

PREPARED

by
Energy Center of Wisconsin

for
Minnesota Power

Minnesota Power's Advanced Metering Infrastructure Project

AMI Behavioral Research Pilot – Phase 1

**Interim Results from a Consumer Enhanced
Feedback Pilot**

March 6, 2014

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TRANSMITTAL LETTER

March 6, 2014

Minnesota Power is pleased to provide the Department of Energy with this interim report of the outcomes so far from the consumer behavior study associated with the Department of Energy under Award Number DE-FOA-0000058. The Consumer Behavior Study Plan (CBSP) is a part of the broader Smart Grid Investment Grant being executed by Minnesota Power. The overall purpose of the CBSP is to evaluate customer acceptance and response to various forms and timing of usage information feedback, some of which are enabled through advanced two-way meters. Through its Power of One® conservation program, Minnesota Power helps customers develop, implement, and adapt a plan to save energy through information, tools and technology options. The Power of One program is an effective, multi-faceted effort, with the residential portion yielding about 20 percent of Minnesota Power's annual conservation savings result. The CBSP is a timely and incremental extension of that effort which incorporates additional technologies such as advanced metering infrastructure (AMI) to help residential customers learn more about how they use energy. The CBSP seeks to test customer response to enhanced usage feedback that is higher in frequency and specificity as compared to the monthly usage information customers currently receive.

Minnesota Power retained the services and expertise of the Energy Center of Wisconsin to assist in the design, development, implementation, and evaluation of its CBSP. The Department of Energy (DOE) sponsored Technical Assistance Group (TAG) assigned to oversee and support this study has also been helpful with the design, implementation, and evaluation of results. We think this modest study provides useful insights both for Minnesota Power and for the energy industry generally.

Minnesota Power will add a time-of-day rate with critical peak pricing to the pilot in the next phase. A final report will provide results from the addition of the rate and continuing results from the feedback portion of the study.

Respectfully submitted,

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EXECUTIVE SUMMARY

Minnesota Power's Smart Grid Investment Grant project (SGIG) involves the installation of advanced metering infrastructure (AMI) and explores the application of distribution automation. The project is aimed at improving customer understanding of their electricity usage, reducing operations and maintenance costs, and improving awareness of and response to distribution system outages. The project implements two-way communication to:

- (1) Provide customers with more timely electricity usage information,
- (2) Identify when and where outages are occurring, and
- (3) Demonstrate the performance of select distribution automation equipment.

As part of its Smart Grid Investment Grant, Minnesota Power is conducting a Consumer Behavior Study Plan (CBSP) designed to answer research questions about residential customers' interest in, use of, and benefits derived from higher resolution feedback on electricity consumption (such as usage data for each individual day or hour). The study is also exploring the customer experience with the tools that provide this information. These questions are of interest because the advanced metering infrastructure associated with a smart grid enables higher resolution usage information for utility customers, which has the potential to better inform them about their energy consumption and help them refine their usage choices. However, this infrastructure comes at a cost, so Minnesota Power is interested to know whether customers derive energy savings or other benefits from higher resolution data. This aspect of the study complements the system's operational benefits and insights gained from the broader grant activities.

The CBSP, branded as the Power of One® Choice Pilot, began in the spring of 2012 and is being implemented in the geography designated by the grant, the Duluth/Hermantown area. This report presents the results of the pilot through its first year. A second phase of the pilot will test consumer interest and response to time-of-day rates with critical peak pricing.

Study design and implementation

A solicitation to 31,548 customers yielded 1,482 voluntary participants who were enticed by the ability to receive more information about their electricity use and be among the first to test new tools. These customers were ultimately enrolled in the pilot. Minnesota Power supplemented this pool of volunteers with an additional pool of 2,303 customers who did not respond to the original solicitation and were assigned into the pilot.

Both pools of customers were randomly assigned to one of three groups, all of whom had access to an online portal that displayed their electricity consumption histories:

- Customers who could see monthly electricity consumption (control)
- Customers who could see daily electricity consumption (treatment)
- Customers who could see (day-late) hourly electricity consumption (treatment)

Those customers who did volunteer for the study reported a high rate of pre-pilot activity to reduce their electricity usage and very high rates of reviewing the electricity usage data they already received on their bills. Two-thirds said they had taken actions to reduce usage. Nearly all said they review the usage information on their bills, and the majority reported some level of tracking that information over time. (There was insufficient comparable data about the assigned participants to know whether or how they differed in this regard.)

Customer interest in enhanced information on electricity usage

Customers provided mixed messages about their interest in enhanced information on electricity usage. Voluntary enrollment in the pilot was lower than Minnesota Power had hoped. Those who volunteered for the pilot expressed a high degree of interest; 75% expressed positive interest in higher resolution feedback in a screening survey and most indicated that they were engaged with the monthly usage charts they already receive on their bills. Nevertheless, their actual use of the enhanced feedback the pilot offered was modest.

Portal usage

Only one-quarter of all participants accessed the online portal at least once during the first year of the pilot.

- As expected, participants who voluntarily joined the pilot were more likely to log on than those who were simply assigned in the pilot without indicating interest. Nevertheless, only half of voluntary participants and eight percent of assigned participants actually logged on to the portal at least once.
- Similarly, 33 percent of voluntary participants in the two treatment groups that received higher resolution usage feedback viewed that feedback at least once, compared with two percent of their counterparts from the assigned participant pool. Arguably, the rate at which Minnesota Power customers beyond the study's geography would view enhanced feedback is likely to be a blend of these two rates, with the assigned participants representing the bulk of the population.
- The two highest levels of viewership occurred immediately after the initial rollout to customers (i.e., when they received a welcome packet) and after the only reminder about the pilot that was sent to all participants during the first year. About half of the page views of the enhanced feedback in the pilot portal occurred during the two months corresponding with these two prompts to participants.

Electricity consumption

Over the first year of the pilot, we found no statistically significant electricity savings for either of the two treatment groups when compared to the control group receiving monthly data. The statistical uncertainty associated with these numbers suggests that if any savings occurred, they are unlikely to be above two percent.

- Electricity consumption increased among all groups due to weather (and possibly other exogenous factors).
- However, the increase was statistically (and practically) comparable between the treatment groups and the control group, as well as among those who viewed their usage information in the pilot portal compared to those who did not.

Customer experience

Participants gave mixed reviews of their experience with the portal in a check-in survey one year into the pilot. Survey respondents rated the individual aspects of the portal reasonably highly, but gave moderate scores to the portal overall.

- The pilot received middling satisfaction ratings among all three groups, which contrasted with the high satisfaction that respondents expressed with Minnesota Power overall.

- The portal's energy usage charts (i.e., its feedback component) received the highest scores for usefulness, with a slight majority of those who reported viewing it indicating that it was "very useful."
- Among the functional aspects of the portal we tested, such as ease of logging in, knowing what to expect, and finding relevant content easily, participants provided predominately positive feedback. The ratios of the instance of positive ratings to negative ratings ranged from 7:1 to 56:1 for active participants and 4:1 to 36:1 for those who have not used the pilot.
- Interestingly, active participants in the pilot were more likely to be concerned about the amount of electricity they use than inactive participants, but they were highly likely to overestimate their actual annual electricity spending (even after viewing the enhanced feedback) by more than 25 percent.

INTRODUCTION

In 2010, Minnesota Power was awarded a Smart Grid Investment Grant from the U.S. Department of Energy (DOE) to place and test advanced metering technology in the Duluth/Hermantown area. The grant provided for the installation of 8,030 advanced meters in the area and is being used to study the use of advanced metering infrastructure (AMI) for:

- distribution automation and outage management (3,910 meters);
- consumer response to high resolution feedback and critical peak pricing (2,370 meters); and
- direct load control (1,750 meters).

The inclusion of consumer behavior in the grant provided an opportunity to study how residential customers would respond to the availability of the type of feedback and price signals that advanced meters would make possible. Advanced meters enable the provision of usage information to customers at much higher resolutions (anywhere from real time to hourly instead of daily and monthly) and the use of rates that provide price signals that more closely match the actual cost of providing electricity during specified time intervals.

Minnesota Power wanted to use the consumer behavior component of its grant to explore whether consumers would value, use, and benefit from higher resolution usage feedback if advanced meters were installed in their homes and study how they would respond to rates that incorporate time-of-day (TOD) pricing with a critical peak price (CPP) when the cost of providing electricity is particularly high. Essentially, Minnesota Power was seeking to understand whether the benefits of installing advanced meters to provide better feedback and more direct price incentives to customers provide further rationale for the investment, beyond system operational benefits, particularly in a utility that has low rates and an active program to encourage energy efficient practices.

Those questions are being answered in a two-part consumer behavior study that focuses on information treatments, or feedback, and the introduction of a time-of-day rate with critical peak pricing. Both components are based on an experimental design with random assignment to treatment and control groups to isolate changes in behavioral and electricity usage patterns associated with information and pricing options that are feasible with advanced metering technology. The study is being conducted in the Duluth/Hermantown area because that portion of Minnesota Power's service area has the necessary communication infrastructure already in place to communicate with advanced meters and was thus selected for the overall grant.

This report presents results from the first year of the information treatments, which were introduced first. Results presented herein are the outcome of an analysis by the Energy Center of Wisconsin for Minnesota Power. The Energy Center has assisted Minnesota Power with the design of the research components of the pilot and analyzed all data collected to-date. A subsequent report will present final results for both information treatments and rate incentives.

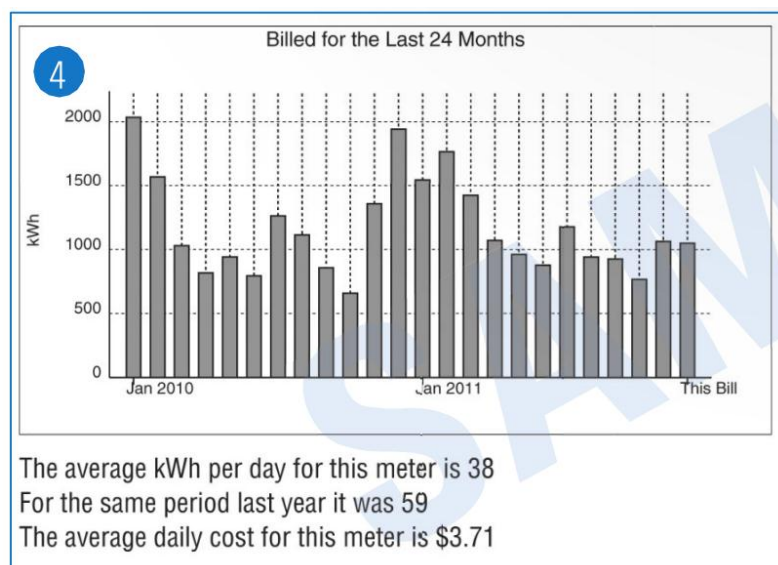
BACKGROUND

Minnesota Power, a division of ALLETE, was incorporated in 1906 and serves about 144,000 retail electric customers and 16 municipal systems across a 26,000-square-mile service area in central and northeastern Minnesota. Additionally, Superior Water, Light and Power, an ALLETE subsidiary, sells electricity to 15,000 customers, natural gas to 12,000 customers, and water services to 10,000 customers in northwestern Wisconsin. The consumer behavior pilot is being conducted in the Duluth/Hermantown area.

System-wide, Minnesota Power serves approximately 121,000 residential accounts and nearly 23,000 non-residential accounts. Residential customers comprise about 17 percent of the utility's total annual delivery.¹ Minnesota Power is a winter-peaking utility due primarily to the year-round production cycle of its large industrial customers and because of growing residential demand for electricity in winter.

Despite low rates,² Minnesota Power has been progressive in providing customers with useful usage information and resources to reduce their consumption. Figure 1 shows an example graphic of historic usage information included on all residential customers' monthly bills.

Figure 1: Usage graphic from Minnesota Power monthly bills



Furthermore, through its Power of One® conservation program, Minnesota Power has experienced good customer response, with approximately 20% of annual energy savings achieved through the residential sector. One component of Minnesota Power's residential conservation program is delivered via the Power of One® web-based portal. Over 5,000 customers have conducted a 10-minute household survey to obtain a "Your Home Energy Report" that provides feedback on the likely make-up of their energy usage and specific suggestions on ways to save energy.

The information treatment component of the consumer behavior research pilot builds on that framework. Minnesota Power is interested in testing whether advanced metering infrastructure offers an opportunity to expand Power of One® through more frequent usage feedback to customers to help them understand and reduce their consumption—whether they do so to save money, help the environment, or just not waste energy. The company's consumer behavior research study is designed to explore the potential effects of enhanced feedback and subsequently customer openness and response to voluntary dynamic pricing rates.

¹ FERC Financial Report 2009/Q4

² Minnesota Power's total average retail electric rate is the fourth lowest in the U.S. among 169 providers surveyed and the lowest in the State of Minnesota (which averages 7.87 cents/kWh). According to statistics compiled by Edison Electric Institute, Typical Bills and Average Rates Report Summer 2012, dated July 1, 2012.

RESEARCH GOALS

The key research questions for the information treatment component of the study fall into three categories:

- customer interest and uptake regarding enhanced usage feedback;
- the extent of customers' use of enhanced usage feedback information; and
- the impact of enhanced usage feedback on electricity use and customer actions.

Research questions about customer interest include:

- What proportion of Minnesota Power single-family customers in the Duluth/Hermantown area are interested in enhanced information on electricity usage?
- How do interested households compare to Minnesota Power's general population of residential customers in terms of:
 - demographics;
 - attitudes;
 - appliance holdings; and
 - electricity usage?

Questions about customer use of enhanced feedback include:

- Do customers make more frequent use of AMI-enhanced usage information compared to standard (monthly) online usage information?
- Does the frequency with which customers view enhanced online information change over time?

Questions about enhanced feedback's impact on electrical usage include:

- What effect (if any) does customer access to enhanced usage information have on electricity usage compared to online access to traditional monthly usage?
- What actions do customers take as a result of enhanced online feedback?

