PA Consulting Group

Cape Light Compact

Residential Smart Energy Monitoring Pilot
Final Report

March 31, 2010

Cape Light Compact

Residential Smart Energy Monitoring Pilot Final Report

March 31, 2010

Prepared for: Cape Light Compact

PA Consulting Group
6410 Enterprise Lane
Suite 300
Madison, WI 53719
USA
Tel: +1 608 316 3700
Fax: +1 608 661 5181
www.paconsulting.com

Version: 1.0

TABLE OF CONTENTS

1. EXECUTIVE SUMMARY

1.1 PILOT OVERVIEW

Cape Light Compact designed and implemented a Residential Smart Energy Monitoring Pilot program in 2009 to evaluate potential energy savings from in-home energy monitoring systems, gain insight to behavioral aspects of energy use, and inform future residential Smart Grid projects. The pilot effort began in the spring of 2009, with a recruit of 100 qualifying households within the Cape Cod and Martha's Vineyard geographies.[1] Pilot participants had in-home monitoring systems installed for a period of one year. They received information and training regarding the system and had access to an internet-based dashboard for one year. The online dashboard offered participants feedback on their energy consumption by providing real-time viewing of current energy use and demand, savings metrics in kWh, dollars, and CO_2 emissions, and provided opportunities to learn about and sign-up for energy saving activities (e.g., unplugging chargers when not in use).

1.2 EVALUATION OVERVIEW

In the summer of 2009, Cape Light Compact selected PA Consulting Group (PA) to evaluate the Residential Smart Energy Monitoring Pilot. PA conducted both process and impact evaluation activities. These included:

- In-depth interviews (IDIs) with three key program design and implementation staff
- Telephone surveys with 66 of the 91 pilot participants
- Telephone surveys with 196 non-participants—96 of whom had initially expressed interest in the pilot program (Interested Group) and 100 randomly selected respondents from the general population (Blind Group)
- A comprehensive energy use analysis, which included an analysis of monthly energy consumption (kWh) across both time (previous year kWh against pilot year kWh) and the two Control Groups
- A literature review of evaluation results from other residential home energy management programs.

1.3 PROCESS EVALUATION KEY FINDINGS AND RECOMMENDATIONS

The key findings resulting from this evaluation were as follows:

- Customer interest in the Residential Smart Energy Monitoring Pilot was high with Cape Light Compact customers. More than enough households signed up for the

[1] A detailed description of pilot participant qualifications is provided within this evaluation report in the "Pilot Selection" section.

pilot from fairly limited marketing activity. The pilot was to enroll 100 participants and 304 completed on-line questionnaires to participate.

- Home energy monitoring pilot programs provide a unique set of implementation difficulties that can, and did, delay project roll-out. While communications across program staff, contractors, and participants were effective, the main sources of delay were completing installation of the energy monitors in all of the selected households and troubleshooting issues that the contractors encountered during installation (i.e., electrical box and connectivity)

- Despite project installation difficulties, participants reported high overall levels of satisfaction with the pilot. They were most satisfied with the actual home installation, with about 90 percent saying they were "very satisfied." Other areas which had at least 60 percent of participants report high levels of satisfaction included the scheduling process for monitor installation, assistance from Cape Light Compact, and the experience of using the online monitor

- Participant interest in keeping the on-line monitoring system was high with 90 percent saying they were very interested in keeping the monitor after the 12-month pilot period. Participant survey results indicate an average willingness to pay for the monitor of approximately $8/month

- Participants view the dashboard, a major component of the program's theory of expected behavior change, for short intervals of time. Participants are most interested in the house monitor graph and are least interested in CO_2 information.

Both the program staff and participant surveys indicate that Cape Light Compact was excellent at predicting and preparing for the difficulties and problems with the pilot implementation. It is inevitable, however, that a pilot will hit numerous bumps during implementation. PA identified the following recommendations from the process evaluation:

- ***Begin the participant screening process early***. The earlier the screening process begins, the earlier potential problems are identified and can be addressed
- ***Increase level of detail during participant screening process***. This point ties into the first; all for the purpose of problem reduction during the project
- ***Include additional time for project scheduling deadlines***. Assume there is a sub-group of about 15 percent of participants for whom it will be difficult to schedule an installation, participate in the program, and/or need to be replaced.
- ***Do not take household connectivity or technical suitability for granted***. The devil is in the details. Cape Light Compact ran into problems with online connectivity (after participants had confirmed high-speed Internet) and experienced problems with routers. Apple computers also needed additional configuration. One household had an antiquated electrical box which had to be replaced for the pilot; another did not have an outlet close enough to the electrical box
- ***Test participant willingness to pay for the pilot services with a reasonable monthly fee*.** The high participant interest in retaining the home energy monitor suggests that customers are willing to pay for this program service. We recommend

that, if Cape Light Compact rolls the pilot out full-scale to its customers, a larger effort include a small monthly fee ($10 or less). A reasonable customer contribution could increase customers' utilization and engagement with the service without generating significant of participation barriers

- ***Tailor the dashboard to capitalize on customer use and interest.*** Because participants only view the dashboard for short intervals of time, it needs to be revised and streamlined based on customer feedback and interest**.** The revised version should result in greater energy saving behavior changes by better targeting information to customers' needs.

1.4 IMPACT EVALUATION KEY FINDINGS AND RECOMMENDATIONS

Below, we present the key findings for the Residential Smart Energy Monitoring Pilot:

- Participant and Control Groups share similar demographic and housing characteristics, supporting the notion that energy use differences across groups are less likely explained by demographic differences and more likely a result of the pilot intervention
- Survey findings show that participants did not engage in energy saving tasks and habits at significantly higher levels than those reported by the Control Groups, yet the energy analysis impact results, highlighted below, reveal savings differences
- Login activity for the home energy monitor remained fairly consistent over the study period once the majority of units had been installed. Toward the end of the study period, however, logins began to vary more from week to week, with some high weeks and some relatively low weeks
- The Residential Smart Energy Monitoring Pilot reduced daily energy consumption among participants by an average of 9.3 percent, controlling for temperature differences and for other Cape Light Compact program activity, which was equivalent to 2.9 kWh per day
- Energy savings were highest in the months August through October, where the average savings rate varied from 3.6 to 4.9 kWh per day, on average
- Seventy-five percent of program participants reduced energy consumption during the program. One-third reduced average energy consumption by four or more kWh per day
- Statistical analysis shows that the correlation is low between self-reported habits and tasks to save energy and actual energy savings. The strongest predictor of energy savings is the frequency and nature of interaction with the Smart Energy Monitor.

Based on the impact evaluation key findings, we present recommendations.

- ***A quantitative energy savings analysis should be part of any evaluation effort of a home energy display pilot***. Despite a strong quasi-experimental design that included surveys with participants and two different Control Groups, customer surveys alone were not able to tease out statistically significant behavioral differences between participants and non-participants. The energy savings resulting

from the pilot were captured through the energy analysis of participants' and Control Groups' consumption.

- ***Increase the effectiveness of customer use and interaction with the Smart Energy Monitor*.** The impact evaluation clearly demonstrates the importance of customer engagement with the home energy monitor to produce expected energy savings. We recommend if the pilot is to be rolled out on a larger scale, that Cape Light Compact conducts a focus group with participants to further identify effective ways to not only increase customer use of the Smart Energy Monitor, but also effective strategies to maintain this level of engagement over time. The period of the evaluation is limited, but the analysis of log-on activity suggests participant engagement was high at the beginning of the pilot and began to wane as time progressed and perhaps the 'novelty' of the home energy monitor wore off.
- ***Target and encourage customer behavior that will result in higher energy savings*.** The impact evaluation found that not all program participants saved energy. Statistical analysis on a number of factors including reported behaviors, attitudes and demographics was unable to distinguish types of customers who saved energy through the pilot versus those who did not. However, clearly the pilot was more effective in resulting in energy savings for some than others. The only clear indicator of energy savings was use of the home energy monitor, as discussed above. Cape Light Compact might want to consider pilot strategies that reward those using the home energy monitor, and therefore likely to be saving energy through the program, versus those who are not. For example, effective strategies could include waiving the monthly fee, discussed above under the process evaluation section, if customers use the home energy monitor a certain number of times a week or providing a 'thank you' to those based on their home energy monitor activity, such as mailing a free compact fluorescent light (CFL) to these participants.

1.5 CONCLUSION

The evaluation demonstrates that the pilot was successful on many fronts, including customer satisfaction and its objectives to save energy. There have been sufficient evaluations of residential energy management technologies in recent years to provide a reasonable picture of the range of energy savings from these systems, which we compiled through a literature review. Our findings for the home energy monitor places its rate of energy savings higher than all but one of the other programs included in the literature review. We believe this is a reasonable finding, given the design of the program, which seeks to deeply engage participants in the habits and tasks of energy savings and targeted the pilot to those with extreme interest and likelihood of participating actively in it. A remaining question is whether this rate of energy savings can be maintained over time. We were not able to assess the sustainability of energy savings within the evaluation time period; however, the recommendations from both the process and impact evaluation suggest several strategies that could assist in both initial energy savings and the sustainability of energy savings over time.

2. INTRODUCTION

2.1 PILOT DESCRIPTION

Cape Light Compact designed and implemented a Residential Smart Energy Monitoring Pilot in 2009 to evaluate potential energy savings from in-home monitoring systems, gain insight to behavioral aspects of energy use, and inform future residential Smart Grid projects. The pilot effort began in spring 2009, with a recruit of 100 qualifying households within the Cape Cod and Martha's Vineyard geographies.[2] Pilot participants had in-home energy monitoring systems installed for a period of one year. They received information and training about the system and had access to an Internet-based dashboard for one year. The online dashboard offered participants feedback on their energy consumption by providing real-time viewing of current energy use and demand, savings metrics in kWh, dollars, and CO_2 emissions. The dashboard provided opportunities to learn about and sign-up for energy saving activities (e.g., unplugging chargers when not in use).

2.1.1 Background and Design

Cape Light Compact was approached by the Northeast Energy Efficiency Partnerships (NEEP) and GroundedPower in late 2008 about participating in a residential energy monitoring pilot program. Cape Light Compact staff showed immediate interest as they viewed it as an opportunity to add something new to their energy efficiency portfolio. The pilot idea also aligned well with what Cape Light Compact staff characterized as a *"highly engaged and energy conscious customer base."* GroundedPower, the monitoring technology contractor, proposed a project scope and Cape Light Compact, with the help of NEEP, designed the project and developed evaluation strategies to assess its effectiveness. The pilot design framework is summarized below.

- Solicit 100 eligible customers as pilot participants, stratifying roughly by Cape Light Compact's customer distribution across Cape Cod (75 participants) and Martha's Vineyard (25 participants)
- Install an in-home energy monitoring system in 100 participant households for a one-year period
- Survey the Participant Group to examine energy monitor satisfaction and assess behavioral changes due to its use
- Adopt a quasi-experimental design by selecting two household Control Groups with geographic, household composition, and energy use characteristics similar to that of the participant (i.e., treatment) group
- Survey Control Group households regarding energy use behaviors and compare results against participants

[2] A detailed description of pilot participant qualifications is provided within this evaluation report in Section 3.2.2 Pilot Selection.

- Evaluate actual participant household electricity use during the pilot using the previous year's electricity use as a benchmark, controlling for differences in weather. And compare participant usage against actual usage of both Control Groups.

2.1.2 Home Energy Monitoring System

The GroundedPower home energy monitor combines hardware with an Internet-based dashboard that is linked to the hardware through wireless technologies. The hardware is composed of a device that clamps on to the electrical panel input of a home and is attached to a power outlet.[3] This monitor device measures household-level electricity consumption in real-time and transmits data to a base station plugged into a household router. The router sends information back to a central GroundedPower database. Participants log in to the dashboard and view their electricity consumption via a real-time "house monitor graph" displaying ongoing demand usage down to the minute. The website provides participants with a variety of website details and options, including:

- Savings information (kWh, dollars, and CO_2)
- Monthly usage and totals
- Learn-and-commit-to energy saving actions (each with estimated savings)
- Household energy use distribution (based on detailed survey usage information)
- Energy use comparison against a cohort customer group
- Shared energy tips among participants
- Alerts to potential demand response events[4].

The sharing of energy information among participants was an important component of the pilot. The idea is that households will provide information, encouragement, and possibly a subtle normative pressure on one another to save energy.[5]

2.2 EVALUATION OBJECTIVES AND METHODS

In the summer of 2009, Cape Light Compact selected PA Consulting Group (PA) to evaluate the Residential Smart Energy Monitoring Pilot. This section discusses the evaluation objectives and the strategy used, and presents the evaluation framework. PA employed a combination of interview, data collection, and analysis activities to assess the impact that in-home energy monitors have on energy consumption and household behavior. PA conducted both process and impact evaluation activities.

