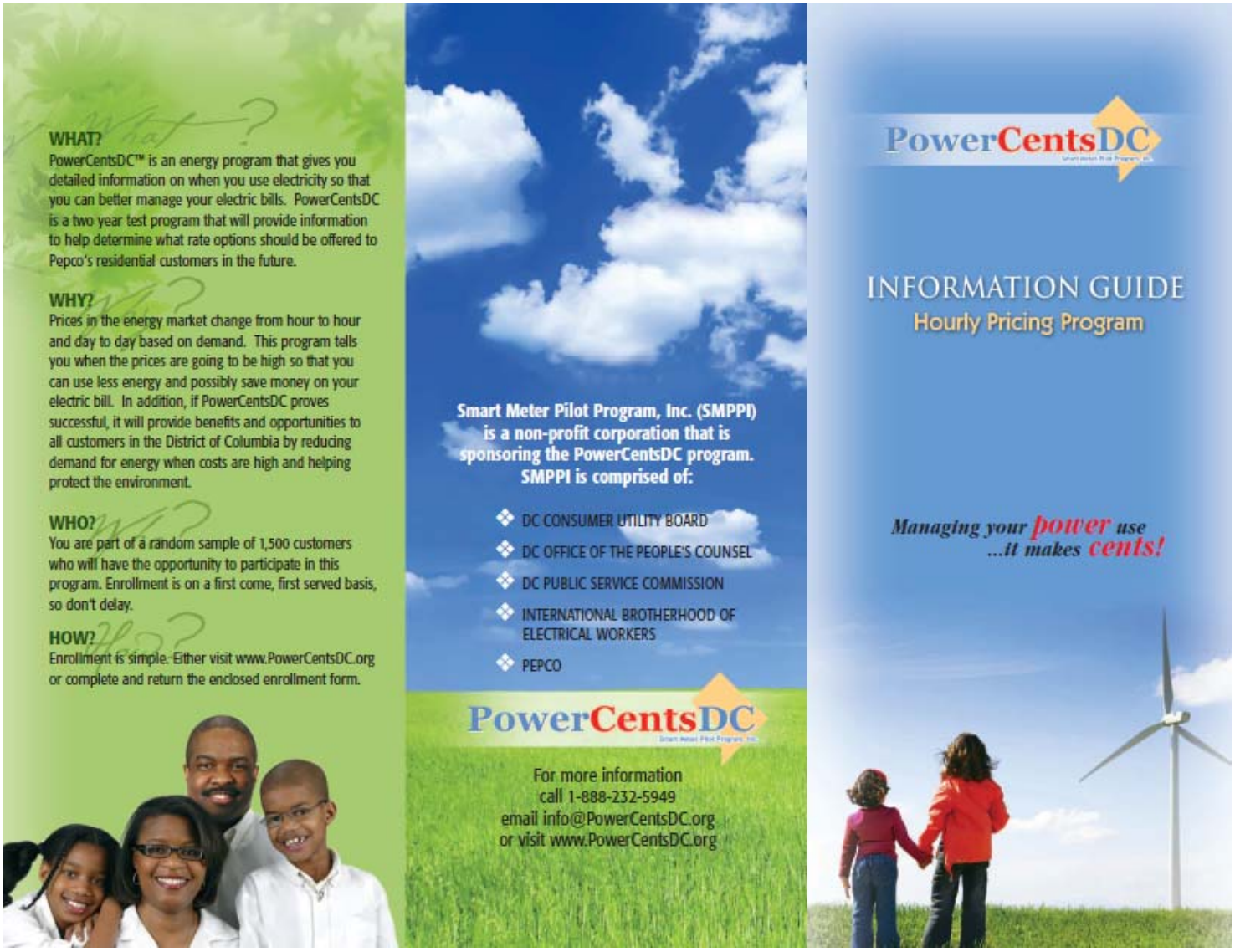
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PowerCentsDC
INFORMATION GUIDE
Hourly Pricing Program
Managing your power use ...it makes cents!

WHAT IS HOURLY PRICING?

In the wholesale market, the price of electricity varies each hour. With the hourly pricing rate plan, prices are sometimes lower and sometimes higher than your current rate. Your electricity prices change each hour to reflect the variation in the wholesale prices.

WHEN DO HIGHER PRICED HOURS OCCUR?

Higher priced hours occur most often on weekday afternoons in July and August when the temperature and humidity are high. They also occur during the winter on very cold days.

In 2006, high prices (those over 22¢ per KWH) occurred less than 2% of the time.

HOW WILL I KNOW WHEN PRICES ARE HIGH?

Hourly prices are posted on www.PowerCentsDC.org daily. If you like, we can also email them to you. If you have a smart thermostat, we will send the hourly prices to your thermostat, which will display the current hourly pricing.

In the event that prices are high, we will notify you the day ahead by telephone, email, text message, or pager – your choice. Notification for Saturday, Sunday and Monday occurs on Friday.

WILL I PAY MORE MONEY IF I DON'T MAKE ANY CHANGES?

You may be able to save money if you pay attention to WHEN you use energy, as well as HOW MUCH. If you make no changes in your energy use you will pay, on average, the same amount over a twelve month period as on the Pepco Standard Offer Service (your current electricity price). Since not all customers are average, if you make no change, you could pay a small amount less over the course of the year, or you could pay a small amount more.

Detailed information provided on how much you are spending each day for electricity.

HOW DO I SAVE MONEY?

You can save money by using less energy during high priced hours. Simply shifting usage from the few high priced hours during the year to hours when prices are lower–most other times – could save you money.

HOW CAN I REDUCE ELECTRICITY USE?

You can reduce electricity use during higher priced hours by raising your thermostat in the summer or lowering it in the winter. You may also change the time when you do laundry, turn off lights or other appliances, and schedule errands or shopping so you are out of the house during higher priced hours.

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9 Appendix B: Analytical Model

The analytical model was developed and implemented by Dr. Frank Wolak of Stanford University. The model used is a nonparametric conditional mean estimation framework. This framework is the most general model one can estimate to recover the impact of a critical peak event, the independent variable in the model. Unlike other pilot results, with this framework, it is hard to think of any omitted variable that is not controlled for that could be causing the results.

Methodology

The demand response impact and conservation effect analysis used a nonparametric conditional mean estimation framework. The framework uses customer-level fixed effects and day-of-sample fixed effects. The demand response impacts were determined using hourly data for the report period of July 2008 through February 2009.

The fixed effects approach uses a separate intercept term for each customer to control for effects that are unique to that customer and constant over the time period being examined. The unique effects of the stable, but unmeasured characteristics of each customer are their "fixed effects" from which this method takes its name. The fixed effects nature of the model means the model does not need to include unchanging customer characteristics such as square footage, number of floors, equipment, etc. Controlling for fixed effects controls the amount of variance (noise) the model is faced with, since each customer has a different base load, a different response to weather, and a different pattern of consumption that changes over time.

The model also uses time effects, which means that the model controls for all differences in consumption across days in the sample due to temperature, sunshine and any other factors common to all customers for the same day. This approach also provides for a much closer fit to the data than most models, as individual responsiveness is incorporated. This approach has worked well in estimating the impacts of mass-market programs such as the California Statewide Pricing Pilot, the Idaho Power critical peak pricing pilot, and the Sacramento Municipal Utility District air conditioning direct load control program. Such an approach is also consistent with the recommendations of the California Evaluation Framework prepared for the California Public Utilities Commission.

The Framework describes the various regression models available for the type of data in the pilot and highlights the benefit of a more general approach:

> Most regression models are estimated as ordinary least squares (OLS), generalized least squares (GLS), or other forms of maximum likelihood estimation. These methods generally produce similar results under similar circumstances. Generalized least squares, as its name implies, is a more generalized statistical equation. If the error term is normally distributed,

both OLS and GLS may be identical to the maximum likelihood estimate (MLE). There are differences in these estimation methods, however, that lead to the decision of which model specification is more appropriate for different circumstances. The more generalized the method, the more it can often be used to correct for different issues. At the same time, it can become more computationally difficult.[12]

The analysis of the pilot could be estimated by GLS but that would not be as robust as the technique used for this pilot. To use technical statistical jargon, the model uses OLS with standard errors that are robust to heteroscedasticity and autocorrelation of an unknown form. If we modeled the structure of correlation and used a GLS estimator, we may be able to improve the apparent efficiency of the estimates, but we would be subject to the criticism that our results may be driven by the method we used to correct for autocorrelation and heteroscedasticity, a complaint that cannot be lodged against the results presented here.

Model

To estimate the analysis results for demand response, we use the general model

$$y_{(i,t)} = \alpha_i + \lambda_t + Treat_i*HP_t*\beta 1 + Treat_i*CPP_t*\beta 2 + Treat_i*CPR_t*\beta 3 + \varepsilon_{(i,t)}$$

where:

$y_{(i,t)}$ is the natural logarithm of consumption for customer *i* during the peak hours on day *t*,

α_i is the customer-level fixed effects,

λ_t is the day of sample fixed effect,

$Treat_i$ is the dummy variable whether a customer is treatment or control,

HP, or CPP_t , or CPR_t is the dummy variable indicating whether a day is a critical peak day or not,

$\beta 1, 2, 3$ is the change in consumption due to the pricing plan for HP, CPP, and CPR customers, respectively, and

$\varepsilon_{(i,t)}$ is the error term for customer *i* during the peak hours on day *t*.

The estimate of β controls for persistent differences in consumption across customers (the α_i) and persistent differences in consumption across days for all customers (the λ_t). In this

[12] - TecMarket Works, "The California Evaluation Framework," June 2004, p. 108

way, it isolates the impact of the desired effect only to the treatment group. The day-of-sample fixed effects account for weather, and other common factors impacting all PowerCentsDC customers during a given day. Thus, claims cannot be made that the load impacts are because it is a hot day or a selected sample was selected, because we control for both of these factors. The statistical error term (the $\varepsilon_{(i,t)}$) is the unexplained variance in hourly electricity consumption for customer *i* during the peak hours on day *t*. The simplicity of the model is its strength: it is the most general model one can estimate to recover the impact of a critical peak day.

The model was refined with the addition of further variables to provide results for individual event days and to separate the effects of smart thermostats.

Results

The following tables show the results. The grayed out, italicized results are not statistically valid.

Parameter	Estimate	Standard Error	t Value	Pr > |t|
HP	-0.02963711	0.00845398	-3.51	0.0005
CPP_NO_RBT	-0.32459969	0.00835407	-38.86	<.0001
CPP_RBT	-0.12301593	0.00794569	-15.48	<.0001

Exhibit 39: Peak demand reductions for Rate R customers, pooled sample.

Parameter	Estimate	Standard Error	t Value	Pr > |t|
HP	*-0.00223244*	*0.01079861*	*-0.21*	*0.8362*
CPP_NO_RBT	-0.28488646	0.01019767	-27.94	<.0001
CPP_RBT	-0.11208617	0.00978262	-11.46	<.0001
HP*THERM	-0.09644995	0.0181326	-5.32	<.0001
CPP_NO_RBT*THERM	-0.20404055	0.01667122	-12.24	<.0001
CPP_RBT*THERM	-0.05575806	0.01472276	-3.79	0.0002

Exhibit 40: Peak demand reductions for Rate R customers without and with smart thermostats, pooled sample.

Parameter	Estimate	Standard Error	t Value	Pr > |t|
HP	-0.02926469	0.00952244	-3.07	0.0021
CPP_NO_RBT	-0.33838062	0.00921183	-36.73	<.0001
CPP_RBT	-0.12865578	0.00874442	-14.71	<.0001

Exhibit 41: Peak demand reductions for Rate R customers for summer, pooled sample.