EXPERIMENTAL DESIGN AND IMPLEMENTATION

The information treatment and rate incentive components of the pilot are structured as an experimental design with two overlapping phases. The information treatment part of the study discussed in this report precedes the rate phase by approximately one year. Information treatments all consist of web-based feedback incorporated into Minnesota Power's existing Power of One® platform. The treatments being tested are finer resolution of usage information. The three study groups are:

- one treatment group that has access to hour-by-hour consumption information on a day-late basis;
- a second treatment group that has access to day-by-day consumption information (also on a day-late basis); and
- a control group that has access only to the traditional month-by-month consumption information.

All participants, including the control group, also have access to a pilot version of the Power of One® platform whose features are described and illustrated with screenshots below. Treatment group members—those in the hourly and daily groups—are able to view usage histories at their respective levels of resolution in various ways, download their data, set energy markers, and obtain threshold alerts.

Study participants were randomly assigned into the three groups and then informed about the feedback available to them. The study's intent was to draw from volunteers who agreed to be part of a pilot study, but a lack of sufficient volunteers prompted a change in the recruitment strategy. Voluntary participants were supplemented with assigned participants, who were informed about the new services available to

them and could then use them if they so choose. Random assignments were done separately for voluntary and assigned participants, so the participants of each type are equally distributed across the three groups.

The study's implementation consisted of:

- recruitment;
- assignment;
- meter installation;
- introduction to the enhanced services;
- provision of enhanced services; and
- tracking of participants' response.

Recruitment

Initial recruiting for the enhanced feedback phase of the study was implemented in late summer and fall of 2011, and primarily involved a postcard mailer and/or letter to all 31,548 eligible customers in the geography being studied (the Duluth/Hermantown area)³. An initial recruitment in the form of a postcard was sent in August 2011 to 24,716 customers on residential rates, but excluded one zip code⁴, renters, those with less than 12 months of usage history, and those with multiple service agreements. Subsequent letters to recruit participants in October 2011 extended the pool of invited customers to also include renters and customers in the zip code that had been previously excluded, adding 6,832 customers for a total of 31,548.

Interested households were asked to enroll in the study online and complete a short screener survey. The screener survey sought to obtain key appliance information, as well as to gauge interest in different types and frequencies of enhanced usage information.

The final recruitment pool of 1,482 voluntary households fell well short of the originally-planned 4,800 customers. Because of this, the study design was revised to eliminate the testing of in-home displays (which had been included in the original study plan),⁵ and to include a pool of approximately 2,500 customers with existing AMI meters. In contrast to the voluntarily participating households, these customers were not self-selected into the study: they were simply informed that enhanced feedback information and tools were available to them. It is also noteworthy that these customers were included in the original solicitation for the pilot, but did not respond—though the extent to which they actively chose not to participate or simply did not pay attention to the solicitation is unknown. Given these fundamental differences, analyses and reporting of outcomes distinguish between the voluntary participants and assigned participants.

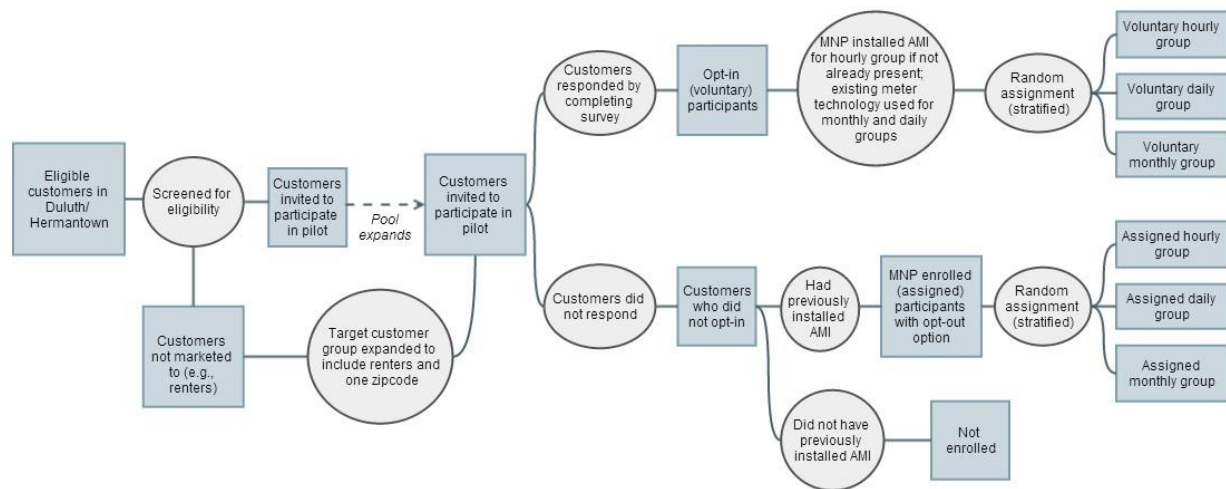
Figure 2 on the following page illustrates the recruitment process from identification of all eligible customers to treatment and control group assignment.

³ There were about 45,000 residential customers in the targeted geography, including customer groups not eligible for the pilot, such as landlords paying the electric bill, customers with multiple service agreements, and those with less than a year of billing history.

⁴ Minnesota Power excluded areas covered by zip code 55802 initially. That part of Duluth extends nearest to Lake Superior and is served by a different weather station than the rest of the studied area.

⁵ On January 14, 2012, the TAG recommended that this study move forward without an IHD component. The TAG strongly preferred this course of action so that the simplicity of the study's design could be retained. Plus, the TAG recognized that the pace of technological change for IHDs is rapid and future approaches will likely involve different devices and techniques than are available today. This was approved by the TPO on January 18, 2012.

Figure 2: Recruitment process



Assignment to Treatment Groups

Households in the voluntary and assigned recruitment pools were randomly assigned to one of the three groups. For the pool of voluntary participants, customers were randomly assigned to the three study groups within 40 separate strata that took into account:

- home tenure (owner or renter);
- presence of electric space heat;
- presence of an electric water heater;
- type of air conditioning (central, room, or none); and
- annual electricity usage.

Except for the annual electricity usage, these data were provided by participants in a short solicitation screener survey. This helped ensure that the three groups were reasonably equivalent in terms of the key variables above.

Because tenure and appliance information is not available for the assigned participants, group assignments for this pool were made randomly from among usage-based strata only.

Initial group sizes are thus as-shown in Table 1.

Table 1: Initial group assignments

Group	Recruitment Pool	
	Voluntary participants	Assigned participants
Control Group 1 (monthly data)	494	768
Treatment Group 1 (daily data)	494	767
Treatment Group 2 (hourly data)	494	768

Meter Installation

Advanced meters were only needed for the hourly treatment group; these were installed in the homes of applicable voluntary participants in December 2011. Members of the assigned participants were deliberately drawn from households with existing advanced meters. Minnesota Power's preexisting meter technology can provide near-daily usage data, or 27 hour minimum read interval data, which is sufficient for both the monthly and daily groups.

Introducing the Enhanced Services

Minnesota Power sent welcome packets to all participants to detail the enhanced services available to them and explain how to access them. The welcome packets comprised a letter and an instruction booklet. There were separate instruction booklets for the hourly, daily, and monthly groups. Welcome packets were mailed to voluntary participants on March 9, 2012 and to assigned participants on August 2, 2012. Participants could avail themselves of the pilot portal upon receiving their welcome packet.

Providing Enhanced Services

To provide enhanced services, Minnesota Power built on its pre-existing Power of One® program. Participants in the pilot were able to access the following features:

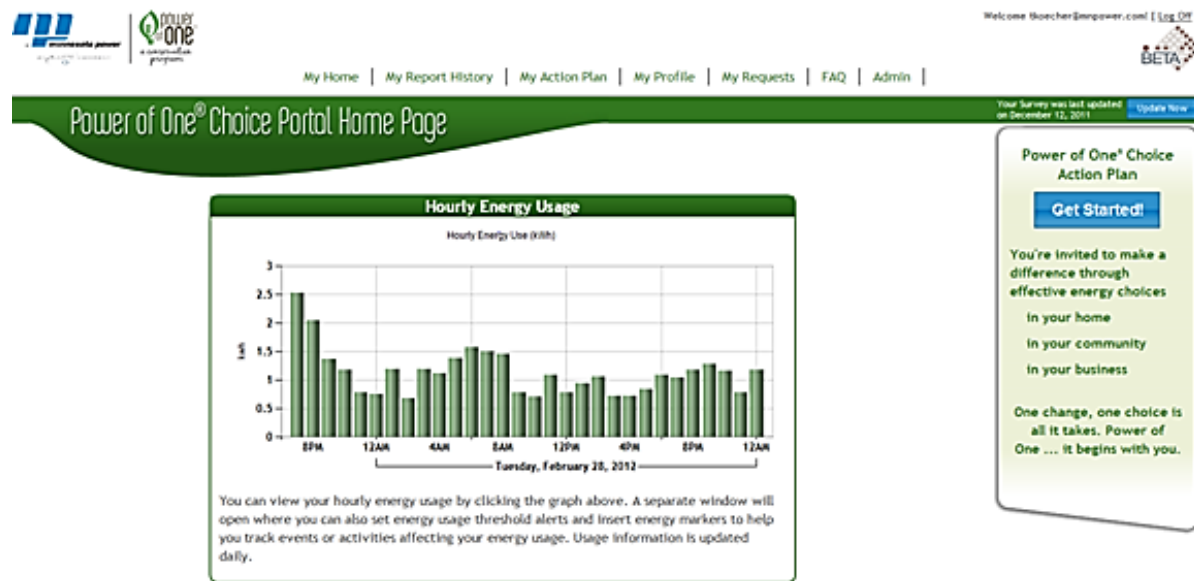
YOUR HOME ENERGY REPORT

The "Your Home Energy Report" provides tailored energy-saving tips based on responses to a questionnaire about the customer's home, appliances, and practices. Responses to this questionnaire are stored and can be revised over time, leading to updates to the "Your Home Energy Report." This feature was already fully available prior to the pilot.

ENHANCED FEEDBACK

After completing or updating the "Your Home Energy Report" questionnaire, pilot participants' new landing page upon logging in featured a graphic showing their recent energy usage. Participants in the monthly group see month-by-month data. Participants in the two treatment groups see either daily or hourly data with the ability to click on the graphic to view their consumption in a variety of graphical ways, as well as see tabular views of the data or download data files containing that data. Figure 3 shows the new landing page that participants in the hourly group see each time they log in after they initially complete or update the "Your Home Energy Report" questionnaire.

Figure 3: Enhanced feedback feature: screenshot of new landing page for hourly group



MY ACTION PLAN

Participants can also track the energy-saving recommendations provided to them in various ways. They can choose to create and view a personal action plan, mark recommendations that have been completed, and view helpful habits. Figure 4 shows an example of a recommendations list, and Figure 5 illustrates some of the helpful habits provided to participants. An enhancement to the “Your Home Energy Report,” this feature was developed and debuted to pilot participants before rolling it out to broader Power of One® portal participants.

Figure 4: My Action Plan feature: screenshot of recommendations list

[How do I use my workbook?](#)

[Get Started!](#)
[Recommendations](#)
[To Do List](#)
[Completed](#)
[Helpful Habits](#)

GET STARTED!
RECOMMENDATIONS
TO DO LIST
COMPLETED
HELPFUL HABITS

Recommendations

Action Chosen	Average 5 Year kWh Savings			
Use of manual or smart power strips on office equipment, home theater, etc. can reduce standby power consumption by 30%	2760	+	-	✓
Laptops use less energy than desktop computers. So consider ENERGY STAR certified laptops next time you're looking for a computer.	630	+	-	✓
Adding weather stripping to doors is relatively inexpensive and an easy way to prevent air leakage.	140	+	-	✓
A CFL bulb could last up to 10,000 hours. Install the new "instant on" 13 and 26-watt CFLs throughout your home.	6835	+	-	✓
Total Estimated 5 Year kWh Savings	10365			
Total Estimated 5 Year Savings	\$800.18			

TO DO LIST
COMPLETED
HELPFUL HABITS

+ Add to To Do List
- Decline Recommendation
✓ Mark as Completed
↺ Reset Recommendation

Figure 5: My Action Plan feature: screenshot of helpful habits page

[How do I use my workbook?](#)

[Get Started!](#)
[Recommendations](#)
[To Do List](#)
[Completed](#)
[Helpful Habits](#)

GET STARTED!
RECOMMENDATIONS
TO DO LIST
COMPLETED
HELPFUL HABITS

Helpful Habits

1. Get the most comfort from your ceiling fan. In the summer, it should turn in a counter-clockwise direction. In the winter, run it at low speed, but clockwise.
2. Place heat-producing appliances, such as lamps and televisions, away from the thermostat to prevent inaccurate temperature readings.
3. Block the sun from overheating your home. Inside, use shades, blinds and drapes. Outside, use awnings, trees and shrubs.
4. Did you know ceiling fans use no more electricity than light bulbs? Here's another tip: Turn off fans when you leave - they only make you feel cooler and do not cool a room.
5. Make sure an outside air conditioning unit or heat pump is not blocked by shrubbery, leaves or other objects.
6. Trees are nature's air conditioners. Plant them for shade on the sunny side of your home
7. When the A/C is on, close your doors and windows tightly. Save even more by turning off kitchen and bath exhaust fans.
8. Cover bare floors. Carpeting adds to comfort and heat retention, especially if there is little or no floor insulation.
9. Don't make your heater work harder than it has to. Make sure drapes and furniture aren't blocking

TO DO LIST
COMPLETED
HELPFUL HABITS

+ Add to To Do List
- Decline Recommendation
✓ Mark as Completed
↺ Reset Recommendation

ENERGY MARKERS

Energy markers, available only to the daily and hourly groups, allow participants to mark points in time at which they took an energy-saving action or that was otherwise noteworthy and could affect electricity consumption. These points are then marked on the detailed and adjustable usage graphs available to these customers for easy comparisons of pre- and post-event electricity usage. Figure 6 displays one such marker and also shows an example of a detailed graph available to hourly and daily participants if they click on the usage chart on their new landing page.