---

[3] Cape Light Compact used an electrical contractor to attach the monitor devise to electrical panels.

[4] With an unusually cool 2009 summer, Cape Light Compact/GroundedPower, did not have the opportunity to communicate any demand response events.

[5] A theory detailed in ACEEE report E087, pg. 11, Behavior, Energy, and Climate Change: Policy Directions, Program Innovations, and Research Paths, November 2008, Karen Ehrhardt-Martinez.

2.2.1 Process Methods

We examined the administration and implementation of the pilot from two perspectives: (1) in-depth interviews (IDIs) of key implementation staff; and (2) pilot participants survey interviews. The purpose of the IDIs was to identify successes and challenges of the pilot's implementation processes and to inform the participant and Control Group surveys. PA used a Computer Assisted Telephone Interview (CATI) system to interview both participant and non-participant groups. Survey questions addressed participant's attitudes towards energy, their energy monitor use, and assessed household behavior modifications though a battery of energy saving tasks and habits suggested by the online dashboard.[6] The process evaluation focused on answering questions, such as:

- How well did the Pilot meet its stated objectives and goals and what changes could have improved Pilot performance?
- How effective is the in-home monitoring system? How are participants using it and what could improve their use?
- How satisfied are participants with the in-home energy monitor and how could satisfaction be increased?

2.2.2 Impact Methods

PA conducted an empirical review of energy consumption effects through a comprehensive energy use analysis, which included an analysis of monthly energy consumption (kWh) across both time (previous year kWh against pilot year kWh) and across two Control Groups. Specifically, we looked for a statistically significant reduction in energy consumption across pilot participants. The impact evaluation sought to answer questions such as:

- Is there a significant difference in electricity usage with in-home energy monitors: (1) when compared to households without them; and (2) when compared to a participant's previous year?
- What are the characteristics of households that show a significant reduction in usage?
- Will any short-term energy savings persist over time?

The relatively short time-frame of the analysis makes conclusions about persistence tentative, especially if there are also seasonal effects that must be accounted for.

The next three sections present the process findings from in-depth interviews, participant and Control Group CATI-based surveys, and empirical kWh impact findings of the home energy monitoring system on participant households.

[6] See Appendix B for a copy of the survey instrument

3. PROCESS EVALUATION RESULTS

We begin this section by highlighting process evaluation key findings. These are followed by more detailed findings from the different data collection activities.

3.1 KEY FINDINGS AND RECOMMENDATIONS

- Customer interest in the home energy monitoring pilot was high with Cape Light Compact's customers. More than enough households signed up for the pilot from fairly limited marketing activity. The pilot was to enroll 100 participants and 304 completed on-line questionnaires to participate.

- Home energy monitoring pilot programs provide a unique set of implementation difficulties that can, and did, delay project roll-out. While communications across program staff, contractors, and participants were effective, the main sources of delay were completing installation of the energy monitors in all of the selected households and troubleshooting issues that the contractors encountered during installation (i.e., electrical box and connectivity).

- Despite project installation difficulties, participants reported high overall levels of satisfaction with the pilot. They were most satisfied with the actual home installation, with about 90 percent of respondents saying they were "very satisfied." Other areas that had at least 60 percent of participants report high levels of satisfaction included the scheduling process for monitor installation, assistance from Cape Light Compact, and the experience of using the online monitor.

- Participant interest in keeping the on-line monitoring system was high. Ninety percent of respondents said they were very interested in keeping the monitor after the 12-month pilot period. Participant survey results indicate an average willingness to pay for the monitor of approximately $8/month.

- Participants viewing of the dashboard, a major component of the program's theory of expected behavior change, is limited to short intervals of time. Participants are most interested in the house monitor graph and are least interested in CO_2 information.

Both the program staff and participant surveys indicate that Cape Light Compact was excellent at predicting and preparing for the difficulties and problems with the pilot implementation. However, it is inevitable that a pilot will hit numerous bumps during implementation. PA identified the following recommendations from the process evaluation:

- ***Begin the participant screening process early***. The earlier the screening process begins, the earlier potential problems are identified and can be addressed.
- ***Increase level of detail during participant screening process***. This point ties into the first—for the purpose of problem reduction during the project.
- ***Include additional time for project scheduling deadlines***. Assume there is a sub-group of about 15 percent of participants for whom it will be difficult to schedule an installation, participate in the program, and/or need to be replaced.

- ***Do not take household connectivity or technical suitability for granted***. The devil is in the details. Cape Light Compact ran into problems with online connectivity (after participants had confirmed high-speed Internet) and experienced problems with routers. Apple computers also needed additional configuration. One household had an antiquated electrical box which had to be replaced for the pilot; another did not have an outlet close enough to the electrical box
- ***Test participant willingness to pay for the pilot services with a reasonable monthly fee*.** The high participant interest in retaining the home energy monitor suggests that customers are willing to pay for this program service. We recommend that, if Cape Light Compact rolls the pilot out full-scale to its customers, a larger effort include a small monthly fee ($10 or less). A reasonable customer contribution could increase customers' utilization and engagement with the service without generating significant of participation barriers
- ***Tailor the dashboard to capitalize on customer use and interest.*** Because participants only view the dashboard for short intervals of time, it needs to be revised and streamlined based on customer feedback and interest**.** The revised version should result in greater energy saving behavior changes by better targeting customers' needs.

3.2 PROGRAM STAFF INTERVIEWS DETAILED RESULTS

As part of the Residential Smart Energy Monitoring evaluation, PA conducted in-depth process interviews with two program managers and one GroundedPower employee. These interviews provided PA with a good understanding of the pilot's design and implementation; and informed the design of the survey instruments for participants and the Control Groups. This section describes the implementation processes for Cape Light Compact's Residential Smart Energy Monitoring Pilot.

After several months of detailed design and preparation, Cape Light Compact launched the Residential Smart Energy Monitoring Pilot in early 2009 simply enough, with a short mention in a local newspaper. Cape Light Compact then began a six month implementation process which included efforts in four areas: marketing and recruitment, pilot participant selection, logistics and communications, and monitor installation. These four areas are each described in brief below.

3.2.1 Marketing and Recruitment

Cape Light Compact marketing efforts served the dual purposes of an initial monitoring pilot recruitment and a continuing effort to market other Cape Light Compact energy efficiency programs to those participants.

a. INITIAL RECRUITMENT

The initial newspaper mention of the pilot proved more than sufficient to recruit participating households. The article led interested readers to an online questionnaire. The questionnaire began a pre-screening process, whereby Cape Light Compact used multiple selection criteria to identify 100 pilot participants. These criteria are defined below in the following section.

b. CONTINUING

In line with the goal of heightening the awareness of Cape Light Compact's portfolio of energy efficiency programs, there was an explicit synergistic effort within the pilot. Cape Light Compact used the dashboard website to market other energy efficiency program offerings, such as www.myenergystar.com , high efficiency lighting, and heating, ventilating, and air conditioning (HVAC) rebate programs.

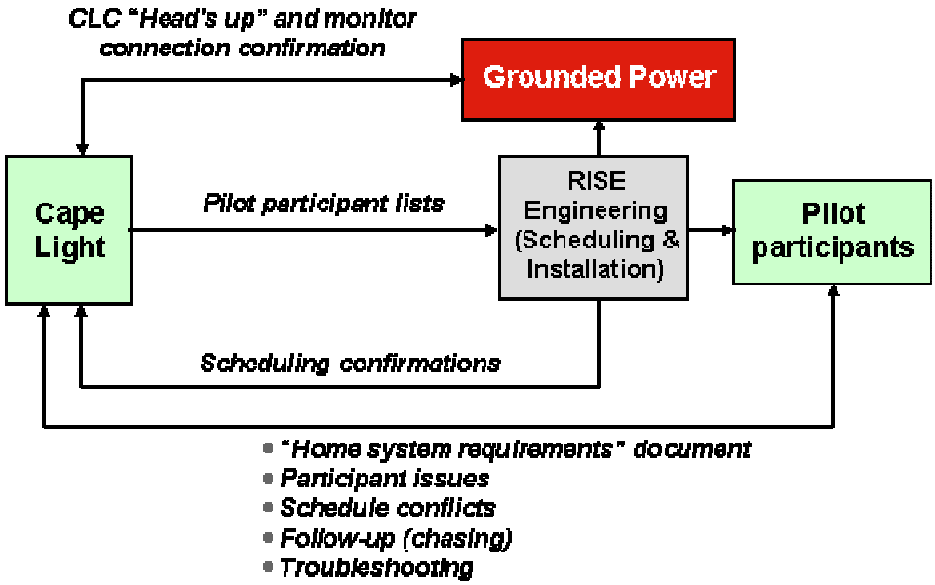
3.2.2 Pilot Selection

The pilot selection process began after collecting the results of 304 pre-screening questionnaires. Cape Light Compact alerted all respondents, via e-mail, that they were in the process of selecting the Participant Group. Selection criteria were both pragmatic, in terms of the pilot's scope and technological needs, and based on specific metrics to accommodate the pilot evaluation research. For example, the pilot required households to be Cape Light Compact customers (i.e. reside in either Cape Cod or Martha's Vineyard), and have high-speed Internet access and a wireless router. Participants needed to be full-time residents and have average monthly household electricity use of at least 600 kWh. Cape Light Compact alerted via e-mail, the 100 selected pilot participants, and told the remaining 204 respondents that they were not selected. These 204 formed the first Control Group, referred to as the Interested Group.

3.2.3 Logistics and Communication

A significant factor contributing to Cape Light Compact's successful implementation of the pilot is effective communication amongst all parties involved. Each completed monitor installation involved Cape Light Compact's coordination of their electrical contractor (RISE Engineering), GroundedPower, and the participant. Figure 3-1 below details communication.

Figure 3-1. Pilot Communication Processes



Cape Light Compact acted as a central communication hub. They provided participants with an initial "home system requirements" document, alerting them of what to expect with the installation. Cape Light Compact then forwarded participant information to RISE Engineering, who then scheduled weekly installation appointments. Once scheduled, Cape Light Compact was notified, along with a "head's-up" to GroundedPower to expect incoming pilot data through the system. When installation issues occurred, the participants e-mailed Cape Light Compact who in turn, had to troubleshoot solutions. This process continued over a period of several months as participants got up and running with the system.

Cape Light Compact primarily identified this communication and logistics process to be effective. However, due to the delays in scheduling, involving a Trouble Group, about 15 participants fell approximately three months beyond the expected participant installation completion date.

3.2.4 Installation

As previously described, Cape Light Compact provided RISE Engineering with participant lists and RISE Engineering conducted weekly telephone scheduling of installation. Cape Light Compact identified the installation process proved the most challenging aspect of pilot implementation. Multiple instances occurred where selected participants either could not agree upon an installation time, or scheduled, only to be cancelled, several times over.[7] These problems, combined with all other documented troubleshooting issues (i.e., electrical box and connectivity) were what Cape Light Compact and the contractors were dealing with on a weekly, sometimes daily basis. Moreover, it is the central contributing factor to a three month delay in installation and ultimately, an inability to reach 100 activated participants.[8]

A participant's installation was confirmed by GroundedPower, when they began receiving energy use data from the household. Participants then used the online dashboard to provide feedback, ask questions, and troubleshoot the monitoring system.

3.3 CUSTOMER SURVEY DETAILED RESULTS

PA conducted CATI-based survey interviews in two waves. The first wave was conducted with the Control Groups in October 2009. Since in-home monitor installations were not completed until October 31, 2009, because of delays discussed in the prior section, we postponed interviewing participant households until February 2010. Our aim in delaying the Participant Group surveys was to allow participants to have as much time as possible with the energy monitors in their households. At the time of the surveys in February, a majority of participants had been active in the pilot for five to eight months.

---

[7] In a study with Seattle City Light customers, implementers experienced similar problems with scheduling installations. About 10 percent of their sample was replaced due to scheduling issues. "In-Home Energy Monitoring Display (IHD) Market Test Report", August 2009, pg. 12, Paragon Consulting Services.

[8] Cape Light Compact did use the Interested Group to replace pilot participants unable to have the system installed. Due to the length of this process, the final Participant Group consisted of 91 participants.

The *Participant Group* consisted of 91 total households. Of that population, we completed interviews with 66 households, for a response rate of 72 percent.[9] There were two non-participant Control Groups.

- *Interested Group*: consisting of 207 households. This group expressed initial interest in pilot participation, completed a screening questionnaire, but was not selected.[10]
- *Blind Group:* 400 households selected using a stratified random sampling process. This group was selected using criteria to mirror the characteristics of the Participant Group (i.e., geography and monthly kWh usage).