Parameter	Estimate	Standard Error	t Value	Pr > |t|
HP	*-0.00802333*	*0.02386359*	*-0.34*	*0.7367*
CPP_NO_RBT	-0.12407266	0.02078064	-5.97	<.0001
CPP_RBT	-0.06988333	0.02004461	-3.49	0.0005

Exhibit 42: Peak demand reductions for Rate R customers for winter, pooled sample.

Parameter	Estimate	Standard Error	t Value	Pr > |t|
HP	-0.08965284	0.01852429	-4.84	<.0001
CPP_NO_RBT	-0.37089811	0.01810451	-20.49	<.0001
CPP_RBT	-0.11055886	0.01699004	-6.51	<.0001

Exhibit 43: Peak demand reductions for Rate AE customers, pooled sample.

Parameter	Estimate	Standard Error	t Value	Pr > |t|
HP	-0.09624346	0.0213389	-4.51	<.0001
CPP_NO_RBT	-0.21716347	0.0215431	-10.08	<.0001
CPP_RBT	-0.05649775	0.01945754	-2.9	0.0037
HP*THERM	0.12042392	0.03738023	3.22	0.0013
CPP_NO_RBT*THERM	-0.28961746	0.03079521	-9.4	<.0001
CPP_RBT*THERM	-0.1813449	0.02923339	-6.2	<.0001

Exhibit 44: Peak demand reductions for Rate AE customers without and with smart thermostats, pooled sample.

Parameter	Estimate	Standard Error	t Value	Pr > |t|
HP	-0.06319983	0.01874498	-3.37	0.0007
CPP_NO_RBT	-0.33310111	0.01766634	-18.86	<.0001
CPP_RBT	-0.1187613	0.01665578	-7.13	<.0001

Exhibit 45: Peak demand reductions for Rate AE customers for summer, pooled sample.

Parameter	Estimate	Standard Error	t Value	Pr > |t|
HP	-0.12963207	0.05696798	-2.28	0.0229
CPP_NO_RBT	-0.13403454	0.05521275	-2.43	0.0152
CPP_RBT	*-0.00402796*	*0.04999633*	*-0.08*	*0.9358*

Exhibit 46: Peak demand reductions for Rate AE customers for winter, pooled sample.

Parameter	Estimate	Standard Error	t Value	Pr > |t|
CPP_RBT	-0.04662779	0.02108649	-2.21	0.027

Exhibit 47: Peak demand reductions for Rate RAD customers, pooled sample.

Parameter	Estimate	Standard Error	t Value	Pr > |t|
CPP_RBT	-0.29833065	0.03229203	-9.24	<.0001

Exhibit 48: Peak demand reductions for Rate RAD-AE customers, pooled sample.

Appendix C: Smart Meter Program Best Practices

The SMPPI Board and program managers presented results from the PowerCentsDC program to federal officials on July 1, 2010. During the discussion, the question arose as to what assistance SMPPI might be able to provide to others regarding design and implementation of similar programs. This appendix provides such information based on the PowerCentsDC program as well as other programs managed by the PowerCentsDC Program Manager, including Pacific Gas & Electric Residential Time-of-Use Rates, the California Statewide Pricing Pilot, the Anaheim Public Utilities "Spare the Power Days" Program, and the Ontario Smart Price Pilot.

Interested persons are encouraged to contact SMPPI with any questions or requests via the PowerCentsDC Program Manager, Chris King, at chris@emeter.com.

1. Literature Review

The most valuable and important step in implementing a smart meter program is learning from others. This includes reviewing the vast literature on pilot programs that includes literally hundreds of programs.

The literature goes back to the 1970s and remains valuable for two reasons. First, every experiment provides insights into consumer behavior. While attitudes and technology change quickly and sometimes transformatively, such as the Internet, human nature remains unchanged. A good example is how people make decisions, including those related to electricity, such as deciding whether to be on a dynamic pricing program.

Second, every pilot provides insights into program design. Each implementation faced and overcame various challenges with equipment, information systems, data analysis, and so on. By gaining the benefit of these lessons learned, implementers are better able to avoid those challenges in the first place – in short, make fewer mistakes and make the best possible use of the limited resources available for the program.

2. Program Design

i. Pilot Goals

The PowerCentsDC design is based on scientific principles of experimental design. A pilot must allow estimates of usage impacts to be developed for the rate, information and technology treatments that are used in the pilot. In order to support rate policy and business planning, the pilot must allow policy makers to extrapolate beyond the rates and treatments that are explicitly tested in the pilot.

It is important that the pilot design be able to capture not only the response of the average customer to various forms of time-varying rates, but the variation in response across customer types and, sometimes, climate zones. This is especially important where there is

variety in climatic conditions and the socio-demographic condition of customers. Prior research conducted by EPRI, using a pooled data set that included data on customer response from California, Connecticut, North Carolina and Wisconsin, indicates that customer responsiveness varies significantly with appliance ownership and climate. For customers living in a hot climate, who had all major electric appliances in their home, measures of customer responsiveness were more than twice the value for those living in cool climates without any major electric appliances in the home.

ii. Multiple Treatments

The pilot should not feature an insufficient number of treatments. For example, it may just feature a critical peak pricing rate. This would mean that the pilot would yield results that are valid for CPP rates but may or may not be valid for other time-differentiated rates, or it might have a single price treatment, in which case one would not be able to extrapolate beyond the specific treatment tested.

Given the level of investment needed in a pilot, combined with the inherent unpredictability of the future – policy preferences, technologies, and customer priorities all will change – it is important to learn as much as possible. This is best done through having multiple treatments. Importantly, too many treatments can also be a problem, if insufficient customers are in each group. Then, the statistical results may not be valid.

For example, in the PowerCentsDC program, the budget did not allow for large enough sample sizes to allow comparison of customer peak demand reductions between participants with central air conditioning and window air conditioning. This was not a program design goal, though the result may be of interest. Pilot planners need to be explicit in their design goals, then establish the treatments and sample sizes accordingly.

iii. Thank You Payments

Pilot participants are nearly always provided with a payment to participate. In some programs, participants are given compensatory payments to make them whole, i.e., to insulate them from any adverse economic impacts that may be caused by the experimental rates. If participants are aware that they will be made whole, they may behave differently than they would otherwise. If the payments are tied closely to the price of electricity, that may introduce bias in the results as well.

Participants may also be encouraged to participate through a sign-up bonus. If presented as such, the payment will tend to motivate the behavior emphasized – signing up – rather than the behavior sought – understanding and responding to different prices or energy information.

The best means of encouraging participation without skewing the results is through a thank-you payment. This is presented as appreciation for participating throughout the program and is best divided between an initial payment and a second one at the program's conclusion. As a fixed amount, guaranteed regardless of the customer's load shifting or conservation behavior, the payment is an externality. Economists have determined that

such an externality will not affect load shifting or energy saving behavior, because consumers receive or fail to receive the benefits of their behavior change regardless of the thank-you payment.

Some programs are sufficiently popular with consumers that thank you payments have been unnecessary. For example, the Critical Peak Rebate customers in PowerCentsDC did not receive such payments, and they participated at levels actually higher than Critical Peak Price and Hourly Pricing customers.

iv. Observation Effect

Program participants may behave differently simply because they are being observed. Known as the Hawthorne effect, this influence can be very difficult to expunge. Those who are getting the treatments may display a response during the experiment that would not match the response during a non-experimental application. There are two best practices in this regard.

The first is to ensure that control customers are not aware that they are being monitored. They receive smart meters to record their detailed data, because such data is essential to the experiment. However, they should not be told that anything is different about their service, and, indeed, there should be nothing different about their rates or service other than the meter. The meter installation should be as unobtrusive as possible. Utilities have successfully used this approach with load research customers for decades.

The second best practice is to run the experiment as closely as possible to conditions that would be in place for a large-scale program. In other words, even though participants will know they are in a new program, that program mirrors what the program would look like in a large-scale implementation. To the extent the experimental program actually approximates the large-scale program, the observation effect loses its meaning. The whole idea is that consumers make changes in response to the program, and if those changes are made in response to a real-world program, then it is irrelevant that the participants are being observed.

3. Experimental Design

i. Internal and External Validity

Given the long history of experimentation in the social sciences, it is possible to identify common errors in experimental design that invalidate the conclusions that one would otherwise draw from these programs. Two conditions render an experiment invalid: lack of internal validity and lack of external validity.

A pilot is invalid internally if it fails to establish a cause-effect relationship between the treatments considered in the pilot and the outcomes measured for the participants who were given the treatments. Threats to internal validity can be controlled by scientific design, specifically by establishing proper treatment and control groups and ensuring that sample sizes for each treatment group are sufficient.

A pilot is invalid externally if its findings cannot be applied outside of the pilot setting, to other populations of interest or during other time periods for the pilot's population.

It is possible to enhance the external validity of a pilot by taking a number of steps. For example, by including a variety of rate treatments in the pilot that span a range of future market conditions and not just the conditions in today's market, one can ensure that the results would be valid in the future. In addition, by measuring the effect of socio-demographic and climatic factors that vary, one can assure that the results will be valid not just for the customers included in the pilot but to the entire target population. However, it is not possible to guarantee external validity, since unusual weather or economic conditions can be encountered during the implementation of any pilot program.[13]

ii. Ensuring Internal Validity

The remainder of this discussion focuses on how to ensure a pilot's internal validity. There are several common design flaws that render a pilot invalid internally; each can be avoided through proper planning and implementation. PowerCentsDC was designed to ensure avoidance of these issues.

Establishing a Control Group

A pilot should have a control group. Some pilots only have customers in one or more treatment groups. In these cases, their usage is observed before and after the treatment has been administered, and the entire change in usage is attributed to the treatments being given. But some of the change in usage may have been due to factors other than the treatment, such as weather or economic conditions. A control group provides a way to control for these effects, and its absence creates the risk that the experimental findings will be plagued by doubt and ambiguity.

Representative Control Group

A control group may exist, but it may not be comparable to the treatment group. Thus, prior to the treatments being administered, usage between the treatment and control groups may diverge. Any divergence after the treatments have been administered would be confounded with the a priori divergence, creating imprecision in the estimated impact. Such experiments are called quasi-experiments. To ensure valid results, the usage of the control group should be compared to the usage of the treatment group, on a time-differentiated basis, for the period prior to the live billing on the treatment prices. A statistical comparison is needed to demonstrate that there are no statistically valid differences between the control and treatment groups in electricity consumption prior to the experiment.

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[13] - The economic downturn during the PowerCentsDC program is an example of external effects that cannot be controlled for entirely; for PowerCentsDC, the downturn significantly affected the results for hourly pricing customers.

Statistical Sampling

The samples that are selected for the experiment must be sufficiently large to test the variables of interest, such as different population groups, income levels, or climate regions. Participants should be randomly selected to be part of the pilot, and then assigned randomly to the various treatment and control group cells.

Stratified samples, where the population is categorized according to known variables (e.g. existing tariffs or geography), are important. With a stratified sample, fewer customers are selected at random from a group that is large in the overall population (e.g., normal income customers), while more, proportionally, are selected from groups that are smaller in the overall population (e.g. customers with limited income). Provided that the actual proportions are known, the results can then be extrapolated to the entire population with confidence, and the reliability of results is enhanced through the proportional oversampling of the smaller populations.

While specific statistical calculations are needed to determine necessary sample sizes for each treatment group, a good rule of thumb is that each group to be analyzed should have a minimum of 30 customers. Researchers find that when they attempt to "slice and dice" the data into smaller categories, the statistical validity or results often falls off rapidly below such levels.

Pre-Treatment Usage

The design should allow for the measurement of pre-treatment usage. This allows validation of the comparability of the treatment and control groups in the final analysis. In addition, it allows for the elimination of the effects of weather and other "confounding" variables that may have changed over time, including changes in appliance holdings or general income levels.