Figure 6: Screenshot of energy markers in detailed graphs



ENERGY NOTIFICATIONS

Hourly and daily group participants could also activate a notification feature that would alert them if their electricity usage reached an established amount. The threshold level is fully customizable by the user, and the feature provides a summary of the user's existing usage as a guide. Figure 7 illustrates the sign-up page for this feature.

Figure 7: Energy notification: screenshot of sign-up page

The screenshot shows the 'Account Details' page of the 'power of one Choice Pilot Program'. It features a navigation bar with 'My Notifications', 'Daily', and 'Contact Us'. Below the navigation bar, there are tabs for 'Accounts', 'Notification Settings', and 'Threshold Settings'. The 'Notification Settings' tab is active, showing a form to set up energy notifications. The form includes a dropdown for 'Notify Me When Meter' (set to '1919 LAKEVIEW DR'), a frequency selector (set to 'Daily'), a threshold selector (set to 'Above'), and a slider for 'kWh' (set to 25). An 'Add' button is present. Below the form, a summary states: 'You currently average 30 kWh per day, 215 kWh per week, and 922 kWh per month on meter 1919 LAKEVIEW DR.' At the bottom, a table titled 'Existing Notifications (1)' shows one notification rule.

Meter	Notification Rule	Created Date	Last Occurrence	Occurrences
1919 LAKEVIEW DR	Daily total energy use Above 25 kWh	3/29/2012 3:55:39 PM		0

Tracking Participants' Response

Electricity usage, customer page views of online usage, and other customer information and behavior (based on periodic surveys) are being tracked for a two-year period, of which this report summarizes the first year. Data being tracked and reported herein include the following:

Usage data — Monthly electricity usage data is being tracked for the year preceding and the two years following implementation of enhanced feedback, and provides the fundamental data for assessing the extent to which enhanced feedback results in changes in electricity usage. Hourly data is also maintained for all households with advanced meters, regardless of the household's group assignment.

Online page views — As noted, Minnesota Power is providing the pilot's usage feedback through an enhanced version of its Power of One® web portal. Customer page view data allow a detailed examination of how frequently participants view their online usage information, and how this behavior changes over time.

Participant surveys — The research plan also calls for a series of surveys of participants during the pilot. We include insights gained from the baseline survey, which was presented to participants the first time they logged into the portal, and the first mid-pilot survey, which was fielded as an online survey in April 2013. We also include results from telephone interviews conducted in December 2012 and early January 2013 with 21 voluntary participants representing a range of engagement levels with the pilot program to that date. These interviews were conducted, in part, to inform the survey design for the first online survey. They examined attitudes, energy-related behaviors, and satisfaction with the pilot and the enhanced information provided.

RESULTS

Results presented here are based on the first year of the consumer feedback portion of the pilot. We present outcomes in separate report sections that align largely with the research questions the project was designed to answer. Those sections are:

- demonstrated interest;
- portal usage;
- effects (of the pilot) on electricity consumption; and
- customer experience.

DEMONSTRATED INTEREST

The first set of research questions for this pilot centered on whether customers would show interest in enhanced usage information. While more than 1,600 customers volunteered to participate in a feedback-oriented pilot, the overall number of volunteers fell short of the number Minnesota Power had hoped to recruit. This list ultimately led to 1,482 eligible participants.

Those results prompted Minnesota Power to supplement the volunteers who came forward after receiving an invitation to participate with a group of utility-assigned participants who were then informed of the new service available to them.

Response to Pilot Offer

Minnesota Power sent invitations for customers to participate in a pilot program that would let the utility test new ways to provide customers with more frequent and meaningful information about their electricity usage and help them make more effective energy-related choices. A progression of marketing consisting of e-mail⁶, post cards, automated calls, and letters were used to reach out to 31,548 eligible customers in the Duluth/Hermantown area between August and October 2011. Copies of the solicitation materials and the sequencing of the marketing are included in Appendix A: Solicitation Collateral.

Minnesota Power received a total of 1,631 responses to its solicitations. Volunteers indicated their interest on a web form listed on the invitation. After screening out various forms of duplicates and some isolated volunteers with technical or eligibility constraints, Minnesota Power was left with 1,482 volunteers, which were assigned into the three study groups.⁷ Duplications included volunteers who completed the web questionnaire twice for the same address or different addresses and volunteers with multiple meters at one location.

Requirements for participating in the pilot included the following filters. Participants:

- could not have multiple service points/service agreements;
- must have at least 12 months of pre-pilot billing history; and
- needed to be on standard residential rates (e.g., not seasonal rates).

In addition, voluntary participants completed a short survey when they expressed their desire to participate in the pilot and answered a few questions about their degree of interest in various types of

⁶ Initial emails were sent to eligible Power of One® participants.

⁷ This participant count includes a group of customers for whom we had account numbers, but did not have any usage data, as well as participants whose accounts appeared to close during the pilot.

usage feedback, the frequency with which they access the Internet, and a few key appliance holdings. In this survey they told us that:

- they did indeed have interest in usage feedback, with more than 75% of volunteers rating their interest as a 4 or 5 on a five-point scale;
- as a group, they had a slight preference for online feedback over in-home displays;
- they were more interested in daily feedback than hourly feedback (with real-time feedback falling between the two);
- they accessed the Internet daily or more often in large numbers (>90% of volunteers).

Utility-Assigned Participants

In addition, Minnesota Power assigned 2,303 eligible households to participate in the pilot from among customers in the Duluth/Hermantown area that already had an advanced meter installed, met the minimum participation criteria, and had not responded to the pilot solicitation. We discuss non-use of the pilot by both recruitment pools in the next section.

Participant Characteristics

More detailed household and demographic characteristics are available for 1,414 of the participants—including 1,005 (68%) of those who volunteered and 410 (18%) of those who were assigned into the pilot. These data stem from a combination of prior responses to the Power of One® portal's primary information-gathering questionnaire and a baseline survey built upon that instrument.

Overall, participants who completed the baseline survey tend to be middle-aged (people in their 50s comprised the largest single age group, representing 26% of participants) with high degrees of formal education (two-thirds have college degrees) in multi-person households (average household size is 2.6) with above average incomes. They live in moderately sized and often somewhat older homes (mean size 1,700 ft², mean vintage 1946). Some of these characteristics are a function of the housing type and demographics of the pilot region being studied. It does seem worth noting, however, that a majority of the voluntary participants claim to have already made efforts to reduce usage, so they appear to be actively interested in applying usage information to reduce their consumption. Furthermore, nearly all voluntary participants said they currently examine their usage as displayed on their Minnesota Power bills, and a majority said they take additional steps to monitor their usage, such as tracking their consumption or billed amounts over time or even making comparisons to similar months in past years.

Participant Feedback

Qualitative feedback from 21 telephone interviews of participants suggested that those who chose to participate were all aware that they were in a pilot study and remembered volunteering for it, regardless of their level of engagement with the pilot to that date. They commented that the pilot's marketing materials made it sound intriguing and useful to them, and they volunteered because they thought the information provided in the pilot would help them save energy, save money, or make their home more efficient. Some of the interviewees who had become more frequent users of the pilot portal also identified specific household activities for which they thought detailed usage data would be helpful. For example, one had recently switched to CFLs and was curious whether he could see the difference. Another wanted to see whether he can use his ground source heat pump more efficiently.

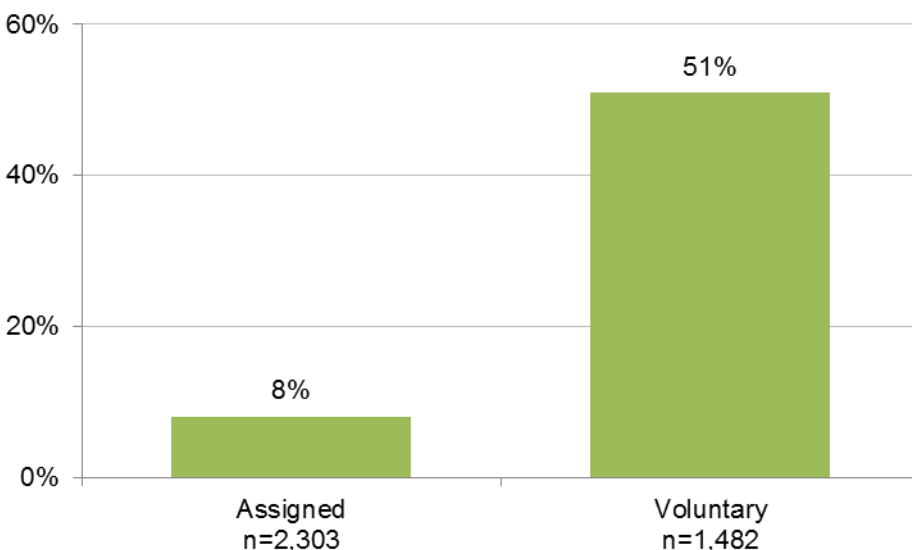
PORTAL USAGE

The second set of research questions Minnesota Power sought to test with its pilot program centered on whether people would view enhanced usage feedback if it were offered. Or, to put this another way: if Minnesota Power builds it, will the customers come? Usage patterns during the first year of the Power of One® Choice Pilot suggest that some customers will come, but only occasionally.

Share of Participants Who Accessed the Portal

Only one-quarter of all participants accessed the online portal at least once during the first year of the pilot. As expected, participants who voluntarily joined the pilot were more likely to log on than those who were simply enrolled (assigned) in the pilot without indicating interest. Still, only half of voluntary participants actually logged on to the portal. This compares to eight percent of assigned participants who logged on at least once.

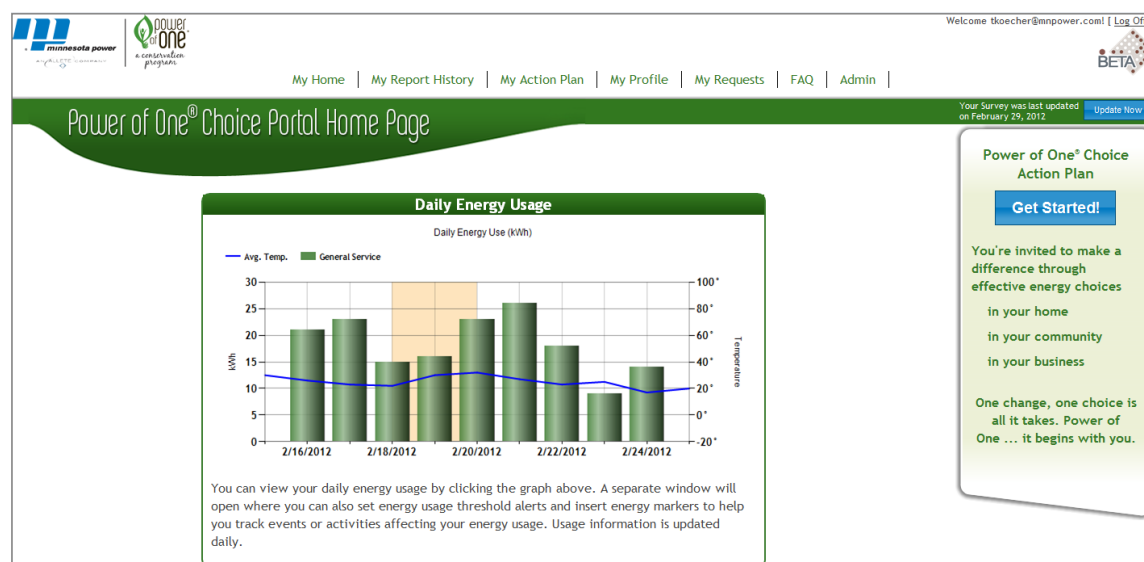
Figure 8: Online portal use, by pilot enrollment pool



Share of Participants Who Viewed the Feedback

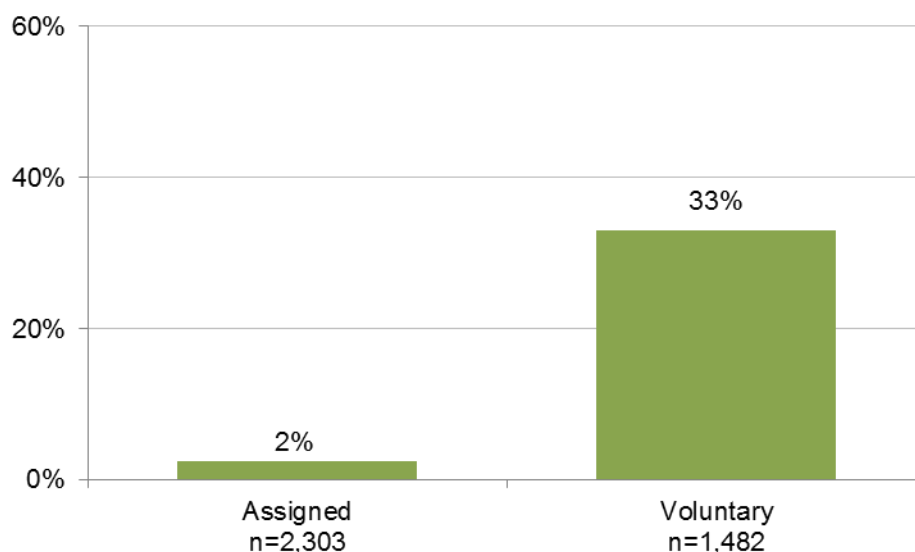
The enhanced usage feedback feature enables some pilot participants to see their electricity usage in daily increments, and others in hourly increments. For participants in the control group, a graph of their month-to-month usage is displayed, similar to what they see on their monthly bills outside of the pilot.