We realized good response with both Control Groups. For the Interested Group, PA completed 96 surveys achieving a 46 percent response rate; with the Blind Group we completed 100 completed surveys (25 percent response rate).

3.3.1 Pilot Satisfaction

Cape Light Compact participants were asked about their satisfaction with various aspects of the pilot. As shown in Table 3-1, participants reported high overall levels of satisfaction with the pilot. They were most satisfied with the actual home installation, with about 90 percent saying they were "very satisfied." Other areas which had at least 60 percent of participants report high levels of satisfaction included the scheduling process for monitor installation (87.9 percent), assistance from Cape Light Compact (62.5 percent), and the experience of using the online monitor (60.9 percent). Few participants reported dissatisfaction with these or other aspects of the pilot. The two areas of dissatisfaction (12.5 percent either very dissatisfied or somewhat dissatisfied), were the breadth of information available through the online monitor and the level of detail available through the online monitor.

Table 3-1. Satisfaction with the Pilot

	Percent Satisfied (n=66)	
	Somewhat	Very
Actual home installation	7.6%	89.4%
Scheduling process for monitor installation	7.6%	87.9%
Assistance from Cape Light Compact	31.3%	62.5%
Experience using the online monitor	34.4%	60.9%
Technical assistance for the online monitor	32.2%	59.3%
Training materials available	41.3%	52.4%
Breadth of information available through the online monitor	35.9%	51.6%
Level of detail available through the online monitor	37.5%	50.0%
Actual cost savings to-date	42.9%	44.4%

[9] See Appendix A for Participant and Control Group survey response rate details. We believe advance notice via e-mail, and the participant's initial agreement to be surveyed, resulted in the high response rate.

[10] It is possible that households in the Interested Group were not selected due to substantial differences in monthly kWh usage compared to the Participant Group.

During the pilot, participants have been able to use the energy monitoring system free of charge. The survey gauged participant's interest in keeping the system permanently once the pilot ends. Nearly 90 percent of participants (n=60) expressed interest in keeping the monitoring system; 63 percent were "very interested," and 25 percent said they were "somewhat interested."

Of the participants who showed an interest in keeping the monitoring system post-pilot, they indicated a willingness to pay an average monthly amount of $7.57. The maximum amount a participant was willing to pay on a monthly basis for the use of the monitoring system was $30, and the minimum was one dollar. However, 38 percent of the participants who expressed interest in keeping the monitoring system reported that they would not pay a monthly fee.

3.3.2 Household Monitoring System Use

The Residential Smart Energy Monitoring Pilot is one of many programs Cape Light Compact has offered. Participants were asked if this is the first Cape Light Compact program in which they've participated. Twenty-three percent of participants indicated they have participated in previous Cape Light Compact programs.

Program participants were surveyed several months after the Blind and Interested Groups had been surveyed, so they would have a few additional months using the home energy monitoring equipment. The goal was for participants to have the equipment for about six months prior to being surveyed. The survey asked approximately how many months the participant has had the home energy monitoring equipment, and participants reported an average of six months, which was the goal when surveying the participants. However, about five percent of participants have only had the monitors for three months and two percent of participants have had the monitors for a year.

One important aspect of the home energy monitoring equipment is the online dashboard website, which respondents use to view their energy use. Participants reported various levels of use of this facility. Table 3-2 shows the frequency with which participants logged into the online dashboard website. About 25 percent of participants logged in daily. At the other end of the spectrum, 20 percent of participants reported logging in less than once per week.

Table 3-2. Frequency of Logging onto the Online Dashboard Website

Frequency of Logging onto the Online Dashboard Website	Percent Mentioned (n=66)
Daily	25.8%
3-6 times per week	21.2%
1-2 times per week	33.3%
Less than 1 time per week	19.7%

Participants reported that when participants logged into the online dashboard, they generally spent a relatively small amount time viewing their energy use data. Sixty-five percent of participants said they were using the online dashboard website for less than five minutes each time they logged on; another 30 percent reported spending five to ten minutes on the online dashboard website; and the remaining five percent were on the online monitor for 11-30 minutes.

The four key information sections of the online dashboard are the house monitor graph, energy actions, energy savings, and savings goals. Participants were asked when they log into the online dashboard website how often they viewed each of the sections. The house monitor graph was the section that was viewed most often, with 70 percent of participants reporting that they always view the house monitor graph. Slightly over half (52 percent) of participants always viewed their savings, 32 percent always viewed their goals, and 14 percent always viewed their actions.

The online dashboard website is meant to be a guide to reducing household energy use. To gauge the effectiveness of the online monitor, participants were asked to rate the several aspects of the online monitor, with "0" being not at all effective and "10" being very effective. The visibility of real-time energy use was rated the most effective aspect of the online dashboard website, with an average rating of 8.17. Table 3-3 shows the ratings. Other aspects of the online monitor receiving a high effectiveness rating of 7.0 or greater include: understanding of household energy use savings (7.92 rating) and understanding of household cost savings (7.67 rating). Participants were notably unimpressed with the ability to monitor CO_2 emissions (4.84 average rating).

Table 3-3. Effectiveness of Online Dashboard Website on Reducing Household Energy Use

Online Dashboard Website Aspects	Average Effectiveness Rating
Visibility of real-time energy use (n=63)	8.17
Understanding of household energy use savings (n=65)	7.92
Understanding of household cost savings (n=66)	7.67
Comparison of energy use again set goals (n=65)	6.94
Suggested energy conservation actions (n=66)	6.82
Comparison of your energy use to a Participant Group average (n=66)	6.36
Understanding of household CO_2 savings (n=63)	4.86

Participants were asked what they find most useful about the home energy monitoring system. As a result of the home energy monitoring system, several pilot participants mentioned specific actions they've taken after seeing spikes in their energy use. Below are quotes from the participants.

> *"It makes me more conscious on what I'm doing so I make a better attempt for [energy] savings. I've installed energy efficient lamps; I've installed light bulbs throughout the house; I turn the computer off at night,[and] things like that. They are checking on me all the time, which is good."*

> *"We could turn something on to get an idea of how one thing would really cost us [a lot of money], and to notice the time of day when we were using more [energy]. We could understand why and what we were turning on. So, when we saw the big spikes, I was able to figure out what it was from, which allowed us to change our pattern in using things that were big spikes. Good example - when we get up in the morning [and] we turned the 60 inch plasma screen on; we didn't realize what a big energy user that was. So, we bought a small 22 inch energy efficient TV for the kitchen. So, we only use the plasma screen for special shows. But we use the small TV for news and*

smaller shows. We eat dinner in the kitchen now - that was a big savings to us, that brought our bill down 25 to 30 dollars a month."

"We go on [to the online dashboard] every day and sometimes even five times a day. I've gone from doing three loads of laundry a day down to one load a day. Once you realize the impact of some of one's actions and how it affects energy use, one adjusts his/her usage, and that is what we've done."

In addition to identifying what had been useful with the home energy monitoring system, participants were also asked what types of equipment they would like to see added to the online monitor. A few participants were pleased with the information on the online monitor and could not thing of anything to add. However, some participants had specific feedback as to what could be improved. Listed below are several recommendations from participants of information to be added to the online monitor.

"I wish there was a way of clearly identifying what the spikes mean. It would be wonderful if it would say this is your electric heater, [or] it would identify the appliance using the energy. I don't know if that can be done because you don't always know what the spikes mean. I can guess [what the spike is], [but] it would be nice if there was such a monitor. I don't know if there is any."

"I would like to be able to connect with other people via bulletin board or chat room."

"I would want the ability to export the data to Excel."

"I'd like to be able to see on a daily basis the comparison with last year. You can only get it on a weekly basis. I'd like to see it on a daily basis."

"I'd like to see the usage adjusted for heating and cooling days."

Individuals generally signed up to participate in the Residential Smart Energy Monitor pilot to become more aware of their energy use and to reduce household energy. Nearly 90 percent of participants reported that they had either "definitely" or "probably" reduced their household energy consumption since participating in the pilot. Table 3-4 shows the breakdown of responses.

Table 3-4. Reduced Household Energy Consumption since Participating in the Pilot

Reduced Household Energy Consumption	Percent Mentioned (n=66)
Definitely yes	62.1%
Probably yes	27.3%
Probably no	7.6%
Definitely no	3.0%

Participants who said they had either probably or definitely reduced their energy consumption since participating in the pilot were then asked if their consumption savings matched their expectations. Two-thirds of participants reported that the savings matched their expectations; the other third indicated that the savings did not match their expectations. For respondents who did not meet their expectations, they were asked why the expectations and results weren't matching. Below are a few typical responses.

"I don't think I had realistic expectations to begin with. There are things we tried. It wasn't working for everyone in the house, that's why it didn't match up. Because, some things will work for some people and some things aren't. That's one reason I'd like to have another energy audit. I think of other things we can do."

"Well, partly because I was already quite conscious of energy, use so I didn't have a lot of room left for improvement. Partly because when other people are in the household I can't control their usage as well as my own."

As described above, the home energy monitoring is an electronic device that collects energy use data. The data can then be viewed online using the online dashboard website. When using electronic equipment and online dashboard website to view data, it was anticipated that a security concern might exist in some users. Participants were asked how concerned they are with the security of online energy use data and sharing energy use information with other participants. Table 3-5 shows the findings. About 33 percent of respondents manifested more than slight concern about the security of online energy use data. Participants were less concerned with sharing their energy use information with other pilot participants; however, only about 21 percent of respondents indicated more than slight concern.

Table 3-5. Level of Concern with Data Security

	Very concerned	Somewhat concerned	Slightly concerned	Not at all concerned
Security of online energy use	16.7%	16.7%	25.8%	40.9%
Sharing energy use information with other participants	7.6%	13.6%	16.7%	62.1%

4. IMPACT EVALUATION

We begin this section by highlighting key findings from the impact evaluation. These are followed by detailed results from specific evaluation activities.

4.1 KEY FINDINGS

- Participant and Control Groups share similar demographic housing characteristics; supporting the notion that energy use differences across groups are less likely explained by demographic differences and more likely a result of the pilot intervention.
- Survey findings show that participants did not engage in energy savings tasks and habits at significantly higher levels than those reported by the Control Groups, yet the energy analysis impact results, highlighted below, reveal savings differences.
- Login activity for the home energy monitor remained fairly consistent over the study period, once the majority of units had been installed. Toward the end of the study period, however, logins began to vary more from week to week, with some high weeks and some relatively low weeks.
- The Residential Smart Energy Monitor Pilot reduced daily energy consumption among participants by an average of 9.3 percent, which was equivalent to 2.9 kWh per day.
- Energy savings were highest in the months August through October, where the average savings rate varied from 3.6 to 4.9 kWh per day, on average.
- Seventy-five percent (75) of program participants reduced energy consumption during the program. One-third reduced average energy consumption by four or more kWh per day.
- Statistical analysis shows that the correlation is low between self-reported habits and tasks to save energy and actual energy savings. The strongest predictor of energy savings is the frequency and nature of interaction with the home energy monitor.

Based on the impact evaluation key findings, we recommend the following:

- ***A quantitative energy savings analysis should be part of any evaluation effort of a home energy display pilot.*** Despite a strong quasi-experimental design that included surveys with participants and two different Control Groups, customer surveys alone were not able to tease out statistically significant behavioral differences between participants and non-participants. The energy savings resulting from the pilot were captured through the energy analysis of participants' and Control Groups' consumption.
- ***Increase the effectiveness of customer use and interaction with the home energy monitoring.*** The impact evaluation clearly demonstrates the importance of customer engagement with the home energy monitor to produce expected energy savings. We recommend if the pilot is to be rolled out on a larger scale, that Cape Light Compact conducts a focus group with participants to further identify effective ways to not only increase customer use of the home energy monitor, but also

effective strategies to maintain this level of engagement over time. The period of the evaluation is limited, but the analysis of log-on activity suggests participant engagement was high at the beginning of the pilot and began to wane as time progressed and perhaps the 'novelty' of the home energy monitor wore off.

- ***Target and encourage customer behavior that will result in higher energy savings.*** The impact evaluation found that not all program participants saved energy. Statistical analysis on a number of factors including reported behaviors, attitudes and demographics was unable to distinguish types of customers who saved energy through the pilot versus those who did not. However, clearly the pilot was more effective in resulting in energy savings for some than others. The only clear indicator of energy savings was use of the home energy monitor as discussed above. Cape Light Compact might want to consider pilot strategies that reward those using the home energy monitor, and therefore likely to be saving energy through the program, versus those who are not. For example, effective strategies could include waiving the monthly fee, discussed above under the process evaluation section, if customers use the home energy monitor a certain number of times a week or providing a 'thank you' to those based on home energy monitor activity such as mailing a free CFL to these participants.

