Vermont Electric Cooperative Consumer Behavior Study Year 2 Final Report

THE EFFECT OF VARIABLE PEAK PRICING ON ELECTRICITY DEMAND

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1. Executive Summary

What influence do changing electricity prices have on residential utility customers? This was the subject of a component of a Smart Grid Investment Grant (SGIG) project awarded to eEnergy Vermont Utilities in 2010. One element of the SGIG award involved a smart grid pricing and information pilot within the Vermont Electric Co-operative (VEC) service territory. VEC is an electric cooperative operating in northeastern Vermont. The study examined the consumption impacts of exposing customers to time-varying electricity pricing (variable peak pricing, or VPP) and notifying customers as to when the VPP rate would rise above a certain threshold.

The study, which concluded in 2014, was conducted jointly by VEC and by the statewide energy efficiency utility, Efficiency Vermont. It involved one customer treatment group that was placed on the VPP rate and received notification when the VPP surpassed a given threshold, and one customer control group that experienced no changes in peak pricing and no notifications. Customers were also given access to an online portal that provided hourly household electricity use data, and a cost comparison of their usage under the VPP rate and the standard rate.

Essential findings. Table E-1 presents a summary of the findings from the load impact analysis. It suggests that consumers in the VEC service territory were responsive to the different pricing periods during the day (the off-peak, on-peak, and VPP hours). Evidence that consumers were responsive to the level of the VPP is mixed. Also apparent were distinct seasonal differences in customer load reductions during the VPP hours. Despite higher levels of the VPP during the wintertime VPP hours, VEC customers were less willing to reduce demands during VPP hours in the winter than they were in spring or summer. Because this study occurred during a particularly cold winter season, however, it might be difficult to project this particular finding onto winter seasons with milder temperatures.

Table E-1. Summary of load impact findings

Rate Period	Load Impact	Percentage
Monthly kWh	-15 to +27 kWh	-5% to +3%
VPP Period	-0.15 to -0.2 kW	-15% to -20%
On-Peak Period	-0.02 to -0.04 kW	-2% to -5%
Off-Peak Period	+0.001 to +0.03 kW	+1% to +5%

Notes: Negative numbers indicate load reductions by the treatment group relative to the control group, whereas positive numbers indicate load increases. Percentage load impacts are calculated relative to the control group

The data analysis led to three conclusions:

1. Customers subjected to variable peak pricing changes reduced their electricity demand during the hours that peak pricing was in place, although the reductions varied seasonally.

2. Higher levels of the variable peak pricing were associated with greater reductions in electricity use during the spring and summer, but not during the fall and winter.

3. Some evidence exists that consumers shifted their demand for electricity between the peak-pricing hours and off-peak hours.

Benefits from notification inconclusive. The value of price notification is inconclusive, in part because the data did not allow study staff to measure variation in customer choice of VPP thresholds above which notifications were sent out. Assuming customers did not change the notification settings they preferred, study staff found little evidence that notification led to any additional demand reductions during the VPP hours beyond the reductions from being in the "treatment" group.

System benefits and lessons for electric utilities in Vermont. Because the study was designed to evaluate whether variable peak pricing and price notification were effective in reducing customer demand during peak pricing periods, the study expected customers to benefit through savings in their monthly bill. Across the long term, reduced peak time loads could potentially translate into customer savings through deferred system upgrades and reduced capacity charges paid to the regional transmission organization (the grid), ISO New England.

The impacts from load reduction associated with the variable rate structure in the VEC service territory suggested a complex role for time-varying electricity pricing as an effective means for demand reduction in Vermont. Our analysis suggests that time-of-use or time-of-day pricing might be both simpler and more effective to implement in Vermont than dynamic retail pricing such as the VPP. As smart grid capabilities in Vermont evolve, however, rate structures like VPP might have a seasonal role to play if accompanied by energy management or technology solutions that facilitate customer response to high price events.

2. Introduction

The eEnergy Vermont Utilities are one of nine Smart Grid Investment Grant (SGIG) recipients nationwide that conducted research into the effectiveness of dynamic electric utility rates and information feedback technologies in changing utility customer behavior. Two of these utilities, the Vermont Electric Cooperative (VEC) and Central Vermont Public Service (CVPS), designed Consumer Behavior Studies (CBSs) to test specific electric rate structures and technology solutions within their service territories. This report addresses only the VEC study, and describes the experience that has been gained by VEC and its implementation partner, Efficiency Vermont, during the second year of the study. An interim evaluation report is available for the first year of the project on smartgrid.gov[1].

2.1 Project Background

The U.S. Department of Energy's (DOE) primary objective for each CBS was to "investigate the power of Advanced Metering Infrastructure (AMI; an integrated system of smart meters, communications networks, and data management processes) in seamlessly integrating pricing, technology, and information feedback to induce a change in behavior."[2] DOE's vision is that the results of the SGIG dynamic rate studies will be applicable nationwide.[3]

Vermont's primary objective for conducting a Consumer Behavior Study as part of the SGIG was to test the effectiveness of dynamic pricing, information, and automation treatments on *lowering peak and total electric loads*, and on making the state's electric service more affordable. Specifically, the objective of the VEC study was to combine a Variable Peak Price (VPP), a Web portal, and a high level of customer support to reduce peak and total energy use. If these customer systems can operate seamlessly within the AMI infrastructure, the hope was that they will "fundamentally change how customers manage their electricity (use)."[4]

2.2 Project Overview

VEC and CVPS submitted a joint CBS Plan to DOE in September 2010. Implementation of the VEC study began after DOE approved the CBS Plan in December 2010, and was divided into five steps, as shown in **Table 1**.

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[1] Vermont Electric Cooperative Consumer Behavior Study Interim Process Evaluation of Year 1, Oct. 2013
[2] DOE Webinar, SGIG_Customer_Behavior_Webinar_Day1_20100420.pdf, Slide 8, April 2010.
[3] eEnergy Vermont Consumer Behavior Study Plan, September 15th, 2010, page 9
[4] eEnergy Vermont Smart Grid Investment Grant Application, August 6th, 2009, pp 1-6

Table 1. CBS implementation sequence

Step	Description
1	Technology development
2	Recruitment
3	Data collection
4	Data analysis
5	Final report

Year 1 of the study spanned July 1, 2012 through June 30, 2013, and addressed information treatments encouraging energy efficiency respectively from customer service and from the technology. This report addresses Year 2 (mid-June 2013 – June 30, 2014), which addressed dynamic pricing and information treatments that encouraged reductions in peak and total electric loads.

2.3 Research Questions of Interest

Using customer-level electric use data available from June 2012 through June 2014 (covering the year prior to the study, plus the study period itself), the load impact analysis of the VEC Consumer Behavior Study attempted to answer these research questions:

1. How does a VPP rate design (in the presence of information feedback from the Web sites and text messages) affect customers' average monthly electricity use throughout the study period? During different seasons within the study period? Is there any correlation between monthly customer electricity use and the monthly average of the variable peak period price (in excess of the minimum threshold)?
2. How does a VPP rate design (in the presence of information feedback from the Web site and text messages) affect customers' average hourly electricity use during the variable peak period:
    a. Over all days in the same season?
    b. Over all days in the same season, when the variable peak period price is (a) at the minimum threshold? (b) above the minimum threshold?
3. How does a VPP rate design (in the presence of information feedback from the Web site and text messages) affect customers' average hourly electricity use during the variable peak period, when comparing customers who received variable peak price updates vs. those who did NOT receive variable peak price updates:
    a. Over all days in the same season?
    b. Over all days in the same season when the variable peak period price was (a) at the minimum threshold? (b) above the minimum threshold?
4. How does a VPP rate design (in the presence of information feedback from the Web site and text messages) affect customers' average hourly electricity use during the on-peak period:
    a. Over all days in the same season?
    b. Over all days in the same season when the variable peak period price is (a) at the minimum threshold? (b) above the minimum threshold, on average?

5. How does a VPP rate design (in the presence feedback information from the Web site and text messages) affect customer average hourly electricity use during the off-peak period:
    a. Over all days in the same season?
    b. Over all days in the same season when the variable peak period price is (a) at the minimum threshold? (b) above the minimum threshold, on average?

3. Project Description

The Project Team implemented the study within the VEC territory, which comprises 30,000 residential customers. The geography is rural, with an average density of 13 customers per square mile. VEC has been deploying a power line carrier (PLC) AMI network since 2005, and as of 2014, 98 percent of its customers were on the network. VEC also offered its members online access to their electricity use information through VEC's longstanding wattWATCHERS web portal.

3.1 Design Elements

The study had three major design elements:

1. Enhanced Web Portal
2. Variable Peak Pricing
3. Price notifications

3.1.1 Target Population and Treatment Groups

VEC serves approximately 30,000 residential customers. To reduce the number of outliers for the study, VEC eliminated customers with monthly consumption above 65,000 kWh and those with consumption below 500 kWh. Sample size requirements of the study were correspondingly reduced to accommodate the lower census of customers. The result was a target population of approximately 19,000 customers. The second year of the CBS specified a single treatment and one control group. The treatment group received the Variable Peak Price supported by an enhanced version of wattWATCHERS Plus, which included a bill comparison calculator and price alerts via text message or e-mail. The control group remained on the standard flat electric rate and had access to the unmodified wattWATCHERS Web portal.

Table 2. Summary of VEC treatment groups

Technology or Price	Treatment Group 1	Control Group 1
Customer service	X	
Flat rate + Web presentment		X
Variable peak price (VPP) + enhanced Web presentment, with price alerts	X	
Designed sample size	**848**	**841**

Figure 1 and Figure 2 present the rate tables for 2013 and 2014, respectively. VEC increased its residential rates by 2.93 percent effective January 1, 2014, which changed the VPP rates. The hours remained the same between 2013 and 2014. Rate tariff sheets can be found in **Appendix B**: Rate Tariffs**.**

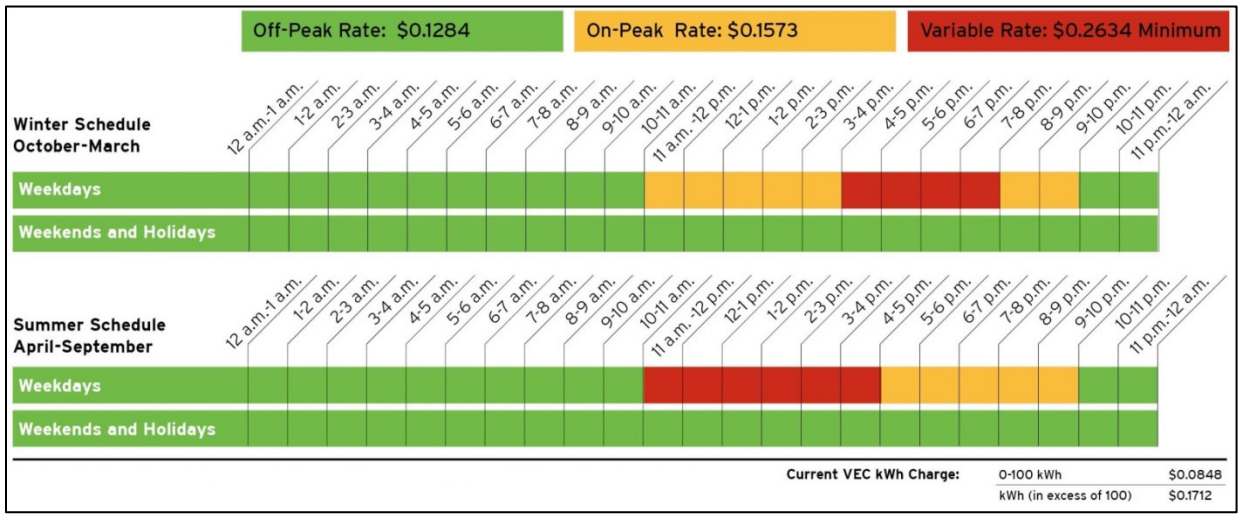


Figure 1. VEC's VPP rates, 2013.

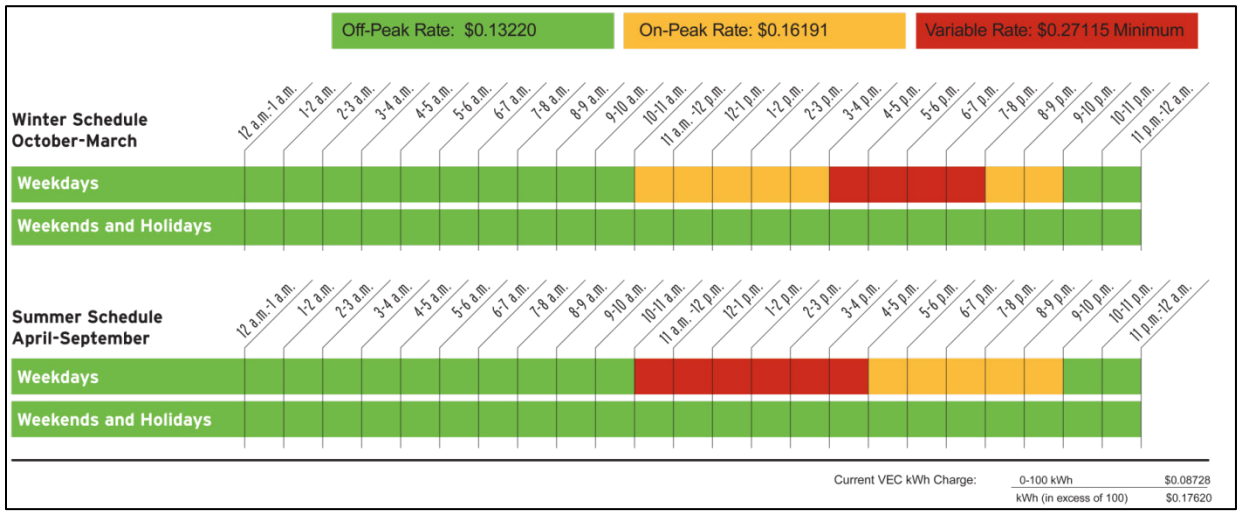


Figure 2. VEC's VPP rates, 2014.

3.1.2 Randomization and Assignment Method

The target population of VEC customers received direct-mail recruitment material: a pre-survey postcard and survey. The postcard alerted customers to the study, encouraging them to "keep an eye out" for the soon-to-follow enrollment survey. Study staff then screened survey respondents for eligibility according to the following criteria:

1. Customer must have an active electric account that used at least 2,400 kWh per year.

2. Customer must have reliable AMI data access.[5]

3. Customer must have Internet access.[6]

Study staff then randomly assigned the eligible respondents to either the treatment group or the control group. Study staff used random-number generation software to assign eligible respondents to either the treatment group or the control group.

3.2 Implementation

Study design began in January 2013. VEC modified the wattWATCHERS Plus portal to accommodate the study, and study staff mailed the recruitment postcards and surveys.

3.2.1 Project Schedule

Table 3. Year 2 sequence of dynamic pricing and information treatment portion of the VEC-Efficiency Vermont CBS

Step	Description	Start	End
1	Technology development	January 2013	June 2013
2	Recruitment	March 2013	April 2013
3	Study period	June 2013	June 2014
4	Data analysis	July 2014	December 2014
5	Final report	December 2014	May 2015

3.2.2 Recruitment and Methods for Customer Retention

The direct-mail recruitment campaign began with the pre-enrollment postcard (**Appendix D: Education Material**) alerting customers to the impending arrival (in 10 days) of the enrollment package, as shown in **Figure 3.**

[5] Note that not all VEC customers who have AMI meters have "reliable" AMI data access. VEC screened out survey respondents who were connected to substations that had a poor history of AMI data access.
[6] Internet access was required so that customers could view the wattWATCHERS Plus portal and receive price alerts.

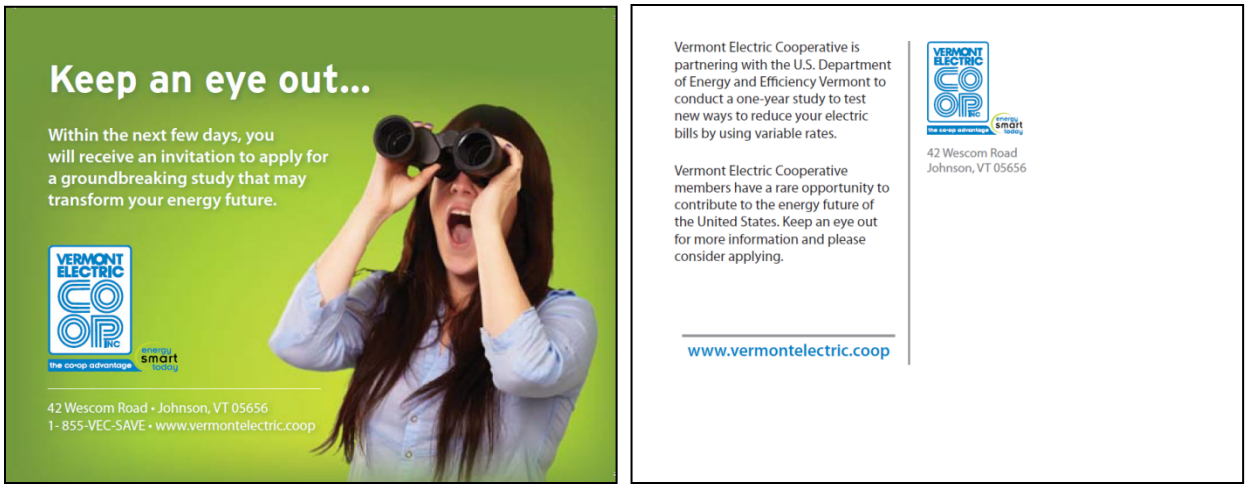


Figure 3. Pre-recruitment postcard.

The enrollment package, send April 2, 2013, contained a cover letter (signed by the VEC CEO) and a survey (see **Appendix A**). The Efficiency Vermont Customer Support group staffed a dedicated, toll-free number.

VEC and Efficiency Vermont co-branded the survey, which included a postage-paid envelope to Efficiency Vermont. Most of the survey's 39 questions were common to all of the CBS utilities statewide. The April 30 deadline allowed acceptance of survey-applications through May 3, making the full recruitment period approximately 5 weeks. At the end of the recruitment period and before the participation notifications were mailed out, VEC assumed customer service responsibilities for the study.

3.2.3 Recruitment and Customer Retention Numbers

The direct-mail recruitment campaign resulted in a 12 percent response rate. Of the 18,977 customers recruited by mail, 2,258 responded with completed survey-applications.

The recruitment period ended in May 2013. On May 24, 2013, study staff mailed letters to all 2,258 responding customers informing them of whether they had been selected to participate in the study (see **Appendix A** and **Figure 4**). Five-hundred and sixty-nine customers did not qualify for the study and received "deny" letters; study staff informed 848 that they had been selected for the study and would be placed on the VPP rate in June 2013. Study staff placed the remaining 841 customers in the control group and would remain on the standard residential rate but be treated as control customers.

The letter for study participants described the purpose, structure, and timeline of the study. The letter also contained a separate VPP schedule and terms for participation.

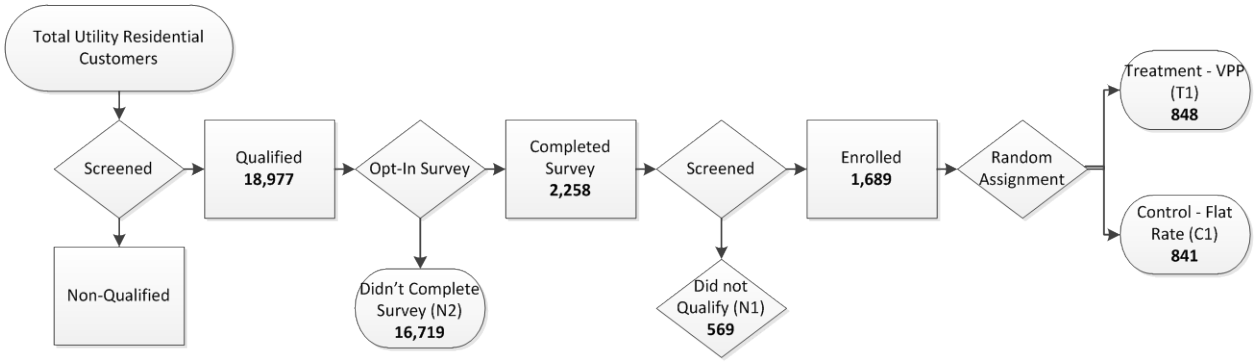


Figure 4. Recruitment and assignment process for study participation.

Study participants could opt out of the study at any time by calling the VPP hotline to speak with a VEC customer service representative. Opt-outs fell into two categories: administrative and voluntary. Administrative Opt-outs were customers who moved or transferred account names during the study or changed to a net metering rate. Voluntary Opt-outs were customers who contacted VEC to drop out of the study because of perceived increased costs, had sufficiently low consumption for the rate not to make sense for them, or because they changed their mind about participation. Sixty-nine participants voluntarily opted out of the study over the course of the year. Administrative Opt-outs were applied to an additional 38 participants.

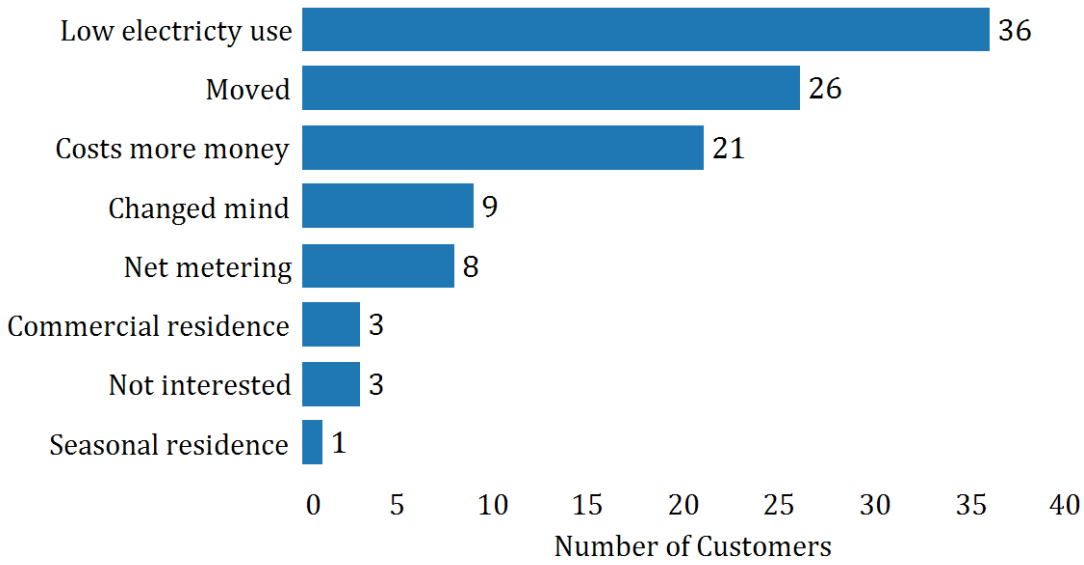


Figure 5. Study staff and customer reasons for opting out of the CBS.