Figure 9: Example of enhanced usage feedback (screenshot of daily energy usage)



Among those who had expressed active interest in feedback by volunteering for the pilot, one-third viewed their usage information in the pilot portal at least once. In contrast, among those assigned to the study, only two percent viewed the usage feedback page in the portal. Arguably, if Minnesota Power made enhanced usage information available system-wide, the rate at which customers would view that information is a blend of the rate at which volunteers and assigned participants are currently making use of it, with assigned participants representing the bulk of the population.

Figure 10: Enhanced usage feedback use, by pilot enrollment pool



Among assigned and voluntary participants who viewed their enhanced usage feedback at all (15 percent of the overall participant pool), most viewed their feedback infrequently. Three-fourths of viewers looked at their enhanced usage graph between one and three times during the first year of the pilot. The remaining quarter looked at their enhanced usage more than three times during this period. We consider the latter group to be the most intentional consumers of the feedback.

Table 2 shows the proportion of all participants who never viewed their enhanced feedback, viewed it between one and three times, or viewed it more three times. Similar proportions are shown for participants who accessed the portal at all (i.e. at least reached the logon page) and those who reached their enhanced feedback page.

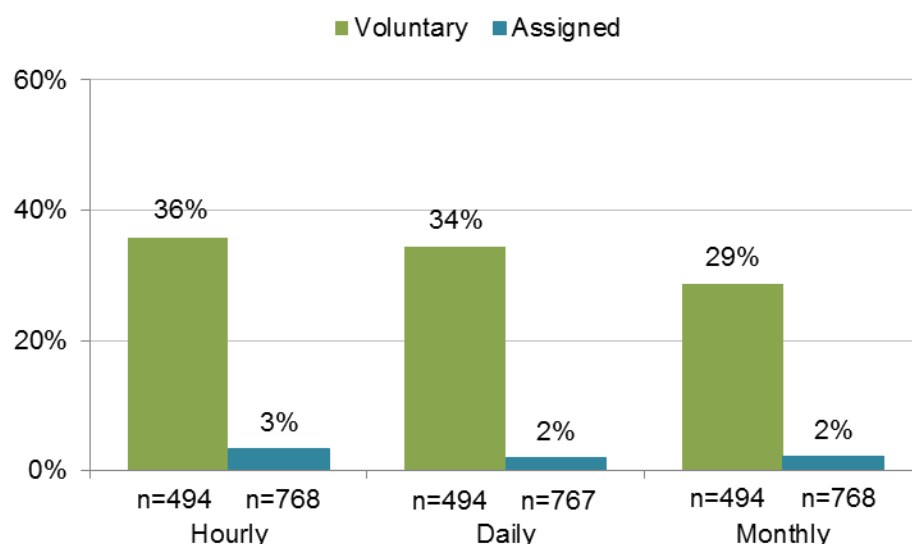
Table 2: Views of enhanced feedback by activity in the portal

Participants who...	as a % of all participants		as a % of participants who accessed portal		as a % of participants who reached enhanced feedback page	
Never viewed enhanced feedback	86%	3,222	41%	379	n/a	
Viewed enhanced feedback 1-3 times	11%	403	44%	403	74%	403
Viewed enhanced feedback more than 3 times	4%	142	15%	142	26%	142
Total	100%	3,767	100%	924	100%	545

As noted, participants were presented with a baseline survey upon their initial login to the pilot. While they could simply click through the survey without answering any questions, it is possible that the initial appearance of a survey upon the participants' first visit deterred casual explorers from further exploration.

To understand whether higher-resolution feedback prompts customers to view their usage data, we examined whether there were any differences among the monthly, daily, and hourly groups. We found that among voluntary participants, higher resolution feedback was correlated with a higher viewing rate. Voluntary participants in the two treatment groups were more likely to view their usage than those in the control group by five to seven percentage points.⁸ This pattern was not evident among assigned participants; despite the larger size of this customer pool, the incidence rate is low, and differences among the groups are small and statistically insignificant.

Figure 11: Enhanced usage feedback use, by pilot enrollment pool and treatment group



⁸ The latter difference (between the hourly- and monthly-feedback groups) is statistically significant at about a 99% confidence level. The former difference (between the daily- and monthly-feedback groups) is statistically significant at better than a 90% confidence level.

Regularity of Feedback Usage

Viewing the feedback information at least once does not indicate that the participant actually examined the chart presented to him or her in any depth or gave any thought to it. For this reason, as a proxy for actual active consideration of the information, we looked at two further components of participants' engagement with the usage feedback:

- the regularity with which they viewed the feedback; and
- the degree to which they used any of the features offered behind the feedback chart.

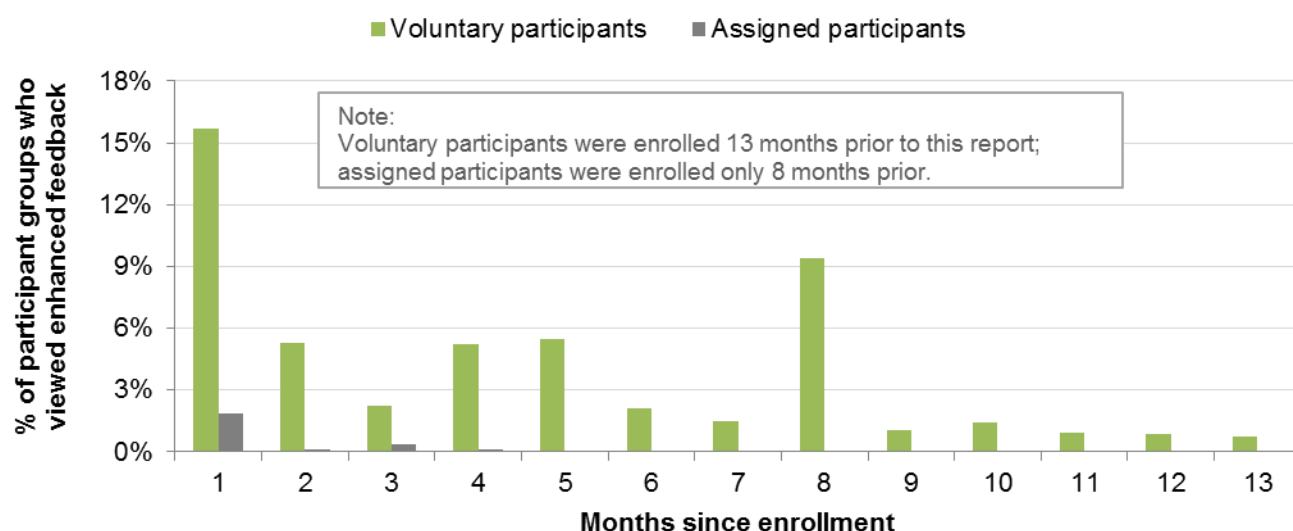
Among the 545 participants who viewed the usage feedback at least once, slightly more than half (55%) saw it just one time. Of the remaining 45 percent of participants who viewed their usage more than once (through March 2013), only three individuals viewed the information once a month or more frequently.

Figure 12 below shows the percent of participants per month since enrollment in the pilot program (broken out into assigned and voluntary) who viewed their enhanced usage. There are two spikes in views of the feedback by pilot volunteers: immediately after it became available and in month 8. After that, participants viewed their feedback information at about 1/10th their initial rate.

Both spikes are associated with prompts from Minnesota Power to participants. The first month of enrollment was initiated with the distribution of welcome packets to all participants. The eighth month of the volunteers' participation (3rd month for assigned participants) corresponded with a reminder e-mail sent to all participants on October 2, 2012. (The only other reminder was a postcard mailed to a sample of participants on August 21, 2012.)

Nearly all participants can be described as having viewed the feature one or two times, while a few individuals looked at it many times, raising the overall monthly average to more than three views per month among people who viewed their usage in the given month.

Figure 12: Frequency of enhanced usage feedback use, by pilot enrollment pool



Depth of Feedback Usage

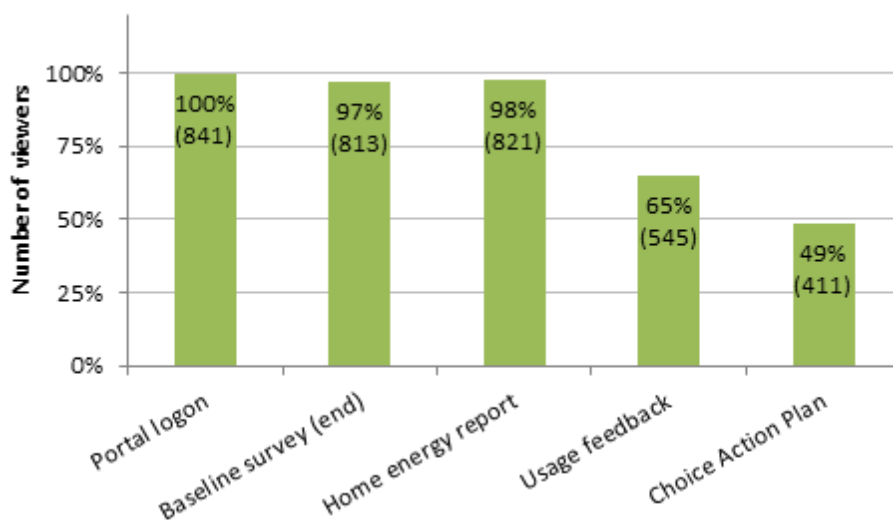
Participants in the treatment groups—i.e., those who received daily or hourly usage data—could also click on their usage graph for access to the MyMeter™ tool, where they can set energy usage threshold alerts, insert energy markers to help track events or activities affecting energy usage, or download daily or hourly usage data. We found that about six percent of treatment group members who saw their enhanced feedback charts explored them more deeply by clicking on them. Both voluntary and assigned participants displayed a similar rate of clicking through to the MyMeter tool, six and seven percent respectively.

How Participants Used the Portal

Participant patterns described above need to be viewed within the context of the portal and the other features it promotes in addition to enhanced usage feedback. To the extent that the portal—and the full set of features and services offered within it—contributed to or reduced the number of logins, those effects are included in the counts of participants who saw their feedback. We took a step back to examine just how participants used the full portal.

Out of the 841 participants (in treatment groups or the control group) who logged on to the portal at least once, nearly all of them completed the baseline survey or reviewed their responses from a previous submission of the survey (97 percent)⁹ and viewed the resulting home energy report (98 percent). Two-thirds (65 percent) viewed their enhanced feedback and half used the My Action Plan tool.

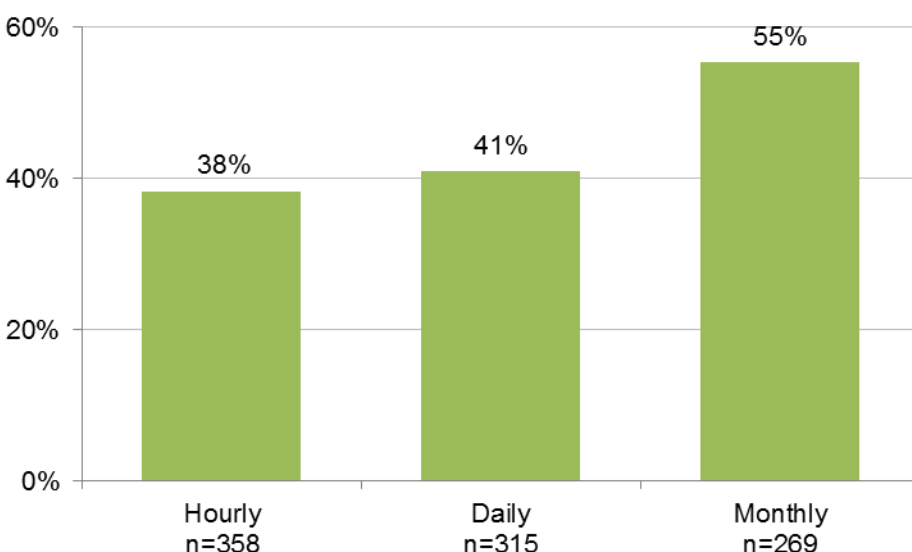
Figure 13: Frequency of use of portal features



As with the enhanced feedback, participants who accessed the action plan tended to look at it just once during the pilot period so far; two-thirds of those who viewed it accessed it a single time. However, interestingly, participants in the control group looked at it more than those in the two treatment groups, as shown in Figure 14.

⁹ In some cases, reviewing previous responses may have entailed simply clicking “next” and paging through the survey that way without making any changes.

Figure 14: My Action Plan use by treatment group



Participant Feedback

Qualitative feedback from the 21 telephone interviews of participants suggests some barriers that prevent greater usage. Those who had not logged on at all yet (the inactive participants) tended to blame lack of time and busy schedules, which we interpreted to be lack of priority compared to their other activities.

The minimal participants spoke of logging in soon after receiving their welcome kit to take a look and explained their absence since then in one of two ways. Some found useful information that they acted upon, but then found themselves too busy to return to the website. These participants identified specific actions they took, such as accelerating their replacement of some aging appliances, unplugging devices, changing light bulbs, and reducing use of an electric fireplace. (The page view data indicates that these participants had not seen the usage data in the portal, so they may have been spurred to action by the energy-saving recommendations in the portal or simply by having been prompted to think about their energy usage.)

Other minimal participants indicated that they did not find the information in the portal compelling or memorable. Again, they did not appear to see the usage information in the portal, so their assessment seems to be based on something other than the usage feedback.

The active participants also spoke of logging on early on and then reducing their usage of the portal over time. Interestingly, these users were able to estimate their number of logons fairly accurately. The majority of active participants said that the usage information in the portal helped them better understand their electricity usage, but they spoke in general terms. Only one elaborated on *specific* insights she had taken away from the information. That participant found herself with heightened awareness of devices that tend to use much electricity while they are running, but do not necessarily contribute much to a home's overall consumption.¹⁰

¹⁰ This participant cited increased awareness of the electricity used by her home's hair dryer, laundry equipment, and vacuum cleaner.

Some active participants said that they did not find the pilot portal very useful and were unlikely to return to it. These participants mirror a subset of the minimal participants, but differ in that they explored the portal sufficiently to have seen the usage comparison at least once.