4.2 CUSTOMER SURVEY RESULTS

4.2.1 Demographics

From the survey data, we collected and assessed demographic attributes across the Participant, Interested, and Blind Groups. These are shown in Table 4-1. The distribution of key housing characteristics variables compared favorably across these groups, as we will discuss below. This finding supports the notion that any energy use differences across groups are less likely explained by differences in their housing characteristics and household composition, which provides more validity for the impact evaluation energy analysis results presented later in this section.

Table 4-1. Housing Characteristics

Housing Characteristics	Participant* (n=66)	Non-participant* Interested (n=96)	Non-participant* Blind (n=100)
Year Home was Built			
Before 1900	1.50%	9.60%	4.00%
1901-1930	4.60%	3.20%	3.00%
1931-1950	4.60%	8.50%	2.00%
1951-1970	15.40%	12.80%	9.00%
1971-1990	44.60%	45.70%	56.00%
1990-present	29.20%	20.20%	26.00%
Number of Bedrooms in Home			
0 bedrooms	0.00%	0.00%	1.00%
1 bedroom	0.00%	2.10%	1.00%
2 bedrooms	10.60%	16.80%	12.00%
3 bedrooms	50.00%	53.70%	51.00%
4 bedrooms	27.30%	18.90%	25.00%
5 bedrooms	12.10%	5.30%	7.00%
6 bedrooms	0.00%	2.10%	2.00%
7 or more bedrooms	0.00%	1.10%	1.00%

* Refusal responses were not included in the derivation of the above results

Differences in housing characteristics across groups are minimal. About one-half (45 percent of participants, 46 percent Interested, and 56 percent Blind) of all homes were built between 1971 and 1990. Approximately one-half of all houses have three bedrooms. The only significant asymmetry rests with houses in the Interested Group. This group tended to be slightly older and have fewer bedrooms in their homes than the Participant and Blind Groups.

Table 4-2 shows household demographics for the three groups. Broadly speaking, the household composition is quite similar. Among the minor differences, The Participant Group and the Interested Group tend to have slightly higher education levels than the Blind Group. The Blind group is somewhat more likely to have a minor or young adult living in the household. Income levels are similar between the Participant and the Blind Group, though average income of the Interested Group slightly lower. Overall, we believe the comparability of the participant and Control Groups is excellent.

Table 4-2. Household Composition

Household Composition	Participant* (n=66)	Non-participant* Interested (n=96)	Non-participant* Blind (n=100)
Number of People Living in Home Year-round			
1	10.60%	5.30%	8.10%
2	51.50%	58.50%	47.50%
3	15.20%	17.00%	17.20%
4	13.60%	14.90%	14.10%
5	3.00%	3.20%	9.10%
6	4.50%	0.00%	2.00%
7	1.50%	0.00%	2.00%
8 or more	0.00%	1.10%	0.00%
At Least One Person Living in Home (by age group)			
<18 years old	28.80%	25.80%	37.40%
18 - 24 years old	6.10%	6.50%	6.00%
25 - 34 years old	12.10%	12.90%	15.20%
35 - 44 years old	15.20%	16.20%	16.20%
45 - 54 years old	25.80%	26.90%	36.40%
55 - 64 years old	43.90%	44.10%	33.40%
>65 years old	34.80%	34.40%	30.30%
Education			
Less than high school	0.00%	0.00%	0.00%
Some high school	0.00%	1.10%	1.00%
High school graduate or equivalent	4.50%	6.40%	11.20%
Trade or technical school	1.50%	2.10%	1.00%
Some college	7.60%	10.60%	21.40%
College graduate degree	37.90%	28.70%	31.60%
Some graduate school	4.50%	5.30%	4.10%
Graduate degree	43.90%	44.70%	26.50%
Other	0.00%	1.10%	3.10%
2008 Household Income			
<$20,000	0.00%	2.50%	2.50%
$20,000-$49,999	7.60%	16.50%	15.00%
$50,000-$74,999	15.20%	29.10%	15.00%
$75,000-$99,999	16.70%	27.80%	22.50%
$100,000-$149,999	36.40%	17.70%	31.30%
$150,000-$199,999	3.00%	3.80%	8.80%
>$200,000	3.00%	2.50%	5.00%

* Refusal responses were not included in the derivation of the above results

4.2.2 Household Energy Use Habits and Tasks

One reason for the participant and Control Group surveys was to examine, across groups, the differences in household engagement with energy savings habits and tasks. Generally speaking, habits are actions that recur relatively frequently and tasks are actions that recur about once every six months. Using a series of six habits and 15 tasks paralleling those offered on the energy monitor's online dashboard, we asked the Control Groups if they had undertaken these actions within the past six months. For participants, we asked if they had undertaken these actions since joining the pilot. (On average this also represents about a six month period.) Table 4-3 shows the level of activity for each habit and task.

Table 4-3. Self-Reported Energy Saving Habits and Tasks

	Participant		Non-participants**	
Since Pilot / In the Last Six Months How Often Does Your Household…*	**Participant (n=66)**	***Pilot Influence***	**Interested (n=96)**	**Blind (n=100)**
Close the refrigerator door immediately after use	100.0%		96.9%	90.9%
Turn off exhaust fans when not in use	96.5%		92.6%	93.4%
Turn off outdoor lights during the day	95.4%		100.0%	92.0%
Unplug chargers when not in use	62.1%		66.7%	59.2%
Power off external computer speakers	61.1%		50.5%	48.9%
Use task lighting	59.7%		75.0%	67.0%
In the Last Six Months Have You…				
Plugged electronics into power strips	77.3%		94.8%	89.8%
Reduced wattage in multiple bulb fixtures	67.7%	+	79.1%	70.7%
Check the temperature of your refrigerator or freezer	66.7%		63.2%	50.0%
Installed ENERGY STAR indoor light fixtures	65.2%	+	60.2%	47.4%
Clean light fixtures	63.1%		57.4%	66.7%
Clean the refrigerator condenser coils	56.1%		51.1%	42.0%
Check the refrigerator door seals	48.5%		57.9%	51.0%
Used lighting controls or timers	46.9%		56.3%	45.0%
Installed ENERGY STAR outdoor light fixtures	46.2%		40.2%	36.7%
Turned off the ice maker	36.0%	+	50.0%	40.0%
Unplugged the second refrigerator or freezer	34.0%	+	30.8%	30.1%
Used timers to turn off standby power	24.6%		18.6%	17.6%

* Percentages represent sum of those responding "Always" or "Often."

** "Not Applicable" responses were not included in the derivation of the above results.

We expected that participants would exhibit higher levels of activity than the Control Groups; however, this was not our finding. Participant and Control Group activities are surprisingly similar. Differences among the groups are negligible. In some cases, the Blind Group exhibits a slightly lower level of action than the Participant and Interested Groups. The differences are negligible, however, and generally too small to be statistically significant. The one exception is that participants installed ENERGY STAR indoor light fixtures more often than the Blind

Group, though not more often than the Interested Group.[11] In other cases, however, Participant Group activity was actually lower than the Control Groups.

For participants, we also attempted to measure their perception of the pilot program's effect on their energy saving behaviors. We asked respondents to rate, on a scale of zero to ten, how important their household's participation in the pilot had been for their engagement with each of the activities. We found a bi-modal distribution that was similar across activities. Respondents in general, felt the pilot either had no importance, or a high level of importance for their undertaking the activities. The "+" notation in the table above shows the four highest pilot influence scores across the activities.[12] We note that in only one case, again, installing indoor fixtures is the report of action for the Participant more frequent than for the Control Groups.

We know from the energy analysis component of the impact evaluation (detailed next in this section) that participants did indeed exhibit a statistically significant reduction in kWh when compared to the non-participant groups. It is curious, then, that self reporting does not show a higher level of participant engagement across activities. There are several possible reasons. It may be that respondents took effective actions to save energy that are not reflected in the survey items. We asked about other energy saving activities participant and Control Group members had engaged in. We asked the Participant group an open ended question about other energy saving activities they had engaged in, not on the list of tasks and habits provided in the survey. The most common answer, given by about one-third (21) of the 64 respondents, was that the system had simply made them more aware of their consumption, and that this was important to their overall energy savings. Another 28 percent of participants (18) named one or more specific habits they had acquired, also pointing to a heightened situational awareness of energy use.

Another explanation of the lack of difference between Participant Group and Control Group activities may be that the survey instrument was not subtle enough to pick up nuances of difference in the way the Participant and Control Groups undertook them or the regularity and intensity with which they undertook them. Still a third possibility is that respondents simply misstated what they had done, either succumbing to the pressure of social desirability or because they do not accurately recall what they had done. In any case, the result is that we cannot, using this survey, provide strong evidence for what caused the very real the differences in consumption.

4.3 GROUNDEDPOWER LOGIN ACTIVITY

GroundedPower provided PA with weekly participant summary data from the online dashboard. The specific metrics provided include: number of system installations, count of online system logins, actions committed and completed, and counts of participant feedback. This section presents an analysis of installation and login data as provided by GroundedPower from June 2009, through January 2010.

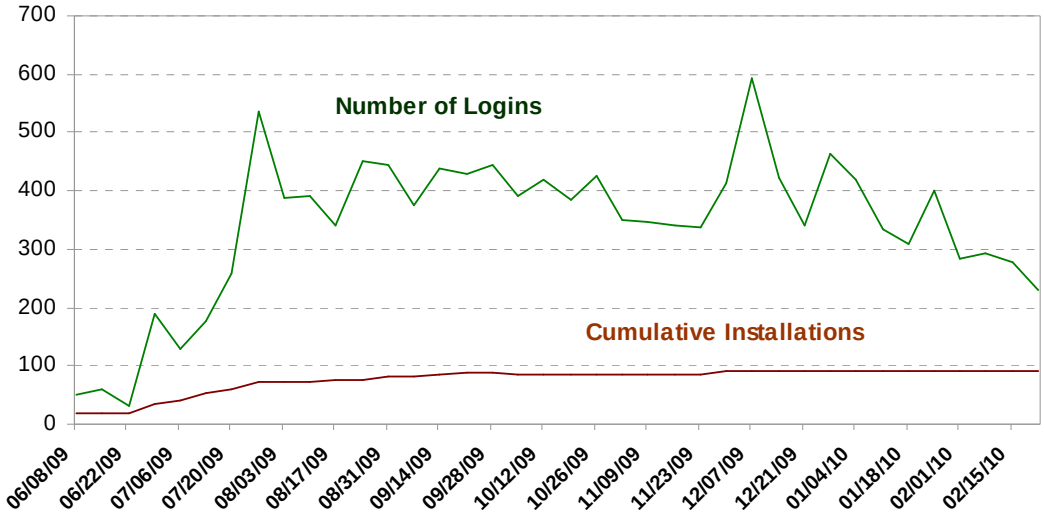
---

[11] $Z = 2.25$, $p = 0.012$.

[12] The four activities denoted as having pilot influence had mean scores between 6.2 and 6.7 on a zero to ten scale.

The participant's dashboard login activity provides a valuable metric to gauge the level and consistency of program engagement. Figure 4-1summarizes participant login activity and the cumulative number system installations for the pilot.

Figure 4-1. Participant Login Activity



System installations occurred during several months in the summer of 2009, increasing from 19 in June to about 75 in August. From August to December, an additional 15 installations occurred, resulting in 90 total installations. Participant login activity showed a ramp-up as participants were installed and able to use the system. Once a majority of participants were installed, an initial spike in interest occurred in late July, then dropped slightly afterward; however, use remained consistently high (about 400 logins per week) through October. The logins decreased during November and then exhibited a more erratic pattern in December and into early 2010. It is possible that participant's holiday schedules contribute to the erratic login levels in December and January. Overall, the consistency in logins across the first half of the one-year pilot point to a high level of engagement, with what may be the beginning of a drop-off in early February.

Participant's logins have remained high, about four logins per week; they generally spend a small amount time on the dashboard. Participant survey data shows that a majority, 65 percent, of participants are using the online dashboard for less than five minutes per viewing. Only five percent of participants report spending 11-30 minutes per session with the online dashboard.

4.4 ENERGY ANALYSIS OF THE RESIDENTIAL SMART ENERGY MONITORING PILOT

To evaluate the energy impact of the Residential Smart Energy Monitoring Pilot we obtained monthly consumption data for the years 2008 and 2009 for the three study groups described in Section 4.2 (i.e., Participant Group, Interested Group, and Blind Group). Our logic is that if the program was effective at reducing energy consumption, we expect less consumption in 2009 than in 2008. We compared consumption during the study period with consumption during the same period in 2008. As a control, we were able to compare changes in participant consumption with changes in consumption among the Interested and Blind Groups. We also

looked at differences between the Interested and Blind Groups themselves, to see how different the households of program volunteers (i.e., the Interested Group) are from non-volunteers (i.e., the Blind Group).