Opt-out activity was slow but steady after the participation letters went out at the end of May 2013. One-fifth (21 percent) of the total Opt-outs occurred before the customer ever took service under VPP; another 35 percent opted out during the first 3 months of being exposed to VPP as part of the study, prior to the start of the winter pricing period (see

Figure 6). This initial spurt of voluntary Opt-outs can be attributed to a lack of comfort with the program. Some participants had logged onto wattWATCHERS Plus and determined that it would be difficult for them to save money on the program. Others did not realize that they were signing up for the study by returning the survey, and decided later not to participate.

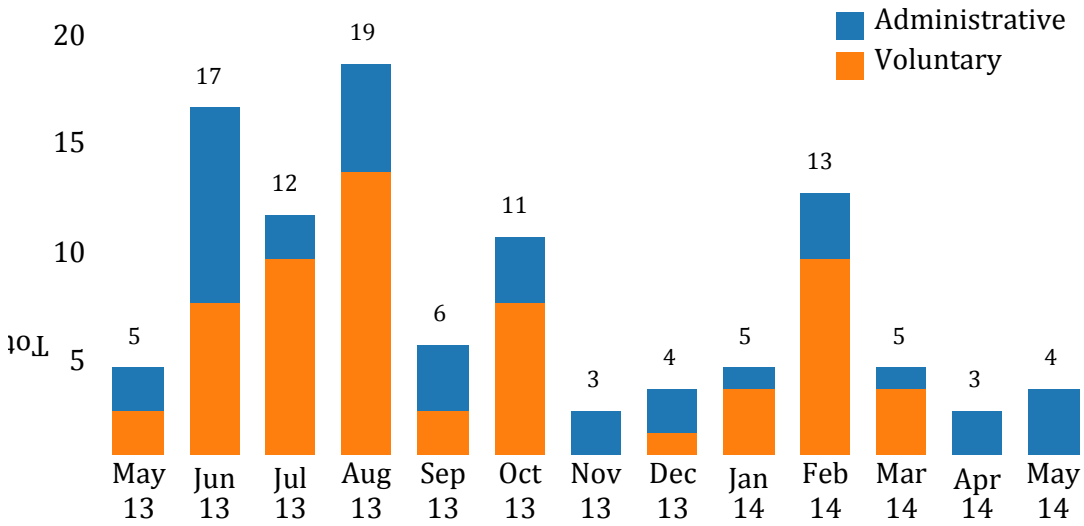


Figure 6. Opt-outs by month.

Predictably, the coldest of the winter months (December through March) saw a spike in the voluntary opt-out rate. Of the total Opt-outs that occurred during these months, 73 percent were voluntary, and accounted for 21 percent of the overall Opt-outs for the entire study. This is likely the reaction to an elevated VPP during that time. Of the 83 variable rate days from December through March, the rate was above the minimum for 73 of them. It rose as high as $0.67608 / kWh on January 28, 2014, as shown in **Figure 7.**

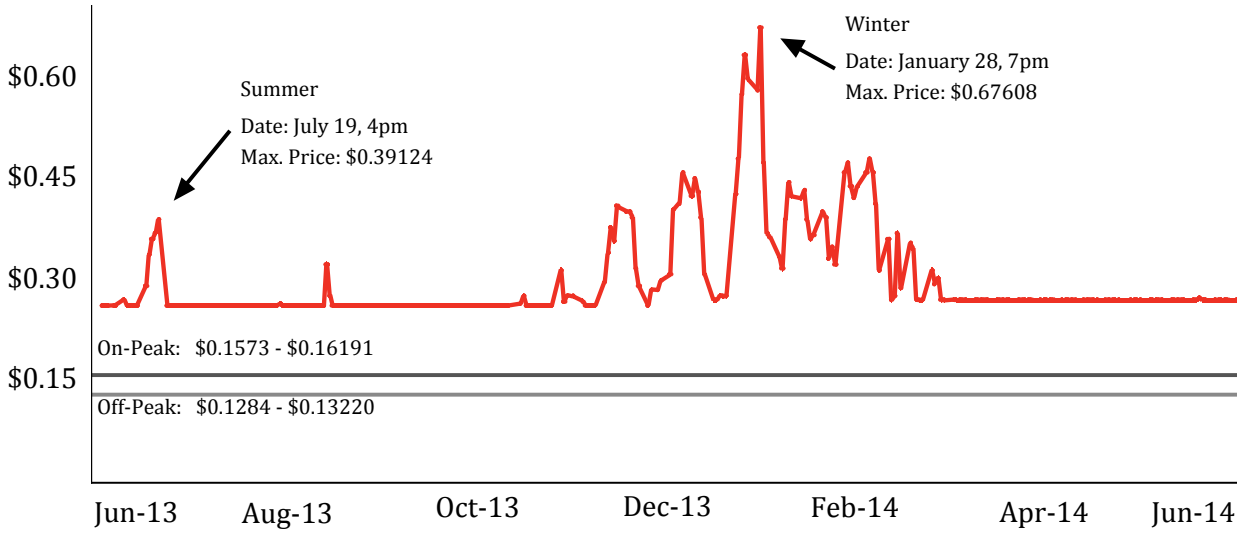


Figure 7. VPP for the 13-month period June 2013 through June 2014.

Overall, the participant retention rate was 87 percent. **Table 4** shows the starting and finishing treatment and control groups' respective sizes.

Table 4. CBS customer retention

Group	Start	End	Retention Rate
Treatment	848	741[7]	87%
Control	841	799[8]	95%

3.2.4 Opt-out Analysis

Although the Opt-out rate was relatively low (~13 percent), it is still important to understand why customers chose to leave the study, and what ultimately affected how they participated in the study.

1. Even when low-use members significantly shifted their loads, they were unable to save money on the VPP. The main reason that low-use customers had trouble saving was due to the multiple-tier standard residential rate, which provided a discount on the initial 100 kWh for each billing cycle. This discounted block applies to all members on the standard residential rate, but it was not available to treatment participants in the study. Low-use members that reduced their energy use were

[7] Opt-outs are both voluntary and administrative
[8] Opt-outs are due to account closures (for example, entered net metering program, customer moved, etc.)

unable to make up the financial loss of the initial block benefit, thus removing their motivation to shift load. The initial eligibility requirement that members average a minimum of 200 kWh per month or 2,400 kWh per year turned out to be too low for customers to break even or save on the VPP. The threshold of 400 kWh per month more closely represented the break-even point, but still was too low to see savings on the VPP. Many members opted out as result of this discovery. Others chose to stay on the program, despite knowing that they would be paying a few dollars more each month.

2. The VPP rose above the minimum at the beginning of December and stayed high through January and February. When participants received bills that were higher than expected during these months, some called and discovered that they were paying more than if they had been on the regular residential rate. Many of these members chose to leave the study.

When participants opted out of the study, the reason was tracked on VEC's internal SharePoint site. The results are summarized in **Table 5.**

Table 5. Voluntary Opt-outs

Reason	Description	Number	Percentage
1	Low use – cannot save money	36	52%
2	Paying more	21	31%
3	Changed mind	9	13%
4	Not interested	3	4%
	Total	**71**	**100%**

Customers could determine whether they were saving money by visiting wattWATCHERS Plus to compare their cost on the VPP rate to what they would have paid on the standard residential rate. Almost 50 percent of the participants who opted out cited the inability to save money on the program because of low electricity use. Another 30 percent did not have low use, but opted out because they were paying more on the program. Therefore, nearly 80 percent of participants who opted out did so because they were not saving money on the program. Another 7 percent felt that the amount of money they were saving was not worth the effort they were putting into shifting their loads. These findings highlight the need to provide a financial motivator to achieve the desired results and retain participants for a voluntary time-of-use or variable peak pricing program.

Study staff removed 35 participants for administrative reasons (for example, name change on the account, account closure, or a net metering application). These are termed *Administrative Opt-outs,* tallied in **Table 6.**

Table 6. Administrative Opt-outs

Reason	Description	Number	Percentage
1	Account closed	26	68%
2	Net metering application	8	21%
3	Commercial residence	3	8%
4	Seasonal residence	1	3%
	Total	**38**	**100%**

3.2.5 Experience with Enabling Technology

The primary channels for communicating the VPP were the Web portal and its alerts feature. wattWATCHERS Plus also enabled participants to track how they were doing on the program and to compare their cost on the study to what they would have paid on the standard residential rate.

Participants did not use wattWATCHERS Plus as heavily as expected. Approximately 25 percent of the participants (n = 204) used the site throughout the course of the study and an approximately 80 (~10 percent) used the website regularly. This site was the primary way for participants to track their use during the study and to compare costs on the VPP rates versus the standard residential rate. The study initially screened out participants if they did not confirm that they had regular access to the Internet (and thus to wattWATCHERS Plus). However, since many did not use the portal, this screening might not have been necessary.

Participants could also sign up for daily price alerts through text or e-mail. Fewer than 20 participants initially opted into receiving these alerts. Because of the low opt-in rate, study staff on October 1, 2013, automatically opted in approximately 100 members (13 percent), because they had an e-mail address on file, to receive alerts when the VPP rate rose above the minimum. This left approximately 700 participants (87 percent) without a notification when the VPP rate rose. Therefore, many participants were not aware of the daily variable price unless they routinely checked wattWATCHERS Plus. After the high-price months of December-February, many participants called when they received a bill that was higher than expected and chose to opt out when they realized that their bills were higher on the VPP Program.

A limitation of the notification analysis is that no records were kept of when participants opted in to receiving price alerts or when they changed the threshold for when they wanted to receive an alert. Participants could log on to wattWATCHERS Plus at any time to sign up, cancel, or change their alert settings. For example, a participant who was automatically opted in for receiving an e-mail alert in October 2013 could log on to wattWATCHERS Plus to cancel that alert, change it to text message, or change the price threshold. Participants had the option of having the alert sent every day, regardless of whether the VPP rate rose above the minimum. Only when the price rose above the minimum; or to a higher rate threshold (VPP rate greater than $0.31 / kWh, greater than

$0.36 / kWh, etc). These changes (if any) were not recorded by the notifications process. Therefore, the data we have offer only a snapshot rather than a comprehensive record of alert configurations for each participant. More information on the wattWATCHERS web portal can be found in **Appendix C: Technology Description**.

4. Analysis Methods

This section describes the regression-based econometric models used to address the five research questions that are central to this study. We note that several research questions effectively share the same modeling approach. This section describes the models and methods; Section 5 contains the results of the analysis.

4.1 Estimating the Impacts of the VPP Rate Design on Monthly Energy Consumption (Research Question 1)

To estimate average effects of being on the VPP rate over the 12-month study period, we estimated the following regression equation, using data from the study period and from the pre-study period:

$$(1) \qquad L_{jt} = \beta_0 + \beta_1 Y_t + \beta_C CDD_t + \beta_H HDD_t + \beta_T T_j + \beta_T T_j Y_t + \beta_P T_j VPP_t + \varepsilon_{jt},$$

where j indexes households; t indexes time (in months); L_{jt} represents total kWh consumption for household j during month t; CDD_t and HDD_t represent total cooling degree days and heating degree days during month t; T_j is an indicator variable equal to 1 for customers in the VPP group and 0 for those in the control group; Y_t is an indicator variable equal to 1 during the study year and 0 during the pre-study year; VPP_t represents the average hourly difference between the prevailing VPP rate and the flat rate for the control group; and ε_{jt} is the error term. In the estimation of Equation (1) and all subsequent regression equations, standard errors are clustered at the customer level.

We estimated Equation (1) for three distinct periods: July 2013 to September 2013 (the "summer VPP" period); October 2013 through March 2014 (the "winter" VPP period); and April 2014 through June 2014 (the "spring" VPP period). During each of the three periods, we used pre-treatment data for the same time horizon (but one year earlier). Thus, the summer VPP period regression used monthly kWh per customer from July to September 2012 as pre-treatment data; the winter VPP regression used monthly kWh per customer from October 2012 through March 2013 as pre-treatment data; and the spring VPP period used monthly kWh per customer from April through June 2013 as pre-treatment data.

4.2 Estimating the Impacts of the VPP Rate Design on Hourly Use during the Variable Peak Period (Research Question 2)

The second research question asked how the VPP rate design induced changes in average hourly electricity consumption during the defined variable-peak period. The VPP period was set as hour-ending 12:00 noon through hour-ending 5:00 pm from April through September, and hour-ending 5:00 pm through hour-ending 8:00 pm for the remainder of

the year. The timing of the VPP period reflects differences in the timing of peak demand periods during the summer (for air conditioning) and winter (for lighting and heating). As such, the load impact analysis addressing this particular research question used pre-study and study period data for these particular hours.

To estimate how the VPP influenced average kWh consumption during the variable peak pricing hours, we estimated the regression specification shown in Equation (2). We estimated Equation (2) for three distinct periods: July 2013 through September 2013 (the "summer VPP" period); October 2013 through March 2014 (the "winter" VPP period); and April 2014 through June 2014 (the "spring" VPP period). During each of the three periods, pre-treatment data for the same time horizon (but one year earlier) was used. Thus, the summer VPP period regression used average hourly kW per customer from July through September 2012 as pre-treatment data; the winter VPP regression used average hourly kW per customer from October 2012 through March 2013 as pre-treatment data; and the spring VPP period used average hourly kW per customer from April through June 2013 as pre-treatment data.

$$(2) \qquad l_{jt} = \beta_0 + \beta_1 Y_t + \beta_C CDD_t + \beta_H HDD_t + \beta_T T_j + \beta_{TY} T_j Y_t + \beta_P T_j VPP_t + \varepsilon_{jt},$$

where j indexes households; t indexes time (in hours, for the VPP period only); l_{jt} represents average hourly kW consumption for household j during VPP hour t; CDD_t and HDD_t represents total cooling degree days and heating degree days during period t; T_j is an indicator variable equal to 1 for customers in the VPP group and 0 for those in the control group; Y_t is an indicator variable equal to 1 during the study year and 0 during the pre-study year; VPP_t represents the difference between the prevailing VPP rate and the flat rate for the control group during hour t; and ε_{jt} is the error term (clustered at the customer level).

Equation (2) is a simple differences-in-differences equation aimed at estimating whether customers on the VPP rate exhibited significantly different consumption patterns during the VPP period, compared to the control group that remained on the VEC flat rate (while controlling for relevant covariates).

4.3 Estimating the Impacts of VPP Notification on Hourly Use during the VPP Period (Research Question 3)

From the start of the study, customers were able to set up text or e-mail notifications via wattWATCHERS Plus and set their own price thresholds for notification. It is important to note that the notification threshold might have differed from the minimum price threshold at which the hourly energy rate became variable. A very low number of participants chose to opt in to this notification. Thus, beginning in September 2013, study participants in the VPP group for whom contact information was available began to automatically receive e-

mail notifications when the variable peak price would exceed the minimum threshold. So few participants opted in (and data do not exist on which customers opted in) that we are not able to estimate any impacts of the choice to receive notifications on consumption during the July 2013 through October 2013 period.

Customers could freely change their notification settings at any time. We do not have a historical record of customers changing their notifications. We do have a record of the notification settings of customers as of the beginning of September 2013. The wattWATCHERS data from 109 customers (representing 13 percent of the total number of customers involved in the study) show that for 102 of them, the price notification threshold was set to 27.12 cents per kWh. Most of those customers had been automatically opted in to receive e-mail notifications. There is therefore insufficient variation in customer price notification threshold settings to estimate any relationship between this threshold-setting and actual consumption during the VPP period.

We can, however, examine differences in consumption during the VPP period between customers who did and did not receive price notifications. This comparison must be treated with care, since the receipt of price notifications was not randomized, but was determined by a combination of self-selection (that is, customers opting in to receive notifications prior to September 2013) and contact information availability within the VEC system. We thus cannot strictly determine whether any observed differences are due to the notification, or whether differences in customer attitudes among customers who provided contact information (e-mail addresses) to VEC or self-selected to receive notifications. The econometric results for this research question should thus be interpreted with some care since they may conflate two different effects: attributes of customers who opted in for notifications or gave e-mail contact information to VEC, and the effect of receiving the notification itself.

To estimate whether customers receiving price notifications exhibited different levels of consumption during VPP hours, we created the regression model shown in Equation (3). As with Equation (2), we estimated the model for the "winter" and "summer" VPP periods.

$$(3) \qquad l_{jt} = \beta_0 + \beta_1 Y_t + \beta_C CDD_t + \beta_H HDD_t + \beta_T T_j + \beta_{TY} T_j Y_t + \beta_P T_j VPP_t + \beta_N T_j N_j VPP_t + \varepsilon_{jt},$$

where N_j is an indicator variable equal to 1 for VPP customers who received price notifications and 0 for all other customers; VPP_t represents the hourly difference between the prevailing VPP rate and the flat rate faced by the control group; and all other variables are defined identically as in Equation (2).

We estimated two versions of Equation (3): one that includes all VPP hours during the study year, and another that includes only the hours when the VPP exceeded the minimum threshold. Based on the VPP rate history for the study year, there were relatively few hours during the period April through September when the VPP exceeded the minimum

threshold, but many such hours the period October through March. In our estimation of Equation (3) using only hours when the VPP exceeded the threshold, we consider only the period October through March. To estimate this regression, we use hourly customer-level data from October 2012 through March 2013 as our pre-treatment data. Creating a counterfactual using a subset of the data for October through March (based on similar prevailing weather conditions, for example) is challenging because of the differences in winter temperatures – particularly extreme low temperatures – during 2012-2013 and 2013-2014. Despite the differences in weather conditions the differences in average hourly consumption between the two winter seasons are quite similar (**See Table 7**). The use of the entire October through March period as the pre-treatment counterfactual thus seems justified. We did run equation (3) using only the December to March period as pre-treatment data (during this time period the VPP exceeded the minimum threshold roughly 70 percent of the time) and the results did not substantially change.

4.4 Estimating the Impacts of the VPP Rate Design on Hourly Use during the On-Peak Period (Research Question 4)

The fourth research question explored how the VPP rate design induced changes in average hourly electricity consumption during the defined on-peak, fixed-rate period. In response to the VPP rate design, consumers could reduce demands during these hours relative to their own behavior during the pre-study period, or relative to the control group (due to conservation efforts or in response to the flat rate that was higher than the off-peak flat rate). They also could increase demands during these hours, shifting electricity use away from the VPP hours. The on-peak period was set as April through September: hour-ending 6:00 pm through hour-ending 10:00 pm, and hour-ending 12:00 noon through hour-ending 4:00 pm; and for the remainder of the year: hours-ending 9:00 and 10:00 pm. The load impact analysis addressing this particular research question used pre-study and study-period data for these particular hours.

To estimate how the VPP rate design influenced average hourly kW consumption during the on-peak fixed-rate hours, we used the regression specification shown in Equation (4). A framework that is essentially identical to that in Section 2.2. The regression specification is shown in Equation (4). We estimate Equation (4) for three distinct periods: July 2013 to September 2013 (the "summer" VPP period); October 2013 through March 2014 (the "winter" VPP period); and April 2014 through June 2014 (the "spring" VPP period). During each of the three periods, we used pre-treatment data for the same time horizon (but one year earlier). Thus, the summer VPP period regression used average hourly on-peak kW per customer from July through September 2012 as pre-treatment data; the winter VPP regression used average hourly on-peak kW per customer from October 2012 through March 2013 as pre-treatment data; and the spring VPP period used average hourly on-peak kW per customer from April through June 2013, as pre-treatment data.

$$(4) \qquad l_{jt} = \beta_0 + \beta_1 Y_t + \beta_C CDD_t + \beta_H HDD_t + \beta_T T_j + \beta_{TY} T_j Y_t + \beta_P T_j VPP_t + \varepsilon_{jt},$$

where *j* indexes households; *t* indexes time (in hours, for the on-peak, fixed-rate period only); VPP_t represents the average daily difference between the prevailing VPP rate and the flat rate for the control group (the VPP_t term will thus be constant across all on-peak, fixed-rate hours within a single day); and other variables are identical to those in Equation (2). In effect, Equation (4) amounts to re-running Equation (2), but for the on-peak fixed-price hours.

4.5 Estimating the Impacts of the VPP Rate Design on Hourly Use during the Off-Peak Period (Research Question 5)

This question asked how the VPP rate design induced changes in average hourly electricity consumption during the defined off-peak, fixed-rate period. In response to the VPP rate design, consumers could reduce demands during these hours relative to their own behavior during the pre-study period or relative to the control group (due to conservation activities that affected electricity use in both on-peak or off-peak hours). Alternatively, customers could increase demands during these hours, shifting electricity use away from the on-peak and VPP hours. The off-peak period was set as hour-ending 1:00 am through hour-ending 11:00 am and hours-ending 11:00 pm and 12:00 midnight throughout the year. All hours on weekends and North American Electric Reliability Corporation (NERC) holidays (New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving and Christmas Day) were also considered to be off-peak hours. The load impact analysis addressing this particular research question used pre-study and study-period data for these particular hours.

To estimate how the VPP rate design influenced average hourly kW consumption during the off-peak hours, we used a framework essentially identical to that in **Section 2.2.** The regression specification is shown in Equation (5). We estimated Equation (5) for three distinct periods: July 2013 to September 2013 (the "summer" VPP period); October 2013 through March 2014 (the "winter" VPP period); and April 2014 through June 2014 (the "spring" VPP period). During each of the three periods, we used pre-treatment data for the same time horizon (but one year earlier). Thus, the summer VPP period regression used average hourly off-peak kW per customer from July to September 2012 as pre-treatment data; the winter VPP regression used average hourly off-peak kW per customer from October 2012 through March 2013 as pre-treatment data; and the spring VPP period used average hourly off-peak kW per customer from April through June 2013 as pre-treatment data.

$$(5) \qquad l_{jt} = \beta_0 + \beta_1 Y_t + \beta_W W_t + \beta_T T_j + \beta_{TY} T_j Y_t + \beta_P T_j VPP_t + \varepsilon_{jt},$$

where j indexes households; t indexes time (in hours, for the off-peak period only); VPP_t represents the average daily difference between the prevailing VPP rate and the flat rate for the control group (the VPP_t term will thus be constant across all off-peak fixed-rate hours within a single day); and other variables are identical to those in Equation (2). In effect, Equation (5) amounts to re-running Equation (2) but for the on-peak fixed-price hours.