Representative Customers

Policymakers almost always require that pilot participants be volunteers. This occurs for two reasons. First, electricity regulators have been very reluctant to force consumers to participate in experiments, reflecting general policymaking preferences in our society. Second, and for similar reasons, dynamic prices provided to consumers have almost always been voluntary. On the other hand, the pilot must be representative of the population.

The best means of accomplishing these twin goals is to limit participation to customers selected by the utility. Only those customers selected and notified by the utility should be permitted to participate. Also, customers who are selected should be notified that they have been selected as participants and may choose to refuse participation, rather than being told they have the opportunity to volunteer. This makes the pilot an "opt-out" program rather than an "opt-in" program and makes the results far more representative of the overall population. This is because consumers tend to remain with the status quo. Therefore, even though opt-in and opt-out percentages are not dissimilar, the starting point (status quo) is very different, and the resulting participation is very different.

The other reality of smart grid and smart meter programs is that customers must affirmatively participate regardless of any potential policymaker's desire to impose a mandatory requirement. This is because these programs require customer action by definition. For example, a customer cannot be notified of critical peak events unless the customer provides a telephone number or email address. Similarly, a smart thermostat cannot be installed without the customer's consent.

iii. The Gold Standard

The best practice is to use an experimental design that features a control and treatment group, and to take measurements before and after the treatments have been administered. Participants should be randomly selected to be part of the pilot, and then assigned randomly to the various treatment and control group cells. The sample should be stratified to ensure sufficient sampling from each of the planned treatment groups. Such a design, dubbed the "gold standard," is shown in Exhibit 49.

The true measure of the impact of a treatment is the difference in usage of the treatment group before and after the treatment has been administered, net of any difference in usage of the control group during the same time period. This measure is labeled (T2-T1)-(C2-C1) in Figure 3-6. It can also be rewritten as (T2-C2)-(T1-C1). If the treatment and control groups are perfectly balanced, there is a good chance that T1-C1 will be zero. Then T2-C2 would provide a reliable impact of program impacts.

	Control Group	Treatment Group
Before Treatment	C_1	T_1
After Treatment	C_2	T_2

I. True Impact Measure = $(T_2 - T_1) - (C_2 - C_1)$

- All other variables are held constant
- Random assignment to control or treatment group

II. Inferior Measures of Impact

- (1) $T_2 - T_1$
- (2) T_2
- (3) $T_2 - C_2$

Exhibit 49: The "Gold Standard" of pilot design provides the best way of obtaining statistically valid results.

iv. Market Research

Market research is valuable before, during, and after the program. As with the program overall, the first step is a thorough review of the available literature with market research findings from prior similar programs.

Pre-Pilot Market Research

It is customary to precede pilot programs with a market research program to ensure that pilot treatments are understandable to customers, do not impose undue hardships, and are generally acceptable (e.g., are not "dead on arrival"). Market research can provide unique insights into customer needs and preferences, and it can help fine-tune the rate treatments that are offered in the pilot to customers. It can also determine the minimum amount of information that should be provided to customers, and the specific characteristics of enabling technology treatments that are offered to them.

If the products being tested in a pilot have no prior history, quantitative market research involving multivariate statistical analysis, conjoint analysis and/or discrete choice modeling may be warranted. Such research, which allows the analyst to get at customer willingness to pay for product features, takes a substantial amount of time and budget. A minimum amount of time for conducting a careful program of quantitative market research is four to six months. However, such research may cost several hundred thousand dollars.

On the other hand, if the products being offered, or similar ones, have a prior history of implementation either in the geographic region where the pilot would be carried out or elsewhere, then it may not be cost-effective to conduct quantitative market research. In such cases, focus groups provide excellent, cost-effective input. This was the case for PowerCentsDC.

Some of the key questions discussed in such focus groups are the following:

- How can the concept of time-varying pricing be best explained to customers?
- What features of such pricing appeal or do not appeal to customers?
- What features of proposed smart thermostats or other devices are appealing or not appealing?
- How can the pricing and technology options be designed to maximize customer acceptance?
- What should be the length, timing and number of peak periods?
- What types of energy information are desirable/acceptable?
- What mechanisms of delivering energy information are desirable/acceptable?
- What is the minimum information treatment that should be made available to all customers?
- What features of event notification procedures are/are not appealing?

Each focus group session should comprise roughly a dozen customers, and lasts for a couple of hours. A facilitator would explain the logic of time-varying pricing to the focus group members, and then walk them through a series of questions. It is best to provide sample materials, such as sample program notification letters, information brochures, and web pages.

This information is used to fine-tune the price, technology, and information options, eliminate any non-starters, and to help refine the specific features that would be offered in the program.

During Pilot Market Research

Once the pilot gets underway, there is an opportunity to conduct additional market research. The results of this research help improve the operation of the program and provide fine tuning of program features, such as information provided to consumers. For example, for PowerCentsDC, following input from participants received through customer service contacts, the Board determined that providing an interactive website would be attractive to participants.

Post-Pilot Market Research

Quantitative consumer surveys following completion of the program provide valuable information for policymakers regarding pricing plans, energy information materials, and smart meter and smart device technologies. Surveys should be conducted of both treatment and control customers. The survey of treatment customers takes advantage of the knowledge and experience of the participants during the program, as well as providing appliance, housing, and demographic data for use in the quantitative analysis. The survey of control customers takes advantage of their not knowing about smart meters, prices, and technologies, but also provides appliance, housing, and demographic data for use in the quantitative analysis.

The surveys can provide insights on numerous issues. For additional examples, see the questions asked in PowerCentsDC, which are provided in Appendices D and E.

a. Pricing Features

The following questions assist in evaluating consumer understanding of dynamic pricing:

1. What rate features are understood and valued by customers? For example, one possible rate feature is that the retail price is more expensive when wholesale prices are high. This concept can easily be understood and valued by customers.

2. Determine customer understanding and fairness perception of various rate features (e.g. relationship between retail price and wholesale cost or system conditions, relationship between demand response and monetary savings, and relationship between appliance efficiency and monetary savings)?

3. Determine customer understanding and fairness perception of incentives involving fixed payments per kWh curtailed versus rate discounts/charges.
4. Determine customer understanding and fairness perceptions for various combinations of features that define existing and potential new rate forms.

b. Information Treatments

The following items assist in evaluating consumer understanding of energy information treatments:

1. Identify customer needs for education and information.
2. Identify critical versus supplemental information needs.
3. Determine interest in next day, online information and in real-time information.
4. Determine interest in different delivery methods, including personalized bill insert (e.g. the PowerCentsDC Energy Usage Reports), mail, email, SMS, and web portals.
5. Determine relative importance of various informational items, including price, usage, cost (e.g. bill to date, cost per hour), and usage by appliance.
6. Establish the willingness to pay for supplemental information.
7. Determine differences between the need for information to support (1) notification versus (2) control.

c. Technology Treatments

The following items assist in evaluating consumer interest in various technologies:

1. Determine interest in controlling different appliances, including air conditioning, electric water heating, space heating, dishwasher, clothes washer and dryer, refrigerators and freezers (e.g. defrost cycle, “ride-through” of critical peak events), and lighting.
2. Determine customer preferences for control.
3. Identify customer needs, preferences and willingness to pay for technologies to adapt to dynamic prices.
4. Identify critical versus supplemental technology needs.
5. Establish the willingness to pay for different control technologies, including simple, low-tech options such as timers on pumps for swimming pools and spas and inter-lock devices that prevent the simultaneous operation of two appliances; medium-tech devices such as receiver switches on air conditioners; and high-tech devices such as smart thermostats and Gateway systems that are always on.

Customer Preference Research

A variety of methods may be used for determining customer preferences. These are briefly described below.

- **Stated intent to purchase.** Customers are queried whether they would agree to switch to a new price plan. This technique produces rough estimates of market shares for specific price plans. It can be implemented quickly over the phone or the Internet.
- **Stated value of product/service attributes.** Customers are asked how much they value particular product attributes. For example, whether they would like a shorter or longer peak period. This technique provides input into product/service design but does not monetize attribute values or allow prediction of participation rates.
- **Conjoint surveys based on stated intent data.** This is a fairly expensive technique that asks customers to rank various combinations of product and service attributes. It monetizes attribute values, and yields "willingness to pay" estimates for specific product features.
- **Regression analysis of "stated intent" to purchase data.** This technique allows prediction of participation as a function of attributes and customer characteristics. Its main limitation is that customers have not actually exercised their preference, and are dealing with a hypothetical situation, which they may or may not comprehend accurately.
- **Regression analysis of actual market purchases.** This technique improves on the previous one, by analyzing actual rather than hypothetical purchase data. It is based on the concept of revealed (as opposed to stated) preference. It provides the most reliable estimates. The main limitation is that it can be implemented only after programs are in place, and it is of limited value when testing new product concepts.

4. Consumer Education and Information

i. Program Information Treatments

Consumer education and information are as important as price plans in inducing consumer response. The best plans begin with studying the literature, the successes and failures of others in providing education and energy information.

Another key consideration is using methods that can be scaled cost-effectively so that the findings are not limited to the pilot but can be utilized in a full-scale rollout situation. This requirement necessitates looking at the cost of delivery of different options, including production costs and IT costs associated with billing, CIS,MDM, and other systems that may be involved.

The other major consideration is having a broad and rich education and information program. Some researchers like to test individual program elements, such as a particular mailed report or a certain online information feature. Because consumers obtain information from multiple sources, the best programs consider the range of opportunities

and use an approach that is integrated and sensible from the consumer's perspective. At a minimum, if possible, a program should include bill inserts and a feature-rich website. These are both very cost effective and scalable means of providing information.

ii. Media Outreach

In addition, the public media are an important information source for consumers. For PowerCentsDC, there was a press conference held at the kickoff of the program, including television and newspaper coverage. PowerCentsDC also maintained a press contact throughout the program, providing information on request. The media coverage heightened awareness of the program and even included some information on smart meters and smart thermostats. Media coverage also is useful for informing policymakers of the existence and content of the program.

In working with the media, it is important to manage expectations. For example, an essential message for PowerCentsDC was that the program was limited to randomly selected participants. By getting this message across clearly, PowerCentsDC successfully prevented people who were not randomly selected from attempting to sign up for the program and being disappointed in not being able to do so. Also, PowerCentsDC took care to educate the media that, while many or most participants would likely save money, the savings would be modest. This prevented unrealistic savings expectations on the part of both the media and participants.

5. Technology

A wide variety of technologies are available today for use in smart meter pilot programs. Two general principles are important in thinking about technology. First, the pilot should be about the customers, not the technology. It should be about providing customers with information and technology and determining customers' ability to utilize that information and technology. The design should determine the goals of the pilot, with technology being a means to achieve those ends rather than the driving purpose of the pilot. Many reliable technologies are available today for use in pilot programs and smart meter deployments.

Second, technology selection and implementation is complex, and an experienced implementation team is the best means of ensuring success. The complexity is a function of several things: 1) the number of technologies available, 2) specific differences in the technologies, 3) the application of the technology in the context of the specific pilot, and 4) the integration of numerous technologies to deliver a complete solution to consumers.

6. Best Practices Summary

The following six elements are the essential ingredients of a well-planned, well-implemented pilot. ,

- **Literature Review.** The implementation team needs a good understanding of what has been done before, what has been learned, what has worked, and what has not.