Because meters are read on different days of the month, and the period between meter readings is a varying number of days, we used the average daily consumption per month as the standard of comparison. To obtain this we divided the total consumption since the previous meter reading by the number of days that had transpired. To analyze monthly changes in consumption we assigned each meter reading to a calendar month. If a meter was read before the 16th of the month, the consumption was attributed to the previous month; otherwise, the consumption was attributed to the current month. Since all consumption is accounted for in this procedure, error in the assignment of consumption to a month does not affect the estimate of overall program savings.

For program initiation we likewise had to assign a month. In nearly every case, there was an asynchrony between the installation of the home energy monitoring technology and the meter reading period. We assigned program initiation to the month that minimized the time period between installation and the closest meter reading. On average there was a gap of about eight days between the installation date and the closest meter reading. When the closest meter reading was more than ten days prior to the installation date, however, we re-assigned initiation to the subsequent month, ensuring there would not be a substantial length of time when consumption without the equipment installed was credited to the program.

For the Participant Group, the study period is the months in 2009 when the home energy monitoring technology was installed, and the equivalent months in 2008. Since there were only ten units installed in June, we do not include this month in the study period. For the Interested and Blind groups, we consider the study period to be July to December in 2008 and 2009.

4.4.1 Consumption Differences by Group

Table 4-4 shows the average daily consumption, during the study period, for the three groups and for a blended Control Group that combines the Interested and Blind groups. The table also shows the difference in consumption between 2008 and 2009 and the percent change between the two periods. Program participants reduced average daily consumption by 3.25 kWh, or about 11 percent of 2008 consumption. The non-participating groups reduced average daily consumption by less than one kWh, or about one percent.

Table 4-4. Average Daily Consumption during the Study Period, By Group

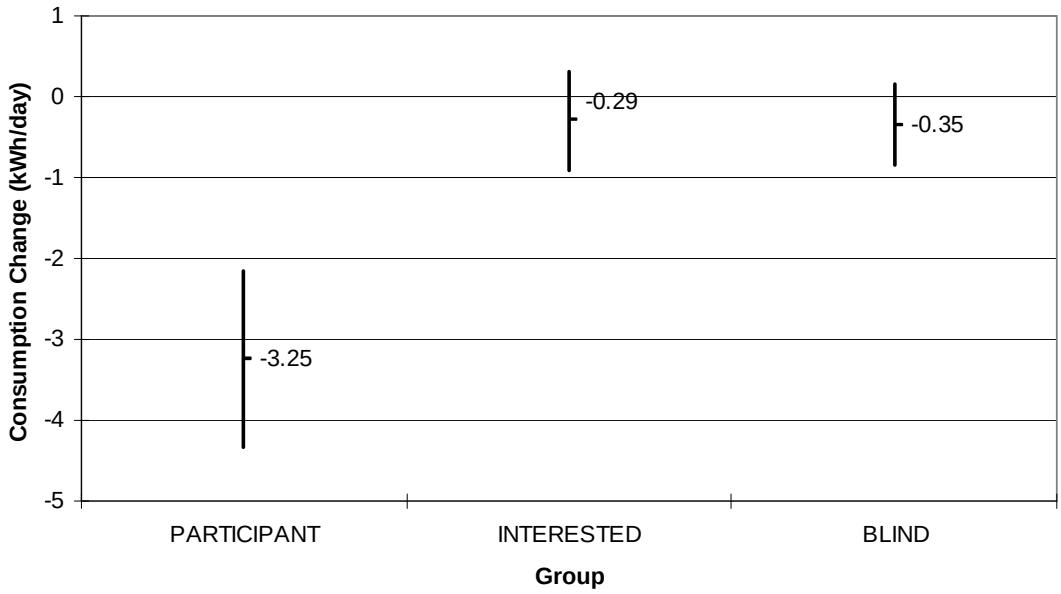
Group	Number of Households	Consumption		Difference	Percent Change
		2008	2009		
Participant Group	88*	30.11	26.86	3.25	-10.8%
Interested Group	160	22.70	22.41	0.29	-1.3%
Blind Group	397	34.05	33.70	0.35	-1.0%
Blended Control Groups	557	30.79	30.46	0.33	-1.1%

* We had consumption data for 90 of the 91 participants in the program. Data for two of these were not complete across both 2008 and 2009, yielding a total of 88 participant records for the impact evaluation.

We have already noted, above, that the three groups are quite similar with respect to demographic characteristics. A noteworthy difference between the groups emerges in Table 4-4, however. The Interested Group had lower average consumption than the Participant Group, and the Blind Group had somewhat higher average consumption. The blended average consumption for the two groups combined is quite close to the average consumption of the Participant Group, at 30.79. This observation points to the blended value as possibly the best Control Group.

Figure 4-2 shows graphically the average change in consumption during the study period for the three groups. The figure also shows 90 percent confidence intervals around the average. A t-test confirms that we should reject a null hypothesis that differences in participant and non-participant groups reflect random sampling error.[13] The two Control Groups, however, are not clearly distinct from one another.[14]

Figure 4-2. Change in Average Daily Consumption, 2008 to 2009, by Group



4.4.2 The Effect of Temperature on Savings

Our thesis is that a reduction in consumption between 2008 and 2009 reflects the effect of the program. We note, however, that both of the Control Groups also reduced consumption slightly between 2008 and 2009. This is likely due to the fact that 2009 was generally cooler than 2008, hence reducing the demand for energy to power HVAC cooling measures.

Table 4-5 shows heating degree days and cooling degree days for four locations in the Cape Light Compact territory: Outer Cape (weather station KPVC at Provincetown), Mid/Lower

[13] Participant vs. Interested: DF = 143, t = -3.93, p < 0.0001; Participant vs. Blind: DF = 483, t = -4.09, p < 0.0001.

[14] Interested vs. Blind: DF = 374, t = 0.12, p < 0.9051.

Cape (KMASOUTH4 at Orleans), Upper Cape (KFMH at Cape Cod Coast Guard Air Station), and Martha's Vineyard (KMVY at the airport). In cooler weather, there should be fewer cooling degree days and more heating degree days. The table shows that the summer did tend to be cooler in 2009, but, in some cases, the heating season was slightly warmer. In none of the locations, however, were the changes in temperature dramatic between 2008 and 2009.

Table 4-5. Heating and Cooling Degree Days during the Study Period, By Location

Location	Record Type	Degree Days		Difference	Percent Change
		2008	2009		
Outer Cape	CDD	448	391	-57	-12.7%
	HDD	2175	2201	26	1.2%
Mid/Lower Cape	CDD	521	433	-88	-16.9%
	HDD	1993	1890	-103	-5.2%
Upper Cape	CDD	458	419	-39	-8.5%
	HDD	2021	2000	-21	-1.0%
Martha's Vineyard	CDD	444	445	1	0.2%
	HDD	2272	2231	-41	-1.8%

For the groups that did not participate in the program, we attribute the slight reduction in average daily consumption to the cooler summer in 2009. The difference varies by location.

As Table 4-6 indicates, Participant and Control households are reasonably well allocated across the locations. Since the locations relative to the weather stations are only approximate, we believe any consumption effect due to slightly different distributions across locations is negligible.

Table 4-6. Distribution of Households by Location and Group

Location	Percent of Total		Total
	Participants	Blended Control	
Outer Cape	4.6%	3.1%	3.3%
Mid/Lower Cape	24.1%	14.2%	15.5%
Upper Cape	52.9%	61.4%	60.2%
Martha's Vineyard	18.4%	21.4%	21.0%
Total	**100.0%**	**100.0%**	**100.0%**
Households	87	160	644

4.4.3 Program Impact Accounting for Temperature Differences

If we assume the total change in consumption for Participants is composed of two parts, one related to the program and one related to weather, we can simply subtract the weather component from the total to obtain the program impact. We can use the change in consumption for the Control Groups to adjust the program impact for differences in weather conditions. Since the Blended group is most similar to the Participant Group, in terms of monthly consumption, we choose that average change, in percentage terms, and subtract it from the total percentage change for the Participant group, yielding 10.8% – 1.1% = 9.7%

average reduction in energy consumption due to the program. This amounts to an average reduction of about 30.11 kWh x 9.7% = 2.9 kWh per day.

4.4.4 Program Impact Accounting for Other Program Activity

One possibility is that part of the difference in consumption between 2008 and 2009 for pilot program households is accounted for by Cape Light Compact program activity other than installation of the Smart Energy Monitor. In an effort to control for the effect of other programming on savings due to the Smart Energy Monitor, we obtained data on all program activity for all study households, both in the participant group and the control group. These data show that 41 percent (36/88) of participant households also participated in other program activities. Among the control group, only 19 percent (106/557) participated in other program activities.

A difficulty in controlling for other program activity is estimating the amount of energy savings to subtract from the Smart Monitoring Pilot program for each instance of participation. We do not have a complete record of deemed annual savings because some measures–especially weatherization measures–are of a custom nature. No annual savings are recorded for these. Thus, the only quantitative approach that is clearly supported in the data is to count the number of instances of program participation. This renders the installation of a single CFL equivalent to the re-insulation of an entire home.

There are also difficult timing issues to account for in controlling for other program activity. Three basic possibilities present themselves.

- A pilot household could install measures supported by Cape Light Compact programming after the study period in 2008 but prior to the study period in 2009. This would reduce consumption between the two periods for reasons that are not related to—at least not clearly related to—the Smart Energy Monitoring Pilot program. These savings would almost certainly need to be subtracted from savings attributed to the program.

- A pilot household could install Cape Light Compact program supported measures during the study period, which would reduce consumption for the succeeding months of the study period. Since one goal of the Smart Energy Monitoring Pilot program is to encourage participants to engage in habits and tasks that are sometimes also promoted by other programs, it would seem that some credit for these savings should go to the pilot. An accurate apportionment of savings, however, would be difficult.

- A pilot household could install Cape Light Compact program supported measures in the midst of the 2008 study period. This would affect part but not all of the contrast period, over-stating pilot related savings for only the months where the other program measures were installed. Again, an accurate accounting of the partial effect would be difficult.

The reality is that a single household could participate in other Cape Light Compact programs in any or all three of these periods. Thirteen percent of the study group indicates program activity on more than one date during the study period.

With these considerations in mind, the best approach to controlling for other program activity is simply to identify households in both the participant and control groups that did not participate in any other programs, and construct the same contrast for them that was constructed for the larger set of households. shows that average daily consumption is slightly higher in both "no-program" groups than in the total samples: 31.24 kWh in 2008 for the no-program participant group, compared to 30.11 for the entire participant sample; 31.55 in 2008 for the no-program control group, compared to 30.79 for the entire control sample. These differences are negligible.[15]

Table 4-7. Average Daily Consumption during the Study Period By Group for No-Program Households Only

Group	Number of Households	Consumption		Difference	Percent Change
		2008	2009		
Participant Group	52	31.24	28.15	3.09	-9.9%
Blended Control Groups	451	31.53	31.34	0.18	-0.6%

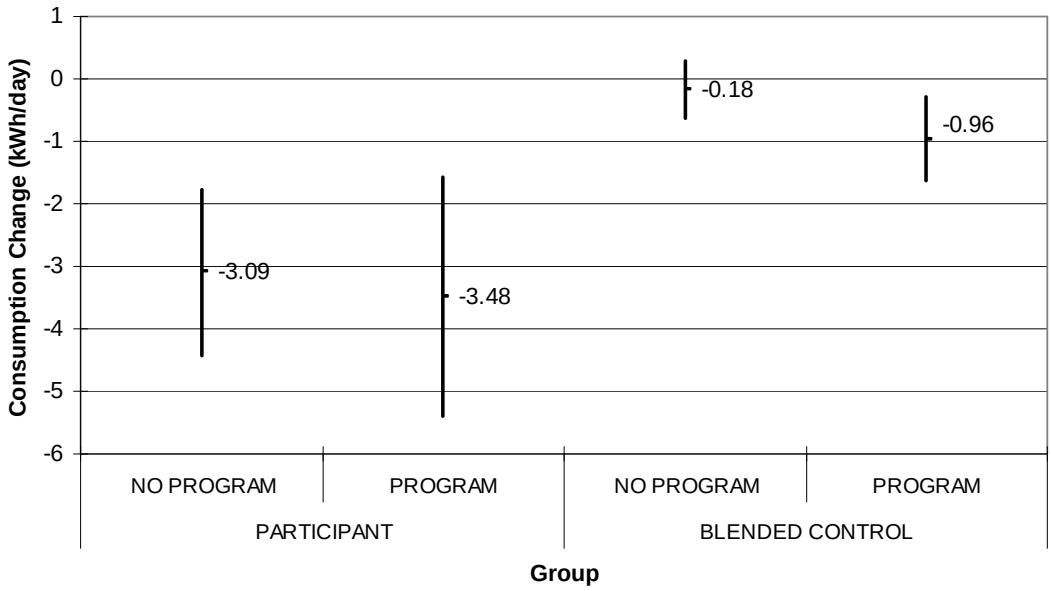
If we recalculate the Smart Energy Monitoring program impact on this no-program contrast, we obtain nearly the same value obtained using the full sample: 9.9% - 0.6% = 9.3%. This is the reduction in energy consumption due to the pilot program. Recall that a 9.7 percent decrease was observed on the full sample of pilot participants. While differences between the two subsets (i.e. program and no-program) are not statistically significant, using the lower, no-program value is a more conservative approach and we recommend its adoption as the best estimate of the program's impact.