4.6 Testing for Shifts in Consumption from Weekdays to Weekends

Since our analysis of the VPP rate hours considers only weekdays, we examine whether customers on the VPP rate are shifting electricity use from weekdays to weekends during the July-September and April-June time periods. We examined the ratio of weekend to weekday use for the treatment and control groups during the pre-treatment and study periods. Specifically, we estimated the following econometric equation:

$$(6) \qquad y_{j,t} = \beta_0 + \beta_1 CDD + \beta_2 HDD + \beta_3 Y_t + \beta_4 T_j + \beta_5 Y_t T_j + e_{t,j},$$

where $y_{j,t}$ is the ratio of total weekend to total weekday kWh use for customer j during week t; CDD_t and HDD_t represent cooling and heating degree days; Y_t is an indicator variable for the pre-treatment versus study year, T_j is an indicator variable for customers on the VPP rate treatment, and $e_{j,t}$ is the error term (standard errors are again clustered at the customer level).

5. Load Impact Analysis Results

We used a regression framework to investigate the five research questions outlined in **Section 4**. In our analysis we used one year of pre-treatment data for each customer and one year of study data. We thus have pre-treatment interval meter data for each customer from July 1, 2012, through June 30, 2013, and study-period data for the period July 1, 2013, through June 30, 2014. As discussed in **Section 4,** we chose pre-treatment data to match the relevant epoch and rate period covered by each regression: on-peak; off-peak; and VPP period. The similarities in consumption among both the treatment and control groups drove our selection of pre-treatment data during all periods in the pre-treatment year and the study year.

VEIC provided hourly interval meter data and the relevant rate level for each customer. Weather data, used to calculate heating and cooling degree days, were obtained from the National Weather Service station at the Burlington International Airport. Heating degrees were calculated as the difference between 65°F and the measured hourly temperature at Burlington International Airport when the average hourly temperature was below 65°F. Cooling degrees were calculated as the difference between the measured hourly temperature at Burlington International Airport and 70°F, when the average hourly temperature was above 70°F.[9] Several items relevant to the data and the analysis procedures are worth noting before discussing the results themselves.

- We used monthly kWh data for each customer to address Research Question 1, whereas we used hourly average kW data for each customer to address the remaining research questions. We calculated monthly kWh figures for each customer by summing hourly average kW for each customer during the relevant month.

- Addressing Research Question 3 required some data on notifications sent to each customer by VEC. Although customers did have a brief opt-in period during the summer of 2013, few customers opted in to the notification system. Study staff added all customers for whom VEC had relevant contact information (that is, an e-mail address) to the notification system by September 2013. Customers receiving price notifications could change their notification settings (the threshold price above which they would receive a notification from VEC), or opt out of receiving notifications using wattWATCHERS Plus. The study did not record customer changes to the notification settings. The notification data made available for our analysis corresponds to the notification settings for each customer receiving notifications as of September 2014. We thus assumed that:

[9] We also calculated heating degree days on a reference temperature of 60°F, and cooling degree days on a reference temperature of 65°F. Neither affected the results of our analysis.

(i) no customer receiving notifications opted out of receiving them and (ii) no customer changed the threshold settings on wattWATCHERS Plus.

- All regressions used the relevant data (monthly kWh or average hourly kW at the customer level) from July 1, 2012, through June 30, 2014. Analysts calculated standard errors in each regression, using clustering at the customer level. The regressions used indicator variables for treatment and control groups rather than customer-level fixed effects.

- As a first check for data robustness, analysts ran two versions of each regression: (1) containing only linear weather terms (heating and cooling degree days), and (2) containing both linear and quadratic weather terms (heating/cooling degree days squared). In general, we found that the regression coefficients for the treatment variables (the treatment dummy, and the various price terms) were robust to the weather specification (that is, whether only linear terms or squared terms were used in the regression equation). **Table 7 through Table 10** show results from both regressions. In general, including the squared weather terms reduced the magnitude of the coefficient on the linear term in the hourly kW regressions, and in a few cases also reduced its statistical significance. The magnitude of the coefficients on the linear weather terms was generally larger in the monthly kWh regressions when the squared weather terms were included. The statistical significance of the linear weather terms, however, was generally robust.

- To examine whether correlations between weather and the level of the VPP might affect our coefficient estimates, we ran versions of our regressions with and without weather variables (heating and cooling degree days) during hours when the VPP exceeded the minimum threshold. Over the course of the study period, the correlation between weather variables and the level of the VPP was 0.05. This correlation increased to 0.09 during the October – March period and increased further to 0.2 during January 2014. The estimated coefficients on the treatment variable and the treatment / VPP interaction variable were not materially affected by the inclusion of heating and cooling degree days in the regression specification.

- We observed virtually no cooling degree days during the second period (October through March) in either the pre-treatment or the study year. We thus removed the cooling degree day variable from the regressions for this second period.

- During the July-September period, we observed only three instances of notifications being sent to customers. During the October-March period notifications were frequent to customers receiving them, particularly during the November to February period in which notifications appear to have been sent nearly every day. During the April to June period, notifications were less frequent, with only a dozen notification days present in our data set. In our analysis of Research Question 3, which considers the effect of the price

notifications, we thus excluded the July – September period because of the very low number of notifications sent.

- Based on the billing data received from VEC, customers were taken off the VPP rate at the end of the relevant billing cycle in June 2014, rather than on June 30, 2014, specifically. Customers thus spent varying amounts of time on the VPP rate during the last month of the study. We ran all regressions including and excluding June 2014 as a sensitivity analysis. Including June did not change the statistical significance level of any estimated coefficient, and changed the magnitudes of the estimated coefficients by less than 5 percent in all cases.

Analysis results for each of the research questions are presented in **Sections 5.2 through 5.7. Section 5.1** presents a graphical and tabular overview of the data.

5.1 Data Overview

Our data set consists of hourly average kW observations for 848 customers in the treatment group and 841 in the control group, for the period July 1, 2012 through June 30, 2014. Overall, customers exhibited consistent use patterns between the pre-treatment period and the study period. **Table 7 through Table 10** present means and standard deviations for average hourly kW use per customer, for the treatment and control groups, during the pre-treatment period (**Table 7** and **Table 8**) and the study period (**Table 9** and **Table 10)**. The rows of each table show the relevant figures for each of the three sub-periods, whereas the columns indicate the relevant pricing periods (off-peak flat rate; on-peak flat rate, VPP). **Table 7** shows the average load shape for the pre-treatment and study periods, for the treatment and control groups.

Table 7. Average hourly kW, July 2012 through June 2013

	Control Group			Treatment Group		
	Off Peak	**On Peak**	**VPP**	**Off Peak**	**On Peak**	**VPP**
Jul-12 to Sep-12	0.78	1.17	0.97	0.77	1.18	0.97
Oct-12 to Mar-13	0.84	1.03	1.32	0.82	1.03	1.32
Apr-13 to Jun-13	0.74	1.08	0.87	0.73	1.07	0.85

Table 8. Standard deviation of hourly kW, July 2012 through June 2013

	Control Group			Treatment Group		
	Off Peak	**On Peak**	**VPP**	**Off Peak**	**On Peak**	**VPP**
Jul-12 to Sep-12	1.12	1.38	1.30	0.83	1.23	1.09
Oct-12 to Mar-13	1.19	1.41	1.43	0.89	1.16	1.31
Apr-13 to Jun-13	1.18	1.47	1.39	0.85	1.21	1.03

Table 9. Average hourly kW, July 2013 through June 2014

	Control Group			Treatment Group		
	Off Peak	On Peak	VPP	Off Peak	On Peak	VPP
Jul-13 to Sep-13	0.78	1.15	0.96	0.79	1.13	0.91
Oct-13 to Mar-14	0.84	1.02	1.29	0.85	1.01	1.27
Apr-14 to Jun-14	0.70	1.02	0.82	0.70	1.00	0.78

Table 10. Standard deviation of hourly kW, July 2013 through June 2014

	Control Group			Treatment Group		
	Off Peak	On Peak	VPP	Off Peak	On Peak	VPP
Jul-13 to Sep-13	1.13	1.36	1.30	0.87	1.22	1.06
Oct-13 to Mar-14	1.07	1.27	1.35	0.94	1.16	1.27
Apr-14 to Jun-14	0.81	1.19	1.03	0.87	1.19	1.05

Table 7 through **Table 10** suggest that hourly average kW consumption did not change significantly from the pre-treatment year to the study year. This visual observation is consistent with our regression results, where we generally did not find that the indicator variable for the study year was statistically significant.

We did observe some changes during the study year for the treatment group, relative to the control group. These changes are summarized in **Table 11.** The percentage reduction numbers in the table are defined as the difference between the control group and the treatment group. Thus, positive numbers in **Table 11** indicate reductions in electricity use by the treatment group relative to the control group during the study year. Negative numbers indicate increases by the treatment group relative to the control group.

Table 11. Percentage reductions in hourly kW by the treatment group, July 2013 through June 2014

	Treatment Group Reduction		
	Off Peak	On Peak	VPP
Jul-13 to Sep-13	-0.47%	1.34%	4.94%
Oct-13 to Mar-14	-0.74%	1.10%	1.86%
Apr-14 to Jun-14	-0.89%	1.74%	4.89%

In general, these observed differences are statistically significant. We performed t-tests for equality of means during each of the three sub-periods of the treatment year and each of the three daily rate periods (9 t-tests total). In all cases we find that the differences in average hourly consumption during the study year are statistically significant. **Table 12**

shows the results of these t-tests. We emphasize that this comparison considers only the study year and does not control for any significant changes in consumption between the pre-treatment year and the study year. We control for the year-to-year effects in the regression results in **Table 12**.

Table 12. T-tests for equality of means in average hourly kW consumption between treatment and control groups, July 2013 through June 2014

	Off Peak	On Peak	VPP
Jul-13 to Sep-13	2.57	5.22	19.26
Oct-13 to Mar-14	6.12	6.81	10.13
Apr-14 to Jun-14	5.23	6.56	18.41

At the monthly kWh level, we observed some changes in annual consumption patterns between the pre-treatment and study periods, due largely to differences in weather conditions between the two years. **Figure 8** shows monthly kWh per customer for the treatment and control groups from July 2012 through June 2014. We observe that electricity use during the summer months was somewhat higher during the study year than during the pre-treatment year, in large part because of warmer weather and increased air-conditioning demand. We observed this difference for both the treatment and control groups. Despite the very cold winter during the study year, we did not visually observe any striking differences in monthly kWh use during the pre-treatment winter months versus the study-year winter months. This is consistent with our observations in the hourly average kW data and our regression results in **Figure 8** that customers in the treatment group did not reduce use by a significant amount during the winter months, even though the VPP rate was substantially higher during those months.

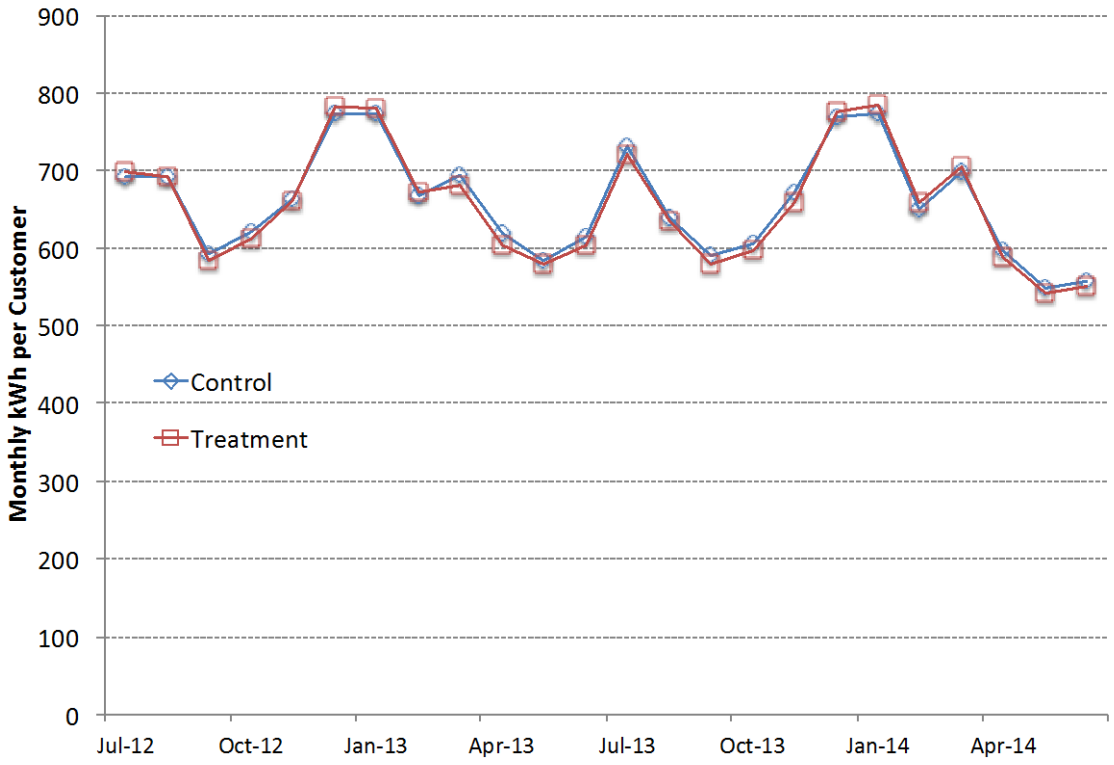


Figure 8. Monthly kWh per customer, July 2012 through June 2014.

Table 13 and **Table 14** show means and standard deviations of monthly kWh consumption for the treatment and control groups during the pre-treatment year (**Table 13**) and the study year (**Table** 14). During the study period we did not find statistically significant differences in a simple comparison of means of monthly kWh consumption between the treatment and control groups. The results of the t-tests for the study period are shown in **Table 15**; in no case do we find a statistically significant difference in simple means. We emphasize, however that this analysis does not consider year-to-year differences in monthly kWh consumption for the treatment or control groups. As we will see in Section 5.2, we do find that the VPP had a statistically significant impact on monthly kWh consumption during some seasons.

Table 13. Summary of monthly kWh consumption, July 2012 through June 2013

	Control Group		Treatment Group	
Period	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Jul-12 to Sep-12	658	51	658	61
Oct-12 to Mar-13	699	128	698	52
Apr-13 to Jun-13	606	152	595	26
All Year	666	110	662	53

Table 14. Summary of monthly kWh consumption, July 2013 through June 2014

Period	Control Group		Treatment Group	
	Mean	Std. Dev.	Mean	Std. Dev.
Jul-13 to Sep-13	654	37	645	61
Oct-13 to Mar-14	695	122	697	69
Apr-14 to Jun-14	568	63	560	56
All Year	653	148	650	71

Table 15. T-tests for comparison of mean monthly kWh between treatment and control groups, July 2013 through June 2014

Period	T-Stat
Jul-13 to Sep-13	0.99
Oct-13 to Mar-14	0.90
Apr-14 to Jun-14	0.46

5.2 Analysis of Research Question 1: Impacts of the VPP Rate Design on Monthly Energy Consumption

To investigate the question of whether the VPP rate design had any impact on monthly kWh consumption, we estimated Regression Equation (1) for each of the three sub-periods (July through September; October through March; and April through June). The results are shown in **Table 16** through **Table 18**. We found that during the October-March period (**Table 17**), the treatment group consumed 30 kWh less each month than the control group for reasons that were not correlated with the average monthly level of the VPP rate. The level of the VPP was statistically significant for all three sub-periods. In the July to September sub-period (**Table 16**), a higher average VPP was associated with higher levels of monthly energy consumption. This is most likely due to very hot weather conditions during July 2013, compared to the same period in 2012.

Table 16. Regression output for Equation (1) – July through September

Note: *=significant at 5% level; **=significant at 1% level
Dependent variable: Monthly kWh consumption

	Coefficient	T-Stat
Treatment	-9.67	-1.38
Treatment*VPP	53.31**	3.14
HDD	-0.01**	-8.12
CDD	0.04**	21.76
Constant	598.94**	141.75
R^2 = 0.16		

Table 17. Regression output for Equation (1) – October through March

Note: *=significant at 5% level; **=significant at 1% level
Dependent variable: Monthly kWh consumption

	Coefficient	T-Stat
Treatment	-29.95*	-2.15
Treatment*VPP	20.14**	6.05
HDD	0.002**	20.96
CDD	-0.002**	-12.99
Constant	612.50**	127.65
R^2 = 0.02		

Table 18. Regression output for Equation (1) – April through June

Note: *=significant at 5% level; **=significant at 1% level
Dependent variable: Monthly kWh consumption

	Coefficient	T-Stat
Treatment	3.54	0.17
Treatment*VPP	-29.88**	-3.34
HDD	N/A	N/A
CDD	0.005	1.71
Constant	594.39**	119.79
R^2 = 0.01		

5.3 Analysis of Research Question 2: Impacts of the VPP Rate Design on Hourly Use during the Variable Peak Period

5.3.1 Impacts During All VPP Hours

To investigate whether the VPP rate design had any impact on average hourly kW consumption during the VPP hours, we estimated Regression Equation (2) for each of the three annual sub-periods (July through September, October through March, and April through June), using all VPP hours. The results are shown in **Table 19** through **Table 21.** During the first and third sub-periods (July to September [**Table 19]** and April to June [**Table 21]**), we found that average hourly consumption among treatment group customers was somewhat higher than control group customers. During the October to March period (**Table 20**) we found that average hourly consumption among treatment group customers was somewhat lower than control group customers. The level of the VPP was statistically significant, with a negative coefficient, during the first and third sub-periods, indicating that customers in the treatment group did reduce demands during the VPP hours in these months, with estimated reductions of 0.15 to 0.2 kW (15 percent to 20 percent relative to the control group during these same periods). The VPP rate effect however, is not statistically significant during the October through March sub-period.

Table 19. Regression output for Equation (2) – July through September

Notes: *=significant at 5% level; **=significant at 1% level
Dependent variable: Average hourly kW consumption during VPP hours

	Coefficient	T-Stat
Treatment	0.24**	11.52
Treat*VPP	-0.19**	-3.07
HDD	-0.01	-1.55
CDD	0.04**	3.08
Year	-0.01	-0.01
Constant	1.04**	19.71
$R^2 = 0.05$		

Table 20. Regression output for Equation (2) – October through March

Notes: *=significant at 5% level; **=significant at 1% level
Dependent variable: Average hourly kW consumption during VPP hours

	Coefficient	T-Stat
Treatment	-0.02**	10.58
Treat*VPP	-0.05	0.15
HDD	0.00**	3.06
CDD	N/A	N/A
Year	-0.03	-0.02
Constant	0.81**	13.76
R^2 = 0.07		

Table 21. Regression output for Equation (2) – April through June

Notes: *=significant at 5% level; **=significant at 1% level
Dependent variable: Average hourly kW consumption during VPP hours

	Coefficient	T-Stat
Treatment	0.31**	10.26
Treat*VPP	-0.15**	-3.52
HDD	0.00	0.54
CDD	-0.01	-0.08
Year	-0.06	-0.04
Constant	0.94**	16.69
R^2 = 0.07		

5.3.2 Impacts during VPP Hours When the VPP Rate Exceeds the Minimum Threshold

We also examined average hourly kW consumption during only the VPP hours when the VPP exceeded the minimum threshold. Data on the prevailing VPP rate level provided by VEC suggests that this happened almost exclusively during the period November 2013 to March 2014. During this period, the VPP was almost always higher than the minimum threshold. During other time periods (July through September and April through June), the VPP was seldom higher than the minimum threshold.

We re-tested the results of Equation (2) using only the days in the October through March sub-period when the average level of the VPP exceeded the minimum threshold. We found that the VPP exceeded the threshold during 70 percent of the VPP rate hours in this sub-period. We thus expected the results of estimating Equation (2) results using this restricted data set to be similar to the results shown in **Table 20.**

The econometric results from re-estimating Equation (2) results, considering only the days when the average VPP exceeded the threshold, are shown in **Table 22.**

Table 22. Regression output for Equation (2) on days when VPP rate exceeded the threshold – October through March

Notes: *=significant at 5% level; **=significant at 1% level
Dependent variable: Average hourly kW consumption during VPP hours exceeding the minimum threshold

	Coefficient	T-Stat
Treatment	-0.04**	-8.18
Treat*VPP	0.04	0.41
HDD	0.00	1.64
CDD	N/A	N/A
Year	-0.03	-0.02
Constant	0.88**	10.24
$R^2 = 0.12$		

The estimated coefficients from this restricted data set are similar to those obtained from considering all VPP rate hours during the October through March period (**Table 20)**. We observed a somewhat larger effect of being in the treatment group during the high VPP hours (a coefficient of -0.04 versus -0.02 when considering all VPP rate hours in the October through March period), although the level of the VPP itself is still not statistically significant.

5.4 Analysis of Research Question 3: Impacts of VPP Notification on Hourly Use during the VPP Period

5.4.1 Impacts during All VPP Hours

Like Research Question 2 (**Section 4.3**), Research Question 3 is concerned with estimating the impact of the VPP rate design on average hourly kW use during the VPP hours. Here we additionally estimate the effect of the VPP rate notifications sent to customers on a day-ahead basis, when the energy charge during the VPP hours would exceed a threshold set by the customer or by VEC on behalf of the customer. The results from implementing Equation (3) are shown in **Table 23** and **Table 24.** We emphasize again three aspects of our notification analysis. First, we were able to obtain only a snapshot of the notification data, so our analysis assumed that no customers changed notification settings throughout the study period. Second, all but a few customers had their price notification set at the minimum threshold, so we were not able to say anything about the effect of different price thresholds. Third, there were a small number of notification events during the period July through September, so we did not estimate Equation (3) for this sub-period.

Table 23. Regression output for Equation (3) – October through March

Notes: *=significant at 5% level; **=significant at 1% level
Dependent variable: Average hourly kW consumption during VPP hours

	Coefficient	T-Stat
Treatment	-0.02**	-10.58
Treat*VPP	0.04	0.15
Notification	-0.05	-0.14
HDD	0.00	3.06
CDD	N/A	N/A
Constant	0.81**	13.76
Year	-0.03	-0.02
R^2 = 0.05		

Table 24. Regression output for Equation (3) – April through June

Notes: *=significant at 5% level; **=significant at 1% level
Dependent variable: Average hourly kW consumption during VPP hours

	Coefficient	T-Stat
Treatment	0.30**	10.21
Treat*VPP	0.01	0.05
Notification	-0.15**	-3.52
HDD	0.0002	0.54
CDD	-0.01	-0.08
Year	-0.03	-0.02
Constant	0.93**	16.66
R^2 = 0.08		

The results in **Table 23** suggest that during the October through March period, when the VPP levels were most consistently above the minimum threshold and notifications were more frequent, customers on the VPP rate who received notifications did not reduce electricity use by a statistically significant amount, relative to the reductions of treatment group customers not receiving notifications, or relative to the control group. This is consistent with what our analysis found in **Section 5.3,** where despite the high levels of the VPP rate, customers were unwilling or unable to take actions to reduce use.