- **Solid Experimental Design.** This starts with having clear objectives, then applying the proper experimental design principles for sample sizes, treatments, controls, and so on.
- **Market Research.** A central goal of behavioral research is to understand customers. The program prices, technologies, and information treatments are only the starting point. Understanding customers requires targeted and effective market research.
- **Experienced Implementation Team.** There is no substitute for experience in order to design and implement the program, especially including the program design, development of information for consumers, and proper design, integration, and implementation of the hardware, software, and IT systems needed to make real the program functionality.
- **Qualified Independent Analysis.** A key goal of every pilot is to provide information valuable for use by decision makers and policymakers. The information must be credible to be useful. A best practice in this regard is to use an independent analyst with a strong reputation in the appropriate field. For PowerCentsDC, this was Professor Frank Wolak of the Stanford University Economics Department.
- **Smart Oversight.** Every program requires ongoing decisions from either a person in charge or an oversight board. These decisions often involve judgments regarding sensitive or complex issues as well as tradeoffs in use of resources. PowerCentsDC benefitted greatly from the wisdom and experience of its oversight board, the SMPPI Board, which included both extensive experience in the industry as well as multiple perspectives – utility, regulator, consumer, labor union, and technical expert.

Appendix D: Participant Survey Results

Appendix D provides results for the following results:

- Participant survey summary results
- Participant survey detailed results

Participant Survey Summary Results

The participant survey was conducted following the completion of live billing at the end of October 2009. The following charts show highlights of the participant survey.

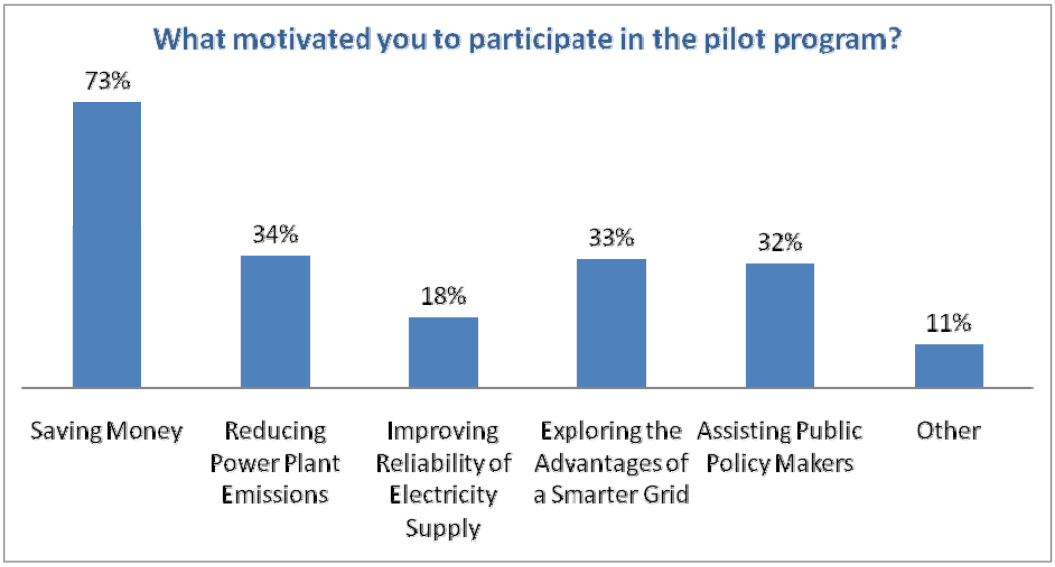

Exhibit 50: Participants had a variety of reasons for participating.

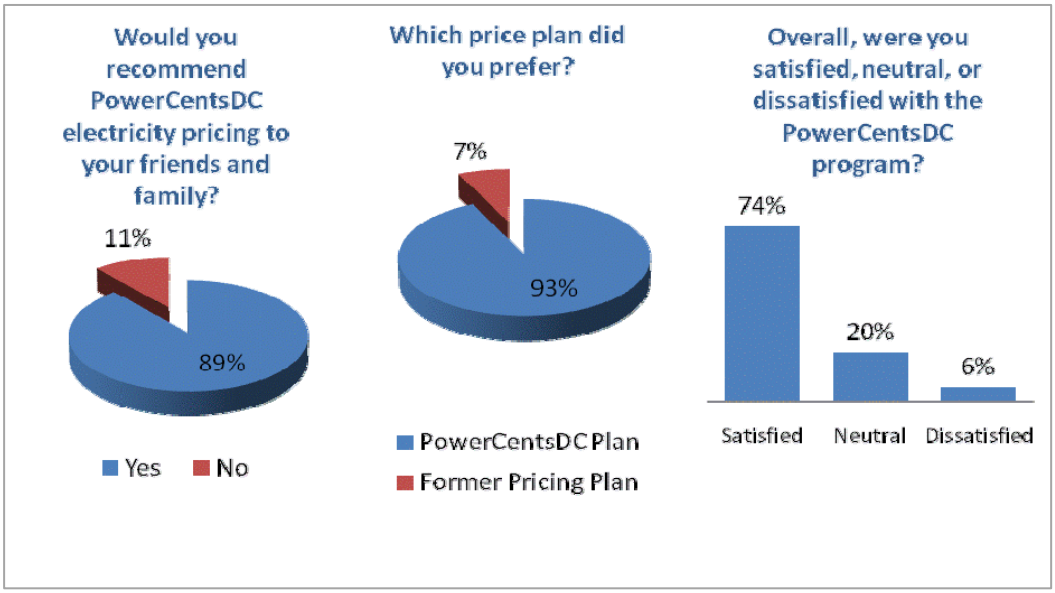

Exhibit 51: Participants expressed high satisfaction levels.

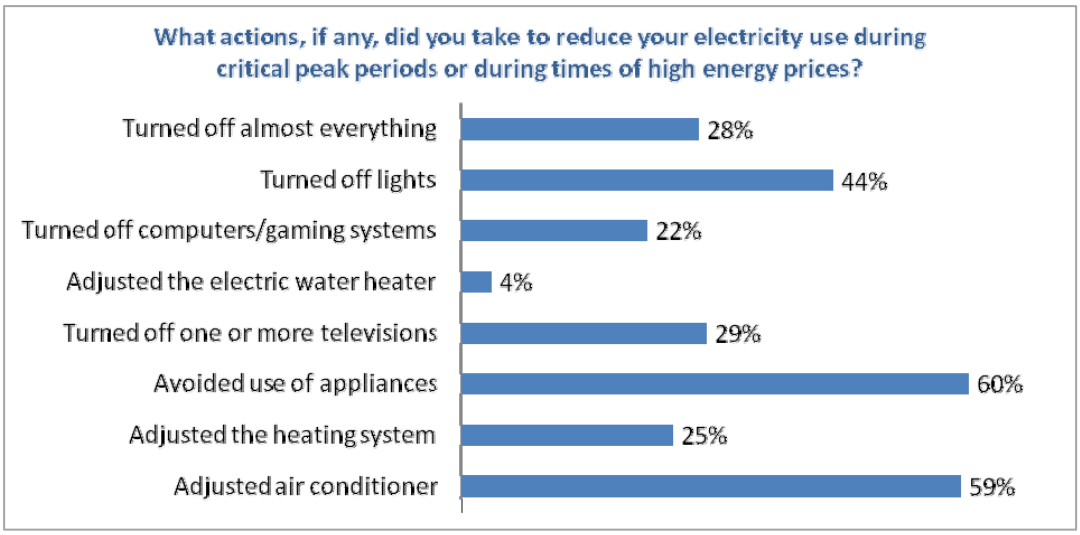

Exhibit 52: Participants were creative in responding to peak price events.

Participant Survey Detailed Results

The following tables show questions asked in the participant survey and the responses.

Could you please select your home type?

	Pricing Plan			
Respondent Answer	**CPP**	**CPR**	**HP**	**Total**
Condominium, townhouse, or duplex	44%	38%	52%	44%
Single family detached house	29%	28%	24%	28%
Apartment	16%	17%	11%	15%
Other	11%	17%	11%	13%
(blank)	0%	0%	1%	0%
Total	**100%**	**100%**	**100%**	**100%**

Exhibit 53: Participants were creative in responding to peak price events.

Please indicate whether you own or rent your home.

	Pricing Plan			
Respondent Answer	**CPP**	**CPR**	**HP**	**Total**
Own	83%	81%	78%	81%
Rent	17%	19%	22%	19%
Total	**100%**	**100%**	**100%**	**100%**

Exhibit 54: Participant home ownership.

Please indicate whether you have air conditioning in your home?

	Pricing Plan			
Respondent Answer	**CPP**	**CPR**	**HP**	**Total**
Yes	97%	98%	97%	97%
No	3%	2%	3%	3%
Total	**100%**	**100%**	**100%**	**100%**

Exhibit 55: Participant air conditioner ownership.

Please indicate how many people (including yourself) live in your home.

Number living in home	Pricing Plan			
	CPP	**CPR**	**HP**	**Total**
1	33%	33%	26%	31%
2	36%	37%	49%	39%
3 or more	31%	30%	25%	30%
Total	**100%**	**100%**	**100%**	**100%**

Exhibit 56: Participant households were of all sizes.

Please provide the highest level of education completed by you.

	Pricing Plan			
Respondent Answers	**CPP**	**CPR**	**HP**	**Total**
Post graduate degree	51%	58%	57%	54%
College / university degree	28%	15%	26%	24%
Some college / university	11%	15%	10%	12%
High school graduate	8%	8%	7%	8%
Some high school (grades 9-12)	1%	3%	0%	2%
Elementary (grades 1-8)	1%	0%	0%	0%
(blank)	0%	1%	0%	0%
Total	**100%**	**100%**	**100%**	**100%**

Exhibit 57: Participant households included highly educated persons.

Please provide the year that your home was built.

	Pricing Plan			
Respondent Answers	**CPP**	**CPR**	**HP**	**Total**
Before 1980	83%	82%	78%	81%
1980-2000	5%	8%	8%	6%
2001 or later	4%	4%	11%	6%
Don't know/blank	9%	7%	2%	5%
Total	**100%**	**100%**	**100%**	**100%**

Exhibit 58: Most participants' homes were built prior to 1980.

Could you please select the range that best describes your household income?

	Pricing Plan			
Respondent Answers	**CPP**	**CPR**	**HP**	**Total**
$100,000 or more	46%	41%	53%	46%
$75,000-$99,999	13%	14%	14%	14%
$50,000-$74,999	16%	12%	10%	13%
Less than $50,000	15%	30%	13%	19%
Not sure/blank	9%	5%	11%	9%
Total	**100%**	**100%**	**100%**	**100%**

Exhibit 59: CPR participants had lower income, reflecting that participation by RAD customers was limited to the CPR price option.

Did PowerCentsDC install a smart thermostat for your household?

	Pricing Plan			
Respondent Answers	**CPP**	**CPR**	**HP**	**Total**
No	52%	60%	52%	55%
Yes	31%	38%	39%	35%
(blank)	17%	2%	9%	10%
Total	**100%**	**100%**	**100%**	**100%**

Exhibit 60: About a third of the participants had smart thermostats.

Did the smart thermostat work out well for your household?

	Pricing Plan			
Respondent Answers	**CPP**	**CPR**	**HP**	**Total**
Yes	77%	80%	79%	79%
Not sure	14%	11%	15%	13%
No	9%	7%	6%	7%
(blank)	0%	2%	0%	1%
Total	**100%**	**100%**	**100%**	**100%**

Exhibit 61: Most participants were satisfied with their smart thermostats.

Please indicate how many times over this past summer did your household override the smart thermostat operations during critical peak periods or when prices were high.

	Pricing Plan			
Number of times	**CPP**	**CPR**	**HP**	**Total**
More than 3 times	14%	20%	18%	17%
2 to 3 times	30%	9%	26%	22%
Once	7%	24%	21%	16%
Never	49%	47%	35%	45%
Total	**100%**	**100%**	**100%**	**100%**

Exhibit 62: CPR participants overrode their thermostats least often.