Figure 4-3 summarizes the average change in daily consumption for four groups: participant households with no other Cape Light Compact program activity, participant households that participated in other programs, blended control-group households with no program activity, and blended control-group households that participated in other programs.

[15] A t-test on pilot participants, contrasting change in consumption for the no-program households against households that did participate in other Cape Light Compact programs shows averages of 3.09 (no program) and 3.47 (program), with t = -0.28 (DF = 67) and p = 0.78. So, while household that participated in other programs did on average see a larger decrease in consumption, the difference is not statistically significant.

The difference in "differences" contrasting participant and blended control groups is statistically significant: DF = 64, t = -3.46, p < 0.001.

Figure 4-3. Change in Average Daily Consumption, 2008 to 2009, With and Without Other Program Activity, By Group



4.4.5 Program Impact by Month

Figure 4-4 shows consumption savings from 2008 to 2009 for each month of the study period, for program participants and for the blended Control Group. In this analysis we revert to the full sample because the effect of other program activity is quite small and we want to retain the statistical power of the full sample. Note that in Figure 4-4 a positive value indicates lower consumption in 2009 than in 2008 (i.e., energy *savings*). The dotted lines represent the 90 percent confidence interval. For the Participant Group, the confidence interval narrows from July to September, as more households join the program. It seems plausible that the pattern for July, with Participant and Control Groups both saving more energy than in other months, reflects cooler summer weather in 2009. The narrower interval between the Participant and Control Groups may reflect a low initial savings at start-up; or, it may reflect a real difference in program impact during the cooling season.

Figure 4-4. Average Daily Consumption Savings, by Month and Group

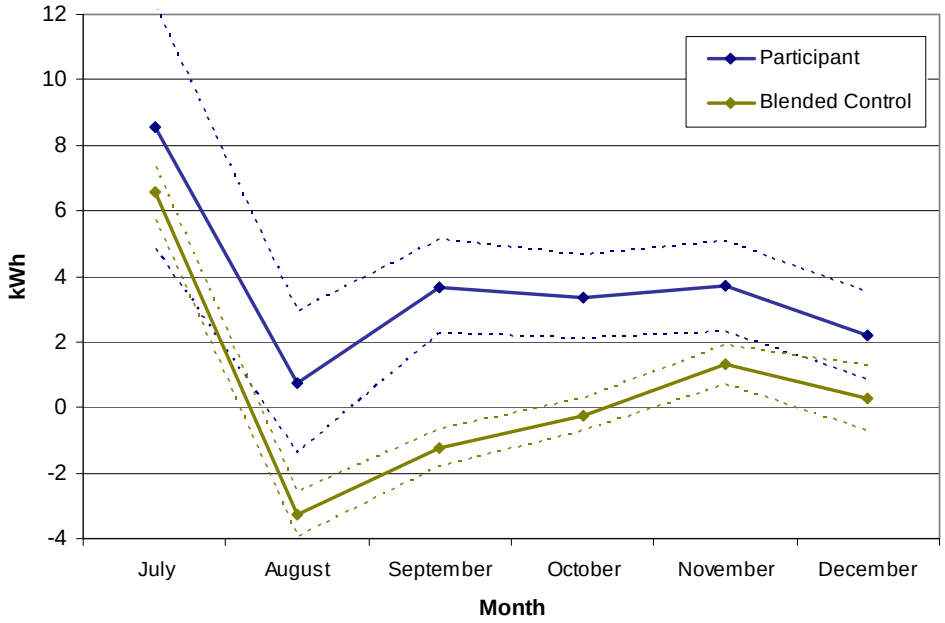
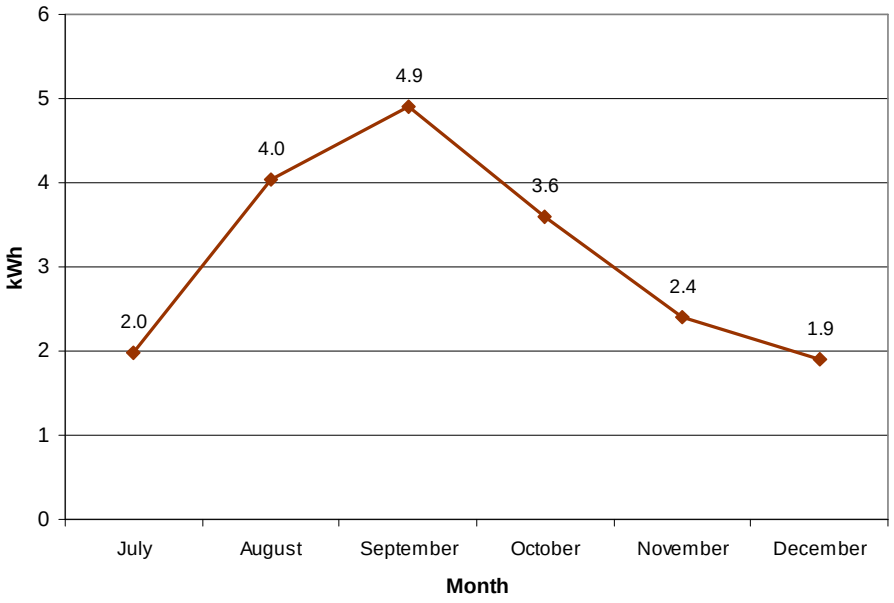


Figure 4-5 plots the difference between the two lines in Figure 4-3, to represent the average daily energy savings due to the program, by month. One question this figure raises is whether the downward sloping savings between September and December indicates a degradation trend in the energy savings or whether it reflects seasonal effects. We do not believe it is possible to resolve this question at present. A longer period of data collection could clarify the matter.

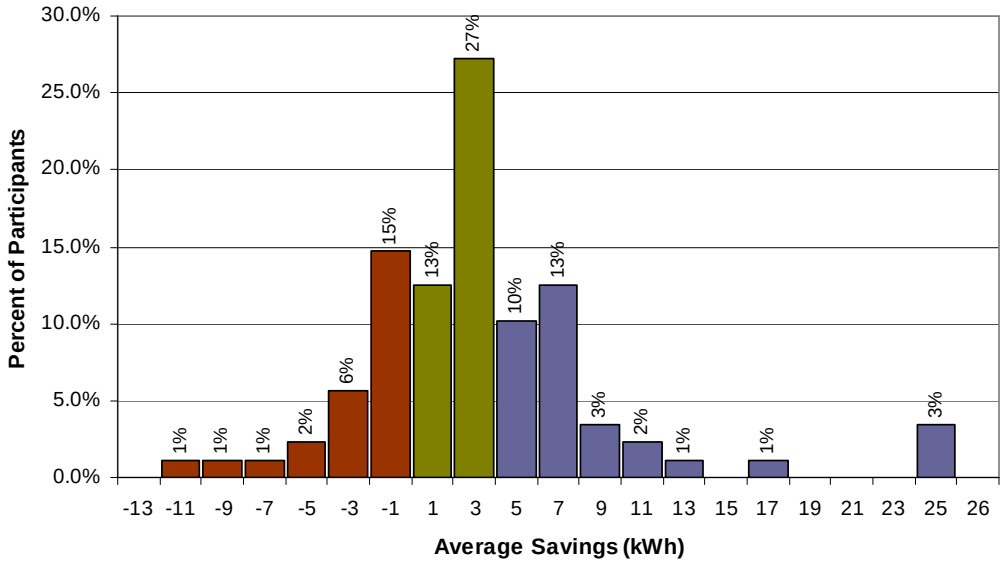
Figure 4-5. Average Daily Energy Savings Attributed to the Program, by Month



4.4.6 The Distribution of Program Energy Savings

Not all program participants saved energy. Of the 88 households who participated and for whom we have complete data, 23—about one quarter—actually used more energy in 2009 than in 2008. Among households that did reduce energy consumption, there was a fairly wide distribution of savings, with about one-third saving four or more kWh per day, on average. In the next section we explore the characteristics of this group of "big savers." Figure 4-6 shows the distribution of savings, in kWh, for the Participant group.

Figure 4-6. Distribution of Energy Savings for Program Participants



4.4.7 Characteristics of Big Savers

To help us understand why some households saved more energy than others, we divided Participant households into three groups: a "Negative Savers" group that used more energy in 2009 (including those who reduced by 1.3 percent or less, the weather adjustment), a "Low Savers" group that reduced their 2008 consumption by 1.3 percent to 11.3 percent (effectively zero to ten percent when adjusting for weather differences), and a "High Savers" group that reduced their 2008 consumption by more than 11.3 percent. We classified participants by percentage reduction rather than kWh reduction to control for differences in normal average consumption. We looked at participant reported behaviors, attitudes, and demographics.

a. BEHAVIORAL CORRELATIONS

Participants were asked how often, since participating in the pilot, they had undertaken a series of six habits that recur on a regular basis. These were actions encouraged by the program. Table 4-7 shows the percentage of survey respondents who replied "always," or "often." There are few strong patterns of increased activity among the high saver group. It does appear that the Low and High savers groups are somewhat more likely to unplug chargers and use task lighting than the negative savers. We also counted the number of

activities respondents said they engaged in “always” or “often” and calculated a mean value for each group. There were no significant differences between groups.

Table 4-8. Percentage of Program Participants Engaging “Always” or “Often” in Habits, by Savings Group

Group	Negative Savers	Low Savers	High Savers
Close Refrigerator Immediately	100%	100%	100%
Turn Off Computer Speakers	73%	57%	58%
Turn Off Exhaust Fans	93%	100%	96%
Turn Off Outdoor Lights	94%	94%	97%
Unplug Chargers	53%	71%	63%
Use Task Lighting	47%	75%	56%
Average Number of Activities	***4.4***	***4.6***	***4.4***
Number of Households	17	17	30

Participants were also asked whether they had undertaken, since the program began, a series of 15 tasks that recur less frequently. Table 4-8 shows the percentage of survey respondents who said they had done so. It also shows the average number of behaviors each group had performed. Again, there is no clear pattern differentiating high savers from low savers. Indeed, the high savers reported performing the fewest total behaviors, on average. The one behavior that seems to distinguish Low and High Savers from Negative Savers is the installation of indoor light fixtures. This, we note, also tended to differentiate the Participant Group from the Blind Group. This difference is not statistically significant; however, the number of cases is small enough that only rather dramatic differences show up as significant.

Table 4-9. Percentage of Program Participants Performing Tasks, by Savings Group

Group	Negative Savers	Low Savers	High Savers
Bought Refrigerator	18%	6%	17%
Checked Refrigerator Seals	53%	59%	40%
Check Refrigerator Temperature	82%	47%	70%
Check Refrigerator Condenser Coils	53%	65%	50%
Turned Off Ice Maker	36%	33%	36%
Unplugged Second Refrigerator or Freezer	31%	29%	33%
Installed Indoor Light Fixtures	41%	76%	73%
Installed Outdoor Light Fixtures	53%	41%	48%
Reduced Wattage of Fixtures	63%	82%	63%
Used Lighting Controls	41%	69%	38%
Cleaned Light Fixtures	71%	75%	53%
Bough Charger	6%	19%	14%
Installed Fans	24%	0%	7%
Plugged Into Power Strips	76%	76%	77%
Used Timers for Standby Power	31%	33%	13%
Average Number of Activities	***6.6***	***6.8***	***6.1***
Number of Households	17	17	30

We also looked at answers to the open-ended survey item inquiring about additional activities that participants had undertaken beyond those listed as habits and tasks to see if there were differences by savings group. The numbers are too small to be statistically significant, but there is a possible trend, worthy of further investigation, indicating that High Savers were more likely to name specific additional activities (39 percent) than the Low Savers (13 percent) and Negative Savers (23 percent). Interestingly, the Negative Savers were more likely than average to say simply that the home energy monitor had increased awareness of their energy consumption.