Receiving notifications did yield statistically significant use reductions during the spring 2014 period (April through June 2014), although in our regressions the level of the VPP was rendered statistically insignificant. We suspect that because of the infrequent notifications during this period, and the infrequency with which the VPP exceeded the threshold during this period, the notification indicator variable is highly correlated with the VPP variable. The estimated coefficient of the notification variable in **Table 24,** -0.15 kW, is identical to the estimated coefficient on the VPP variable in **Table 21.**

5.4.2 Impacts during VPP Hours When the VPP Rate Exceeds the Minimum Threshold

We examined whether the impact of receiving VPP price notifications on average kW consumption during those days when the average VPP exceeds the minimum threshold. As discussed in **Section 5.3.2**, we ran this analysis by re-estimating Equation (3) for the period October through March, considering only the days when the average VPP exceeded the threshold.

Table 25 presented the econometric results for the high-VPP days in the October through March period. Our findings were consistent with those shown in **Table 23.** The level of the VPP was not statistically significant, although the effect of being on the VPP rate treatment was larger during the set of high-VPP days than during the entire set of VPP days in the October through March period.

Table 25. Regression output for Equation (3) on days when VPP rate exceeded the threshold – October through March

Notes: *=significant at 5% level; **=significant at 1% level
Dependent variable: Average hourly kW consumption during VPP hours exceeding the minimum price threshold

	Coefficient	T-Stat
Treatment	-0.05**	8.15
Treat*VPP	0.004	0.07
Notification	0.04	0.41
HDD	0.00	1.64
CDD	N/A	N/A
Year	-0.03	-0.02
Constant	0.88**	10.22
R^2 = 0.09		

5.5 Analysis of Research Question 4: Impacts of the VPP Rate Design on Hourly Usage During the On-Peak (Flat Rate) Period

5.5.1 Impacts during All On-Peak Hours

To investigate the impact of the VPP rate design on average hourly kW consumption during the on-peak flat-rate period, we estimated Equation (4) for each of the three sub-periods (July through September; October through March; and April through June), using all on-peak hours. The results are presented in **Table 26** through **Table 28**.

Overall we found some evidence that customers in the treatment group reduced electricity use by small but statistically significant amounts (1 percent to 4 percent) relative to the

control group during the on-peak, flat-rate hours. The average daily level of the VPP was not a statistically significant predictor of hourly kW use during the on-peak, flat-rate hours.

Table 26. Regression output for Equation (4) – July through September

Notes: *=significant at 5% level; **=significant at 1% level
Dependent variable: Average hourly kW consumption during on-peak hours

	Coefficient	T-Stat
Treatment	-0.019**	7.54
Treat*VPP	-0.06	-0.13
HDD	-0.010	-1.64
CDD	0.04	1.70
Year	-0.02	-0.02
Constant	0.92**	15.36
R^2 = 0.11		

Table 27. Regression output for Equation (4) – October through March

Notes: *=significant at 5% level; **=significant at 1% level
Dependent variable: Average hourly kW consumption during on-peak hours

	Coefficient	T-Stat
Treatment	-0.02**	7.00
Treat*VPP	-0.05	-0.12
HDD	0.001	2.52
CDD	N/A	N/A
Year	-0.01	-0.01
Constant	0.78**	10.16
R^2 = 0.11		

Table 28. Regression output for Equation (4) – April through June

Notes: *=significant at 5% level; **=significant at 1% level
Dependent variable: Average hourly kW consumption during on-peak hours

	Coefficient	T-Stat
Treatment	-0.04**	-6.13
Treat*VPP	-0.01	0.005
HDD	0.002	0.52
CDD	-0.2396	-0.19
Year	-0.14	-0.10
Constant	0.75**	12.25
R^2 = 0.11		

5.5.2 Impacts on Days When the VPP Rate Exceeds the Minimum Threshold

To assess whether average hourly kW consumption during the on-peak, flat-rate period was different during days with a VPP that exceeds the minimum threshold, we re-estimated Equation (4) for the period October through March, using only the days when the average VPP was higher than the minimum threshold. This approach did not affect the definitions of any of the variables used in Equation (4); we simply considered a smaller number of days in the October through March period. (Recall from **Section 5.3.2** that the VPP exceeded the threshold 70 percent of the time October 2013 through March 2014.)

The results of re-running Equation (4) are shown in **Table 29.** As with our original estimates shown in **Table 27,** the level of the VPP was not a statistically significant determinant of average hourly kW consumption during the on-peak, flat-rate period. We did observe a slightly larger effect of being on the VPP rate treatment during days with high average VPP (a coefficient of -0.03 versus -0.02 when considering all days during the October through March period).

Table 29. Regression output for Equation (4) on days when VPP rate exceeded the threshold – October through March

Notes: *=significant at 5% level; **=significant at 1% level
Dependent variable: Average hourly kW consumption during on-peak hours

	Coefficient	T-Stat
Treatment	-0.03**	4.90
Treat*VPP	-0.04	-0.08
HDD	0.00	1.64
CDD	N/A	N/A
Year	-0.01	-0.01
Constant	0.82**	7.26
R^2 = 0.11		

5.6 Analysis of Research Question 5: Impacts of the VPP Rate Design on Hourly Use during the Off-Peak Period

5.6.1 Impacts during All Off-Peak Hours

To investigate how the VPP rate design impacts hourly average kW consumption during the off-peak period, we estimated Equation (5) for each of the three sub-periods (July through September; October through March; and April through June), using all off-peak hours. In this analysis, off-peak hours involved not only the overnight hours on weekdays,

but all weekend hours and all NERC holidays. The results are shown in **Table** 30 through **Table 32.**

Table 30. Regression output for Equation (5) – July through September

Notes: *=significant at 5% level; **=significant at 1% level
Dependent variable: Average hourly kW consumption during off-peak hours

	Coefficient	T-Stat
Treatment	0.026**	15.40
Treat*VPP	-0.01	-0.02
HDD	-0.006*	-2.13
CDD	0.04**	6.03
Year	0.01	0.00
Constant	0.68**	29.05
R^2 = 0.04		

Table 31. Regression Output for Equation (5) – October through March

Notes: *=significant at 5% level; **=significant at 1% level
Dependent variable: Average hourly kW consumption during off-peak hours

	Coefficient	T-Stat
Treatment	0.001**	13.66
Treat*VPP	0.02	0.11
HDD	0.006**	8.45
CDD	N/A	N/A
Year	0.00	0.00
Constant	0.53**	19.01
R^2 = 0.07		

Table 32. Regression output for Equation (5) – April through June

Notes: *=significant at 5% level; **=significant at 1% level
Dependent variable: Average hourly kW consumption during off-peak hours

	Coefficient	T-Stat
Treatment	0.02**	13.52
Treat*VPP	0.000	0.061
HDD	0.003	1.84
CDD	0.059	0.71
Year	-0.05	-0.04
Constant	0.59**	25.08
R^2 = 0.09		

We estimated that treatment group customers exhibited higher hourly kW use than customers in the control group by small but statistically significant magnitudes (from less than 1 percent to 5 percent). The daily average level of the VPP was not a statistically significant predictor of off-peak hourly kW consumption by customers in the treatment group.

5.6.2 Impacts on Days When the VPP Exceeds the Minimum Threshold

We re-estimated Equation (5) considering only the days in the October through March period when the average VPP exceeded the minimum threshold. This approach did not affect the definitions of any of the variables used in Equation (5); we simply considered a smaller number of days in the October to March period.

The results are shown in **Table 33**. As with our original estimates from Equation (5), shown in **Table 31,** the level of the VPP was not statistically significant. Being on the VPP rate treatment was still statistically significant, and the sign of the estimated coefficient was negative when high-VPP days were considered, versus a positive coefficient when all days in the October through March period were considered. The estimated coefficient on the VPP rate treatment indicator variable was five times larger in magnitude when only high-VPP days were considered (a magnitude of 0.01 versus a magnitude of 0.002).

Table 33. Regression output for Equation (5) on days when VPP rate exceeded the threshold – October through March

Notes: *=significant at 5% level; **=significant at 1% level

	Coefficient	T-Stat
Treatment	-0.01**	9.31
Treat*VPP	0.04	0.14
HDD	0.006**	6.37
CDD	N/A	N/A
Year	0.00	0.00
Constant	0.52**	12.67
R^2 = 0.06		

5.7 Evidence for Shifting Loads to Weekends

Our analysis of the impacts of the VPP rate treatment on average hourly kWh consumption and monthly kWh consumption suggested two broad conclusions.

1. During the July through September and April through June periods, customers on the VPP rate treatment did reduce average weekday kW consumption during the VPP hours. Relative to the control group that was not on the VPP rate, this reduction amounted to 10 to 20 percent, depending on the time period. High levels of the VPP were infrequent during these time periods, but use reductions

by treatment group customers were larger during high-VPP days. This reduction appears to have persisted into the on-peak, flat-rate hours.

2. On the other hand, being on the VPP treatment did not appear to have reduced monthly kWh consumption by a statistically significant amount.

Taken together, these two results suggest that customers on the VPP rate might have been shifting use to avoid the high VPP rate, rather than engaging in overall demand reduction.

Equation (6) was estimated separately for the July through October period and the April through June period. The estimated coefficients are shown in **Table 35.**

Table 34. Regression output for Equation (6)

Notes: *** = significant at 1% level; ** = significant at 5% level; * = significant at 10% level

	July - September		April - June	
	Coefficient	**T-Stat**	**Coefficient**	**T-Stat**
Constant	0.41***	27.32	0.47***	16.57
Year	-0.03	-0.09	0.04	0.23
Treatment	0.002	098	-0.01	0.22
Year*Treatment	0.03*	1.90	0.04*	1.93
HDD	-0.001	-1.60	0.00	0.53
CDD	0.003	1.47	-0.23	-0.14

$R^2 = 0.09$

The analysis shown in **Table 35** provides some support for the notion that consumers in the treatment group did shift some loads from weekdays to weekends during the study year. The coefficients for the treatment-year interaction variable are both positive and significant at the 10 percent level. The coefficient of 0.03 for the July through September period can be interpreted as finding that customers on the VPP rate treatment increased weekend use relative to weekday use by roughly 3 percent. The coefficient of 0.04 for the April through June period can be interpreted as a 4 percent increase in weekend use relative to weekday use. We did not find significant differences in the ratio of weekend to weekday electricity use by year (that is, between the pre-treatment and study years), or by group.

5.8 Additional Results

Study staff sent a satisfaction survey at the conclusion of the study period to all participants who had an active e-mail account on file. Questions related to the VPP program, wattWATCHERS, their energy use, and how the VPP affected how they used energy, as well as their overall satisfaction with the study. The survey had a response rate of 35 percent, which represented 20 percent of the total study participants. The survey was hosted on Survey Monkey, an online survey tool.

Table 35. Summary of satisfaction survey

Survey Characteristic	Satisfaction Survey
Population surveyed	433 customers from treatment group (with email address)
Issue date	July 2014 (post study)
Response rate	35%
Contact method	E-mail
Administration method	Web site only (Survey Monkey)

Of all survey respondents, 86 percent reported that they at least closely followed the VPP schedule that was sent to them at the beginning of the study (**Figure 9**). Only about 13 percent of respondents did not closely follow the schedule.

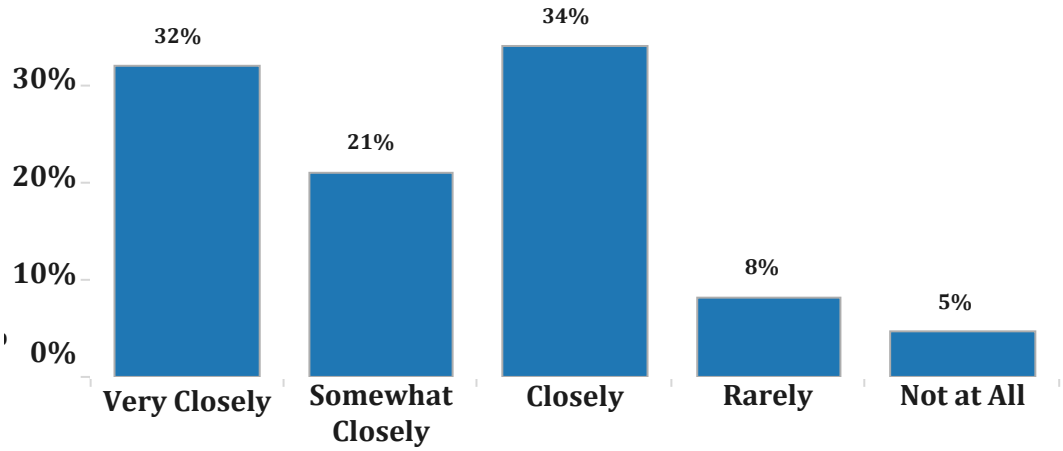


Figure 9. How closely did you follow the VPP program schedule? (% of total respondents)

Additionally, 73 percent of respondents closely followed changes in the daily VPP rate (**Figure 10)**.

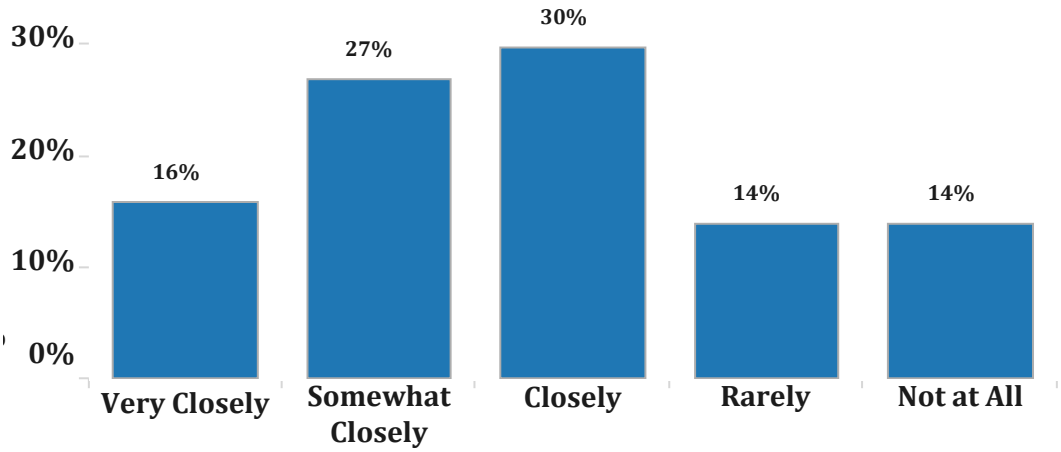


Figure 10. How closely did you follow changes in the variable rate? (% of total respondents)

Customer use of wattWATCHERS Plus was much lower than expected, with less than 20 percent of respondents checking their portal weekly or more (**Figure 11**). 66 percent of respondents reportedly rarely or never checked their portal.

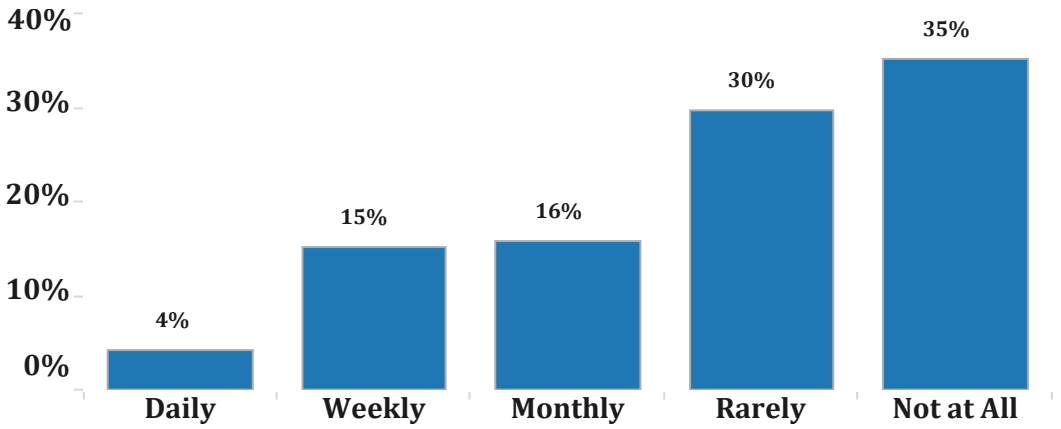


Figure 11. How often did you log into the wattWATCHERS Plus Web portal? (% of total respondents)

Respondents overwhelmingly indicated that they changed their electrical consumption habits throughout the course of the study; 81 percent felt they adjusted their consumption habits, whereas only 16 percent continued to use electricity as they had, prior to the study (**Figure 12**).

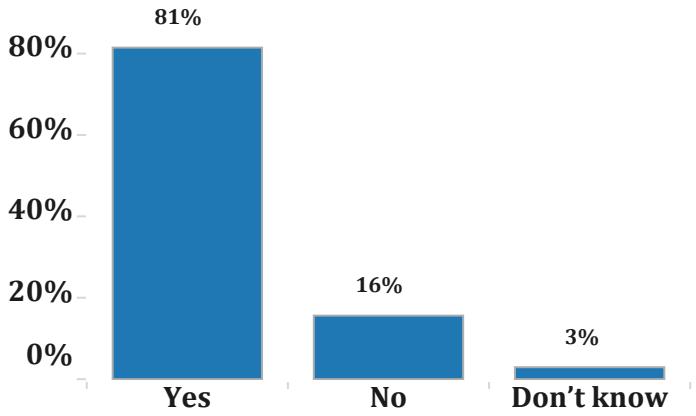


Figure 12. Throughout the course of the study, do you feel you changed your electrical consumption habits? (% of total respondents)

Although a majority of respondents indicated they changed consumption habits, a much smaller number of customers felt they had saved money as a result of the study. That is, 47 percent of respondents felt they had saved money, and 53 percent did not think or did not know if they saved money due to the VPP program (**Figure 13**).

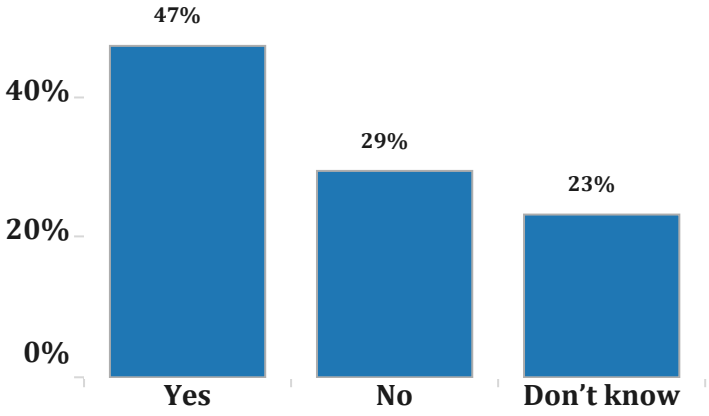


Figure 13. Do you feel you saved money? (% of total respondents)

Similarly, 48 percent of respondents also felt they had saved energy, and 51 percent did not think or did not know if they had saved energy (**Figure 14**).

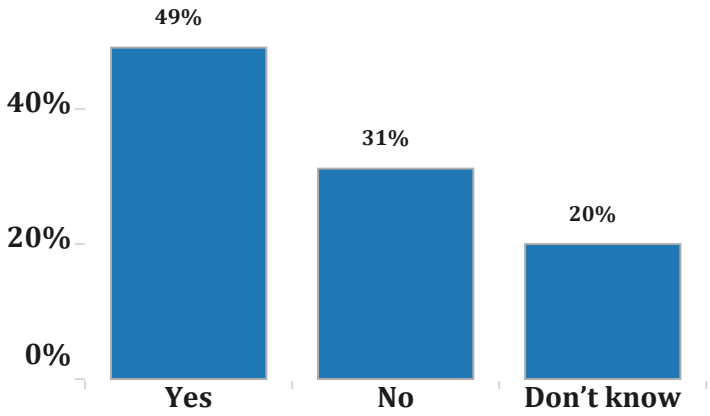


Figure 14. Do you feel you used less energy? (% of total respondents)

Almost 71 percent of respondents felt as if they better understood their energy use, a conclusion that closely resembled the responses regarding whether they felt they had changed their energy use habits. About 30 percent did not feel better informed about their energy use habits (**Figure 15**).

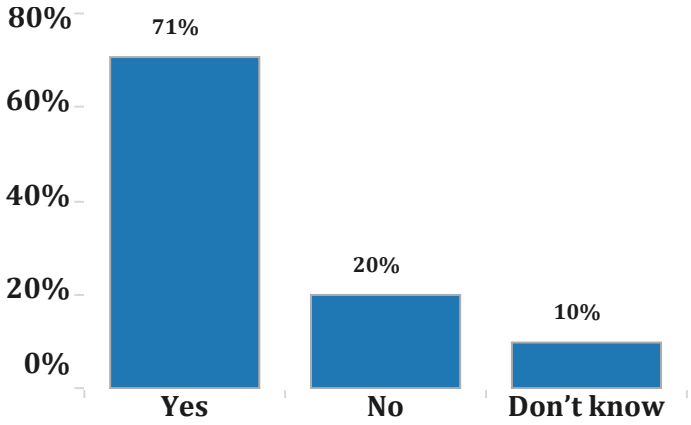


Figure 15. Do you feel better informed about your energy use habits? (% of total respondents)

More than half of respondents had a positive satisfaction level with the VPP program, and 23 percent had a negative reaction. Further, 24 percent felt neither satisfied nor unsatisfied with the program (**Figure 16**).

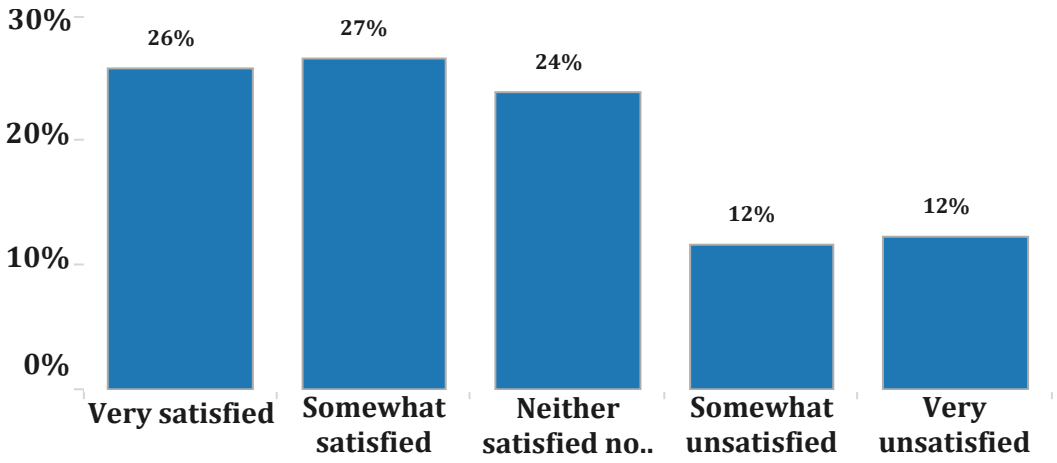


Figure 16. Please rate your overall satisfaction with the VPP Program(% of total respondents)

Survey respondents were asked to check all that apply from a list of reasons that they were participating in the VPP program. **Figure 17** shows that 70 percent participated to save money on their electric bills. Surprisingly, about 3 percent did not know they were participating in the study, even though they received multiple pieces of communication regarding the study, and completed and returned an enrollment survey prior to the study start date.