EFFECTS ON ELECTRICITY CONSUMPTION

The previous section indicates that some customers will take advantage of the online tools provided by Minnesota Power to help users better understand their consumption patterns. The next question is, does use of these tools, specifically availability of and exposure to enhanced usage feedback, impact customers' electricity consumption?

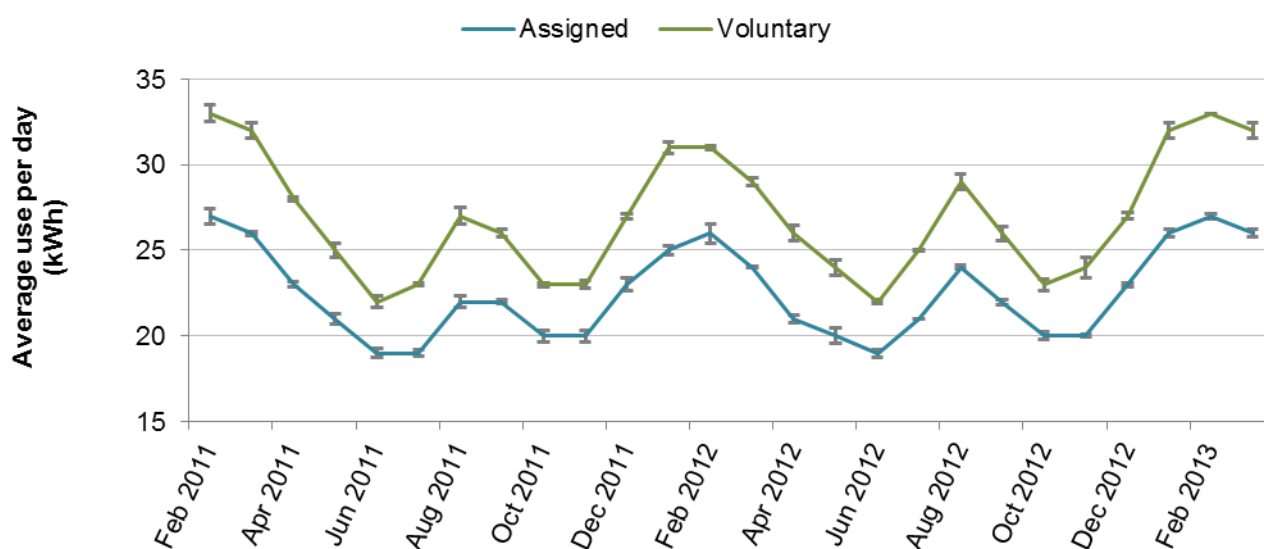
To answer this question, we conducted an analysis of the change in electricity consumption following initial participation in the pilot.¹¹ During the first year of the pilot, we found no statistically significant changes in electricity consumption—either between the treatment and control group or between those who viewed the available usage feedback and those who did not. However, the sample sizes were such that we would be unlikely to detect between-group differences of less than two percent.

We present our results in two different ways: first, a quantitative comparison of treatment groups, and then a qualitative comparison of participants by their level of engagement.

Results by Treatment Group

Overall, pre-pilot annualized electricity usage by pilot participants averaged around 9,000 kWh (approximately 19 to 34 kWh per day), which is in line with typical usage levels for Minnesota Power's residential customers. Voluntary participants used somewhat more electricity than assigned participants, albeit with similar patterns of use (see Figure 15). These differences in consumption could be due, at least in part, to the greater prevalence of multi-family housing units in the assigned pool.

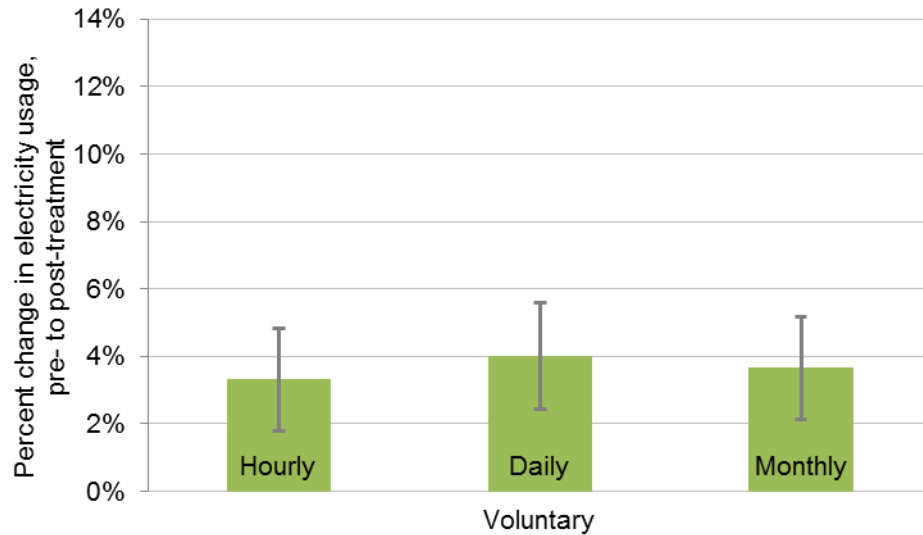
Figure 15: Average electricity use per day, by pilot status



¹¹ See Appendix B: Analysis Methodology for a description of our methodology.

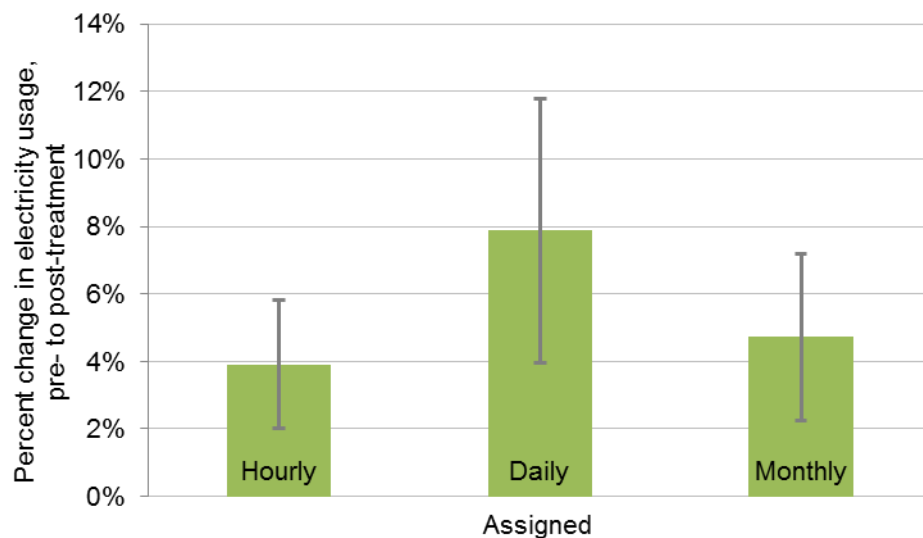
Electricity usage increased across the board during the pilot due to colder weather and possibly other exogenous factors (Figures 16 and 17).

Figure 16: Percent change* in electricity usage for voluntary participants, by treatment group



* Note: Electricity usage was higher for all groups during the first year of the pilot than the pre-pilot period due to weather or other exogenous factors.

Figure 17: Percent change* in electricity usage for assigned participants, by treatment group



* Note: Electricity usage was higher for all groups during the first year of the pilot than the pre-pilot period due to weather or other exogenous factors.

Of interest here, however, is how much usage changed for the treatment groups *relative* to the changes in their respective control group. Because customers were randomly assigned to the groups, any *net* changes in the treatment groups' usage (i.e. treatment-group change minus control-group change) can be attributed to the feedback provided by the pilot. Table 3 summarizes this difference-in-differences (DID) approach. The point estimates of the net change in consumption for the treatment groups range from -0.4 percent to +1.6 percent. However, all are within the statistical margin of error, which ranges from ± 2.1 to ± 2.5 percentage points. Because our statistical uncertainty range spans zero in all cases, we cannot confidently conclude from this analysis that exposure to the enhanced usage feedback has an impact on electricity usage in general.

We also undertook a somewhat more complex regression analysis that controls for the seasonal variation in electricity usage that is evident in Figure 15 (see Appendix B for details). This analysis yielded slightly tighter confidence intervals, but similarly found no statistically significant impact on electricity usage from exposure to the enhanced feedback compared to exposure to standard monthly information (Table 4). Interestingly, there is one statistically significant difference in the change of usage—between the hourly and daily treatment groups among the assigned customers, which is statistically significant at about a 99 percent confidence level. We have no explanation for what might be driving this result.¹²

The fact that we cannot confidently conclude that the enhanced feedback has an impact on electricity consumption is not the same as confidently concluding that it has *no* impact. It is possible that the impact is simply too small to be detected given the study group sizes involved. The confidence intervals here suggest that if there is an impact, it is unlikely to be more than about two percentage points.

Table 3: Summary of changes in electricity usage by treatment group (DID)

Pool	Group	avg pre-pilot usage	avg change in usage		avg net change in usage (treatment – control)		n
		annual kWh	kWh	%	kWh	%	
Voluntary	Hourly (trmt)	9,491 \pm 512	172 \pm 128	3.3% \pm 1.5%	-51 \pm 201	-0.5% \pm 2.1%	454
	Daily (trmt)	9,590 \pm 543	254 \pm 141	4.0% \pm 1.6%	30 \pm 209	0.3% \pm 2.2%	464
	Monthly (ctrl)	9,666 \pm 524	224 \pm 155	3.7% \pm 1.5%			457
Assigned	Hourly (trmt)	8,375 \pm 434	176 \pm 157	3.9% \pm 1.9%	-36 \pm 209	-0.4% \pm 2.5%	672
	Daily (trmt)	8,285 \pm 405	340 \pm 140	7.9% \pm 3.9%	129 \pm 197	1.6% \pm 2.4%	693
	Monthly (ctrl)	8,220 \pm 399	211 \pm 139	4.7% \pm 2.5%			681

¹² One could hypothesize that the hourly data is more effective at providing useful, actionable insights to customers, but the assigned participants viewed their feedback at much lower rates than the voluntary participants, where the difference in usage changes between the hourly and daily groups is lower and not statistically significant.

Table 4: Summary of changes in electricity usage by treatment group (regression analysis)

Pool	Group	avg pre-pilot usage	estimated net change in usage		n
		annual kWh	(treatment – control) kWh	%	
Voluntary	Hourly (trmt)	9,491 ±512	-45 ±172	-0.5% ±1.8%	454
	Daily (trmt)	9,590 ±543	55 ±171	0.6% ±1.8%	464
	Monthly (ctrl)	9,666 ±524			457
Assigned	Hourly (trmt)	8,375 ±434	-60 ±131	-0.7% ±1.6%	672
	Daily (trmt)	8,285 ±405	109 ±130	1.3% ±1.6%	693
	Monthly (ctrl)	8,220 ±399			681

Results by Level of Engagement

We also explored whether participants' use of their enhanced feedback (rather than just its availability) made a difference in their electricity usage. A quantitative assessment of the net impact of portal use was not possible given the structure of the pilot program¹³; instead we provide some descriptive statistics of active versus inactive participants and a brief qualitative discussion. Table 5 summarizes usage levels and changes for all participants who viewed their enhanced feedback at least once (active participants), and those who did not view their enhanced feedback (inactive participants).

Table 5: Summary of changes in electricity usage by level of engagement

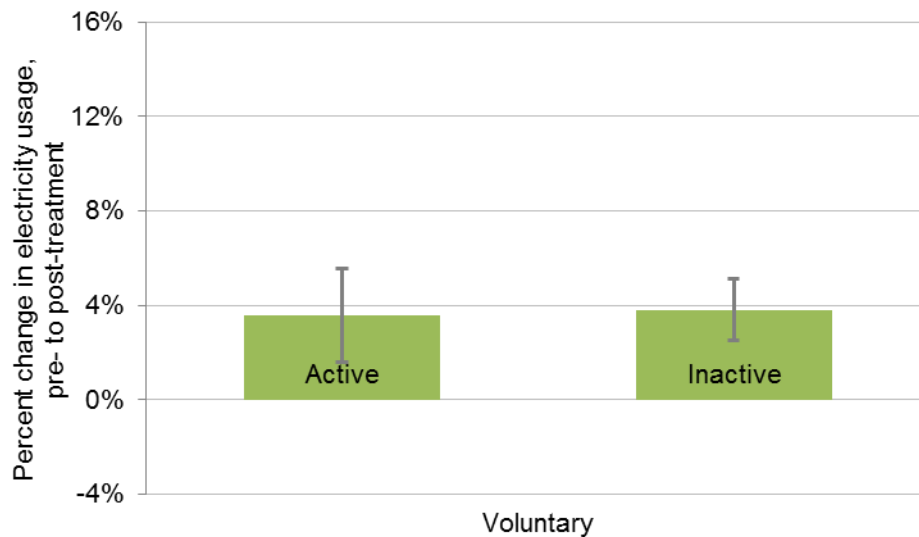
Pool	Group	avg pre-pilot usage	avg change in usage		n
		annual kWh	kWh	%	
Voluntary	Active	9,574 ±526	186 ±151	3.8% ±1.6%	466
	Inactive	9,587 ±372	233 ±97	3.6% ±1.0%	909
Assigned	Active	8,670 ±1875	363 ±513	5.8% ±7.2%	61
	Inactive	8,281 ±239	240 ±85	5.5% ±1.7%	1985

Again, we see increases in usage across all groups due to factors outside the pilot (probably weather); however the increase associated with active users of the portal is not statistically different from non-users. Moreover, without a true control group of customers who lacked any access to the portal, this analysis is potentially confounded by other unobserved differences between the self-selected active and inactive portal users.

As Figure 18 shows, voluntary participants experienced very similar increases in electricity consumption regardless of group assignment or whether they viewed the enhanced feedback available to them.