On a scale of 1 to 5 (where 1 is "the highest benefit"), please rank the potential benefits of PowerCentsDC pricing for electricity -
Makes me more aware of when my household uses electricity during the day or week.

	Pricing Plan			
Ranking	**CPP**	**CPR**	**HP**	**Total**
1 - Highest benefit	34%	43%	48%	40%
2	29%	29%	23%	28%
3	13%	14%	13%	13%
4	3%	1%	1%	2%
5 - Lowest benefit	2%	8%	2%	4%
(blank)	20%	6%	14%	14%
Total	**100%**	**100%**	**100%**	**100%**

Exhibit 63: Electricity usage awareness was ranked as an important benefit.

On a scale of 1 to 5 (where 1 is "the highest benefit"), please rank the potential benefits of PowerCentsDC pricing for electricity -
Makes me more conscious of what I can do to reduce my electricity bill.

	Pricing Plan			
Ranking	**CPP**	**CPR**	**HP**	**Total**
1 - Highest benefit	35%	38%	47%	39%
2	24%	28%	26%	26%
3	13%	12%	10%	12%
4	4%	8%	3%	5%
5 - Lowest benefit	3%	7%	1%	4%
(blank)	21%	8%	13%	15%
Total	**100%**	**100%**	**100%**	**100%**

Exhibit 64: Making participants conscious of ways to reduce electricity bills was important.

On a scale of 1 to 5 (where 1 is "the highest benefit"), please rank the potential benefits of PowerCentsDC pricing for electricity -
Makes me more conscious of my home's electricity use during "peak" usage times and when electricity is most expensive.

	Pricing Plan			
Ranking	**CPP**	**CPR**	**HP**	**Total**
1 - Highest benefit	48%	49%	56%	50%
2	20%	23%	19%	20%
3	8%	13%	10%	10%
4	3%	3%	1%	3%
5 - Lowest benefit	2%	7%	1%	3%
(blank)	20%	6%	13%	14%
Total	**100%**	**100%**	**100%**	**100%**

Exhibit 65: Making participants conscious of usage during peak was ranked highest.

On a scale of 1 to 5 (where 1 is "the highest benefit"), please rank the potential benefits of PowerCentsDC pricing for electricity -
Gives me more control over my electricity costs.

	Pricing Plan			
Ranking	**CPP**	**CPR**	**HP**	**Total**
1 - Highest benefit	35%	30%	40%	34%
2	21%	29%	31%	26%
3	17%	16%	8%	15%
4	5%	9%	6%	7%
5 - Lowest benefit	2%	7%	3%	4%
(blank)	20%	9%	13%	15%
Total	**100%**	**100%**	**100%**	**100%**

Exhibit 66: Gaining control over electricity costs was ranked highest by a third of participants.

On a scale of 1 to 5 (where 1 is "the highest benefit"), please rank the potential benefits of PowerCentsDC pricing for electricity -
Helps me reduce my electricity costs.

	Pricing Plan			
Ranking	**CPP**	**CPR**	**HP**	**Total**
1 - Highest benefit	33%	40%	44%	38%
2	28%	23%	25%	26%
3	11%	18%	9%	13%
4	4%	6%	6%	5%
5 - Lowest benefit	4%	7%	1%	4%
(blank)	20%	7%	15%	15%
Total	**100%**	**100%**	**100%**	**100%**

Exhibit 67: Reducing electricity costs was ranked lower than some other benefits.

On a scale of 1 to 5 (where 1 is "the highest benefit"), please rank the potential benefits of PowerCentsDC pricing for electricity -
Makes me more aware of my household's total electricity consumption regardless of when it is used.

	Pricing Plan			
Ranking	**CPP**	**CPR**	**HP**	**Total**
1 - Highest benefit	27%	28%	38%	30%
2	30%	41%	27%	33%
3	15%	13%	13%	14%
4	4%	3%	2%	4%
5 - Lowest benefit	3%	8%	3%	4%
(blank)	21%	8%	17%	16%
Total	**100%**	**100%**	**100%**	**100%**

Exhibit 68: Usage awareness was ranked lowest among the benefits.

How did you know what your hourly price was for any particular hour?

Depended on notifications from PowerCentsDC	66%
Learned when prices generally tended to be high	24%
Looked on smart thermostat	17%
Looked on website	14%
Didn't know	10%
Other	6%
(blank)	3%
Total	**100%**

Exhibit 69: One in ten customers did not know when prices were high.

Did you read the electricity usage reports you received?

	Pricing Plan			
Respondent Answers	**CPP**	**CPR**	**HP**	**Total**
Yes	74%	71%	78%	74%
Sometimes	18%	20%	11%	17%
No	2%	3%	3%	3%
(blank)	6%	7%	7%	6%
Total	**100%**	**100%**	**100%**	**100%**

Exhibit 70: Only 3% of participants did not read their Electric Usage Reports.

Thinking about the last electricity usage report that you received, to what extent do you agree with each of the following statements?
The information provided was easy to understand.

	Pricing plan			
Respondent Answers	**CPP**	**CPR**	**HP**	**Total**
Strongly agree	21%	13%	30%	21%
Agree	48%	43%	50%	47%
Neither agree nor disagree	13%	18%	6%	13%
Disagree	9%	13%	7%	10%
Strongly disagree	4%	4%	1%	3%
(blank)	5%	9%	7%	7%
Total	**100%**	**100%**	**100%**	**100%**

Exhibit 71: One in eight participants said they could not easily understand their Electric Usage Reports.

Thinking about the last electricity usage report that you received, to what extent do you agree with each of the following statements?
The information provided helped you understand how much electricity you use during critical peak hours or high priced hours.

	Pricing plan			
Respondent Answers	**CPP**	**CPR**	**HP**	**Total**
Strongly agree	26%	14%	40%	26%
Agree	51%	51%	45%	49%
Neither agree nor disagree	7%	11%	2%	7%
Disagree	7%	12%	5%	8%
Strongly disagree	3%	4%	1%	3%
(blank)	8%	8%	7%	8%
Total	**100%**	**100%**	**100%**	**100%**

Exhibit 72: One in nine participants felt their Electric Usage Reports did not help them understand their peak energy usage better.

Thinking about the last electricity usage report that you received, to what extent do you agree with each of the following statements?
The information provided helped you save on you electricity bill.

	Pricing plan			
Respondent Answers	**CPP**	**CPR**	**HP**	**Total**
Strongly agree	14%	13%	22%	16%
Agree	37%	31%	42%	36%
Neither agree nor disagree	26%	27%	25%	26%
Disagree	11%	14%	3%	10%
Strongly disagree	4%	7%	1%	4%
(blank)	8%	8%	7%	8%
Total	**100%**	**100%**	**100%**	**100%**

Exhibit 73: About four times as many participants agreed that the Electric Usage Reports helped them save on their bill compared to those who disagreed (52% to 14%).

After reviewing your electricity usage statements, how much did you change how you or other members of your household use electricity? *During critical peak periods or high priced hours.*

	Pricing Plan			
Respondent Answers	**CPP**	**CPR**	**HP**	**Total**
Significantly	44%	43%	35%	42%
Slightly	38%	31%	49%	38%
Did not change	10%	15%	8%	11%
Not sure	1%	3%	1%	2%
(blank)	7%	8%	7%	7%
Total	**100%**	**100%**	**100%**	**100%**

Exhibit 74: One in nine participants made no changes in peak electricity consumption following review of their Electric Usage Reports.

As a result of reviewing your electricity statements, please indicate how likely you are to change how you use electricity in the future -
During critical peak periods or high priced hours.

	Pricing Plan			
Respondent Answers	**CPP**	**CPR**	**HP**	**Total**
Very likely	43%	42%	44%	43%
Likely	43%	36%	47%	42%
Not likely	7%	8%	5%	7%
Not very likely	3%	6%	3%	4%
Not sure	2%	4%	1%	3%
(blank)	2%	4%	0%	2%
Total	**100%**	**100%**	**100%**	**100%**

Exhibit 75: Five in six participants said they are likely or very likely to change their peak electricity usage in the future.

Please indicate the type of water heating system that you use in your home.

	Home Ownership		
Respondent Answers	**Own**	**Rent**	**Total**
Natural gas	67%	37%	62%
Electric	25%	41%	28%
Other/don't know/blank	8%	22%	10%
Total	**100%**	**100%**	**100%**

Exhibit 76: Renters have much higher levels of electric water heating.

Please select the type of primary heating system that you use in your home.

	Home Ownership		
Respondent Answers	**Own**	**Rent**	**Total**
Natural gas	60%	26%	54%
Electric - heat pump	13%	14%	13%
Electric - furnace	7%	23%	10%
Hot water baseboard	8%	7%	8%
Other	4%	8%	5%
Electric - space heaters	4%	5%	4%
Don't know	2%	14%	4%
Electric - baseboard	2%	3%	2%
Total	**100%**	**100%**	**100%**

Exhibit 77: Renters have much higher levels of electric space heating

Please select the type of air conditioning that you have.
By Own or Rent?

	Home Ownership		
Respondent Answers	**Own**	**Rent**	**Total**
Central air conditioning	83%	66%	80%
Individual window unit(s)	12%	34%	16%
Don't know/blank	4%	0%	4%
Total	**100%**	**100%**	**100%**

Exhibit 78: Renters have much higher levels of window air conditioning.

Please indicate how many of the following appliances/equipment do you have in your home.
Washing machine.

	Home Ownership		
Respondent Answers	**Own**	**Rent**	**Total**
No	4%	62%	15%
Yes	94%	37%	84%
(blank)	1%	1%	1%
Total	**100%**	**100%**	**100%**

Exhibit 79: Renters have much lower levels of washing machine ownership.

Please indicate how many of the following appliances/equipment do you have in your home:
Electric clothes dryer.

	Home Ownership		
Respondent Answers	**Own**	**Rent**	**Total**
No	20%	60%	28%
Yes	72%	36%	65%
(blank)	8%	4%	7%
Total	**100%**	**100%**	**100%**

Exhibit 80: Renters have much lower levels of clothes dryer ownership.

Please indicate how many of the following appliances/equipment do you have in your home.
Stand-alone freezer

	Home Ownership		
Respondent Answers	**Own**	**Rent**	**Total**
No	58%	77%	61%
Yes	24%	19%	24%
(blank)	18%	4%	15%
Total	**100%**	**100%**	**100%**

Exhibit 81: Renters have much lower levels of stand-alone freezer ownership.

Please indicate how many of the following appliances/equipment do you have in your home.
Dishwasher

	Home Ownership		
Respondent Answers	**Own**	**Rent**	**Total**
No	13%	47%	20%
Yes	84%	51%	77%
(blank)	3%	3%	3%
Total	**100%**	**100%**	**100%**

Exhibit 82: Renters have much lower levels of dishwasher ownership.

Please indicate how many of the following appliances/equipment do you have in your home.
Flat screen television

	Home Ownership		
Respondent Answers	**Own**	**Rent**	**Total**
No	31%	49%	34%
Yes	60%	48%	58%
(blank)	9%	3%	8%
Total	**100%**	**100%**	**100%**

Exhibit 83: Renters own fewer flat screen TVs.

Please indicate how many of the following appliances/equipment do you have in your home:
Electric cook top, stove, or range.

	Home Ownership		
Respondent Answers	**Own**	**Rent**	**Total**
No	55%	37%	51%
Yes	31%	56%	36%
(blank)	15%	7%	14%
Total	**100%**	**100%**	**100%**

Exhibit 84: Renters own more electric cook tops.