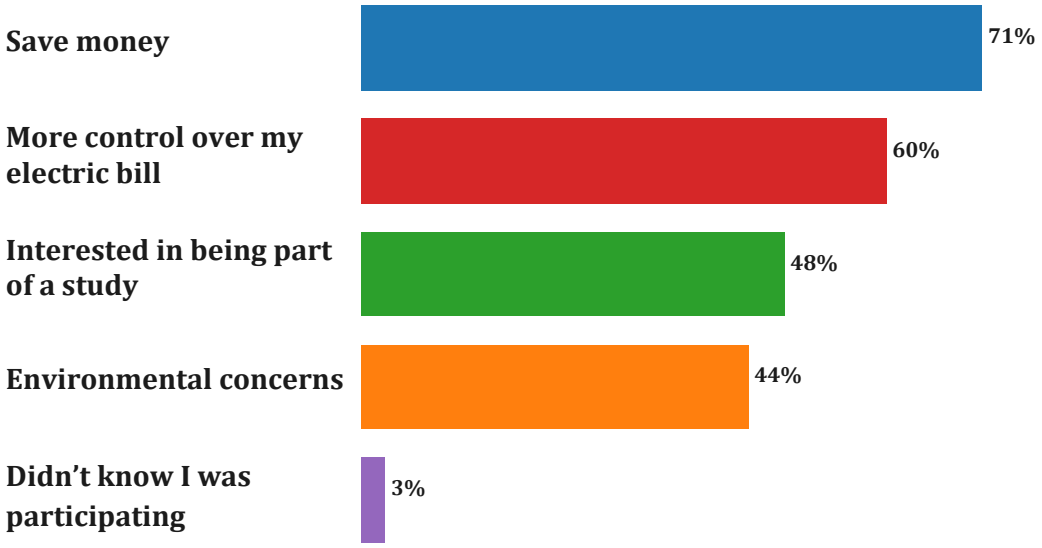


Figure 17. What were the reasons you participated in the VPP Program?

What might be the most interesting result of the satisfaction survey is the positive response when asked if customers would participate again: 72 percent indicated that they would sign up for a VPP rate schedule again in the future (**Figure 18**).

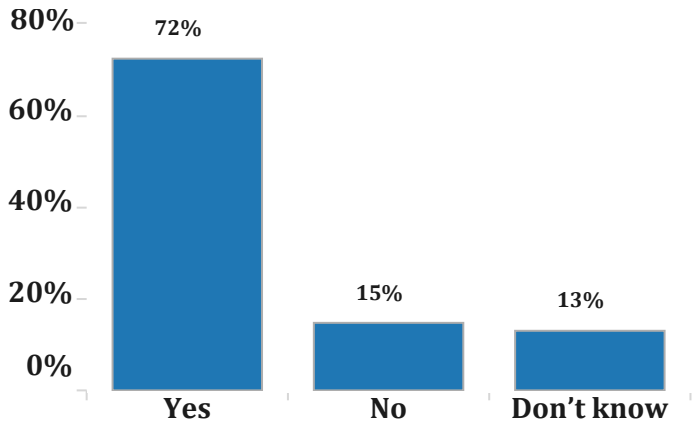


Figure 18. Would you sign up for this type of rate schedule in the future? (% of total respondents)

A full copy of the satisfaction survey is in **Appendix A: Survey Instruments,** as well as responses from customers to questions that had an option for "other" or "please explain."

6. Conclusions

The Consumer Behavior Study conducted by VEC and Efficiency Vermont between June 2013 and July 2014 was designed to evaluate the effectiveness of variable peak pricing and notification of high levels of the VPP in motivating consumers to reduce electricity use during periods of high energy supply costs. The study design involved a randomized control trial, with one treatment group and one control group. The treatment group was placed on the VPP rate, whereas customers in the control group remained on the standard VEC residential rate. Treatment group customers who provided mobile phone or e-mail contact information also received notifications when the daily average VPP rate would exceed a specified price threshold. All customers were given access to the wattWatchers Web portal, which displayed their hourly household electricity use, and access to a bill comparison tool that compared the cost of their use using the VPP rate and the standard rate.

The study's purpose was to test whether Variable Peak Pricing and price notification were effective in reducing customer demand during peak pricing periods. Customers were expected to benefit through savings in their monthly bills. Across the long term, reduced peak time loads would also translate into customer savings through deferred system upgrades and reduced capacity charges paid to the regional transmission organization, ISO New England.

Our analysis of the load reduction impacts associated with the VPP rate structure in the VEC service territory suggested a complex role for time-varying electricity pricing to be an effective means for demand reduction in Vermont. We articulated three lessons learned from the implementation of VPP in this study.

First, customers on the VPP rate treatment did reduce demand during peak pricing hours, although this reduction varied seasonally. During the periods of July through September and April through June, we estimated that customers in the VPP rate treatment reduced average hourly use by 0.15 to 0.2 kW during the hours when the VPP was in effect (15 to 20 percent, relative to the control group during these same periods). During the period of October through March, however, we did not find any statistically significant reductions in use by the VPP treatment group during the hours when the VPP was in effect. Moreover, we found that customers on the VPP treatment group exhibited somewhat higher levels of monthly energy (kWh) use than customers in the control group.

Second, we found little evidence that higher levels of the VPP were associated with greater reductions in use by treatment group customers during the hours when the VPP was in effect. We did find that hourly use by VPP customers declined by 0.02 kW during hours in the October through March period when the VPP was above the minimum threshold, relative to consumption by this same group during hours when the VPP was at its threshold. Because the VPP was seldom above the threshold during the July through September period and the April through June period, we could not draw any similar conclusions for these time periods. Despite the VPP being above the minimum threshold approximately 70 percent of the time in the October through March period, the level of the

VPP was not a statistically significant factor in reducing average hourly demands during hours when the VPP was in effect.

Third, we found some evidence that consumers shifted demands between VPP hours and off-peak hours. We estimated that customers on the VPP rate increased average hourly demands during the off-peak, flat-rate hours by small but statistically significant magnitudes (from less than 1 percent to 5 percent, relative to the control group during these same hours). The level of the VPP on any given day was not a statistically significant factor in increasing average hourly demands during the off-peak period.

Overall, our findings suggest that consumers in the VEC service territory were responsive to the establishment of different pricing periods during the day (the off-peak, on-peak, and VPP hours), but were not responsive to the level of the VPP itself. Moreover, we found distinct seasonal differences in customer load reductions during the VPP hours. Despite higher levels of the VPP during the wintertime VPP hours, VEC customers were less willing to reduce demands during VPP hours in the winter than they were during the spring or summer. Although time-differentiated pricing has some potential to be effective in reducing peak-time customer demands in the VEC service territory, it appeared that the costs to customers (in terms of comfort levels) of demand reductions were larger during the winter than during the summer. Because this study was undertaken during a particularly cold winter season, however, it might be difficult to project this particular finding on to winter seasons with milder temperatures.

Our assessment of the value of price notification is inconclusive, in part because we were not able to measure variation in customer choice of VPP thresholds above which notifications were sent out. Under the assumption that customers did not change their notification settings, we found little evidence that notification led to any additional demand reductions during the VPP hours beyond the reductions from being in the treatment group.

7. Appendices

Appendix A: Survey Instruments

Appendix B: Rate Tariffs

Appendix C: Technology Description

Appendix D: Education Material

Appendix E: Marketing Material

Appendix A: Survey Instruments

Eligibility and Enrollment Survey

Participant Letter

Control Letter

Deny Letter

Satisfaction Survey

Vermont Electric Cooperative, Inc.

42 Wescom Road
Johnson, VT 05656-9717

Toll Free: 1-800-832-2667
Telephone: 802-635-2331
Fax: 802-635-7645

www.vermontelectric.coop

April 2013

Name
Address
City, State Zip

Dear VEC Member,

By now, you've received a postcard from us about a one-year study being conducted by Vermont Electric Cooperative, the U.S. Department of Energy, and Efficiency Vermont. The purpose of the study is to test new ways to reduce your electric bills and improve the efficiency of the electric grid by using variable rates.

Study participants will have the opportunity to take advantage of reduced rates during weekday mornings and evenings, and all day Saturdays and Sundays. There will also be 4-6 weekday hours where the cost per kWh will vary and be higher than your current rate. By using electricity when rates are low and avoiding the times when rates are highest, participants can save by reducing electric bills.

Vermont utilities are also interested in reducing the need to purchase electricity during times of peak demand, because this electricity is generally the most expensive and the most polluting type of electricity on the market. Through this study, we hope to understand if a variable time of use rate can reduce peak time electricity use and reduce customers' electric bills.

Here's how the new rate for the study works:

- **Off-peak hours:** You'll receive a rate that is lower than the standard fixed rate on the amount you pay for your electricity each month during off-peak hours. Off-peak hours are Monday-Friday from 10pm until 11am the following day, all day Saturdays, Sundays and certain holidays.

- **On-peak hours:** You'll also receive a lower rate than the standard fixed rate during on-peak hours. On-peak hours are 5pm-10pm during the summer schedule or 11am-4pm and 8pm-10pm during the winter schedule.

- **Variable rate hours:** During variable rate hours, the price you pay will be higher than the standard fixed rate. Variable rate hours are 11am-5pm during the summer schedule or 4pm-8pm during the winter schedule. During these 4 hours in the winter and 6 hours in the summer, we hope to work together to keep electricity use, and your bills, as low as possible.

For more details on this new rate, please review the enclosed schedule.

Participating in this study will take little of your time and will provide a way to gain control over your household energy use. The study is scheduled to begin in May 2013 and end in April 2014. Participation is voluntary and you may withdraw from the study if you choose to.

Enrollment is limited, so if you would like to be considered for participation, please complete the enclosed survey and return it using the postage paid envelope by **April 30, 2013.**

Should you have any questions before then, please contact a Vermont Electric Cooperative representative at 1-855-832-7283 (1-855-VEC-SAVE).

Sincerely,

David C. Hallquist
Chief Executive Officer

CONSUMER BEHAVIOR STUDY
ELIGIBILITY & ENROLLMENT SURVEY

Vermont Electric Cooperative and Efficiency Vermont will maintain the privacy of your electric account information. However, by participating in this study it may be necessary for approved third parties to periodically access electricity usage information. In such cases, the information provided will be "blind" so that no connection can be made between the data and the customer without the customer's prior consent.

If you previously completed a similar survey during an earlier phase of this study, thank you! To participate in the next phase, please complete this survey so that we may assess your current eligibility.

1. Is the name and address information above correct?

   ☐ Yes ☐ No

   If you checked NO, fill out your information at #2 (if you checked YES move on to #3):

2. Name (first & last): _____

   Street Address: _____

   City: _____ Zip Code: _____

3. The telephone number that we can reach you at between 1PM and 5PM is _____

4. Your e-mail address is: _____

5. ☐ I certify that I am the person responsible for making decisions on this account. (Please check.)

6. Does your residence have a single electric meter? ☐ Yes ☐ No

7. Do you pay the electric bill for your household? ☐ Yes ☐ No

8. Will you stay in your current home for the next two years? ☐ Yes ☐ No

9. Do you have regular access to the internet? ☐ Yes ☐ No

10. Do you own or rent your home? ☐ Own ☐ Rent

11. What type of residence do you live in? Do you live in a:

    ☐ Single Family
    ☐ Duplex or Two Family
    ☐ Apartment/condo in a 2-4 unit building
    ☐ Apartment/condo in a >4 unit building
    ☐ Townhouse or row house (adjacent walls to another house)
    ☐ Mobile home, house trailer

12. Does your home have central air conditioning? ☐ Yes ☐ No

13. Do you have any room air conditioners? ☐ Yes ☐ No

14. If yes, how many? _____

15. Do you have a programmable thermostat? ☐ Yes ☐ No

(If YES, go to question 16. If NO go to question 17)

(Continued on back...)

16. Is the programmable thermostat currently set to automatically change temperatures during the day when no one is home? ❒ Yes ❒ No

17. Do you have an electric clothes dryer? ❒ Yes ❒ No

18. Including yourself, how many adults, 18 or older, currently live in your household? _____

19. How many of these adults are currently over 65? _____

20. How many children under the age of 18 live in your household at least part of the week? _____

21. Do you or does anyone in your household have a chronic illness or disability that requires regular medical treatment? ❒ Yes ❒ No

22. Is there someone home Monday to Friday sometime between 1PM and 5PM at least one day a week? ❒ Yes ❒ No

23. Is there anyone in your household working full time for pay? ❒ Yes ❒ No

24. Do you or anyone in your household have a job where you work at home at least one weekday a week rather than go into an office or some other location? ❒ Yes ❒ No

25. Do you remember personally receiving any information from your electric utility that told you how you could save money on your current electric rate by changing what activity you do in your home or when you do the activity? ❒ Yes ❒ No

(If YES, go to question 29. If NO go to question 31)

26. Do you think the information was useful? ❒ Yes ❒ No

27. Did you do anything that was suggested by this utility information to help you save money? ❒ Yes ❒ No

28. Last year—that is, in 2010—what was your total family income from all sources, before taxes?

- ❒ Less than $10,000
- ❒ $10,000 to less than $20,000
- ❒ $20,000 to less than $30,000
- ❒ $30,000 to less than $40,000
- ❒ $40,000 to less than $50,000
- ❒ $50,000 to less than $75,000
- ❒ $75,000 to less than $100,000
- ❒ $100,000 to less than $150,000
- ❒ $150,000 or more

(Continue to next page)

29. What is the LAST grade or class that you COMPLETED in school?

- ☐ None, or grade 1-8
- ☐ High School incomplete (grade 9-11)
- ☐ High School complete (9-12)
- ☐ Technical, trade or vocational school AFTER High school
- ☐ Some college, no four-year degree (includes Associate degree)
- ☐ College graduate (B.S., B.A., or other four-year degree)
- ☐ Post-graduate or professional schooling after college (e.g. toward a Master's degree or Ph.D; law or medical school)

30. Do you use a dehumidifier in your home? ☐ Yes ☐ No

31. If yes, how many dehumidifiers do you use? _____

32. Do you own a swimming pool? ☐ Yes ☐ No

33. Do you own an electric hot tub, whirlpool or spa? ☐ Yes ☐ No

34. What kind of primary heating do you use in your home? (Check multiple boxes if they apply)

☐ Electric	☐ Natural Gas Boiler	☐ Natural Gas Hot Air
☐ Wood Stove	☐ Oil Boiler	☐ Oil Hot Air
☐ Pellet Stove	☐ Kerosene Boiler	☐ Kerosene Hot Air
☐ Heat Pump	☐ LP Gas Boiler	☐ LP Gas Hot Air

35. How do you heat your hot water? (Check multiple boxes if they apply)

☐ Electricity	☐ LP Gas	☐ Oil	☐ Wood
☐ Kerosene	☐ Natural Gas	☐ Solar	

36. What is the size of your home? (Check only one)

- ☐ 500 sq. ft. - 1,000 sq. ft.
- ☐ 1,100 sq. ft. - 1,500 sq. ft.
- ☐ 1,600 sq. ft. - 2,000 sq. ft.
- ☐ More than 2,000 sq. ft.

37. How many bedrooms in your home? _____

38. How many bathrooms in your home? _____

39. How many total rooms in your home? _____

Please return this in the postage-paid envelope provided, or to:

VEC Member Survey
Efficiency Vermont
128 Lakeside Ave., Suite 401
Burlington, VT 05401

Vermont Electric Cooperative, Inc.
42 Wescom Road
Johnson, VT 05656-9717
www.vermontelectric.coop

Toll Free: 1-800-832-2667
Telephone: 802-635-2331
Fax: 802-635-7645

May 24, 2013

Account #

Name
Address
City, State Zip

Dear Vermont Electric Cooperative Member,

Earlier this spring, you submitted a survey that indicated your willingness to participate in a one-year study being conducted by Vermont Electric Cooperative (VEC), the U.S. Department of Energy and Efficiency Vermont. We are happy to inform you that you have been selected to participate in the study, hereafter referred to as the Variable Peak Pricing (VPP) Program. This letter will describe what participation means for you. It is organized into four parts:

- What is the purpose of the study?
- How do the new rates work?
- What are the risks and rewards?
- What are the next steps?

If at any time you have questions regarding the VPP Program, you may call 1-855-VEC-SAVE (1-855-832-7283), and a VEC representative will be happy to answer your questions.

What is the purpose of the VPP Program?

The purpose of the VPP Program is to measure changes in electricity use that result from charging members rates that vary according to the time of day rather than the standard residential or "flat" rate.

How do the new rates work?

For at least 75% of each weekday and all day on weekends/holidays, you will be charged a rate that is lower than the flat rate. During the variable rate hours, the price of your electricity will be higher and will change daily based on the wholesale price of electricity during peak hours. The price will be published the evening before so you can plan your electric usage during those higher-cost hours. The schedule for on- and off-peak hours will change based on the time of year; please refer to the accompanying graphic for details.

The original wattWATCHERS is available to all VEC members; however, wattWATCHERS *Plus* (WW+) will be available only to members participating in the VPP Program. WW+ features many important tools to help you make the most of the study rates. You can logon to WW+ to:

- See the current and next day's variable rate;
- Track your electric usage for previous hours, days, weeks and months;
- Compare your cost on the study rates to what you would have paid on the flat rate;
- Sign up to be alerted by text message or email when the variable rate is higher than whatever threshold you set.

What are the rewards and risks?

By participating in the VPP Program, you have the opportunity to save money on your electric bill. You will pay less for your electricity during most of the day on weekdays and all day on weekends/holidays. Some members may find that they will pay less without making changes to their usage habits. Others will find that they can save more by shifting usage of appliances such as dishwashers, clothes washers and electric dryers to off-peak hours or by reducing their overall electric consumption.

Even with the many opportunities to save, we cannot guarantee that your overall bill will be lower. During the variable rate hours, your electricity cost will be higher, and as a result, your overall bill might be higher than it would have been on the flat rate. For this reason, you may opt out of the VPP Program at any time. However, once you leave the VPP Program, you will not be able to rejoin, and you will lose the opportunity to take advantage of the lower and variable rates for the remainder of the Program.

What are the next steps?

Please read the attached Member Participation Terms and Conditions. By participating in the VPP Program, you are agreeing to accept these Terms and Conditions.

You will be switched to the new rates with your June meter read. We will send you another communication before your June meter read begins with more details about how to logon to WW+ and the exact date when the new rates will begin for your account.

Thank you for your willingness to participate in the VPP Program. We hope that together we can increase your control over the cost of your electricity and make an important difference for others in Vermont. Again, please contact a VEC representative at 1-855-VEC-SAVE (1-855-832-7283) with any questions.

Sincerely,

Dave Hallquist
CEO

Vermont Electric Cooperative, Inc.
42 Wescom Road
Johnson, VT 05656-9717
www.vermontelectric.coop

Toll Free: 1-800-832-2667
Telephone: 802-635-2331
Fax: 802-635-7645

Variable Peak Pricing (VPP) Program

Member Participation Terms and Conditions

MEMBER ACCOUNT NAME: <First Name, Last Name>
ACCOUNT NUMBER: <VEC Account #>

1. **Eligibility.** Eligibility for the Variable Peak Pricing (VPP) Program is restricted to residential members of Vermont Electric Cooperative (VEC).

2. **Funding**. VEC is receiving funds for the VPP Program through the American Recovery and Reinvestment Act of 2009 (ARRA) and a contract with the US Department of Energy (DOE).

3. **Purpose and Duration.** The VPP Program is part of a study to measure changes in electricity usage that result from variable peak pricing of electricity. The study will collect one year of electric usage information, and the data will be used to publish a report to DOE.

4. **Member Information**. By participating in the VPP Program, members authorize VEC to collect, store and use information about their household and electric usage for study and analysis purposes.

5. **Member Privacy and Public Information**. *To protect Member privacy and confidentiality, all Member-specific information will be removed prior to any disclosure, including name, address, phone number, account number and e-mail address.* Member data will be used only for the study and will not be sold to or used by third parties for non-study purposes. Because this study is federally funded, the information collected during the initial recruitment survey and the study will be delivered to DOE at the end of the study period.

6. **Variable Peak Price**. Members participating in the VPP Program agree to have their rate changed from the RS-1 rate to Variable Peak Pricing (VPP) Program rates (see enclosed rate schedule).

7. **Voluntary Participation.** Members who do not wish to participate in the VPP Program may opt out at any time by calling 1-855-VEC-SAVE (-855-832-7283). The privacy and confidentiality practices noted above will apply to any data already collected. Members will not be able to re-enter the VPP Program once they have opted out.

8. **Authorization.** Only the account owner is authorized to act on behalf of the account named above. By participating in the VPP Program, the account owner releases his or her account information for analysis and reporting purposes. This information may include, but is not limited to, read date, number of billed units (e.g., kWh, kW) by intervals as short as one hour and billed costs. Identifying information, such as name, address and account number, will not be released as part of this authorization.

Vermont Electric Cooperative, Inc.
42 Wescom Road
Johnson, VT 05656-9717
www.vermontelectric.coop

Toll Free: 1-800-832-2667
Telephone: 802-635-2331
Fax: 802-635-7645

May 24, 2013

Account #

Name
Address
City, State Zip

Dear Vermont Electric Cooperative Member,

Earlier this spring, you submitted a survey that indicated your willingness to participate in a one-year study being conducted by Vermont Electric Cooperative (VEC), the U.S. Department of Energy and Efficiency Vermont. We are writing to inform you that you have been randomly selected to participate in the study as a member of the control group.

The control group is an *indispensable* part of the study. As a member of the control group, your electricity usage will help form a baseline of comparison that will be used to determine changes in electricity consumption that result from variable rates being tested by other participants in the study.