¹³ To conduct a true assessment of the net impacts of portal use (regardless of feedback resolution), we would need randomly assigned treatment (those with access to the portal) and control (those without access to the portal) groups. Allocation of the active and inactive participants in the Minnesota Power pilot program were dependent on a self-selection process among only customers who were offered access to the portal; hence, a statistical comparison of these groups' usage changes over the span of the pilot would potentially be biased.

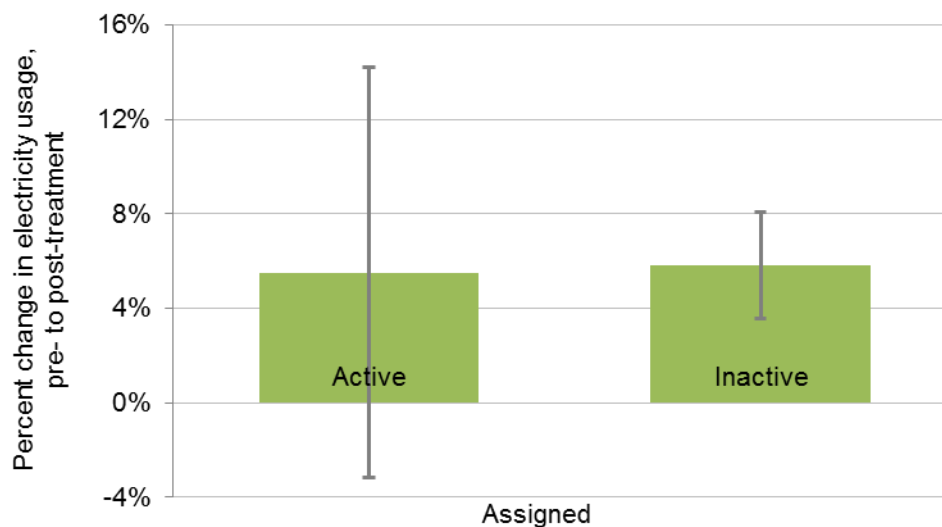
Figure 18: Percent change* in electricity usage for voluntary participants, by use of the feedback



* Note: Electricity usage was higher for all groups during the first year of the pilot than the pre-pilot period due to weather or other exogenous factors.

Among assigned participants, we had far fewer active users of the feedback, which resulted in greater statistical uncertainties. Here, too, there are no statistically significant differences between participants who viewed their enhanced feedback and those who did not view the feedback available to them. Figure 19 shows these results graphically.

Figure 19: Percent change* in electricity usage for assigned participants, by use of the feedback



* Note: Electricity usage was higher for all groups during the first year of the pilot than the pre-pilot period due to weather or other exogenous factors.

Sensitivity to Outliers

Because outliers—customers with extremely high electricity usage or unusually large changes in usage that are probably not related to the treatment—can have problematic effects on usage analyses, we conducted a sensitivity analysis. Excluding customers who used more than 40,000 kWh in either the pre- or post-treatment period or who experienced a change in usage (up or down) by more than 50 percent from the pre-treatment period to the post-treatment period tightened up the statistical uncertainties by a few tenths of a percentage point, but did not change the relative differences between groups in any significant way from the results shown above.

CUSTOMER EXPERIENCE

Minnesota Power conducted an online “check-in” survey in April 2013 of 1,747 participants for whom valid e-mail addresses were available to learn more about their perceptions, satisfaction, and self-reported use of the pilot to-date. Four hundred twenty-four participants responded for an overall response rate of 24 percent after two reminders to non-respondents. Response was highest among treatment group members (those in the hourly and daily feedback groups) who had used the portal. For analysis, we divided respondents into those who had not used the portal at all, those in the control (monthly feedback) group who had accessed it at least once, and those in the treatment groups who had accessed it at least once. Table 6 shows responses for each of these groups. The survey instrument is attached as Appendix C.

Table 6: Responses to April 2013 survey of participants

	successful e-mail deliveries	responses	response rate
active participants in the daily/hourly treatment groups	550	234	43%
active participants in the monthly control group	251	92	37%
inactive participants (from any group)	946	98	10%

Overall, the Power of One® Choice Pilot received middling satisfaction scores from all three groups with mean satisfaction scores on a 10-point scale ranging from 5.6 to 6.1 across the three groups. In comparison, two-thirds of respondents rated their overall satisfaction with Minnesota Power higher than their satisfaction with the pilot, some of them dramatically so with score differentials of 3 or more points for a quarter of respondents. Another quarter of respondents provided the same scores to the pilot and to Minnesota Power overall, and only 10 percent rated the pilot higher than Minnesota Power overall.

Individual aspects of the pilot seem to have received better evaluations than the pilot overall, however, as we describe below.

Perceptions of the Portal's Features

In analyzing self-reported usage and perceptions of the various features included in the pilot portal, we found that awareness was high across all groups for the energy-saving recommendations and the availability of an action plan and moderate to high for historic energy usage (feedback) charts, energy markers and notifications. The historic energy usage charts received the highest scores for usefulness, with a slight majority of those who reported viewing them—and a bit more than a third of active participants overall—indicating that they were very useful. Recommendations for ways to save energy were viewed as somewhat useful by most active participants. The other features—action plans, energy markers, and notifications—were also viewed as generally somewhat useful by those who used them, but use of these features was not as widespread.

Figure 20 through Figure 24 display participant assessments of the features in more detail.

Figure 20: Awareness and perception of features among active users: energy-savings recommendations

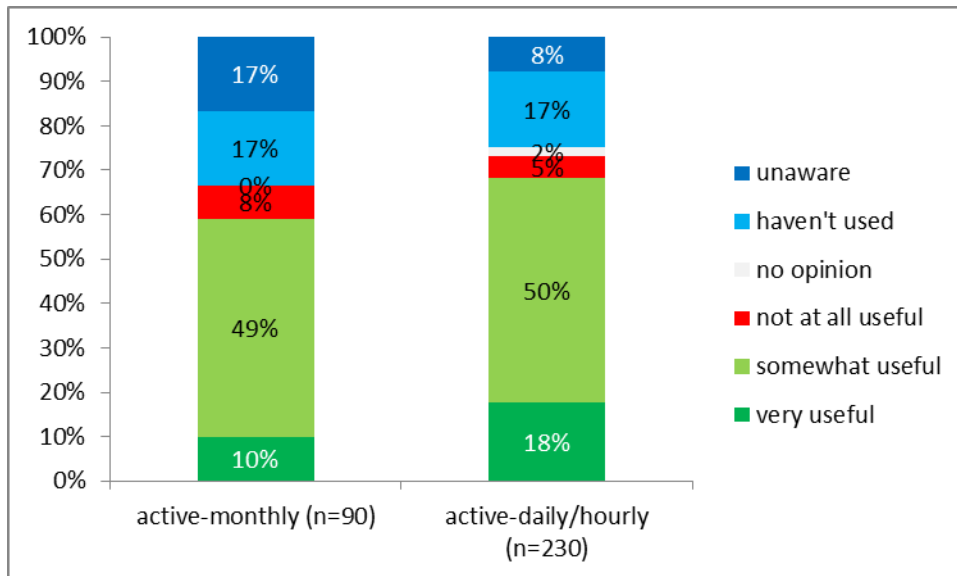


Figure 21: Awareness and perception of features among active users: My Action Plan

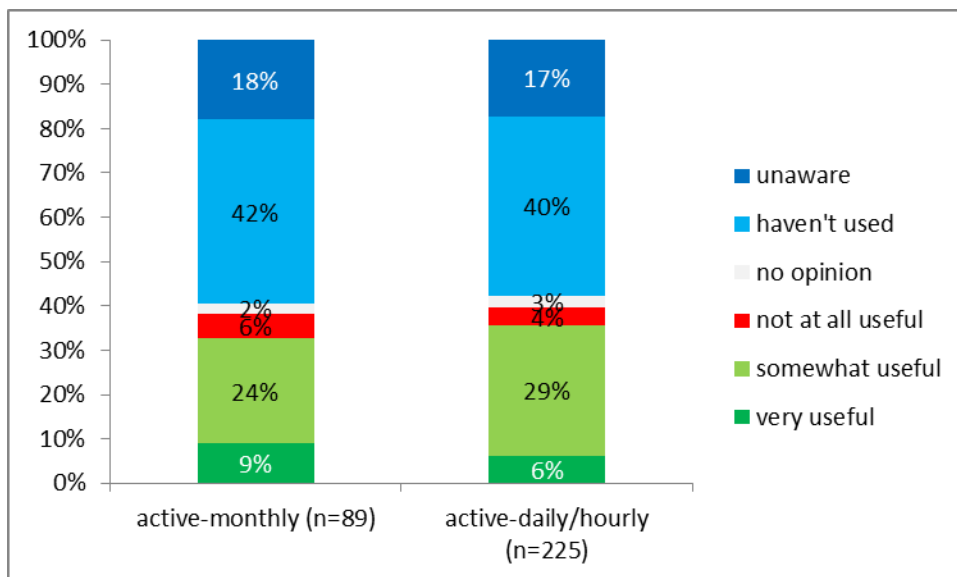


Figure 22: Awareness and perception of features among active users: historic usage (feedback) chart

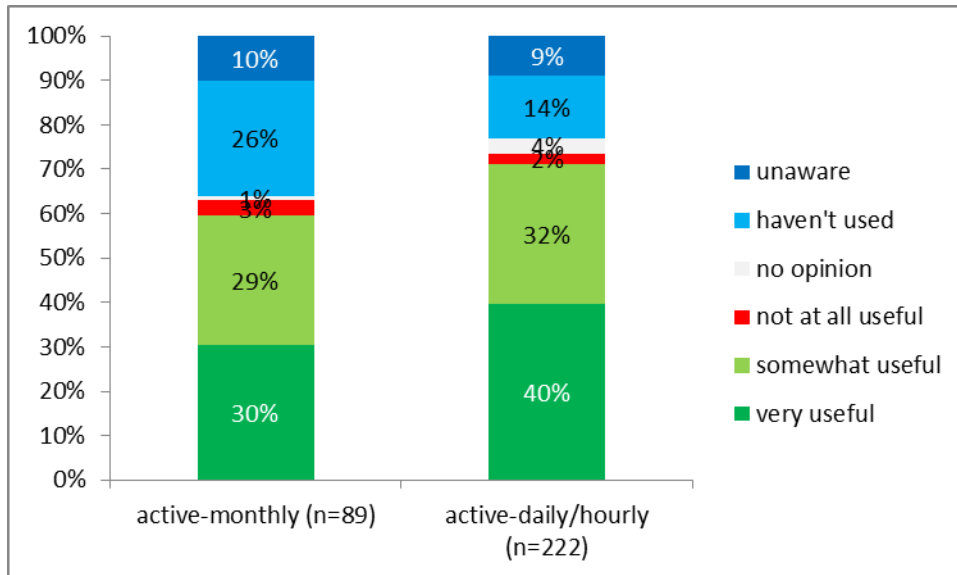


Figure 23: Awareness and perception of features among active users: energy markers

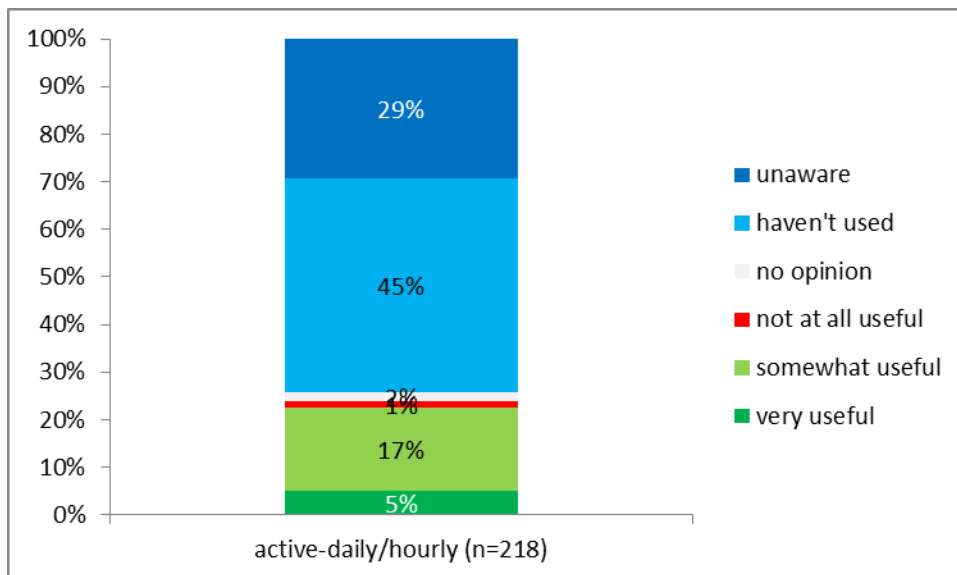
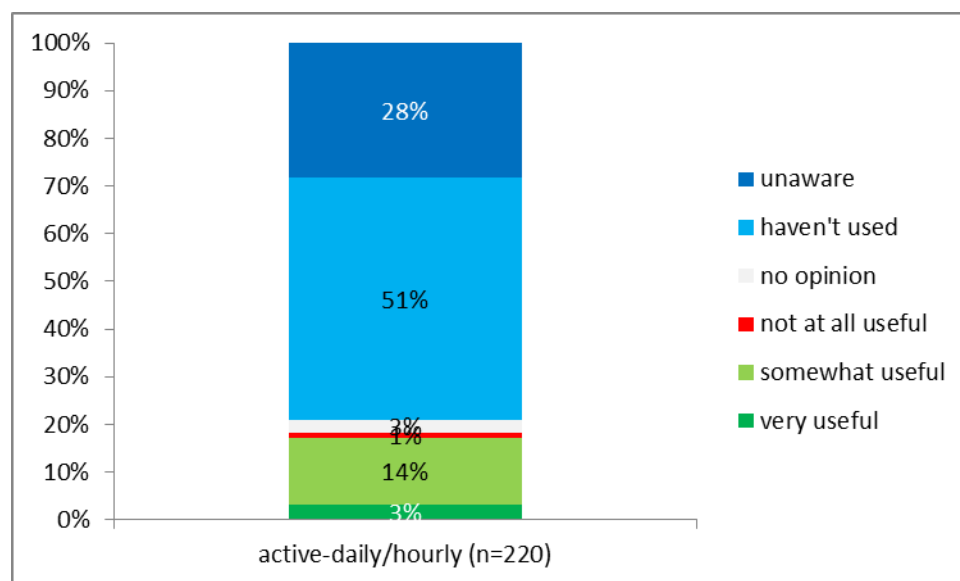


Figure 24: Awareness and perception of features among active users: notifications



Usability of the Portal

We also explored the usability of the portal to determine whether it worked well for participants as it was structured and communicated. For our analysis of these questions, we included inactive participants to see how they differed from active participants. Not surprisingly, inactive participants were much more likely than active participants to say that they had no basis for an opinion.¹⁴ This suggests that many inactive participants just didn't explore the portal (rather than being deterred by some aspect of it).¹⁵

Among those who offered an opinion, clear majorities thought that:

- the portal's user guide (i.e., the welcome kit) gave them a good sense of what they would find in the portal;
- getting into the portal was easy;
- the portal's features were easy to find; and
- they could get to the content that interested them quickly.