Please indicate how many of the following appliances/equipment do you have in your home.
Electric Oven

	Home Ownership		
Respondent Answers	**Own**	**Rent**	**Total**
No	46%	38%	50%
Yes	39%	55%	42%
(blank)	15%	7%	8%
Total	**100%**	**100%**	**100%**

Exhibit 85: Renters own more electric ovens.

Could you indicate how often the following appliances/equipment are used in your home between 2 pm and 6 pm on summer weekdays?
Washing machine

	Home Ownership		
Respondent Answers	**Own**	**Rent**	**Total**
3 or more times per week	9%	15%	10%
Once or twice per week	37%	44%	38%
Not at all	50%	33%	49%
Not sure/blank	3%	7%	3%
Total	**100%**	**100%**	**100%**

Exhibit 86: Renters do more clothes washing during peak hours.

Could you indicate how often the following appliances/equipment are used in your home between 2 pm and 6 pm on summer weekdays?
Electric clothes dryer

	Home Ownership		
Respondent Answers	**Own**	**Rent**	**Total**
3 or more times per week	7%	8%	7%
Once or twice per week	34%	42%	35%
Not at all	52%	38%	51%
Not sure	2%	4%	2%
(blank)	4%	8%	5%
Total	**100%**	**100%**	**100%**

Exhibit 87: Renters do more clothes drying during peak hours.

Could you indicate how often the following appliances/equipment are used in your home between 2 pm and 6 pm on summer weekdays?
Electric cook top, stove or range

	Home Ownership		
Respondent Answers	**Own**	**Rent**	**Total**
3 or more times per week	30%	51%	36%
Once or twice per week	20%	24%	21%
Not at all	43%	17%	36%
(blank)	7%	7%	7%
Total	**100%**	**100%**	**100%**

Exhibit 88: Renters do more cooking during peak hours.

Could you indicate how often the following appliances/equipment are used in your home between 2 pm and 6 pm on summer weekdays?
Oven(s) - electric

	Home Ownership		
Respondent Answers	**Own**	**Rent**	**Total**
3 or more times per week	**9%**	**38%**	**16%**
Once or twice per week	**29%**	**30%**	**29%**
Not at all	54%	28%	47%
Not sure/blank	1%	0%	1%
Total	**100%**	**100%**	**100%**

Exhibit 89: Renters do more baking during peak hours

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Could you indicate how often the following appliances/equipment are used in your home between 2 pm and 6 pm on summer weekdays?
Dishwasher

	Home Ownership		
Respondent Answers	**Own**	**Rent**	**Total**
3 or more times per week	**15%**	**11%**	**14%**
Once or twice per week	**26%**	**22%**	**26%**
Not at all	54%	65%	55%
Not sure/blank	5%	3%	5%
Total	**100%**	**100%**	**100%**

Exhibit 90: Renters do less automatic dishwashing during peak hours.

Could you indicate how often the following appliances/equipment are used in your home between 2 pm and 6 pm on summer weekdays?
Flat screen television

	Home Ownership		
Respondent Answers	**Own**	**Rent**	**Total**
3 or more times per week	**49%**	**74%**	**53%**
Once or twice per week	**18%**	**6%**	**16%**
Not at all	31%	17%	29%
(blank)	2%	3%	2%
Total	**100%**	**100%**	**100%**

Exhibit 91: Renters watch more flat screen television during peak hours.

Appendix E: Control Customer Survey Results

Results of PowerCentsDC Control Customer Survey

Q3: Could you please select your home type?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Single family detached house	10	16.1	16.1	16.1
	Condominium, townhouse, or duplex	24	38.7	38.7	54.8
	Apartment	28	45.2	45.2	100.0
	Total	62	100.0	100.0	

Q4: Please indicate whether you own or rent your home.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Own	26	41.9	42.6	42.6
	Rent	35	56.5	57.4	100.0
	Total	61	98.4	100.0	
Missing	System	1	1.6		
Total		62	100.0		

Q5: How would you prefer to get detailed information about your electricity usage (please check all that you would want to receive)?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	On my electric utility bill	31	50.0	51.7	51.7
	By logging in to the utility or other website	8	12.9	13.3	65.0
	On detailed reports sent to me by regular mail	12	19.4	20.0	85.0
	On detailed reports sent to me by email	8	12.9	13.3	98.3
	Through messages sent to my mobile phone	1	1.6	1.7	100.0
	Total	60	96.8	100.0	
Missing	System	2	3.2		
Total		62	100.0		

Q6: Please indicate your level of interest in being able to login to an online website and receive each of the following online services - Up-to-date daily energy usage for your home

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Interested	29	46.8	48.3	48.3
	Somewhat Interested	15	24.2	25.0	73.3
	Not Interested	16	25.8	26.7	100.0
	Total	60	96.8	100.0	
Missing	System	2	3.2		
	Total	62	100.0		

Q6: Please indicate your level of interest in being able to login to an online website and receive each of the following online services - Up-to-date hourly energy usage for your home

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Interested	15	24.2	25.4	25.4
	Somewhat Interested	18	29.0	30.5	55.9
	Not Interested	26	41.9	44.1	100.0
	Total	59	95.2	100.0	
Missing	System	3	4.8		
	Total	62	100.0		

Q6: Please indicate your level of interest in being able to login to an online website and receive each of the following online services - Up-to-date daily energy cost information for your home

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Interested	24	38.7	40.7	40.7
	Somewhat Interested	21	33.9	35.6	76.3
	Not Interested	14	22.6	23.7	100.0
	Total	59	95.2	100.0	
Missing	System	3	4.8		
	Total	62	100.0		

Q6: Please indicate your level of interest in being able to login to an online website and receive each of the following online services - Up-to-date daily environmental impact information for your home, showing amount of C02 generated to create the electricity used by your home

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Interested	22	35.5	37.3	37.3
	Somewhat Interested	20	32.3	33.9	71.2
	Not Interested	17	27.4	28.8	100.0
	Total	59	95.2	100.0	
Missing	System	3	4.8		
	Total	62	100.0		

Q6: Please indicate your level of interest in being able to login to an online website and receive each of the following online services - Usage and cost comparisons showing how your home's energy usage compares to similar households in your neighborhood

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Interested	22	35.5	36.7	36.7
	Somewhat Interested	22	35.5	36.7	73.3
	Not Interested	16	25.8	26.7	100.0
	Total	60	96.8	100.0	
Missing	System	2	3.2		
	Total	62	100.0		

Q6: Please indicate your level of interest in being able to login to an online website and receive each of the following online services - Energy updates emailed to you weekly, showing a summary of your energy usage and cost for the current bill-period

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Interested	19	30.6	32.2	32.2
	Somewhat Interested	25	40.3	42.4	74.6
	Not Interested	15	24.2	25.4	100.0
	Total	59	95.2	100.0	
Missing	System	3	4.8		
	Total	62	100.0		

Q6: Please indicate your level of interest in being able to login to an online website and receive each of the following online services - Energy alerts through email or text messages indicating there has been a spike in your home's energy usage, or that your current month usage has crossed your pre-set budget threshold

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Interested	19	30.6	32.2	32.2
	Somewhat Interested	23	37.1	39.0	71.2
	Not Interested	17	27.4	28.8	100.0
	Total	59	95.2	100.0	
Missing	System	3	4.8		
	Total	62	100.0		

Q6: Please indicate your level of interest in being able to login to an online website and receive each of the following online services - Information about the breakdown of energy usage in your home by appliance (e.g. air conditioning, refrigeration, lighting, etc.)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Interested	32	51.6	56.1	56.1
	Somewhat Interested	14	22.6	24.6	80.7
	Not Interested	11	17.7	19.3	100.0
	Total	57	91.9	100.0	
Missing	System	5	8.1		
Total		62	100.0		

Q7: Please rank each of the categories of electricity usage below according to the total amount of electricity used in your home during the year. Please rank each item from 1 to 8 where 1 indicates the most usage and 8 indicates the least usage) - Air conditioning

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 - The Most Usage	22	35.5	38.6	38.6
	2	6	9.7	10.5	49.1
	3	8	12.9	14.0	63.2
	4	8	12.9	14.0	77.2
	5	8	12.9	14.0	91.2
	7	2	3.2	3.5	94.7
	8 - The Least Usage	3	4.8	5.3	100.0
	Total	57	91.9	100.0	
Missing	System	5	8.1		
Total		62	100.0		

Q7: Please rank each of the categories of electricity usage below according to the total amount of electricity used in your home during the year. Please rank each item from 1 to 8 where 1 indicates the most usage and 8 indicates the least usage) - Home electronics - includes TV's, VCR's, computers, etc.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 - The Most Usage	19	30.6	33.3	33.3
	2	9	14.5	15.8	49.1
	3	10	16.1	17.5	66.7
	4	10	16.1	17.5	84.2
	5	4	6.5	7.0	91.2
	6	1	1.6	1.8	93.0
	7	1	1.6	1.8	94.7
	8 - The Least Usage	3	4.8	5.3	100.0
	Total	57	91.9	100.0	
Missing	System	5	8.1		
Total		62	100.0		

Q7: Please rank each of the categories of electricity usage below according to the total amount of electricity used in your home during the year. Please rank each item from 1 to 8 where 1 indicates the most usage and 8 indicates the least usage) - Kitchen appliances - includes coffee makers, dishwashers, electric stoves, electric ovens, microwave ovens, etc. (excluding refrigerators and freezers)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 - The Most Usage	9	14.5	15.5	15.5
	2	10	16.1	17.2	32.8
	3	9	14.5	15.5	48.3
	4	11	17.7	19.0	67.2
	5	9	14.5	15.5	82.8
	6	5	8.1	8.6	91.4
	7	3	4.8	5.2	96.6
	8 - The Least Usage	2	3.2	3.4	100.0
	Total	58	93.5	100.0	
Missing	System	4	6.5		
	Total	62	100.0		

Q7: Please rank each of the categories of electricity usage below according to the total amount of electricity used in your home during the year. Please rank each item from 1 to 8 where 1 indicates the most usage and 8 indicates the least usage) - Laundry - includes washers and electric dryers

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 - The Most Usage	2	3.2	3.4	3.4
	2	6	9.7	10.3	13.8
	3	10	16.1	17.2	31.0
	4	8	12.9	13.8	44.8
	5	2	3.2	3.4	48.3
	6	4	6.5	6.9	55.2
	7	6	9.7	10.3	65.5
	8 - The Least Usage	20	32.3	34.5	100.0
	Total	58	93.5	100.0	
Missing	System	4	6.5		
	Total	62	100.0		

Q7: Please rank each of the categories of electricity usage below according to the total amount of electricity used in your home during the year. Please rank each item from 1 to 8 where 1 indicates the most usage and 8 indicates the least usage) - Lighting

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 - The Most Usage	13	21.0	22.0	22.0
	2	5	8.1	8.5	30.5
	3	12	19.4	20.3	50.8
	4	9	14.5	15.3	66.1
	5	7	11.3	11.9	78.0
	6	5	8.1	8.5	86.4
	7	6	9.7	10.2	96.6
	8 - The Least Usage	2	3.2	3.4	100.0
	Total	59	95.2	100.0	
Missing	System	3	4.8		
Total		62	100.0		

Q7: Please rank each of the categories of electricity usage below according to the total amount of electricity used in your home during the year. Please rank each item from 1 to 8 where 1 indicates the most usage and 8 indicates the least usage) - Refrigeration - includes refrigerators and freezers

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 - The Most Usage	22	35.5	38.6	38.6
	2	8	12.9	14.0	52.6
	3	8	12.9	14.0	66.7
	4	8	12.9	14.0	80.7
	5	3	4.8	5.3	86.0
	6	2	3.2	3.5	89.5
	7	3	4.8	5.3	94.7
	8 - The Least Usage	3	4.8	5.3	100.0
	Total	57	91.9	100.0	
Missing	System	5	8.1		
Total		62	100.0		

Q7: Please rank each of the categories of electricity usage below according to the total amount of electricity used in your home during the year. Please rank each item from 1 to 8 where 1 indicates the most usage and 8 indicates the least usage) - Space heating - includes electric heaters and furnace fans

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 - The Most Usage	7	11.3	12.3	12.3
	2	5	8.1	8.8	21.1
	3	4	6.5	7.0	28.1
	4	2	3.2	3.5	31.6
	6	5	8.1	8.8	40.4
	7	2	3.2	3.5	43.9
	8 - The Least Usage	32	51.6	56.1	100.0
	Total	57	91.9	100.0	
Missing	System	5	8.1		
	Total	62	100.0		

Q7: Please rank each of the categories of electricity usage below according to the total amount of electricity used in your home during the year. Please rank each item from 1 to 8 where 1 indicates the most usage and 8 indicates the least usage) - Water Heating - includes electric water heaters

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 - The Most Usage	11	17.7	19.0	19.0
	2	4	6.5	6.9	25.9
	3	7	11.3	12.1	37.9
	4	6	9.7	10.3	48.3
	5	9	14.5	15.5	63.8
	7	5	8.1	8.6	72.4
	8 - The Least Usage	16	25.8	27.6	100.0
	Total	58	93.5	100.0	
Missing	System	4	6.5		
	Total	62	100.0		

Q8: Please indicate which of the following best describes how you are currently charged for the electricity you use. If you are not sure or do not know how you are charged, please answer "Don't know."