To protect VEC member privacy and confidentiality, all member-specific information will be removed prior to any disclosure. This information includes the member name, address, phone number and VEC account number. Your data will be used only for the study and will not be sold to or used by third parties.

Thank you for your willingness to participate in this important study. Please contact a VEC representative at 1-855-VEC-SAVE (1-855-832-7283) with any questions.

Sincerely,

Dave Hallquist
CEO

Vermont Electric Cooperative, Inc.
42 Wescom Road
Johnson, VT 05656-9717
www.vermontelectric.coop

Toll Free: 1-800-832-2667
Telephone: 802-635-2331
Fax: 802-635-7645

Control Group Terms and Conditions

MEMBER ACCOUNT NAME: <First Name, Last Name>
ACCOUNT NUMBER: <VEC Account #>

1. **Eligibility.** Eligibility for the Control Group is restricted to residential members of Vermont Electric Cooperative (VEC).

2. **Funding**. VEC is receiving funds for the study through the American Recovery and Reinvestment Act of 2009 (ARRA) and a contract with the US Department of Energy (DOE).

3. **Purpose and Duration.** The purpose of the study to measure changes in electricity usage that result from variable peak pricing of electricity. The study will collect one year of electric usage information, and the data will be used to publish a report to DOE.

4. **Member Information**. By participating in the Control Group, members authorize VEC to collect, store and use information about their household and electric usage for study and analysis purposes.

5. **Member Privacy and Public Information**. *To protect Member privacy and confidentiality, all Member-specific information will be removed prior to any disclosure, including name, address, phone number, account number and e-mail address.* Member data will be used only for the study and will not be sold to or used by third parties for non-study purposes. Because this study is federally funded, the information collected during the initial recruitment survey and the study will be delivered to DOE at the end of the study period.

6. **Voluntary Participation.** Members who do not wish to participate in the Control Group may opt out at any time by calling 1-855-VEC-SAVE (-855-832-7283). The privacy and confidentiality practices noted above will apply to any data already collected.

7. **Authorization.** Only the account owner is authorized to act on behalf of the account named above. By participating in the Control Group, the account owner releases his or her account information for analysis and reporting purposes. This information may include, but is not limited to, read date, number of billed units (e.g., kWh, kW) by intervals as short as one hour and billed costs. Identifying information, such as name, address and account number, will not be released as part of this authorization.

Vermont Electric Cooperative, Inc.
42 Wescom Road
Johnson, VT 05656-9717
www.vermontelectric.coop

Toll Free: 1-800-832-2667
Telephone: 802-635-2331
Fax: 802-635-7645

May 24, 2013

Account #

Name
Address
City, State Zip

Dear Vermont Electric Cooperative Member,

Thank you for returning the survey we sent you earlier this spring regarding a one-year study being conducted by Vermont Electric Cooperative (VEC), the U.S. Department of Energy and Efficiency Vermont. We are writing to inform you that you have not been selected to participate in the study.

From the surveys we received, members were chosen for participation based on a variety of criteria, including availability of technology and the level of average monthly electric usage. While we wish that everyone with interest could be part of the study, we were unable to include all respondents.

Thank you for taking the time to complete the survey. Please contact a VEC representative at 1-855-VEC-SAVE (1-855-832-7283) with any questions.

Sincerely,

Dave Hallquist
CEO

Consumer Behavior Study Variable Pricing Survey

1. You are receiving this email because you participated in Vermont Electric Co-op's Variable Peak Pricing (VPP) Program. The short survey below will help VEC better understand how the VPP rate schedule and program worked for members. Please take a few minutes to provide us with your valuable feedback.

How closely did you follow the Variable Peak Pricing (VPP) Program schedule (off-peak, on-peak and variable rate hours) variable rate?

- ◯ Not at All
- ◯ Rarely
- ◯ Somewhat Closely
- ◯ Closely
- ◯ Very Closely

Other (please specify)

2. How closely did you follow daily changes in the variable rate?

- ◯ Not at All
- ◯ Rarely
- ◯ Somewhat Closely
- ◯ Closely
- ◯ Very Closely

Other (please specify)

3. Did you receive variable rate alerts by text or email?

- ◯ Yes
- ◯ No
- ◯ Not sure

Other (please specify)

Consumer Behavior Study Variable Pricing Survey

4. If so, did you adjust your energy usage after you received a rate alert?

- [ ] Yes
- [ ] No
- [ ] Did not receive alerts
- [ ] Please Explain:

5. 5. How often did you log into the wattWatchers Plus web portal?

- ◯ Not at all
- ◯ Rarely
- ◯ Monthly
- ◯ Weekly
- ◯ Daily

6. How would you prefer to receive alerts?

- [ ] Text
- [ ] Email
- [ ] Web
- [ ] Phone call
- [ ] All of the above

Other (please specify)

7. Throughout the course of the Study, do you feel you changed your electrical consumption habits?

- ◯ Yes
- ◯ No
- ◯ Don't know

Other (please specify)

Consumer Behavior Study Variable Pricing Survey

8. Do you feel like you saved money?

- ◯ Yes
- ◯ No
- ◯ Don't know

Other (please specify)

9. Do you feel like you used less energy?

- ◯ Yes
- ◯ No
- ◯ Don't know

Other (please specify)

10. Do you feel better informed about your energy usage habits?

- ◯ Yes
- ◯ No
- ◯ Don't know

Other (please specify)

11. Did you call the VPP hotline (1-855-VEC-SAVE) with any questions?

- ◯ Yes
- ◯ No

12. Was your question answered to your satisfaction?

- ◯ Yes
- ◯ No

Other (please specify)

Consumer Behavior Study Variable Pricing Survey

13. Please rate your overall satisfaction with the VPP Program.

- ◯ Very unsatisfied
- ◯ Somewhat unsatisfied
- ◯ Neither satisfied nor unsatisfied
- ◯ Somewhat satisfied
- ◯ Very satisfied

Please Explain:

14. For what reasons did you participate in the VPP Program? Please check all that apply.

- ☐ Save money
- ☐ Environmental concerns
- ☐ More control over my electric bill
- ☐ Interested in being part of a study
- ☐ Didn't know I was participating

Please Explain:

15. Would you sign up for this type of rate schedule in the future?

- ◯ Yes
- ◯ No
- ◯ Don't know

Please Explain:

Appendix B: Rate Tariffs

2013 Residential Rate Tariff

2013 VPP Rate Tariff

2014 Residential Rate Tariff

2014 VPP Rate Tariff

VERMONT ELECTRIC COOPERATIVE, INC.
SERVICE CLASSIFICATION #1
RESIDENTIAL RATE

AVAILABILITY:

Available in all territory served by the Cooperative in Vermont.

APPLICABILITY:

Applicable to residential dwellings, individual apartments, and optional for farms.

CHARACTER OF SERVICE:

Single-phase, 120/240 nominal, or three-phase, 120/208, or 277/480 nominal voltage service is available. Service type and location shall meet with the Cooperative's review for reasonable safety, reliability, and accepted industry standards.

RATE PER MONTH

Customer Charge	$ 16.73
kWh Charge	
0-100 kWh	$ 0.08480 per kWh
All kWhs in excess of 100 kWhs per month	$ 0.17118 per kWh

MINIMUM

The minimum charge under this schedule for all or part of a monthly billing period shall be the monthly customer charge.

MULTIPLE RESIDENTIAL METER PROVISION

For customers with multiple residential meter usages servicing the same residential living quarters, the above RATE PER MONTH rates will be applied to the initial meter and the following rates will be used to bill each additional meter servicing the same residential living quarters.

Customer Charge per month	$ 5.46
kWh Charge for all kWh	$ 0.17118 per kWh

Issue Date: November 12, 2010 as Amended on December 15, 2010

Effective: For service rendered on and after January 1, 2011

SERVICE CLASSIFICATION #1
VERMONT ELECTRIC COOPERATIVE, INC.
RESIDENTIAL RATE (cont'd)

TERMS AND CONDITIONS:

The Cooperative's General Rules and Regulations as set forth in this tariff, where not inconsistent with any specific provisions hereof, are part of this rate.

Service under this schedule is for the exclusive use of the customer and shall not be resold or shared with others.

Service under this schedule is limited to residential dwellings and is optional for farms. Residential dwellings are limited to a separate house, apartment, flat or other living quarters occupied by a person constituting a distinct household, including seasonal occupancies.

Residential dwellings do not include separately metered structures or service locations that are not used as living quarters. Examples of these separately metered service locations are pump houses, garages, and detached buildings. However, if the primary usage of these separate structures is residential in nature and if the electrical service is connected and metered through the single residential meter, the total metered usage will be considered residential and serviceable under this schedule.

Service under this schedule should be metered through a single meter. The Cooperative will bill multiple residential meters pursuant to the MULTIPLE RESIDENTIAL METER PROVISION.

VERMONT ELECTRIC COOPERATIVE, INC.
SERVICE CLASSIFICATION #1.2
RESIDENTIAL TIME-OF-DAY
PILOT STUDY RATES – VARIABLE PEAK PRICING

AVAILABILITY:

Available in all territory served by the Cooperative in Vermont.

APPLICABILITY:

Participation is voluntarily and the number of participants is limited. The pilot program is solely for research and the Cooperative reserves the right to select and limit member participants to those that meet the requirements of the study. Service under Service Classification #1.2 is in lieu of service under Service Classification #1, and is in effect for the entire period of the study.

CHARACTER OF SERVICE:

Single-phase, 120/240 nominal, or three-phase, 120/208, or 277/480 nominal voltage service is available. Service type and location shall meet with the Cooperative's review for reasonable safety, reliability, and accepted industry standards.

OFF-PEAK / ON-PEAK ENERGY USAGE HOURS

Off-Peak Fixed Rate Hours
All hours on Saturday, Sunday, and NERC holidays[1] are Off-Peak Fixed Rate hours. On all weekdays (Monday – Friday), from 10:01 pm through 11:00 am are Off-Peak hours.

On-Peak Fixed Rate Hours - Monday – Friday (non-NERC holiday weekdays)
Period 1: During the months of April through September, the five hours from 5:01 pm through 10:00 pm are On-Peak Fixed rate hours.
Period 2: During the months of October through March, the five hours from 11:01 am through 4:00 pm, and the 2 hours from 8:01 pm through 10:00 pm are On-Peak Fixed rate hours.

On-Peak Variable Rate Hours - Monday – Friday (non-NERC holiday weekdays)
Period 1: During the months of April through September, the six hours from 11:01 am through 5:00 pm are On-Peak Variable rate hours.
Period 2: During the months of October through March, the four hours from 4:01 pm through 8:00 pm are On-Peak Variable rate hours.

[1] The NERC **(**North American Electric Reliability Corporation**)** holidays consist of New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, and Christmas Day. The exact dates of these holidays can be found at the NERC website, www.nerc.com.

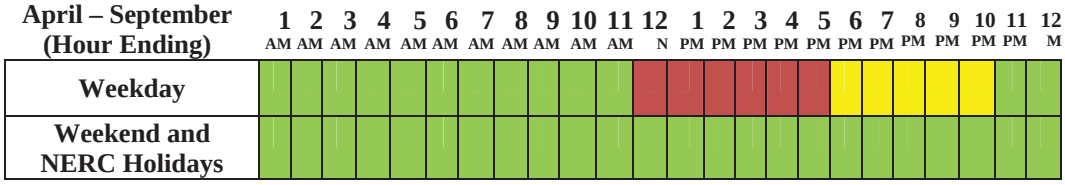
Issue Date: June 7, 2011

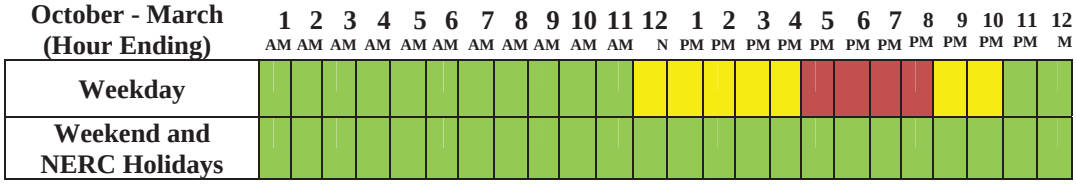
Effective: October 1, 2012

VERMONT ELECTRIC COOPERATIVE, INC.
SERVICE CLASSIFICATION #1.2
RESIDENTIAL TIME-OF-DAY
PILOT STUDY RATES – VARIABLE PEAK PRICING (Cont'd)

OFF-PEAK / ON-PEAK ENERGY USAGE HOURS (Cont'd)

Off-Peak Fixed Rate	On-Peak Fixed Rate	On-Peak Variable Rate





MONTHLY CUSTOMER CHARGES

Customer Charge - first meter	$ 16.73
Customer Charge for additional meters, if any, servicing the same residential living quarters. Charge per meter	$ 5.46

ENERGY USAGE CHARGES

Off-Peak Fixed Rate (kWh)	$0.12844
On-Peak Fixed Rate (kWh)	$0.15730

On-Peak Variable Rate (kWh) Formula

1. Vermont Load Zone Hourly Day-Ahead Market Locational Marginal Price[2] (VT DAM LMP), expressed in $/kWh) plus,
2. $0.19168 per kWh

Note: If the VT DAM LMP is $0.07175/kWh or less the Minimum rate of $0.26343 is used.

Minimum On-Peak Variable Rate (kWh)	$0.26343

[2] The VT Load Zone DAM LMP prices can be found on the web at the ISO New England website at http://www.iso-ne.com (the website LMP's are expressed in $/MWh and can be converted to $/kWh by dividing by 1,000)

Issue Date: June 7, 2011

Effective: October 1, 2012

VERMONT ELECTRIC COOPERATIVE, INC.
SERVICE CLASSIFICATION #1
RESIDENTIAL RATE

AVAILABILITY:

Available in all territory served by the Cooperative in Vermont.

APPLICABILITY:

Applicable to residential dwellings, individual apartments, and optional for farms.

CHARACTER OF SERVICE:

Single-phase, 120/240 nominal, or three-phase, 120/208, or 277/480 nominal voltage service is available. Service type and location shall meet with the Cooperative's review for reasonable safety, reliability, and accepted industry standards.

RATE PER MONTH

Customer Charge	$ 17.22
kWh Charge	
0-100 kWh	$ 0.08728 per kWh
All kWhs in excess of 100 kWhs per month	$ 0.17620 per kWh

MINIMUM

The minimum charge under this schedule for all or part of a monthly billing period shall be the monthly customer charge.

MULTIPLE RESIDENTIAL METER PROVISION

For customers with multiple residential meter usages servicing the same residential living quarters, the above RATE PER MONTH rates will be applied to the initial meter and the following rates will be used to bill each additional meter servicing the same residential living quarters.

Customer Charge per month	$ 5.62
kWh Charge for all kWh	$ 0.17620 per kWh

Issue Date: November 14, 2013

Effective: For service rendered on and after January 1, 2014

SERVICE CLASSIFICATION #1
VERMONT ELECTRIC COOPERATIVE, INC.
RESIDENTIAL RATE (cont'd)

TERMS AND CONDITIONS:

The Cooperative's General Rules and Regulations as set forth in this tariff, where not inconsistent with any specific provisions hereof, are part of this rate.

Service under this schedule is for the exclusive use of the customer and shall not be resold or shared with others.

Service under this schedule is limited to residential dwellings and is optional for farms. Residential dwellings are limited to a separate house, apartment, flat or other living quarters occupied by a person constituting a distinct household, including seasonal occupancies.

Residential dwellings do not include separately metered structures or service locations that are not used as living quarters. Examples of these separately metered service locations are pump houses, garages, and detached buildings. However, if the primary usage of these separate structures is residential in nature and if the electrical service is connected and metered through the single residential meter, the total metered usage will be considered residential and serviceable under this schedule.

Service under this schedule should be metered through a single meter. The Cooperative will bill multiple residential meters pursuant to the MULTIPLE RESIDENTIAL METER PROVISION.

VERMONT ELECTRIC COOPERATIVE, INC.
SERVICE CLASSIFICATION #1.2
RESIDENTIAL TIME-OF-DAY
PILOT STUDY RATES – VARIABLE PEAK PRICING

AVAILABILITY:

Available in all territory served by the Cooperative in Vermont.

APPLICABILITY:

Participation is voluntarily and the number of participants is limited. The pilot program is solely for research and the Cooperative reserves the right to select and limit member participants to those that meet the requirements of the study. Service under Service Classification #1.2 is in lieu of service under Service Classification #1, and is in effect for the entire period of the study.

CHARACTER OF SERVICE:

Single-phase, 120/240 nominal, or three-phase, 120/208, or 277/480 nominal voltage service is available. Service type and location shall meet with the Cooperative's review for reasonable safety, reliability, and accepted industry standards.

OFF-PEAK / ON-PEAK ENERGY USAGE HOURS

Off-Peak Fixed Rate Hours
All hours on Saturday, Sunday, and NERC holidays[1] are Off-Peak Fixed Rate hours. On all weekdays (Monday – Friday), from 10:01 pm through 11:00 am are Off-Peak hours.

On-Peak Fixed Rate Hours - Monday – Friday (non-NERC holiday weekdays)
Period 1: During the months of April through September, the five hours from 5:01 pm through 10:00 pm are On-Peak Fixed rate hours.
Period 2: During the months of October through March, the five hours from 11:01 am through 4:00 pm, and the 2 hours from 8:01 pm through 10:00 pm are On-Peak Fixed rate hours.

On-Peak Variable Rate Hours - Monday – Friday (non-NERC holiday weekdays)
Period 1: During the months of April through September, the six hours from 11:01 am through 5:00 pm are On-Peak Variable rate hours.
Period 2: During the months of October through March, the four hours from 4:01 pm through 8:00 pm are On-Peak Variable rate hours.

[1] The NERC (North American Electric Reliability Corporation) holidays consist of New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, and Christmas Day. The exact dates of these holidays can be found at the NERC website, www.nerc.com.

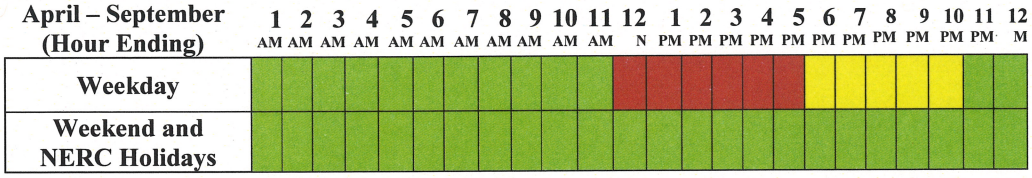
Issue Date: June 7, 2011

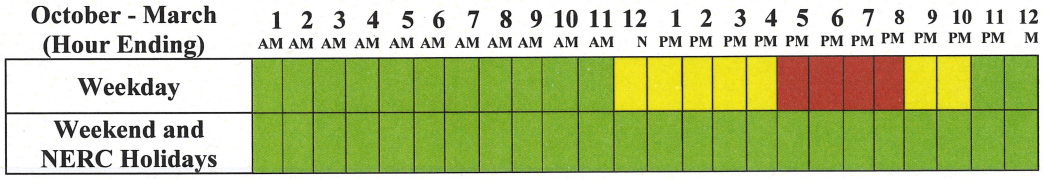
Effective: October 1, 2012

VERMONT ELECTRIC COOPERATIVE, INC.
SERVICE CLASSIFICATION #1.2
RESIDENTIAL TIME-OF-DAY
PILOT STUDY RATES – VARIABLE PEAK PRICING (Cont'd)

OFF-PEAK / ON-PEAK ENERGY USAGE HOURS (Cont'd)

Off-Peak Fixed Rate | **On-Peak Fixed Rate** | **On-Peak Variable Rate**





MONTHLY CUSTOMER CHARGES

Customer Charge - first meter	$ 17.22
Customer Charge for additional meters, if any, servicing the same residential living quarters. Charge per meter	$ 5.62

ENERGY USAGE CHARGES

Off-Peak Fixed Rate (kWh)	$0.13220
On-Peak Fixed Rate (kWh)	$0.16191

On-Peak Variable Rate (kWh) Formula

1. Vermont Load Zone Hourly Day-Ahead Market Locational Marginal Price[2] (VT DAM LMP), expressed in $/kWh) plus,
2. $0.19730 per kWh

Note: If the VT DAM LMP is $0.07385/kWh or less the Minimum rate of $0.27115 is used.