Figure 25 through Figure 28 display participant responses in more detail.

¹⁴ We offered "no basis for opinion" as an additional response option beyond "neutral" to allow respondents who had not engaged with the pilot or not done so sufficiently to have an opinion to opt out of making a judgment about various aspects of its usability.

¹⁵ It isn't clear on what the inactive participants who did have opinions about the portal based their assessments. It's possible that they relied on the descriptions in the welcome packet and other communications about the portal, but some may have offered uninformed opinions.

Figure 25: Participant perceptions: “The user's guide gave me a good sense of what I would find in the portal.”

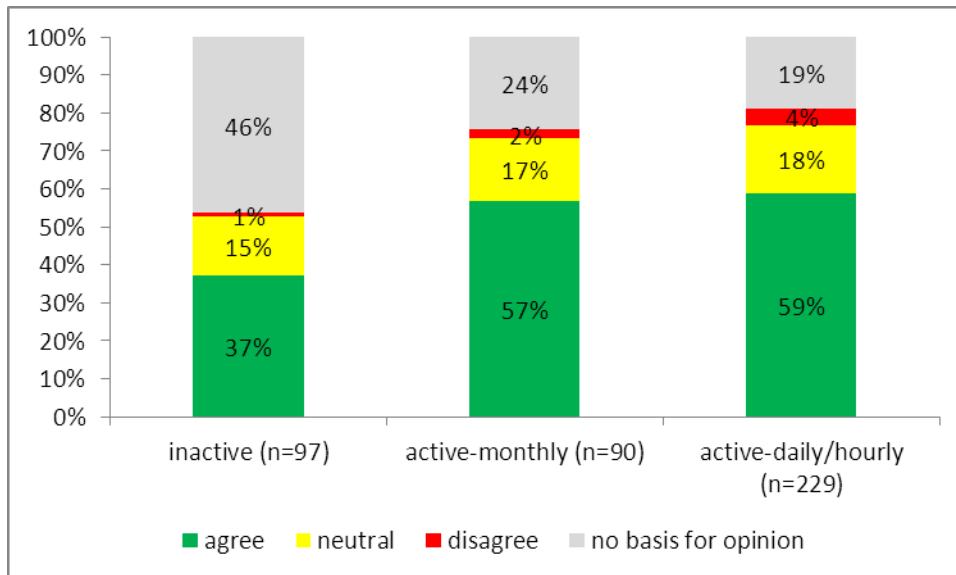


Figure 26: Participant perceptions: “Getting into the portal is easy.”

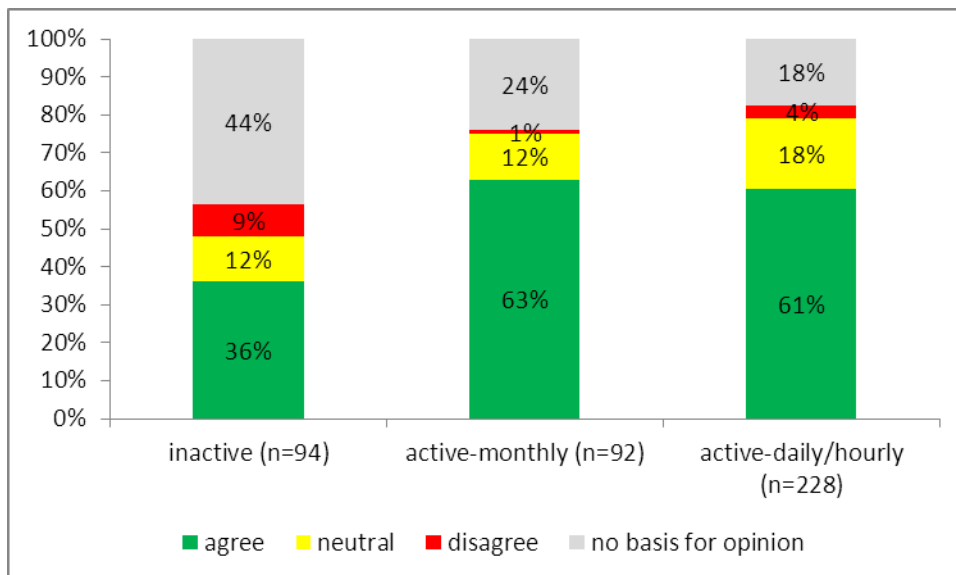


Figure 27: Participant perceptions: “The portal's features are easy to find.”

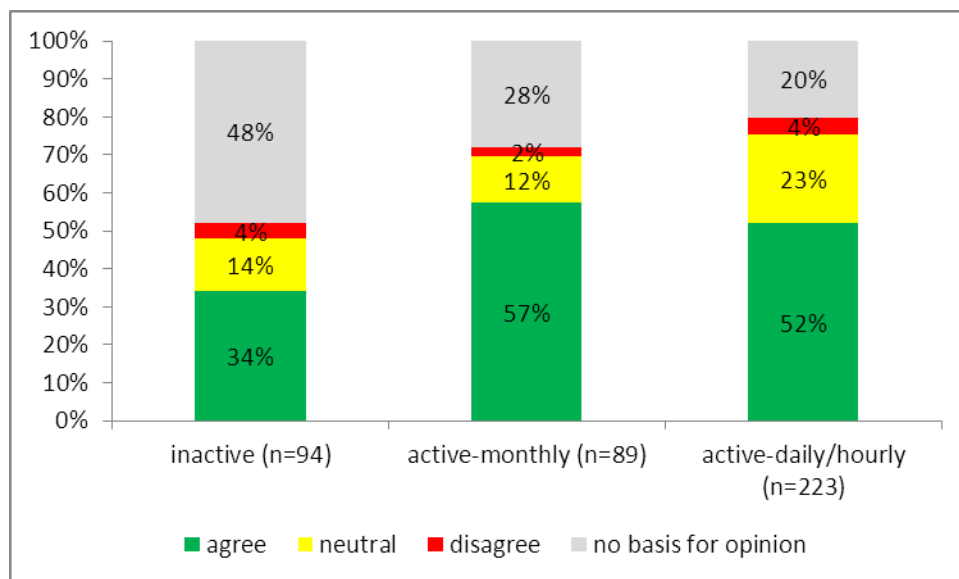
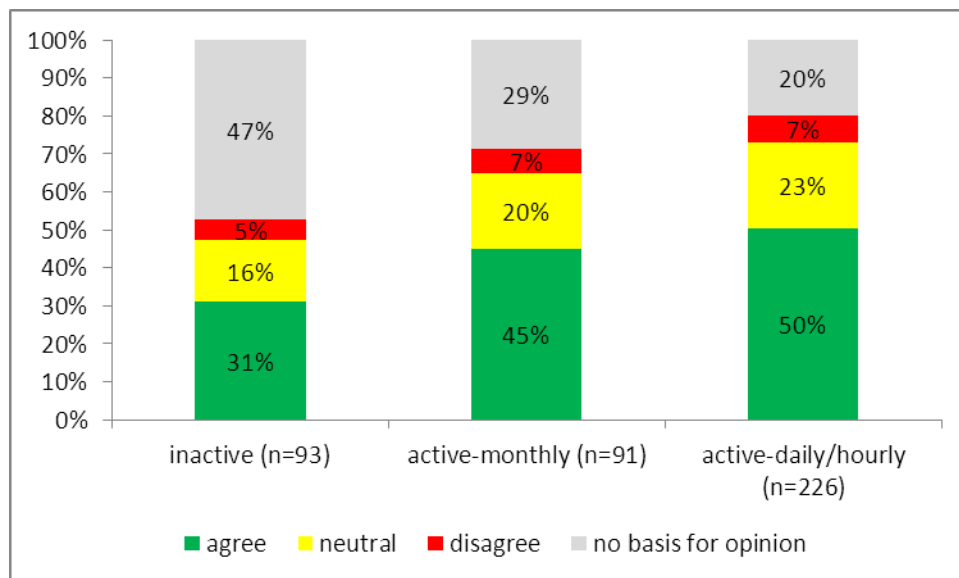


Figure 28: Participant perceptions: “I can get to the interesting content quickly.”



Perceptions about Electricity Consumption

Finally, we examined participants' perceptions of their electricity usage and expenditures. Those who had not actively used the pilot portal were somewhat more likely to be satisfied with the amount of their spending and usage of electricity, and were less likely to see room for improvement (Table 7). This is consistent with inactive users having less interest in using tools designed to help customers conserve. Overall, however, the plurality of respondents in all groups said that their usage, while reasonable, could be improved.

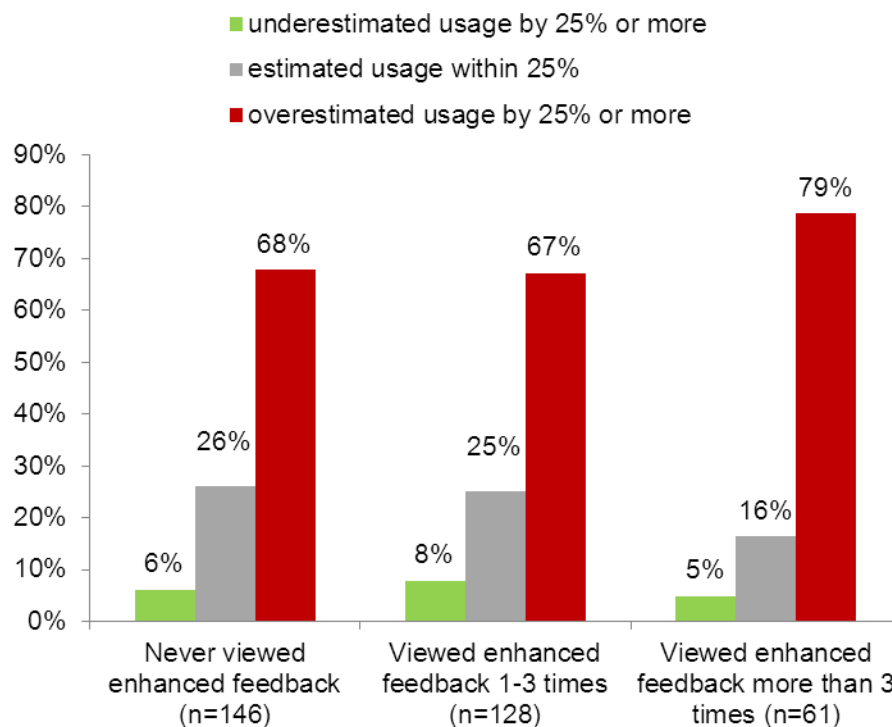
Table 7: Perceptions about current level of electricity usage, by level of engagement

	inactive (n=92)	active monthly (n=87)	active daily/hourly (n=212)
satisfied with usage level	24%	14%	15%
reasonable usage level, but see room for improvement	46%	62%	60%
high usage with interest in reducing	26%	22%	22%
usage “way too high” with interest in reducing	4%	2%	3%

Interestingly, when we compared actual electricity costs for survey respondents to what they reported on the survey in response to the question “*Without looking at your bills, how much would you estimate your household spent on electricity in the past 12 months?*” we found that participants from all groups overestimate their actual consumption. On average, respondents estimated their electricity costs to be \$950 during the 12 months prior to the (April 2013) survey, while their actual usage plus fixed monthly charges averaged \$715. In fact, nearly nine out of ten respondents provided estimates that were higher than their actual costs, and six out of ten estimated costs that were more than 25 percent higher than actual.

Whether or not participants viewed their enhanced usage feedback via the online portal did not have a sizable effect on their ability to accurately estimate their annual electricity cost. In fact, those who viewed their enhanced feedback more regularly (more than three times) were slightly less likely to estimate their costs accurately (within 25 percent of the actual value), as shown in Figure 29, leaving them more likely to overestimate costs.

Figure 29: Participants' estimates of their 12-month electricity costs



While on the one hand, this finding seems counterintuitive, it is possible that customers who overestimate their electricity usage and are more concerned about it were more likely to volunteer for the pilot and make use of the feedback. Furthermore, the enhanced feedback does not show usage in financial terms and thus may not correct misperceptions about customers' usage when expressed as costs.

CONCLUSIONS

The first year of the Power of One® Choice pilot program—and Minnesota Power customers’ responses to it—go a long way toward answering several of the research questions this consumer behavior pilot is designed to answer. We have organized our conclusions by research question and then offer some tentative lessons learned for Minnesota Power and other utilities seeking to use feedback as a customer service or efficiency intervention.

TENTATIVE ANSWERS TO THE RESEARCH QUESTIONS

What proportion of Minnesota Power single-family customers in the Duluth/Hermantown area are interested in enhanced information on electricity usage?

Consumers provide mixed messages about their interest in higher resolution usage feedback, but active interest appears to be modest. Both volunteers for the pilot program and participants who completed the baseline survey expressed high interest in high resolution feedback, with 75 percent of volunteers indicating interest in usage feedback and most indicating active tracking of their energy usage already. However, the volunteer rates for the pilot (1,631 volunteers from an eligible population of 31,548) fell substantially below Minnesota Power’s expectations and the use of the enhanced feedback is fairly light.