The survey asked participants about their use of the home energy monitor (e.g., how often they log on, how much time they spend, and which information they review). Although not statistically significant, there is a marked trend for the High Savers to log onto the home energy monitor more frequently than Negative and Low savers. Thirty-seven (37) percent of high savers reported logging onto the home energy monitor every day, compared to 18 percent of the other two groups. There was also a trend (p = 0.07) for High Savers to spend more time logged onto the home energy monitor than other saving groups. Seventy-six percent (76 percent) of Negative and Low Savers reported spending less than five minutes on the system when they logged on. Only 53 percent of High Savers spent such a small amount of time; 43 percent spent from five to ten minutes.

The content of information sought was also different by savings group. High Savers were more likely than Negative or Low Savers to report “always” or “often” when reviewing their house monitor graph, actions, and savings. These are statistically significant differences. Table 4-10 through Table 4-12 show the relationships between information seeking behaviors and energy savings.

Table 4-10. Frequency of Reviewing House Monitor Graph, By Savings Group

	Negative/ Low Saver	High Saver	Total
Sometimes / Rarely / Never	32%	10%	22%
Often / Always	68%	90%	78%
Total	100%	100%	100%

Chi Square = 4.66, p = 0.031

Table 4-11. Frequency of Reviewing Energy Actions, By Savings Group

	Negative/ Low Saver	High Saver	Total
Sometimes / Rarely / Never	88%	60%	75%
Often / Always	12%	40%	25%
Total	100%	100%	100%

Chi Square = 6.78, p = 0.009

Table 4-12. Frequency of Reviewing Energy Savings, By Savings Group

	Negative/ Low Saver	High Saver	Total
Sometimes / Rarely / Never	47%	23%	36%
Often / Always	53%	77%	64%
Total	100%	100%	100%

Chi Square = 3.90, p = 0.048

Clearly, households that used the home energy monitor frequently to keep track of savings were more likely to obtain a higher level of savings. Although we have seen that reports of specific activities and behaviors do not unequivocally point to what it was the high savers did to achieve savings, interaction with the home energy monitor seems to have played a role in their outcomes.

b. ATTITUDINAL CORRELATIONS

Program participants were asked how important they rated a series of four benefits to their household related to energy consumption. The benefits were reducing emissions, teaching children about energy use, saving money, and energy independence. There were no statistically significant differences among the three savings groups, although the High Savers were least likely to rate teaching children and saving money as very important (rating of eight to ten on a ten-point scale).

The survey followed up on questions about habits and tasks actually undertaken with a series of questions about the importance of the home energy monitor in motivating those actions. Table 4-13 shows the percentage of participants who rated the program very important (rating of eight to ten on a ten-point scale). The behaviors that were rated disproportionately to be very important by big savers were checking refrigerator condenser coils and installing indoor and outdoor lighting fixtures.

Table 4-13. Percent of Participants Saying Program Influenced their Habits and Tasks

Group	Negative Savers	Low Savers	High Savers
Close Refrigerator Immediately	38%	24%	18%
Turn Off Computer Speakers	25%	12%	21%
Turn Off Exhaust Fans	33%	16%	18%
Turn Off Outdoor Lights	42%	16%	26%
Unplug Chargers	17%	24%	23%
Use Task Lighting	13%	24%	18%
Bought Refrigerator	4%	0%	8%
Checked Refrigerator Seals	8%	16%	10%
Check Refrigerator Temperature	17%	8%	15%
Check Refrigerator Condenser Coils	8%	12%	26%
Turned Off Ice Maker	13%	4%	10%
Unplugged Second Refrigerator or Freezer	8%	8%	10%
Installed Indoor Light Fixtures	17%	20%	33%
Installed Outdoor Light Fixtures	13%	8%	23%
Reduced Wattage of Fixtures	17%	24%	28%
Used Lighting Controls	13%	12%	8%
Cleaned Light Fixtures	21%	16%	18%
Bough Charger	0%	0%	3%
Installed Fans	13%	0%	3%
Plugged Into Power Strips	38%	20%	26%
Used Timers for Standby Power	8%	12%	3%
Number of Households	17	17	30

c. DEMOGRAPHIC CORRELATIONS

We looked for relationships between demographic characteristics and energy savings. We looked at the number of people in the household, the age of the home, the number of bedrooms, the respondent's education level, the distribution by age, gender of respondent, and income. We found no significant relationships between these variables and energy savings. The only relationship approaching statistical significance was the relationship between gender and energy savings, with a linear but weak tendency for males to be over-represented in the high savings group and females overrepresented in the negative savings group.

4.4.8 Discussion of the Impact Findings

Finally, we return to the issue of how savings were achieved by the program, considering the lack of evidence for a difference in actions. The evidence that households that logged into the system tended to save more energy suggests the following conjecture.

One of the important effects of the program was to remind customers about the activities they should take in order to save energy. The more often customers checked energy savings and other information; the more often they received this reminder of positive habits and behaviors. As expected, this increased the salience of all energy saving actions, whether noted on the site or otherwise, and would be expected to increase performance of the activities. This would decrease energy consumption. In effect, when participants claimed they "always" or "often" undertook habits and tasks, they were closer to the truth— i.e., meaning more actual actions—than control group respondents. We are suggesting there was a bias in the control groups toward over-stating performance of actions simply because they had many fewer reminders that they should do so. The more reminders, the stricter the standard of what constitutes "often" or "always." This would also explain why participants who logged on less frequently saved less energy even though they claimed as many actions: they had fewer reminders of how often "often" actually is.

Certainly, this can only be a partial explanation. Why did different participants log in at different rates? We have to expect that positive reinforcement of the activity would tend to encourage it; lack of reinforcement would tend to extinguish it. In this light, it will be interesting to observe the persistence of login activities and whether a possible drop-off of logins in February presages a decrease in energy savings.

5. CONCLUSION

The evaluation demonstrates that the pilot was successful on many fronts including customer satisfaction and its objectives to save energy. There have been sufficient evaluations of residential energy management technologies in recent years to provide a reasonable picture of the range of energy savings from these systems, which we compiled through a literature review.

Table 5-1 shows energy savings that have been attributed to residential energy management systems in recent evaluations, including the Residential Smart Energy Monitoring Pilot in the first row of the table. The third column shows the per-household annual reduction that could be expected, assuming an average annual consumption of 10,717 kWh. This represents the average across all households in this evaluation study. In estimating an overall average, we removed the high and low values.

Our findings for the home energy monitor places its rate of energy savings higher than all but one of the other programs included in the literature review. We believe this is a reasonable finding, given the design of the program, which seeks to deeply engage participants in the habits and tasks of energy savings and targeted the pilot to those with extreme interest and likelihood of participating actively in it. A remaining question is whether this rate of energy savings can be maintained over time. We were not able to assess the sustainability of energy savings within the evaluation time period. The recommendations from both the process and impact evaluations, however, suggest several strategies that could assist in both initial energy savings and the sustainability of energy savings over time.

Table 5-1. Energy Savings Attributed to Energy Management Systems

Source	Percent Reduction	Implied Average Energy Savings (Avg. Annual kWh = 10,717)	Study Type
Newfoundland - PowerCost Monitor Pilots (2005)	18.1%	1,940	In-Home Display
Residential Smart Energy Monitoring Pilot	***9.3%***	***997***	***In-Home Display***
Florida Solar Energy Center - Residential Energy Feedback Device Pilot (2006 - 2007)	7.0%	750	In-Home Display
Hydro One - PowerCost Monitor Pilot Program (2004 - 2005)	6.5%	697	In-Home Display
Ameren T-Stat Energy Savings DLC program (RLW Analytics)	6.0%	643	Programmable Thermostats
Nevada Power - In-Home Energy Display (HED) Study (2008)	5.5%	589	In-Home Display
Emerging Technologies Report (ACEEE - July 2007)	5.0%	536	In-Home Display
Seattle City Light - IHD Market Test (2008 - 2009)	3.0%	322	In-Home Display
NSTAR - PowerCost Monitor Pilot (2008)	2.9%	311	In-Home Display
British Columbia - PowerCost Monitor Pilots (2005)	2.7%	289	In-Home Display
SMUD Positive Energy Pilot (2008)	2.5%	268	Utility Feedback Reports
Energy Trust of Oregon - Home Energy Monitor Pilot (2008)	0.0%	0	In-Home Display
Average Reductions (excluding high and low values)	***5.1%***	***544***	

APPENDIX A: SURVEY RESPONSE DETAIL

Table A-1 describes in detail the survey response rates across all groups.

Table A-1. Survey Response Rates

Sample Disposition	Blind-Martha's Vineyard	Blind-Cape Cod	Interested	Participant	Total
Sample Size	**100**	**300**	**207**	**91**	**698**
Temporarily disconnected	0	1	0	0	1
Fax/data line	3	2	0	0	5
Non-working number	0	1	4	0	5
Disconnected number	2	3	0	0	5
Business number	0	3	3	0	6
Number not in service	8	28	12	2	50
Person not at number	1	7	0	1	9
Adjusted Sample Size	***87***	***262***	***188***	***89***	**626**
Hard Refusal[1]	13	41	14	1	**69**
Soft Refusal[2]	9	23	0	0	**32**
Incompletes (partial interviews)	2	4	1	2	**9**
Unavailable for duration	0	3	0	0	**3**
Incapable/incoherent	0	0	0	0	**0**
Language barrier/non-English	0	2	1	0	**3**
Active[3]	***38***	***114***	***76***	***20***	***248***
Completed Surveys	**25**	**75**	**96**	**66**	**262**
Response Rate[4]	25.0%	25.0%	46.4%	72.5%	37.5%

[1] Two soft refusals become a hard refusal

[2] Attempts were made to convert all soft refusals

[3] An average of 6.36 contacts per active case were made to reach these still active cases

[4] Number of completed surveys divided by Sample Size

APPENDIX B: SURVEY INSTRUMENT

RESIDENTIAL SMART ENERGY MONITORING PILOT
(PARTICIPANT & NON PARTICIPANT SURVEY)

Hello, my name is [interviewer name], and I'm calling on behalf of Cape Light Compact. May I speak with [named respondent]?

1 Yes
2 No *[If named respondent is not available: ask for another adult who is most involved in managing their household's energy use] [May need to mention energy monitors to the Pilot group to make sure we're talking with person knowledgeable about Pilot participation]*

I'm with PA Consulting Group, an independent research firm. We are talking with customers of Cape Light Compact to understand their views on energy use and conservation. I'm not selling anything; I'd just like to briefly talk about your household's energy use. Your responses will be kept confidential and your name will not be revealed to anyone.

(**Who is Cape Light Compact?** Cape Light Compact is an energy services organization made up of all 21 towns of Barnstable and Dukes counties. They administer regional energy efficiency programs and negotiate lower electricity rates.)

(**Why are you conducting this study**: Studies like this will help Cape Light Compact understand and shape their energy conservation programs.)

(**Timing:** This survey should take about 15 to 20 minutes. *IF NOT A GOOD TIME, SET UP CALL BACK APPOINTMENT OR OFFER TO LET THEM CALL US BACK AT 1-800-454-5070.*)

(**Sales concern**: This is not a sales call; we would simply like to learn about your household's experiences with energy use and conservation. Your responses will be kept confidential. If you would like to talk with someone at Cape Light Compact regarding this work, please call Briana Kane at 508-744-1277.)

[PART & NONPART] Familiarity with CLC and its programs

F1 Before this interview, were you familiar with Cape Light Compact?

1 Yes
2 No

F2 [If yes to F1] Has your household participated in any of Cape Light Compact's residential energy efficiency programs?

1 Yes
2 No
D Don't know

F3 [If no to F1] Has your household participated in any energy efficiency programs designed to save energy at your home?

1 Yes
2 No
D Don't know

F4 [If yes to F2 or F3] Which program or programs? [Do not read] [Select all that apply]

1 Energy education program
2 Home energy audit
3 www.myenergystar.com (Energy Star information)
4 www.massenergystarhomes.com (New home information)
5 Lower Income energy efficiency program
6 Other [Please specify]
D Don't know [What did the program do?]

[PART & NONPART] General Household Energy Use

I'd like to ask a few questions regarding household energy use.

G1 Using a scale from zero to ten, where one is not at all important and is ten extremely important, how important are the following items to your household…? [Read categories]

_____ Reducing emissions
_____ Teaching children about energy use
_____ Saving money
_____ Energy independence

G2 I'm going to list a number of energy conservation activities. [If Blind or Interested, show "Within the last six months," If Participant, show "Since participating in the pilot,"] please let me know how often you or someone in your household has…

How often do you or someone in your household…?

[Always / Often / Sometimes / Rarely / Never]

Have you…?