Minimum On-Peak Variable Rate (kWh)	$0.27115

[2] The VT Load Zone DAM LMP prices can be found on the web at the ISO New England website at http://www.iso-ne.com (the website LMP's are expressed in $/MWh and can be converted to $/kWh by dividing by 1,000)

Issue Date: November 14, 2013

Effective: For service rendered on and after January 1, 2014

Appendix C: Technology Description

wattWATCHERS Home Page

wattWATCHERS Daily Usage view

wattWATCHERS Pricing Alerts Enrollment

wattWATCHERS Plus Main page

wattWATCHERS Plus Monthly Energy view

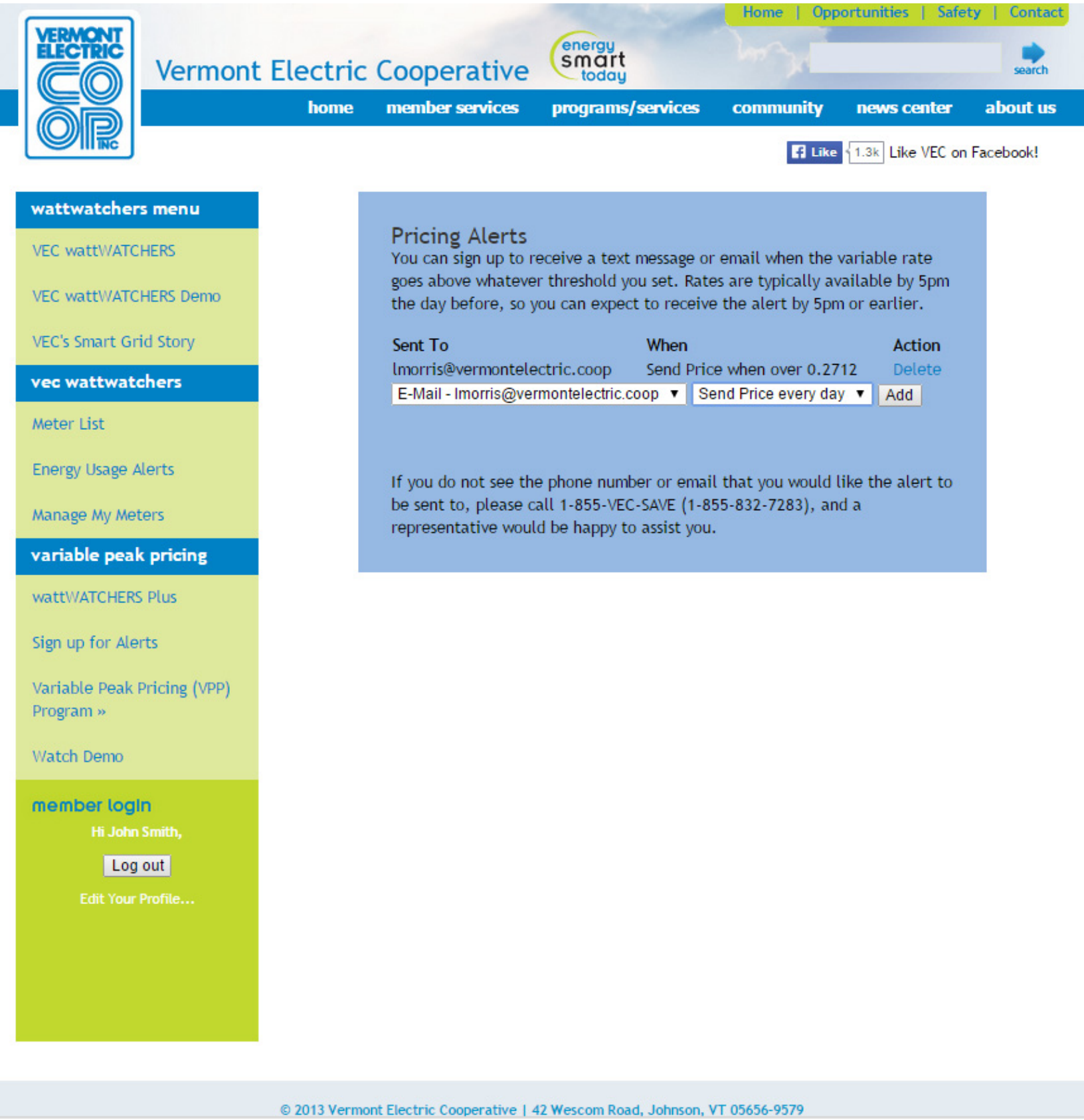
wattWATCHERS Plus Daily Energy view

wattWATCHERS Plus Hourly Energy view

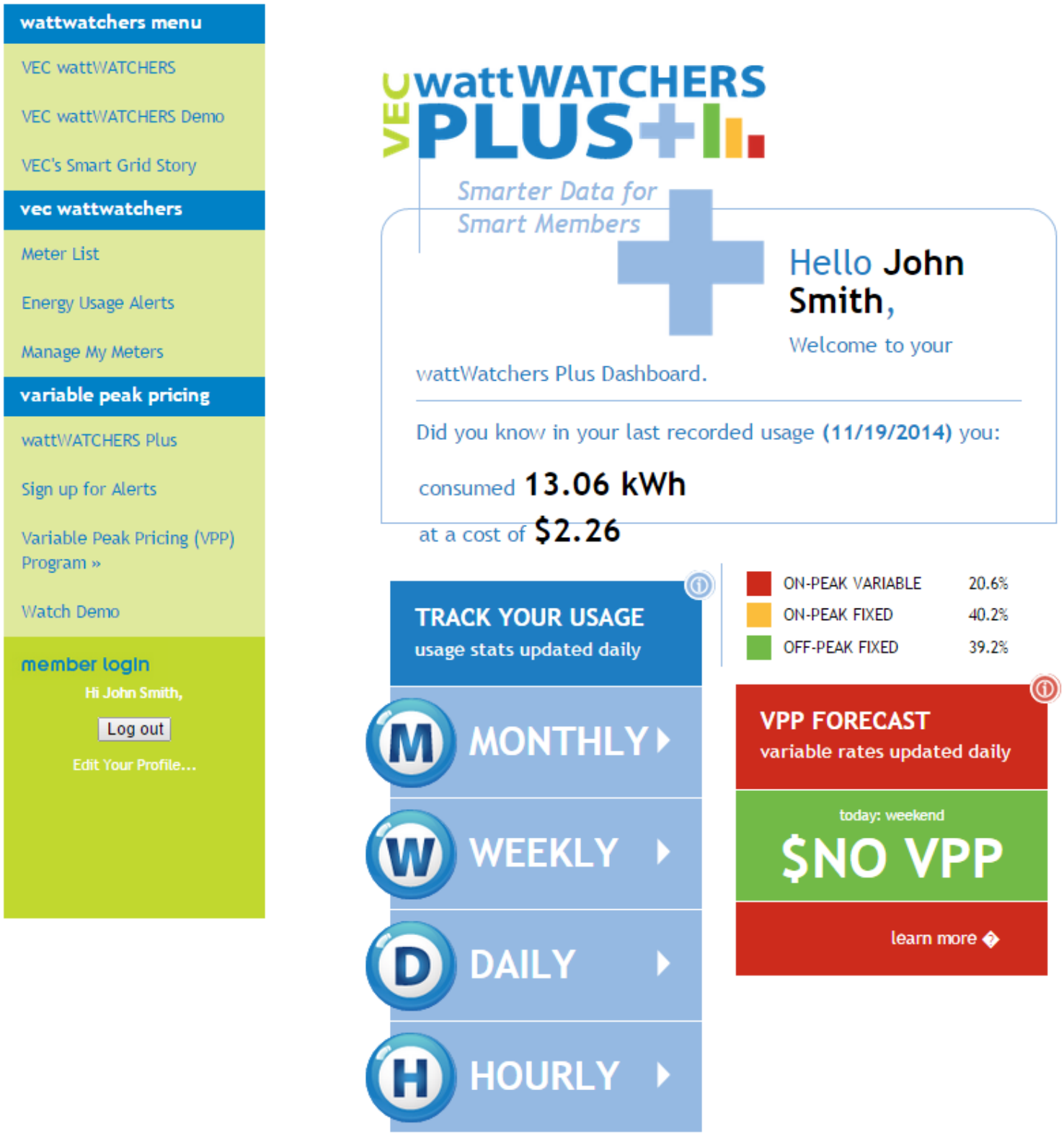
wattWATCHERS Home Page

wattWATCHERS Daily Usage view

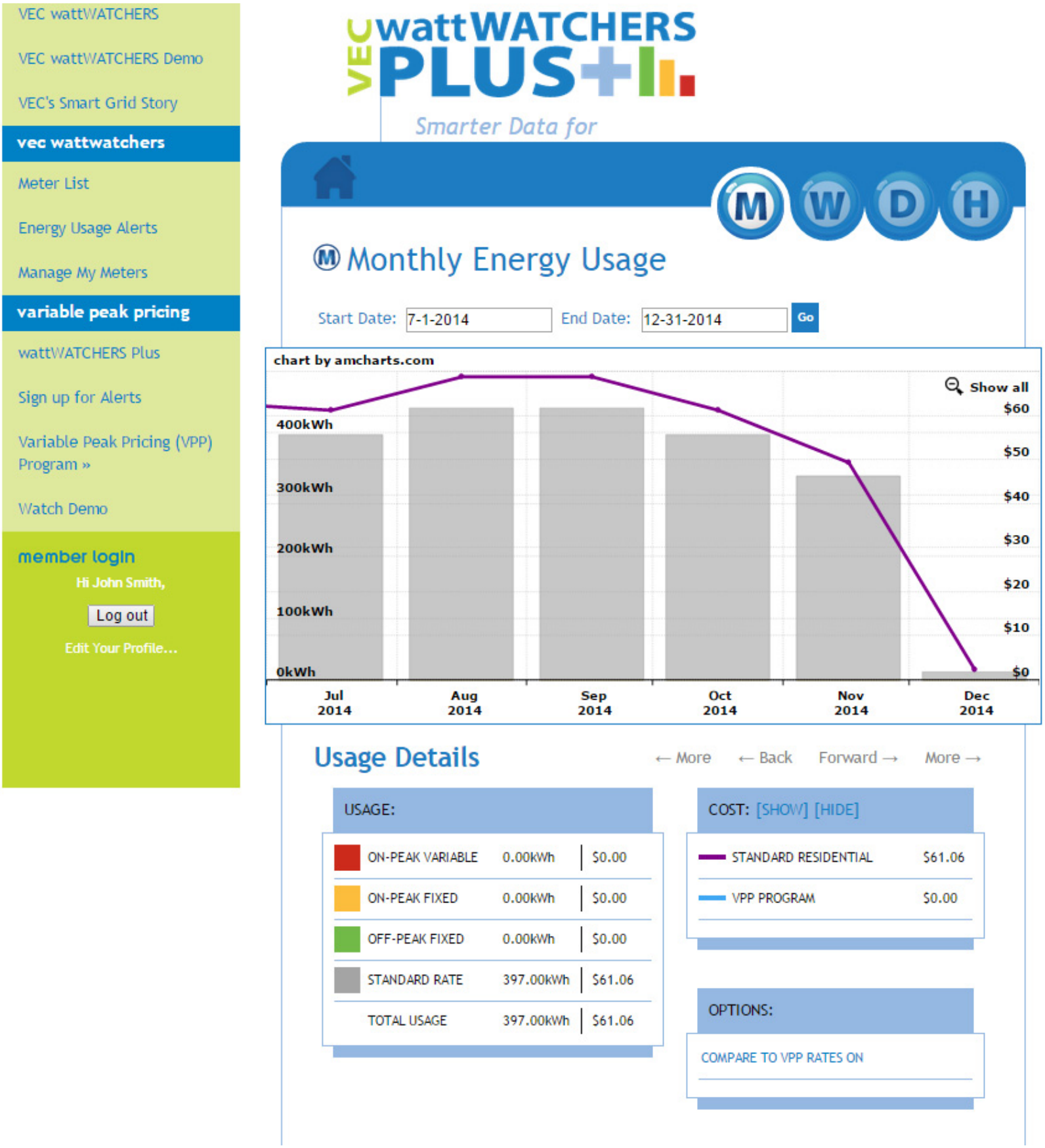
wattWATCHERS Pricing Alerts Enrollment



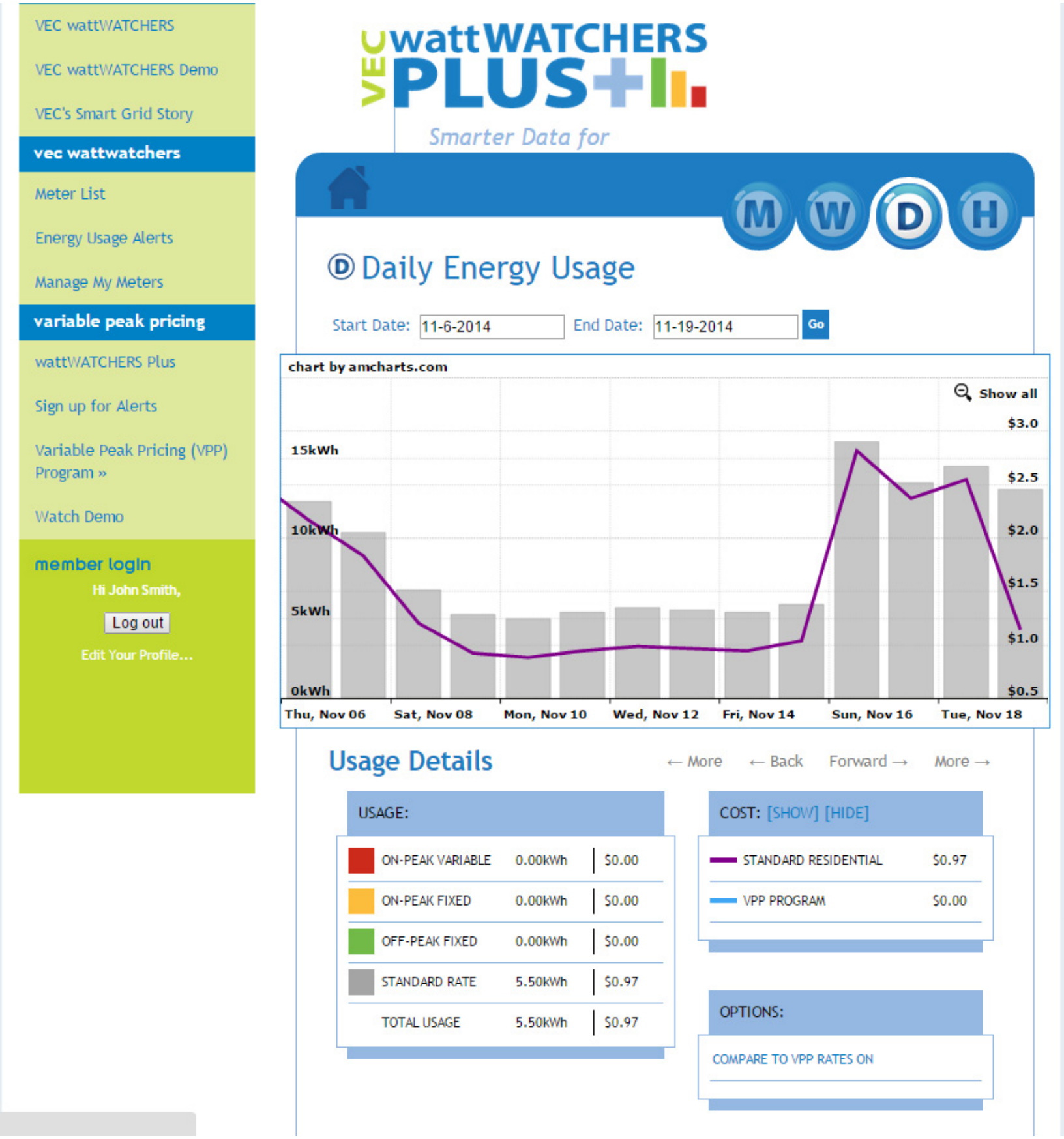
wattWATCHERS Plus Main page



wattWATCHERS Plus Monthly Energy view



wattWATCHERS Plus Daily Energy view



wattWATCHERS Plus Hourly Energy view

Appendix D: Education Material

Summer 2013 Study e-Newsletter

Fall 2013 Study e-Newsletter

Winter 2013-14 Study e-Newsletter

Spring 2014 Study e-Newsletter

January 2014 VPP Bill Insert

wattWATCHERS VPP Frequently Asked Questions

wattWATCHERS About VPP

This e-newsletter is brought you by Vermont Electric Cooperative (VEC) and Efficiency Vermont. As a participant in the Variable Peak Pricing (VPP) Program, you have the opportunity to save money by cutting down on your electric use during higher-rate hours. These summer tips can help you stay informed, save money and make the most of the VPP Program.

Stay informed about your energy use.

You can use wattWATCHERS Plus to follow your electric use and see how you're doing on the VPP Program. This site offers a variety of tools to help you stay on track.

- **Track your usage**. View your electric usage by month, week, day or hour, and see how much it cost you. You can use this information to identify ways to cut down on energy usage during higher-cost hours.

- **Compare rates.** See how you're doing on the VPP rates compared to the standard residential rate and how much you would have paid in the past on the VPP Program, going as far back as Feb 2012.

- **Set up alerts.** Sign up to receive a text or email on days when the variable rate goes higher than the minimum.

- **Watch a demo.** Learn how to navigate wattWATCHERS Plus with quick video clips that walk you through the different features.

Logon to wattWATCHERS Plus today by visiting www.vermontelectric.coop and clicking on the "VEC wattWATCHERS" icon on the right side of the screen.

Save energy while staying cool.

Using an air conditioner isn't the only answer to beating the heat during these summer months. These helpful strategies can keep you cool without resorting to energy intensive (and energy bill-raising) air conditioners.

- **Keep Cool Air In & Hot Air Out.** At night, open your windows and use a window fan, blowing toward the outside, to pull cool air in through other windows and to push hot air out. In the morning, when it's warmer outside than inside, close your windows and then draw window coverings against direct sunlight.

- **Seal It.** Caulk around window and door frames, use weather stripping on exterior doors, and have a professional properly seal gaps where air can travel between the attic and your living space.

- **Clean and Maintain.** Fill gaps along the sides of your air conditioner to keep outside air from leaking in. Remember to clean air conditioner filters regularly and keep the front and back of air conditioners unobstructed.

Visit www.efficiencyvermont.com for more energy saving tips.

Save money and improve the energy efficiency of your home.

Efficiency Vermont can help you to keep your home more comfortable - warmer in the winter, and cooler in the summer. Whether you're making home improvements or simply shopping for light bulbs, there are energy-efficient products and services available that can help to lower your energy bills.

- **Lighten Up.** Incandescent light bulbs lose 90% of their energy as heat, so switch to compact fluorescent light bulbs (CFLs). CFLs operate cooler and cost you less to use because more of their energy is used to produce light, and less is lost as heat. Efficiency Vermont offers Vermonters discounts on CFLs as low as 99¢ per bulb! Find where you can buy discounted CFLs near you.

- **Control moisture.** The hot summer months can lead to excessive moisture in your home. Controlling moisture can help combat unpleasant musty smells and allergies caused by the growth of bacteria and mold. For fresh air and energy savings, purchase an energy-efficient dehumidifier. Look for the blue ENERGY STAR label when you shop—and take advantage of the $25 rebate on ENERGY STAR certified dehumidifiers from Efficiency Vermont.

- **Shop Smart.** When buying air conditioners, choose the smallest ENERGY STAR® qualified unit appropriate for the size of the room you're cooling. Oversized models can be less effective at reducing uncomfortable humidity and they cost more to operate. Find the right size air conditioner for your room.

This e-newsletter is brought you by Vermont Electric Cooperative (VEC). As a participant in the Variable Peak Pricing (VPP) Program, you have the opportunity to save money by cutting down on your electric use during higher-rate hours. These tips can help you stay informed, save money and make the most of the VPP Program.

Switch to the Winter VPP Schedule Oct 1!

It's hard to believe it, but summer is already over, and the variable peak pricing (VPP) program will shift to the winter schedule starting October 1st. The schedule changes for winter months because electric usage peaks later as long, hot days give way to long, cold nights. Check out the schedule below to stay on top of how much your electricity will cost for different hours during the winter months.

Know Your Rate

As you know, the variable rate (11am-5pm in summer, 3pm-8pm in winter) is subject to change on a daily basis, with a minimum of $0.26343. To help you stay informed about each day's variable rate, we have enrolled your account in our variable rate email alert system. When the variable rate rises above the minimum, you will receive an email the day before notifying you about the next day's rate.

If you prefer to receive a text message instead, simply logon to wattWATCHERS Plus and select that option. If you prefer the email to come to another address, you can call us at 1-855-VEC-SAVE (1-855-832-7283) to make that change.

Save Money While Staying Warm and Well-Lit

As Vermonters, we know that winters can be cold and dark, prompting us to turn up the thermostat and turn on the lights on early. These tips can help you keep your electric bill in check without scrimping on winter comforts.

- Consider a programmable thermostat to keep the temperature at the lowest comfortable setting and program for periods when you're not home. Limiting use of these systems during the variable and on-peak hours will return the highest savings.
- Reduce or eliminate the use of high-cost heating appliances, such as electric space heaters, especially during higher-cost hours.
- Install timers on humidifiers and electric block heaters to run them during off-peak hours.
- Switch from incandescent to compact fluorescent (CFL), or better yet, LED lightbulbs. You can cut your cost by 75% or more for the same amount of light. Find out where you can buy discounted CFLs near you.
- Use photocells and/or timers on exterior and holiday lighting.

Variable Peak Pricing (VPP) Program Winter Newsletter

New 2014 VPP Rates

As a result of rising transmission costs, VEC requested a rate increase of 2.93% last November. This increase is effective 1/1/14 and applies to all members, including participants in the VPP Program. The increased cost for a member with average usage of 500 kWh per month will be about $2.74. Please see the enclosed rate schedule for the new VPP rates.

Simple ideas to offset the increased cost through energy conservation include:

- Replace three to five 75-watt incandescent light bulbs with CFLs or LEDs. CFLS are available for as little as $0.99 and LEDs for $4.99.
- Turn off the dry cycle on your dishwasher
- Avoid using your electric dryer at least once a week and instead hang your clothes to dry

wattWATCHERS Plus – A Great Way to Stay Energy Smart!

As a participant in the VPP Program, you have access to wattWATCHERS Plus, an online tool that can help you stay on top of your energy usage.

Logon to wattWATCHERS Plus today to do the following things:

- See the current and next day's variable rate;
- Track your electric usage for previous hours, days, weeks and months;
- Compare your cost on the VPP Program to what you would have paid on the standard residential rate;
- Sign up to be alerted by text message or email when the variable rate is higher than whatever threshold you set.

Stay Warm and Save Money All Winter Long

Winter can be a tough time for energy bills in Vermont. However, simple changes can help you rack up savings.

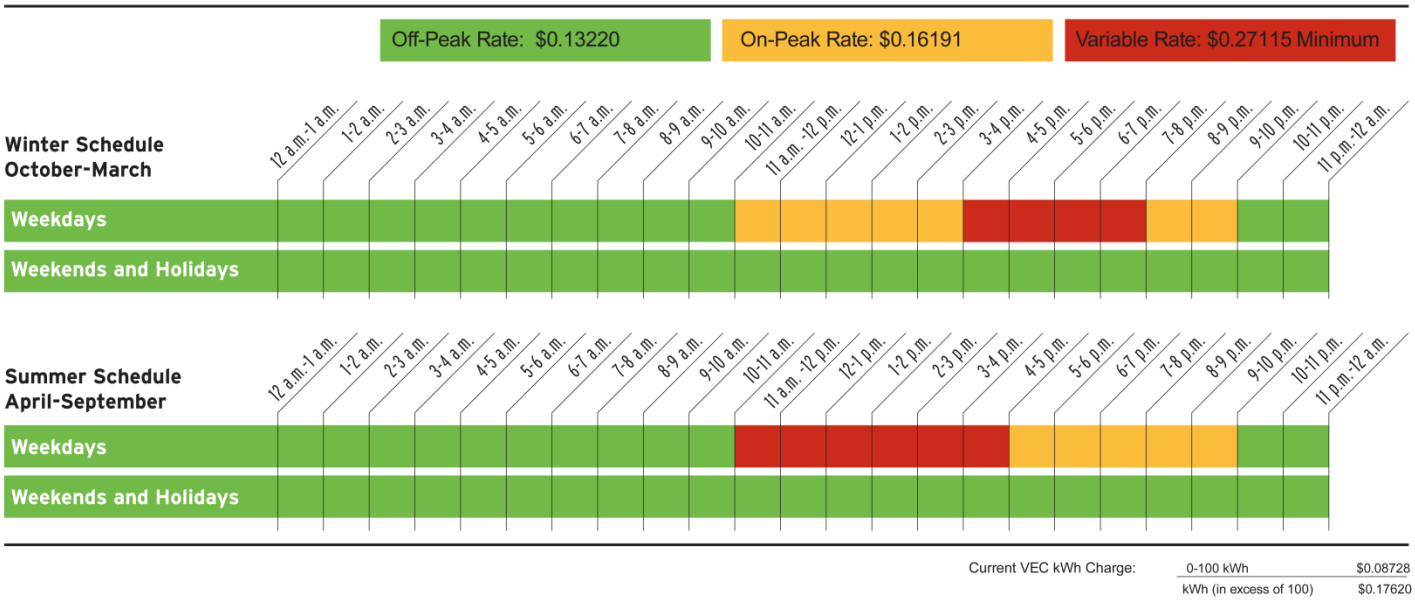
Here are some tips to help keep costs down:

- **Turn down the thermostat.** Lowering your thermostat from 72° to 65° at night and while you're at work can save you as much as 10% on your annual heating costs. Programmable thermostats make setting the right temperature even easier.
- **Use the heat from your windows but keep the cold out.** Opening the curtains during the day can help fill your home with free solar heat. Close them after dark to provide extra insulation against the cold.
- **Lower your water temperature.** Turning your water heater down to the warm setting (120°) can cut down significantly on your water heating costs.
- **Use appliances efficiently.** Run full loads of laundry and dishes. Using the cold water setting on your laundry machine saves gallons of hot water and clothes come out just as clean.