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	I am charged a flat price per kWh, independent of how much e	5	8.1	8.3	8.3
	I am charged one price per kWh rate for the first 400 kWh an	10	16.1	16.7	25.0
	I am charged one price per kWh rate for the first 400 kWh an	1	1.6	1.7	26.7
	I am charged different prices per kWh depending on the time	1	1.6	1.7	28.3
	Don't know	43	69.4	71.7	100.0
	Total	60	96.8	100.0	
Missing	System	2	3.2		
Total		62	100.0		

Q9: Please indicate whether you have air conditioning in your home.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	62	100.0	100.0	100.0

Q10: Please select the type of air conditioning that you have.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Central air conditioning	50	80.6	80.6	80.6
	Individual window unit(s)	12	19.4	19.4	100.0
	Total	62	100.0	100.0	

Q11: The highest or peak energy use in the summer in the District of Columbia tends to occur on weekdays between 2 pm and 6 pm. Please indicate how often your air conditioning is usually turned on before, during, and after these hours. - Weekdays before 2 pm

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Often (4+ days/week)	15	24.2	25.4	25.4
	Sometimes (2-3 days/week)	14	22.6	23.7	49.2
	Rarely (1-2 days/week or less)	21	33.9	35.6	84.7
	Never	9	14.5	15.3	100.0
	Total	59	95.2	100.0	
Missing	System	3	4.8		
	Total	62	100.0		

Q11: The highest or peak energy use in the summer in the District of Columbia tends to occur on weekdays between 2 pm and 6 pm. Please indicate how often your air conditioning is usually turned on before, during, and after these hours. - Weekdays between 2 and 6 pm

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Often (4+ days/week)	18	29.0	30.5	30.5
	Sometimes (2-3 days/week)	19	30.6	32.2	62.7
	Rarely (1-2 days/week or less)	17	27.4	28.8	91.5
	Never	5	8.1	8.5	100.0
	Total	59	95.2	100.0	
Missing	System	3	4.8		
	Total	62	100.0		

Q11: The highest or peak energy use in the summer in the District of Columbia tends to occur on weekdays between 2 pm and 6 pm. Please indicate how often your air conditioning is usually turned on before, during, and after these hours. - Weekdays after 6 pm

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Often (4+ days/week)	34	54.8	58.6	58.6
	Sometimes (2-3 days/week)	6	9.7	10.3	69.0
	Rarely (1-2 days/week or less)	14	22.6	24.1	93.1
	Never	4	6.5	6.9	100.0
	Total	58	93.5	100.0	
Missing	System	4	6.5		
	Total	62	100.0		

Q12: Please indicate how many people (including yourself) live in your home.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	29	46.8	46.8	46.8
	2	22	35.5	35.5	82.3
	3	2	3.2	3.2	85.5
	4	5	8.1	8.1	93.5
	5	3	4.8	4.8	98.4
	6 or more	1	1.6	1.6	100.0
	Total	62	100.0	100.0	

Q13: Please indicate how many people (including yourself) live in your home and are 18 years or older.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	36	58.1	58.1	58.1
	2	22	35.5	35.5	93.5
	3	2	3.2	3.2	96.8
	4	1	1.6	1.6	98.4
	5	1	1.6	1.6	100.0
	Total	62	100.0	100.0	

Q14: Please provide the highest level of education completed by the head of household in your home.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Some high school (grades 9-12)	2	3.2	3.2	3.2
	High school graduate	12	19.4	19.4	22.6
	Some college / university	13	21.0	21.0	43.5
	College / university degree	14	22.6	22.6	66.1
	Post graduate degree	21	33.9	33.9	100.0
	Total	62	100.0	100.0	

Q15: Please provide the year that your home was built.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Before 1980	35	56.5	56.5	56.5
	1980-2000	8	12.9	12.9	69.4
	2001 or later	8	12.9	12.9	82.3
	Don't know	11	17.7	17.7	100.0
	Total	62	100.0	100.0	

Q16: Please indicate whether you have made any of the following energy efficiency improvements to your home in the last two years. - Added Insulation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	38	61.3	80.9	80.9
	Added Insulation	9	14.5	19.1	100.0
	Total	47	75.8	100.0	
Missing	System	15	24.2		
	Total	62	100.0		

Q16: Please indicate whether you have made any of the following energy efficiency improvements to your home in the last two years. - Purchased Energy Efficient Appliances

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	31	50.0	66.0	66.0
	Purchased Energy Efficient Appliances	16	25.8	34.0	100.0
	Total	47	75.8	100.0	
Missing	System	15	24.2		
	Total	62	100.0		

Q16: Please indicate whether you have made any of the following energy efficiency improvements to your home in the last two years. - Installed New Windows

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	40	64.5	85.1	85.1
	Installed New Windows	7	11.3	14.9	100.0
	Total	47	75.8	100.0	
Missing	System	15	24.2		
	Total	62	100.0		

Q16: Please indicate whether you have made any of the following energy efficiency improvements to your home in the last two years. - Installed Programmable Thermostat

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	34	54.8	72.3	72.3
	Installed Programmable Thermostat	13	21.0	27.7	100.0
	Total	47	75.8	100.0	
Missing	System	15	24.2		
	Total	62	100.0		

Q16: Please indicate whether you have made any of the following energy efficiency improvements to your home in the last two years. - Installed Solar System

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	46	74.2	97.9	97.9
	Installed Solar System	1	1.6	2.1	100.0
	Total	47	75.8	100.0	
Missing	System	15	24.2		
Total		62	100.0		

Q16: Please indicate whether you have made any of the following energy efficiency improvements to your home in the last two years. - Use Energy Efficient Light Bulbs

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	10	16.1	21.3	21.3
	Use Energy Efficient Light Bulbs	37	59.7	78.7	100.0
	Total	47	75.8	100.0	
Missing	System	15	24.2		
Total		62	100.0		

Q16: Please indicate whether you have made any of the following energy efficiency improvements to your home in the last two years. - Other

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	42	67.7	89.4	89.4
	Other	5	8.1	10.6	100.0
	Total	47	75.8	100.0	
Missing	System	15	24.2		
Total		62	100.0		

Q17: Please indicate how many square feet of heated living space there is in your home.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1,000 sq ft or less	19	30.6	30.6	30.6
	1,001-1,500 sq ft	11	17.7	17.7	48.4
	1,501-2,000 sq ft	3	4.8	4.8	53.2
	2,001-2,500 sq ft	3	4.8	4.8	58.1
	2,501+ sq ft	1	1.6	1.6	59.7
	Don't know	25	40.3	40.3	100.0
	Total	62	100.0	100.0	

Q18: Please indicate the type of water heating system that you use in your home. - Natural gas

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	43	69.4	69.4	69.4
	Natural gas	19	30.6	30.6	100.0
	Total	62	100.0	100.0	

Q18: Please indicate the type of water heating system that you use in your home. - Electric

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	37	59.7	59.7	59.7
	Electric	25	40.3	40.3	100.0
	Total	62	100.0	100.0	

Q18: Please indicate the type of water heating system that you... - Don't know

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	44	71.0	71.0	71.0
	Don't know	18	29.0	29.0	100.0
	Total	62	100.0	100.0	

Q19: Please select the type of primary heating system that you use in your home.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Hot water baseboard	1	1.6	1.6	1.6
	Natural gas	14	22.6	22.6	24.2
	Electric - furnace	15	24.2	24.2	48.4
	Electric - baseboard	3	4.8	4.8	53.2
	Electric - heat pump	9	14.5	14.5	67.7
	Other	4	6.5	6.5	74.2
	Don't know	16	25.8	25.8	100.0
	Total	62	100.0	100.0	

Q20: Please indicate how many of the following appliances/equipment do you have in your home. - Washing machine

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	21	33.9	35.0	35.0
	1	38	61.3	63.3	98.3
	2	1	1.6	1.7	100.0
	Total	60	96.8	100.0	
Missing	System	2	3.2		
Total		62	100.0		

Q20: Please indicate how many of the following appliances/equipment do you have in your home. - Natural gas clothes dryer

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	49	79.0	90.7	90.7
	1	5	8.1	9.3	100.0
	Total	54	87.1	100.0	
Missing	System	8	12.9		
Total		62	100.0		

Q20: Please indicate how many of the following appliances/equipment do you have in your home. - Electric clothes dryer

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	27	43.5	45.0	45.0
	1	31	50.0	51.7	96.7
	2	2	3.2	3.3	100.0
	Total	60	96.8	100.0	
Missing	System	2	3.2		
Total		62	100.0		

Q20: Please indicate how many of the following appliances/equipment do you have in your home. - Electric cooktop, stove, or range

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	29	46.8	52.7	52.7
	1	25	40.3	45.5	98.2
	4 or more	1	1.6	1.8	100.0
	Total	55	88.7	100.0	
Missing	System	7	11.3		
Total		62	100.0		

Q20: Please indicate how many of the following appliances/equipment do you have in your home. - Gas cooktop, stove or range

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	19	30.6	35.8	35.8
	1	34	54.8	64.2	100.0
	Total	53	85.5	100.0	
Missing	System	9	14.5		
Total		62	100.0		

Q20: Please indicate how many of the following appliances/equipment do you have in your home. - Oven(s) - natural gas

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	28	45.2	50.9	50.9
	1	26	41.9	47.3	98.2
	2	1	1.6	1.8	100.0
	Total	55	88.7	100.0	
Missing	System	7	11.3		
Total		62	100.0		

Q20: Please indicate how many of the following appliances/equipment do you have in your home. - Oven(s) - electric

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	27	43.5	46.6	46.6
	1	30	48.4	51.7	98.3
	2	1	1.6	1.7	100.0
	Total	58	93.5	100.0	
Missing	System	4	6.5		
Total		62	100.0		

Q20: Please indicate how many of the following appliances/equipment do you have in your home. - Refrigerator

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	58	93.5	95.1	95.1
	2	2	3.2	3.3	98.4
	4 or more	1	1.6	1.6	100.0
	Total	61	98.4	100.0	
Missing	System	1	1.6		
Total		62	100.0		

Q20: Please indicate how many of the following appliances/equipment do you have in your home. - Stand-alone freezer