[Yes / No / Not Applicable]

Within the last six months, how often do you or someone in your household…?	**Within the last six months, have you…?**
Close the refrigerator door immediately after use	Bought an ENERGY STAR refrigerator
Power off external computer speakers	Check the refrigerator door seals
Turn off exhaust fans when not in use	Check the temperature of your refrigerator or freezer
Turn off outdoor lights during the day	Clean the refrigerator condenser coils
Unplug chargers when not in use	Turned off the ice maker
Use task lighting	Unplugged the second refrigerator or freezer
	Installed ENERGY STAR indoor light fixtures
	Installed ENERGY STAR outdoor light fixtures
	Reduced wattage in multiple bulb fixtures
	Used lighting controls or timers
	Clean light fixtures
	Bought an ENERGY STAR charger
	Installed ENERGY STAR exhaust and ventilation fans
	Plugged electronics into power strips
	Used timers to turn off standby power

[PART] SM Pilot Monitor Use

M1 Is the Smart Monitoring Pilot the first Cape Light Compact program in which you have participated?

1 Yes
2 No
D Don't know

M2 Approximately how many months have you had the Smart Monitor installed?

_____ Months
D Don't know

M3 Approximately how often during the week does your household log onto the online monitor? [Read categories] [Select one]

1 Every day (7 times per week)
2 Three to six times per week
3 Once or twice per week
4 Less than once per week
D Don't know

M4 On days when you log onto the online monitor, approximately how much time does your household spend with it? [Read categories] [Select one]

1 Less than five minutes
2 Five to 10 minutes
3 11 to 30 minutes
4 31 to 60 minutes
5 More than 60 minutes
D Don't know

M5 When you log onto the online monitor, how often do you review each of the following sections. Is it always, often, sometimes, rarely, or never? [Read categories] [Select one]

1 House monitor graph
2 Energy actions
3 Your savings (cost, energy, or emissions)
4 Your goals
5 Other [Please specify]

M6 Using a scale of zero to ten, where one is not at all effective and ten is extremely effective, how effective are each of following aspects of the online monitor on reducing your household's energy use…? [Read categories]

[Randomize items below]]

_____ Visibility of real-time energy use

_____ Comparison of energy use against set goals

_____ Understanding of household cost savings

_____ Comparison of your energy use to a Pilot group average

_____ Understanding of household energy use savings

_____ Understanding of household CO2 savings

_____ Suggested energy conservation actions

M7 What do you find most useful about the Smart Monitoring system? [Open-End]

M8 What additional types of information would you like to see with the online monitor? [Open-End]

M9 Since you began using the Smart Monitoring system have you reduced your household energy consumption? Would you say…[Read categories]

1 Definitely yes
2 Probably yes
3 Probably no
4 Definitely no
D Don't know/Unsure

M10 [If M9=1 or M9=2] Are these consumption savings matching your expectations?

1 Yes
2 No [Why aren't they matching your expectations?]
D Don't know

M11 Would you say you are very concerned, somewhat concerned, slightly concerned, or not at all concerned about the following…? [Read categories]

_____ security of online energy use data?
_____ sharing energy use information with other participants?

[PART & NONPART] Behavioral Changes

BC1 **[PART]** Earlier, you mentioned that your household had engaged in energy conservation activities within the last six months.

Using a scale from zero to ten, where one is not important and ten extremely important, how important was your household's participation in the Smart Monitoring system on…?

[List energy conservation activities mentioned in G2]

BC2 **[PART]** What other energy saving activities has the Smart Monitoring system influenced at your household? [Open-End]

[PROBE: for example, energy saving activities with TVs, computers, laundry, or kitchen appliances]

BC3 **[NONPART]** How likely is it that you or someone in your household will perform each of the following activities sometime during the next six months? Very likely, somewhat likely, somewhat unlikely, very unlikely…[energy conservation activity mentioned in G2]

0 **[PART & NONPART]** In two years?

BC4 **[PART & NONPART]** Has your household experienced any discomforts or annoyances as a result of the energy conservation activities?

1 Yes [please explain]
2 No
D Don't know

[PART] SM Pilot Satisfaction

Now I would like to discuss your satisfaction level with several aspects of the Smart Monitor Pilot. For each, tell me whether you were very dissatisfied, somewhat dissatisfied, somewhat satisfied, or very satisfied.

S1 Were you very dissatisfied, somewhat dissatisfied, somewhat satisfied, or very satisfied with the…? [Read categories]

_____ scheduling process for monitor installation
_____ actual home installation
_____ training materials available
_____ assistance from Cape Light Compact
_____ technical assistance for the online monitor
_____ experience using the online monitor
_____ breadth of information available through the online monitor
_____ level of detail available through the online monitor
_____ actual cost savings to-date

S2 After the Pilot ends, how interested would you be in using the Smart Energy Monitoring equipment permanently? Would you be… [Read categories] [Select one]

1 Very interested
2 Somewhat Interested
3 Slightly interested
4 Not at all interested
D Don't know

S3 After the Pilot, how much would you be willing to spend monthly for use of the monitor system?

[**INTERVIEWER NOTE**: If asked by the Customer why we are asking this or if we are going to charge them, Answer: No, the Pilot Project is fully funded by the energy efficiency programs and this question is just to inform any future programs that may be developed].

_____ $ Monthly
D Don't know

[PART & NONPART] SM Pilot Demographics

Finally, I'd like to ask you a few questions about your household. I would like to remind you that your responses will be kept completely confidential.

D1. Including yourself, how many people currently live in your home year-round?

_____ People living in home year-round
D Don't know
R Refused

D2 Approximately what year was your house built? [Read categories] [Select one]

1 Before 1900
2 1901 to 1930
3 1931 to 1950
4 1951 to 1970
5 1971 to 1990
6 1991 to present
D Don't know
R Refused

D3 How many bedrooms are in your house?

_____ Total bedrooms
D Don't know
R Refused

D4 What is the highest level of education you have completed? [Read categories] [Select one]

0 No schooling
1 Less than high school
2 Some high school
3 High school graduate or equivalent (e.g., GED)
4 Trade or technical school
5 Some college
6 College graduate degree
7 Some graduate school
8 Graduate degree
9 Other [Specify]
D Don't know
R Refused

D5 Including yourself, how many people currently living in your home year-round are in the following age groups…? [Read categories]

_____ Less than 18 years old
_____ 18-24 years old
_____ 25-34 years old
_____ 35-44 years old
_____ 45-54 years old
_____ 55-64 years old
_____ 65 or older

D6 Which of the following best represents your annual household income from all sources in 2008, before taxes? Was it…? [Read categories] [Select one]

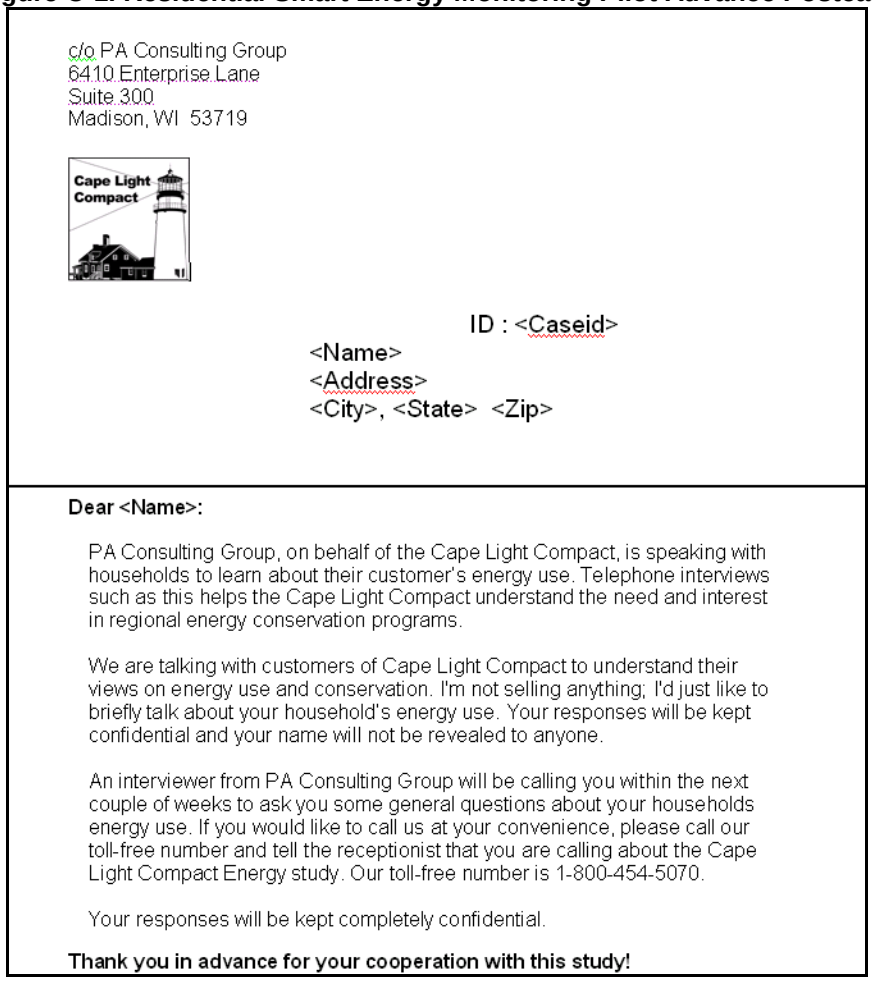
1 Less than $20,000 per year
2 $20,000 - $49,999
3 $50,000 - $74,999
4 $75,000 - $99,999
5 $100,000 - $149,999
6 $150,000 - $199,999
7 $200,000 or more
D Don't know
R Refused

Gender: [DO NOT READ] is respondent male or female?

Thank you for your time. Do you have any questions or comments?

APPENDIX C: ADVANCE POSTCARD AND REMINDER E-MAIL

Figure C-1. Residential Smart Energy Monitoring Pilot Advance Postcard



c/o PA Consulting Group
6410 Enterprise Lane
Suite 300
Madison, WI 53719

Cape Light Compact

ID : <Caseid>
<Name>
<Address>
<City>, <State> <Zip>

Dear <Name>:

PA Consulting Group, on behalf of the Cape Light Compact, is speaking with households to learn about their customer's energy use. Telephone interviews such as this helps the Cape Light Compact understand the need and interest in regional energy conservation programs.

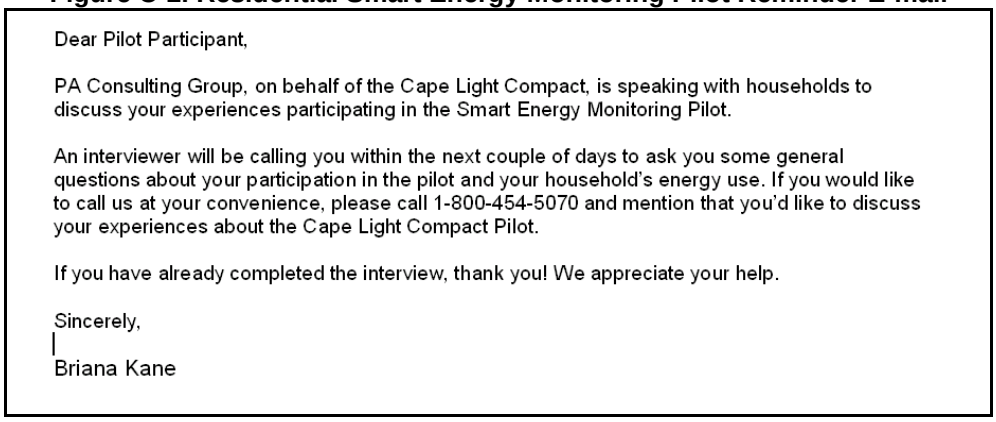
We are talking with customers of Cape Light Compact to understand their views on energy use and conservation. I'm not selling anything; I'd just like to briefly talk about your household's energy use. Your responses will be kept confidential and your name will not be revealed to anyone.

An interviewer from PA Consulting Group will be calling you within the next couple of weeks to ask you some general questions about your households energy use. If you would like to call us at your convenience, please call our toll-free number and tell the receptionist that you are calling about the Cape Light Compact Energy study. Our toll-free number is 1-800-454-5070.

Your responses will be kept completely confidential.

Thank you in advance for your cooperation with this study!

Figure C-2. Residential Smart Energy Monitoring Pilot Reminder E-mail



Dear Pilot Participant,

PA Consulting Group, on behalf of the Cape Light Compact, is speaking with households to discuss your experiences participating in the Smart Energy Monitoring Pilot.

An interviewer will be calling you within the next couple of days to ask you some general questions about your participation in the pilot and your household's energy use. If you would like to call us at your convenience, please call 1-800-454-5070 and mention that you'd like to discuss your experiences about the Cape Light Compact Pilot.

If you have already completed the interview, thank you! We appreciate your help.

Sincerely,

Briana Kane