Variable Peak Pricing (VPP) Program Spring Newsletter

Reminder! Switch Back to the Summer Rate Schedule

We know it doesn't feel like summer yet, but on April 1, the VPP Summer Rate Schedule went into effect. The most expensive, variable rate hours are now from 11am – 5pm.



VPP Program Will End with Your June Billing Cycle

The VPP Program is set to end with participants' June billing cycles, which will complete the 12-month study period. At that time, you will be put back on the regular residential rate of $0.08728 for the first 100 kWh per billing cycle and $0.17620 for any usage after that.

Thank you for your participation! The information gathered through the VPP Program will help VEC determine how well this rate structure works for members and whether to offer a program like this in the future.

Spring Efficiency Tips

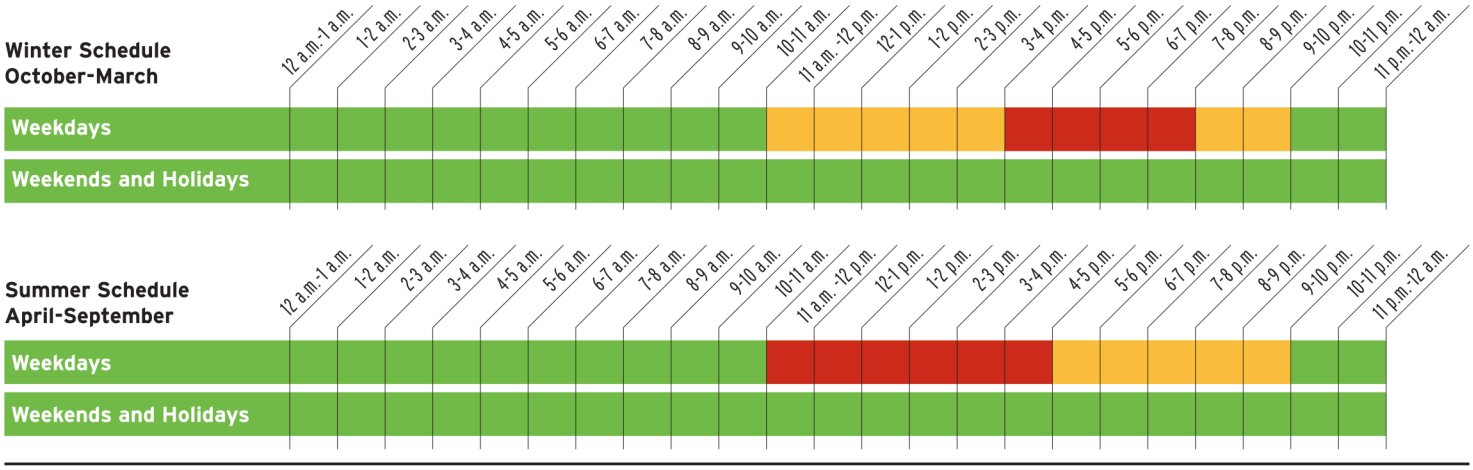
- **Consolidate refrigerators.** Spring Cleaning! One large refrigerator is more efficient than two partially filled units. Clean the air grills and evaporator coils periodically for more efficient cooling. You can take advantage of Efficiency Vermont's refrigerator recycling program to earn a $50 rebate: www.efficiencyvermont.com/refrigerator.

- **Install a timer on your dehumidifier.** Set your dehumidifier to run only during lower-cost hours.

- **Program your thermostat.** With any luck, cold winter days are behind us, and warm summer days are yet to come. Take advantage of the moderate temperatures to save some money by setting you thermostat to turn off during mild days.

Variable Peak Pricing Schedule—Effective 1/1/14

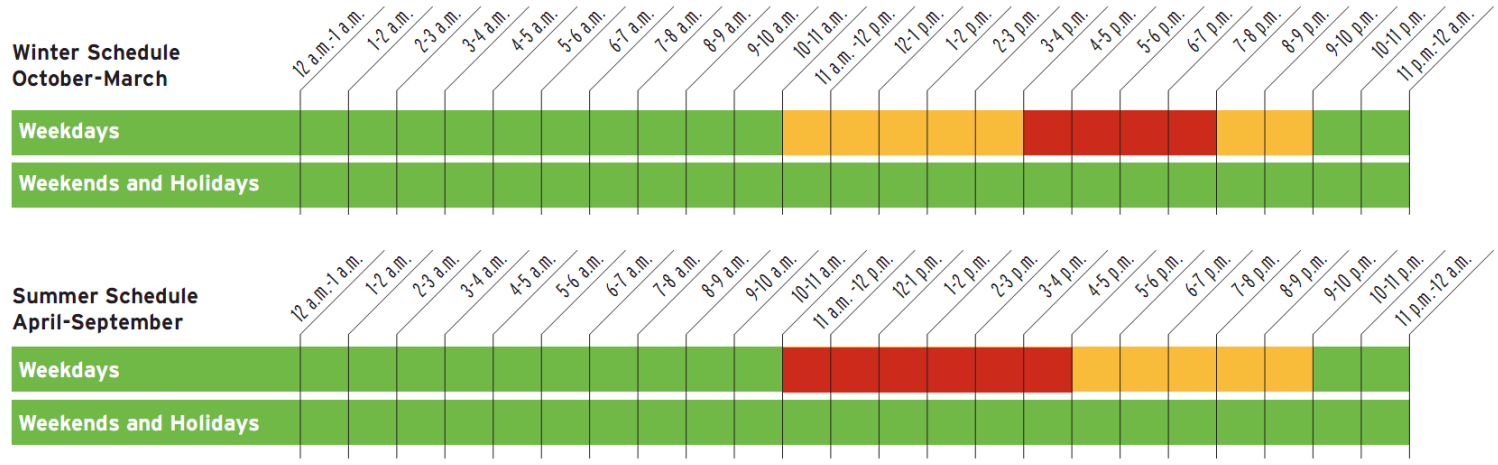
Off-Peak Rate: $0.13220 | On-Peak Rate: $0.16191 | Variable Rate: $0.27115 Minimum



Current VEC kWh Charge:	0-100 kWh	$0.08728
	kWh (in excess of 100)	$0.17620

Variable Peak Pricing Schedule—Effective 1/1/14

Off-Peak Rate: $0.13220 | On-Peak Rate: $0.16191 | Variable Rate: $0.27115 Minimum



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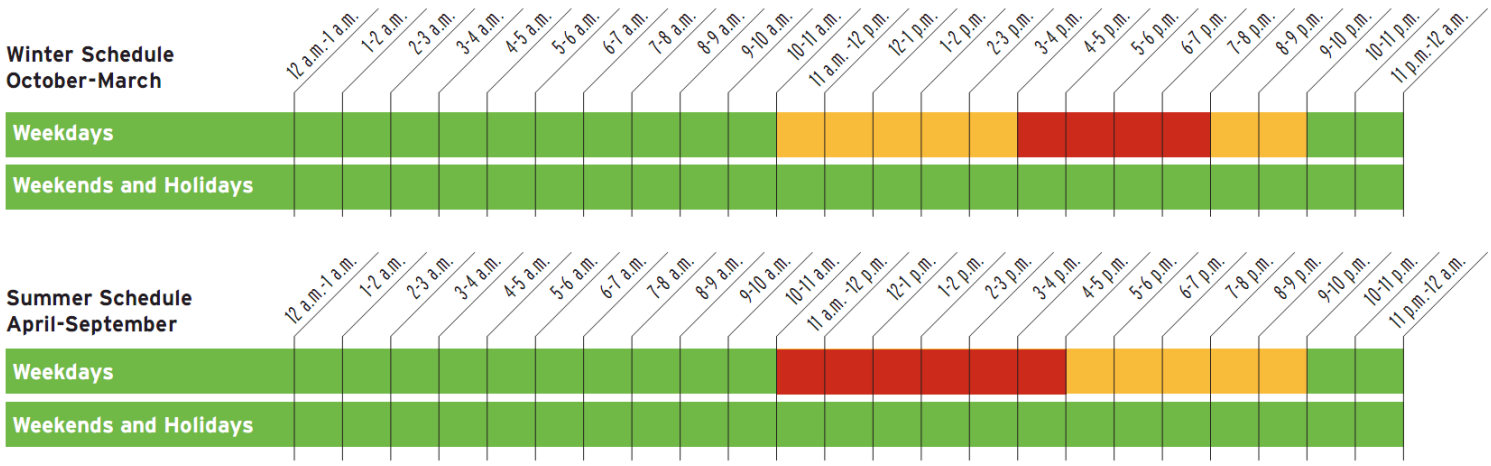

Current VEC kWh Charge:	0-100 kWh	$0.08728
	kWh (in excess of 100)	$0.17620

Know Your Rate

Winter variable rates have been more subject to change, so now is a great time to sign up for variable pricing alerts. Stay informed when the variable rate goes above the minimum ($0.27115 per kWh as of 1/1/14).

You can receive a text or email with the daily price. It's easy to set up your alerts so that you only receive a message when the prices goes above the minimum.

Call 1-855-VEC-SAVE or logon to wattWATCHERS Plus to sign up for alerts today.

http://www.vermontelectric.coop/vec-watt-watchers

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http://www.vermontelectric.coop/vec-watt-watchers

wattwatchers menu

VEC wattWATCHERS

VEC wattWATCHERS Demo

VEC's Smart Grid Story

vec wattwatchers

Meter List

Energy Usage Alerts

Manage My Meters

variable peak pricing

wattWATCHERS Plus

Sign up for Alerts

Variable Peak Pricing (VPP) Program »

Watch Demo

member login

Hi John Smith,

Log out

Edit Your Profile...

FAQ

When does the VPP Program start?

The VPP rates will start with your June 2013 meter read. To find this exact date, you can refer to your May 2013 bill. The VPP rates will begin the day after your May usage ends.

How long will the VPP program last?

The VPP Program will begin with your June 2013 meter read and continue for one year.

How do I opt out of the VPP Program?

You may opt out of the VPP Program at any time by calling 1-855-VEC-SAVE (1-855-832-7283). However, once you opt out you will not be able to rejoin the program and take advantage of the VPP rates.

Why are VPP rates so much more expensive at the beginning of the month compared to the standard residential rate?

On the standard residential rate, the first 100 kWh are discounted. You pay only $0.0848 per kWh for the first 100 kWh in each billing cycle. For all usage over 100 kWh, you are charged the standard residential rate of $0.1712.

This discount does not apply on the VPP Program, which is why it looks more expensive at the beginning of your billing cycle. As the month goes on and your usage goes above 100 kWh, you will begin to see the cost even out, and the VPP Program could end up saving you money, especially if you shift usage from high-cost to lower-cost hours.

How do I see whether I would have paid more or less if I had been on the VPP Program in the past?

You can see whether you would have paid more or less if you had been on the VPP Program in the past. Go to the Monthly view. Scroll down to "Options," and click on "Compare to VPP Rates." This will update the monthly view to show what you would have paid for your usage in the past if you had been on the VPP Program. This history goes back to Feb 2012.

Remember that this is without making any changes based on having a different rate for different times of day. If you would have paid more or about the same, there may be opportunities to shift usage to lower-cost hours. If you would have saved money, there may be opportunities to cut your cost down even more.

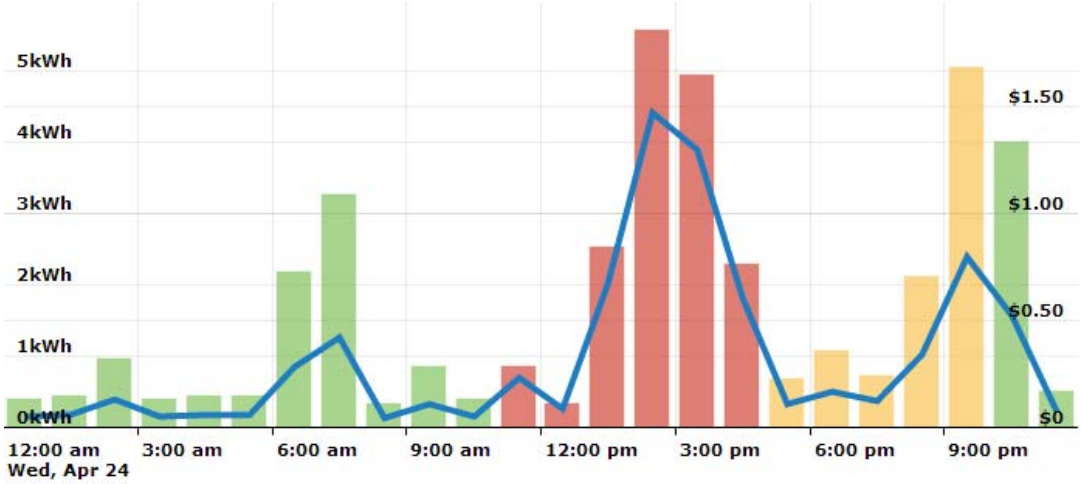
Why is my monthly total in wattWATCHERS Plus lower than the total on my bill?

The monthly total displayed in wattWATCHERS Plus is the charge for your electric usage only. The customer charge and energy efficiency charge are not factored into the total that is displayed.

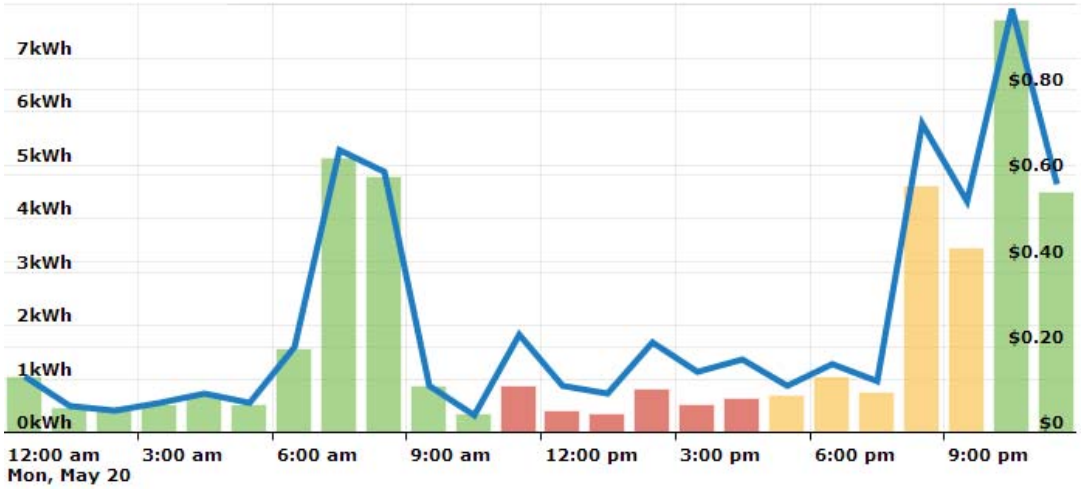
How can I save money on the VPP Program?

For at least 75% of each weekday and all day on weekends/holidays, your rates on the VPP Program will be lower than the standard residential rate that you normally pay. However, for 4-6 hours each weekday, your rate will be higher (see Rate Schedule). The best way to save money and lower the overall cost of your electric bill is to cut back on your electric usage during the higher-cost variable rate hours. To do so, you can either lower your usage overall or simply shift usage from higher- to lower-cost hours.

For example, the member whose usage is shown below could have saved money if she had shifted her 1-4pm usage to later in the evening. The red spikes between 1-4pm might have been a dishwasher cycle, cooking or a load of laundry.



On the day shown below, the same member used the most electricity after 5pm, when summer rates are lower, and saved money.



Here are some ways to make the most of your VPP rates:

- Sign up to receive alerts by text or email when the variable rate is higher than usual. These alerts will help you plan your electric usage and save on days when rates spike.
- Avoid activities such as intensive cleaning, cooking, lawn/garden watering and operating shop tools during higher-cost hours.
- Use the timer on your dishwasher, clothes washer or electric dryer (if so equipped) to run these appliances after peak has ended for the day.
- Many of today's dishwashers and clothes washers turn "on" with the push of a button. In some cases, holding that same button allows you to select "delayed on" (consult your owner's manual for more

details).

- Consider turning off the dishwasher dry cycle, which uses about three times as much electricity as the wash cycle.
- Do most of your laundry at night, in the morning or on weekends, especially if you're using an electric dryer, which is an electricity-intensive appliance.
- Use cold- instead of hot-water wash cycles. You can buy cold-water detergents that clean clothes just as well in cold water.
- Consolidate refrigerators. One large refrigerator is more efficient than two partially filled units. Clean the air grills and evaporator coils periodically for more efficient cooling.
- If you have electric heat or central air-conditioning, consider a programmable thermostat to keep the temperature at the lowest comfortable setting in winter and the highest in summer. You can also program for periods when you're not home. Limiting use of these systems during the variable and on-peak rate hours will return the highest savings.
- Reduce or eliminate use of high-cost heating and cooling appliances, such as electric space heaters and air-conditioning (central or window unit), especially during higher-cost hours.
- Switch from incandescent to compact fluorescent (CFL), or better yet, LED lightbulbs. You can cut your cost by 75% or more for the same amount of light.
- Use photocells and/or timers on exterior and holiday lighting.
- Install timers and/or variable or two-stage pumps on pool pumps. Program them for reduced run-time during peak hours.
- Install timers on dehumidifiers (summer) and humidifiers (winter).
- Schedule, or program, lawn watering for off-peak hours.
- Use powerstrips to reduce "phantom loads" (i.e., devices that use power even when off).
- Install timers on block heaters for vehicles that are plugged in.
- Program EV or PIHEV (electric and hybrid plug-in) vehicles to charge during off-peak hours.
- Look for Energy Star Rated appliances whenever you make major home purchases. Some appliances qualify for incentives through Efficiency Vermont.

For more ways to conserve electricity and save money, please click here to visit Efficiency Vermont.

How much electricity do my appliances use?

For information on electric usage for specific appliances, please click here to visit Efficiency Vermont.

Office Hours: Monday - Friday, 7:30 a.m. to 4:30 p.m.

Phone: 1-800-832-2667 or 1-802-635-2331 | Fax: 1-802-635-7645 | Email: support@vermontelectric.coop | Site Map

Outage Center | Energy Portfolio | Smart Meter | Net Metering | Beat the Peak | Cogeneration

wattWATCHERS About VPP

Variable Peak Pricing (VPP) Program

What is variable peak pricing (VPP)?

Currently, residential members are charged one rate for all hours of the day, even though the wholesale cost of electricity (what VEC and other utilities pay) varies throughout the day.

Variable peak pricing (VPP) captures two factors that influence the wholesale cost of electricity. The first is the time of day. Demand tends to peak around 2pm in the summer (when many users have air-conditioning turned on) and 5pm in the winter (when people come home from work, turn on lights and turn up the thermostat). These peaks are fairly predictable and consistent.

The second is critical peaks. Critical peaks are the days when the price of peak electricity is higher than usual. These days tend to be the hottest days of the summer and coldest days of the winter. Critical peak is the reason why the variable rate is subject to change on a daily basis, so that the variable rate that VPP Program participants pay will change as the wholesale cost of electricity changes. Members on the VPP Program can sign up to receive alerts when the variable rate spikes so that they can adjust their usage during these hours.

Why is VEC studying VPP?

As stated above, electricity usage, or demand, varies greatly throughout the day and based on the time of year. At night, when most people are sleeping and most businesses are closed, demand falls off dramatically. During the day, it goes back up and peaks around 5pm in the winter and 2pm in the summer. The electric grid must have enough generation and transmission capacity to meet peak demand, even though it is only needed for a small percentage of the time.

This “peak” electricity costs the most to deliver to members and also tends to be produced by the least environmentally friendly sources—oil and coal. If we could decrease this peak, we could save money and fossil fuels by buying less electricity when it is most expensive and most environmentally costly to produce and deliver.

The question asked by the VPP Program is, will members change their consumption habits if electricity is more expensive during peak hours and cheaper during off-peak hours? If we can conserve electricity and shift usage of items such as dishwashers, clothes washers and electric dryers to off-peak times, we could potentially reduce peak demand and help control costs that impact your electric rates.

How does the VPP Program work?

Beginning with your June 2013 meter read, you will be charged the VPP rates for one year, after which time you will be put back on the standard residential rate.

For at least 75% of each weekday and all day on weekends/holidays, you will be charged a rate that is lower than the standard residential rate. During the variable rate hours, the price of your electricity will be higher and will change daily based on the wholesale price of electricity during variable rate hours. The price will be published the evening before so you can plan your electric usage during those higher-cost hours. Click here to see the Rate Schedule.

If you decide that you no longer wish to participate in the VPP Program, you can contact a VEC representative at 1-855-VEC-SAVE (1-855-832-7283) to return to the standard residential rate. However, once you opt out of the VPP Program, you will not be able to rejoin and take advantage of the VPP rates.

Click here for program Terms and Conditions.

Appendix E: Marketing Material

Keep an Eye Out Postcard

Keep an eye out...

Within the next few days, you will receive an invitation to apply for a groundbreaking study that may transform your energy future.

VERMONT ELECTRIC CO-OP INC
the co-op advantage
energy smart today

42 Wescom Road • Johnson, VT 05656
1- 855-VEC-SAVE • www.vermontelectric.coop

Vermont Electric Cooperative is partnering with the U.S. Department of Energy and Efficiency Vermont to conduct a one-year study to test new ways to reduce your electric bills by using variable rates.

Vermont Electric Cooperative members have a rare opportunity to contribute to the energy future of the United States. Keep an eye out for more information and please consider applying.

www.vermontelectric.coop

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Johnson, VT 05656