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	51	82.3	86.4	86.4
	1	7	11.3	11.9	98.3
	2	1	1.6	1.7	100.0
	Total	59	95.2	100.0	
Missing	System	3	4.8		
Total		62	100.0		

Q20: Please indicate how many of the following appliances/equipment do you have in your home. - Dishwasher

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	23	37.1	37.7	37.7
	1	37	59.7	60.7	98.4
	4 or more	1	1.6	1.6	100.0
	Total	61	98.4	100.0	
Missing	System	1	1.6		
Total		62	100.0		

Q20: Please indicate how many of the following appliances/equipment do you have in your home. - Microwave

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	3	4.8	4.8	4.8
	1	58	93.5	93.5	98.4
	3	1	1.6	1.6	100.0
	Total	62	100.0	100.0	

Q20: Please indicate how many of the following appliances/equipment do you have in your home. - Flat screen television

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	24	38.7	44.4	44.4
	1	19	30.6	35.2	79.6
	2	8	12.9	14.8	94.4
	3	1	1.6	1.9	96.3
	4 or more	2	3.2	3.7	100.0
	Total	54	87.1	100.0	
Missing	System	8	12.9		
Total		62	100.0		

Q20: Please indicate how many of the following appliances/equipment do you have in your home. - Other television

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	14	22.6	23.3	23.3
	1	28	45.2	46.7	70.0
	2	10	16.1	16.7	86.7
	3	6	9.7	10.0	96.7
	4 or more	2	3.2	3.3	100.0
	Total	60	96.8	100.0	
Missing	System	2	3.2		
Total		62	100.0		

Q20: Please indicate how many of the following appliances/equipment do you have in your home. - Computer

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	10	16.1	16.4	16.4
	1	38	61.3	62.3	78.7
	2	8	12.9	13.1	91.8
	3	4	6.5	6.6	98.4
	4 or more	1	1.6	1.6	100.0
	Total	61	98.4	100.0	
Missing	System	1	1.6		
Total		62	100.0		

Q20: Please indicate how many of the following appliances/equipment do you have in your home. - Printer, scanner, copier

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	22	35.5	36.7	36.7
	1	34	54.8	56.7	93.3
	2	2	3.2	3.3	96.7
	3	2	3.2	3.3	100.0
	Total	60	96.8	100.0	
Missing	System	2	3.2		
Total		62	100.0		

Q20: Please indicate how many of the following appliances/equipment do you have in your home. - Dehumidifier

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	53	85.5	88.3	88.3
	1	6	9.7	10.0	98.3
	2	1	1.6	1.7	100.0
	Total	60	96.8	100.0	
Missing	System	2	3.2		
Total		62	100.0		

Q20: Please indicate how many of the following appliances/equipment do you have in your home. - Fan(s) - portable or ceiling mount

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	23	37.1	38.3	38.3
	1	17	27.4	28.3	66.7
	2	10	16.1	16.7	83.3
	3	6	9.7	10.0	93.3
	4 or more	4	6.5	6.7	100.0
	Total	60	96.8	100.0	
Missing	System	2	3.2		
Total		62	100.0		

Q20: Please indicate how many of the following appliances/equipment do you have in your home. - Heated waterbed

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	59	95.2	100.0	100.0
Missing	System	3	4.8		
Total		62	100.0		

Q20: Please indicate how many of the following appliances/equipment do you have in your home. - Spa / Hot tub

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	58	93.5	98.3	98.3
	1	1	1.6	1.7	100.0
	Total	59	95.2	100.0	
Missing	System	3	4.8		
Total		62	100.0		

Q20: Please indicate how many of the following appliances/equipment do you have in your home. - Heated swimming pool

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	59	95.2	100.0	100.0
Missing	System	3	4.8		
Total		62	100.0		

Q21: Could you indicate how often the following appliances/equipment are used in your home between 2 pm and 6 pm on summer weekdays? - Washing machine

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3 or more times per week	4	6.5	6.5	6.5
	Once or twice per week	20	32.3	32.3	38.7
	Not at all	37	59.7	59.7	98.4
	Not sure	1	1.6	1.6	100.0
	Total	62	100.0	100.0	

Q21: Could you indicate how often the following appliances/equipment are used in your home between 2 pm and 6 pm on summer weekdays? - Natural gas clothes dryer

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3 or more times per week	1	1.6	1.8	1.8
	Once or twice per week	4	6.5	7.1	8.9
	Not at all	51	82.3	91.1	100.0
	Total	56	90.3	100.0	
Missing	System	6	9.7		
	Total	62	100.0		

Q21: Could you indicate how often the following appliances/equipment are used in your home between 2 pm and 6 pm on summer weekdays? - Electric clothes dryer

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3 or more times per week	3	4.8	5.0	5.0
	Once or twice per week	17	27.4	28.3	33.3
	Not at all	39	62.9	65.0	98.3
	Not sure	1	1.6	1.7	100.0
	Total	60	96.8	100.0	
Missing	System	2	3.2		
	Total	62	100.0		

Q21: Could you indicate how often the following appliances/equipment are used in your home between 2 pm and 6 pm on summer weekdays? - Electric cooktop, stove or range

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3 or more times per week	15	24.2	24.6	24.6
	Once or twice per week	9	14.5	14.8	39.3
	Not at all	36	58.1	59.0	98.4
	Not sure	1	1.6	1.6	100.0
	Total	61	98.4	100.0	
Missing	System	1	1.6		
	Total	62	100.0		

Q21: Could you indicate how often the following appliances/equipment are used in your home between 2 pm and 6 pm on summer weekdays? - Gas cooktop, stove or range

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3 or more times per week	15	24.2	26.8	26.8
	Once or twice per week	10	16.1	17.9	44.6
	Not at all	30	48.4	53.6	98.2
	Not sure	1	1.6	1.8	100.0
	Total	56	90.3	100.0	
Missing	System	6	9.7		
	Total	62	100.0		

Q21: Could you indicate how often the following appliances/equipment are used in your home between 2 pm and 6 pm on summer weekdays? - Oven(s) - natural gas

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3 or more times per week	9	14.5	16.4	16.4
	Once or twice per week	6	9.7	10.9	27.3
	Not at all	39	62.9	70.9	98.2
	Not sure	1	1.6	1.8	100.0
	Total	55	88.7	100.0	
Missing	System	7	11.3		
	Total	62	100.0		

Q21: Could you indicate how often the following appliances/equipment are used in your home between 2 pm and 6 pm on summer weekdays? - Oven(s) - electric

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3 or more times per week	17	27.4	27.4	27.4
	Once or twice per week	13	21.0	21.0	48.4
	Not at all	30	48.4	48.4	96.8
	Not sure	2	3.2	3.2	100.0
	Total	62	100.0	100.0	

Q21: Could you indicate how often the following appliances/equipment are used in your home between 2 pm and 6 pm on summer weekdays? - Dishwasher

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3 or more times per week	7	11.3	11.3	11.3
	Once or twice per week	14	22.6	22.6	33.9
	Not at all	37	59.7	59.7	93.5
	Not sure	4	6.5	6.5	100.0
	Total	62	100.0	100.0	

Q21: Could you indicate how often the following appliances/equipment are used in your home between 2 pm and 6 pm on summer weekdays? - Microwave

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3 or more times per week	30	48.4	49.2	49.2
	Once or twice per week	12	19.4	19.7	68.9
	Not at all	17	27.4	27.9	96.7
	Not sure	2	3.2	3.3	100.0
	Total	61	98.4	100.0	
Missing	System	1	1.6		
	Total	62	100.0		

Q21: Could you indicate how often the following appliances/equipment are used in your home between 2 pm and 6 pm on summer weekdays? - Flat screen television

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3 or more times per week	17	27.4	30.4	30.4
	Once or twice per week	5	8.1	8.9	39.3
	Not at all	33	53.2	58.9	98.2
	Not sure	1	1.6	1.8	100.0
	Total	56	90.3	100.0	
Missing	System	6	9.7		
Total		62	100.0		

Q21: Could you indicate how often the following appliances/equipment are used in your home between 2 pm and 6 pm on summer weekdays? - Other television

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3 or more times per week	31	50.0	50.8	50.8
	Once or twice per week	5	8.1	8.2	59.0
	Not at all	22	35.5	36.1	95.1
	Not sure	3	4.8	4.9	100.0
	Total	61	98.4	100.0	
Missing	System	1	1.6		
Total		62	100.0		

Q21: Could you indicate how often the following appliances/equipment are used in your home between 2 pm and 6 pm on summer weekdays? - Computer

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3 or more times per week	32	51.6	51.6	51.6
	Once or twice per week	5	8.1	8.1	59.7
	Not at all	20	32.3	32.3	91.9
	Not sure	5	8.1	8.1	100.0
	Total	62	100.0	100.0	

Q21: Could you indicate how often the following appliances/equipment are used in your home between 2 pm and 6 pm on summer weekdays? - Printer, scanner, copier

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3 or more times per week	11	17.7	17.7	17.7
	Once or twice per week	10	16.1	16.1	33.9
	Not at all	35	56.5	56.5	90.3
	Not sure	6	9.7	9.7	100.0
	Total	62	100.0	100.0	

Q21: Could you indicate how often the following appliances/equipment are used in your home between 2 pm and 6 pm on summer weekdays? - Dehumidifier

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3 or more times per week	3	4.8	5.0	5.0
	Once or twice per week	1	1.6	1.7	6.7
	Not at all	50	80.6	83.3	90.0
	Not sure	6	9.7	10.0	100.0
	Total	60	96.8	100.0	
Missing	System	2	3.2		
Total		62	100.0		

Q21: Could you indicate how often the following appliances/equipment are used in your home between 2 pm and 6 pm on summer weekdays? - Fan(s) - portable or ceiling mount

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3 or more times per week	14	22.6	23.0	23.0
	Once or twice per week	11	17.7	18.0	41.0
	Not at all	33	53.2	54.1	95.1
	Not sure	3	4.8	4.9	100.0
	Total	61	98.4	100.0	
Missing	System	1	1.6		
Total		62	100.0		

Q21: Could you indicate how often the following appliances/equipment are used in your home between 2 pm and 6 pm on summer weekdays? - Heated waterbed

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3 or more times per week	1	1.6	1.7	1.7
	Not at all	52	83.9	86.7	88.3
	Not sure	7	11.3	11.7	100.0
	Total	60	96.8	100.0	
Missing	System	2	3.2		
Total		62	100.0		

Q21: Could you indicate how often the following appliances/equipment are used in your home between 2 pm and 6 pm on summer weekdays? - Spa / Hot tub

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3 or more times per week	1	1.6	1.7	1.7
	Not at all	52	83.9	86.7	88.3
	Not sure	7	11.3	11.7	100.0
	Total	60	96.8	100.0	
Missing	System	2	3.2		
Total		62	100.0		

Q21: Could you indicate how often the following appliances/equipment are used in your home between 2 pm and 6 pm on summer weekdays? - Heated swimming pool

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3 or more times per week	1	1.6	1.7	1.7
	Not at all	52	83.9	86.7	88.3
	Not sure	7	11.3	11.7	100.0
	Total	60	96.8	100.0	
Missing	System	2	3.2		
Total		62	100.0		

Q22: Could you please select the range that best describes your household's total income?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than $25,000	20	32.3	32.3	32.3
	$25,000-$49,000	9	14.5	14.5	46.8
	$50,000-$74,999	4	6.5	6.5	53.2
	$75,000-$99,999	9	14.5	14.5	67.7
	$100,000-$149,999	9	14.5	14.5	82.3
	$150,000-$199,999	8	12.9	12.9	95.2
	$200,000 or more	1	1.6	1.6	96.8
	Not sure	2	3.2	3.2	100.0
	Total	62	100.0	100.0	