Minnesota Power’s program was designed to take a lighter touch in terms of marketing efforts and did not provide for an incentive to customers who signed up. This was in part due to the modest nature of the pilot and related budget allocation, Minnesota Power’s interest in testing consumer response to the notion of enhanced usage information and tools on their own merit, and the unlikelihood that Minnesota Power would offer an incentive in the event of a broader system-wide rollout of such tools. Further, customers were not provided explicit details in the solicitation materials about what information or tools they would have access to as part of the pilot. Messaging was more general in nature to allow for random assignment to one of three groups, all of whom had access to an online portal that displayed their electricity consumption histories:

- Customers who could see monthly electricity consumption (control)
- Customers who could see daily electricity consumption (treatment)
- Customers who could see (day-late) hourly electricity consumption (treatment)

Conceivably, a more explicit solicitation coupled with incentives and/or intensified marketing efforts could have increased interest in the pilot. Such an approach would have budget and timing implications and should be carefully considered by those considering similar tool offerings.

How do interested households compare to Minnesota Power’s general population of residential customers in terms of demographics, attitudes, appliance holdings, and electricity usage?

We were not able to glean much insight on the characteristics of customers who are most likely to engage with—or sign up for—enhanced feedback. The few demographic variables we were able to compare within and outside the study geography do not point to any differences that would obviously result in greater or lesser interest territory-wide than Minnesota Power is seeing in Duluth/Hermantown. However, the study did not collect relevant attitudinal factors and preferences of customers outside the Duluth/Hermantown area, which could provide additional insight, or test actual uptake outside the study geography, which would be the most accurate indicator of them all, as this study is showing.

Do customers make more frequent use of AMI-enhanced usage information compared to standard (monthly) online usage information?

Participant engagement with higher resolution feedback was relatively low in the first year. Three details warrant further elaboration.

First, voluntary participants with daily or hourly feedback resolution (i.e., those in the treatment groups) did look at their usage charts in the portal at a somewhat higher rate that was statistically distinguishable from the control group's rate of viewing feedback (34-36% compared to 29%).

Secondly, however, differences between voluntary and assigned participants dwarf the effect of the feedback resolution. Voluntary participants looked at feedback in much greater numbers than those who were assigned, regardless of the resolution available to them. While a third of voluntary participants viewed the usage feedback provided to them in the portal, only two to three percent of assigned participants did so. Given that only about five percent of customers in the Duluth/Hermantown area responded to the pilot solicitation, the results for the assigned group, which represents the 95 percent of customers who did not respond, arguably provides a better indication of how the bulk of customers in the area would respond if Minnesota Power simply made the portal available to everyone without specifically recruiting customers into a pilot.

This last point raises the third issue, namely that some aspects of the pilot may well have reduced the rate at which participants viewed their feedback below the levels Minnesota Power might have seen in a standard program offering. Pilot participants needed to navigate through a baseline survey before they had full access to the pilot portal. While they could skip all the questions and most participants who saw the survey proceeded through it, it is possible that the placement of the survey between the participant and the pilot's features served as a barrier to some participants. Furthermore, Minnesota Power intentionally took a very light touch to promoting the pilot once it was launched, thus possibly forgoing traffic to the portal that reminders to participants may have generated. The company is exploring greater promotion of the pilot and its features to participants in the second year to see what effect the promotion has on portal usage.

Does the frequency with which customers view enhanced online information change over time?

Early indications suggest that customers who do look at their enhanced usage information do so when it is first offered and possibly again if prompted to do so by a reminder from the utility. Rates at which pilot volunteers viewed their feedback spiked at 15 and 9 percent of participants at initial enrollment and around the time of the only reminder sent to all participants. Otherwise, rates at which participants viewed the feedback dropped over time to about 1/10th of the initial level by the time a year had passed.

What effect (if any) does customer access to enhanced usage information have on electricity usage compared to online access to traditional monthly usage?

Observed electricity savings associated with access to high resolution usage feedback were within the statistical margin of error for the study groups, which was about \pm two percentage points. We thus did not see any statistically significant electricity savings for participants who were provided higher resolution usage feedback, and if the enhanced feedback does have an impact on consumption, the results here suggest that it is unlikely to be more than two percentage points. The same is true of participants who viewed the feedback and those who viewed the feedback more than a few times (albeit, that number was small, leading to larger uncertainties in our statistical comparisons). These results suggest that, overall, those who viewed higher resolution feedback did not make substantial changes in their electricity usage early on in the pilot.

We do not know, however, whether exposure to this sort of feedback contributes to more substantial long-term changes in behavior or results in more energy-efficient choices when consumers make decisions about appliance purchases or remodels. Minnesota Power will continue to monitor electricity consumption, and we will report changes over a longer time period in the final report for this pilot program.

What actions do customers take as a result of enhanced online feedback?

We have limited information about what actions participants have taken. Considering the results of our usage analysis, it seems that pilot participants have not undertaken actions that save substantial amounts of electricity in large numbers. It is possible that isolated customers have been spurred to take significant actions. Whether participants are changing—or will change—their electricity consumption in measurable ways over time remains to be seen.

We do have anecdotal, qualitative information from a handful of interviews that some participants used the enhanced feedback to examine the effect of changes they had already made and figure out how much electricity various appliances were using. Some interviewees spoke of being spurred to take specific steps, such as accelerating their replacement of some aging appliances, unplugging devices, changing light bulbs, and reducing use of an electric fireplace. Interestingly, self-reports of some of the more effective energy-saving measures were offered by participants who had engaged with the pilot in only minimal ways. Hence, the pilot may be having some influence simply by reminding participants of energy-saving steps they already knew about or were intending to take, even if they never viewed high-resolution feedback now available to them.

What is the customer experience with the pilot?

Despite the modest rates of pilot use, customers do appear to appreciate access to usage feedback, and providing such feedback can be a service that utility customers value. As noted, the feedback component of the pilot portal was easily the feature participants found to be the most useful, even more so than the energy-saving tips. About two-thirds of active pilot participants indicated that the feedback information was useful to them. Furthermore, in response to the baseline survey, a majority of voluntary participants who responded to the baseline survey indicated that they engage with the usage levels reported to them on Minnesota Power bills beyond the cursory review that one often assumes of utility bills.

It is not clear whether the Power of One® Choice Pilot taps into the customer service aspect of providing higher resolution usage information as fully as it might, however. Satisfaction with individual components of the pilot that Minnesota Power tested in its one-year check-in survey pointed to general customer satisfaction, but respondents indicated a lower level of satisfaction with the pilot than they have with Minnesota Power overall.

LESSONS LEARNED ABOUT WEB-BASED FEEDBACK AS A TOOL FOR EFFICIENCY AND CUSTOMER SERVICE

To date, the Power of One® Choice Pilot has offered lessons learned, reminders, and useful observations for Minnesota Power. These same take-aways also apply broadly to utility programs seeking to engage customers on energy efficiency or provide efficiency-related customer service. While they are not proven in an empirical sense, we share them here as observations for further consideration.

Customers' information preferences may not align with the features that advanced meters make possible. Pilot participants who did view their enhanced feedback information found that aspect of the pilot to be more useful than any other major feature. Nevertheless, they largely viewed it only once. It is possible that customers learn about their usage—or prefer to learn about their usage—through individual snapshots or insights than by studying high-resolution usage over time. If this is the case, interpretative information may be more useful than usage feedback alone. This topic warrants more exploration and consideration.

Self-reported customer interest does not necessarily translate to actual engagement. Customers have indicated widespread interest in usage-related feedback, which suggests that they would view the newly developed usage information made available by Minnesota Power more frequently than they actually did or, at least, look at it an initial time in greater numbers to gauge its usefulness. The reality is that customers are busy and have a greater intention to act than they have time or willingness to follow through. Hence, interest does not necessarily translate to usage, and the only way to know whether customers will use a new service or offering may be to pilot it. When piloting is expensive or time-consuming, more extensive customer research that teases out the degree of customers' interest in a new service and the choices they would make when confronted with realities of life (competing choices, time constraints, etc.) may provide more realistic predictions of participation rates than simple survey questions.

Reminders prompt forgotten actions. When customers did have an intention to act, reminders about a service's availability spurred action. Even when providing services for the customer's benefit, marketing can increase uptake rates. Again, Minnesota Power took a light approach on this aspect in the initial year to get a baseline idea of how much customers chose to access available tools on the merits of the tools and their general interest in accessed enhanced information. This was also to avoid unduly affecting results regarding portal access frequency and subsequent actions. With this baseline established, Minnesota Power intends to explore more frequent prompts and messaging highlighting the various tools and features available.

Experimental design and dynamic program piloting can be at odds, resulting in trade-offs. The incorporation of experimental design in Minnesota Power's consumer behavior pilot resulted in a slower design process that also made it more difficult for the pilot to adjust dynamically to indications of what is or is not working. This does not afford the flexibility of a more general pilot. In Minnesota Power's case, for example, adjustments to pilot design were needed when initial solicitations did not provide the targeted number of participants. These adjustments were made with careful consideration to research implications needed to be considered by Minnesota Power research contractor (the Energy Center) and the DOE's technical advisory group, all of which introduced complexity to an intentionally focused design with a pre-established budget.

APPENDIX A: SOLICITATION COLLATERAL

Sequencing of the marketing:

- email to existing Power of One® customers
- post card (included below) mailed to about 24,716 customers on August 19, 2011
- auto calls to 5,000 of the post card recipients between September 15 and 19, 2011
- letter (included below) to 22,262 customers in the initial post card mailing and a new group of 6,832 customers
- total number of customers contacted: 31,548

The graphic is a postcard for the "Power of One Choice Pilot Program". It features a green header with the program title. Below the title, on the left, is an invitation to participate in a special pilot study, followed by instructions on how to participate (visiting a website and using an entry code) and a list of questions. On the right, there are logos for Minnesota Power and the Power of One program, and a green pyramid diagram with four levels: "Right Fit Options", "Informed Choices", "New Tools & Resources", and "Understanding". An arrow points up the pyramid with the text "Get the Most For Your Energy Dollar". At the bottom, it states that the project is supported by the Department of Energy.

Power of One® Choice Pilot Program

You're Invited to help us identify ways to better serve you!
We're inviting select customers in your neighborhood to participate in a *special pilot study* to test exciting new ways to provide you with more information about your electricity use.

How to Participate:
If you are a homeowner, visit us at www.mnpower.com/pilot to learn more and register your interest. Use the **entry code** on the other side of this postcard, located above your mailing address, when completing your response. There is no cost to you, but enrollment is limited, so act now.

As a participant in the Power of One® Choice Pilot Program, you will have the opportunity to experience new tools and access resources designed to help you get the most for your energy dollars.

Questions:
If you have questions, you may reach a Customer Information Representative at 218.722.2625 or toll free at 800.228.4966.

Efficiently yours,
Minnesota Power—Power of One® Energy Conservation Team

Get the Most For Your Energy Dollar

Right Fit Options
Informed Choices
New Tools & Resources
Understanding

minnesota power
AN ALLETE COMPANY

power of one
a conservation program

This project is based upon work supported by the Department of Energy under Award Number DE-FOA-0000058.

power of one® Choice Pilot Program

You're invited to join our Power of One® Choice Pilot Program. Through our current Power of One® conservation program, we provide rebates, tools, and information to help customers like you get the most for your energy dollar. As part of our effort to continually improve our customer-based programs and services, we are exploring additional options such as:

- advanced metering
- enhanced Web tools
- in-home displays

These technologies are evolving as a potential way to provide our customers more frequent and meaningful information about energy usage, along with choices for using energy more effectively. As we consider investments in these technologies, **we want to hear from customers like you.**

Why participate?

By participating in the Power of One® Choice Pilot Program, you will:

- **get a first-chance opportunity to test drive new technologies and tools** and let us know what you think along the way
- learn how to **get the most for your energy dollar** through greater awareness and understanding about how you use energy and how you could save in your home
- **receive personalized recommendations and special offers**
- **become part of an exclusive community of customers** who will guide future conservation program offerings and help to mitigate costs
- **reduce your impact on the environment** by using less energy
- **help those in need ...** For every customer that signs up for the Power of One® Choice Pilot Program, a contribution will be made to the Salvation Army's HeatShare program. For those who sign up by October 25, 2011, the contribution will be matched by the Minnesota Power Foundation, up to a total contribution of \$10,000.

Thank you for your support and your commitment to helping us better serve our residential customers. Together, we have the power to make more effective energy choices. *Demonstrating the Power of One® ... it begins with you.*

Sincerely,

Minnesota Power's Power of One®
Energy Conservation Team

This project is based upon work supported by the Department of Energy under Award Number DE-FOA-0000058.

*You're invited to
make a difference ...*

in your home ...

by using energy more effectively

in your community ...

*by ensuring a contribution to
HeatShare for those in need*

for fellow Minnesota

Power customers ...

*by guiding future program offerings
and helping to mitigate costs*

for the environment ...

by using less energy

matching contribution sponsored by:



to benefit:



How to participate?

Enrollment is limited, so act now.

1. Visit us at www.mnpower.com/pilot and complete a brief survey to show your interest.
2. Use this code when completing the survey:
3. We'll follow up with more details about the program.

Questions?

Call 218.722.2625 or 800.228.4966.



APPENDIX B: ANALYSIS METHODOLOGY

PORTAL ANALYSIS

We examined logon and page view data for the 942 (out of 3,785) pilot participants who viewed any aspect of the online portal at least one time. The primary metrics of portal usage were:

- Initial registration: date the participant accessed the portal within the pilot program for the first time—regardless of whether or not a customer had enrolled in the Power of One® program prior to the pilot program;
- Initial viewing of the enhanced feedback feature: first date the participant viewed their usage—this was determined for participants in both the treatment groups and the control group even though control group participants were only able to view their monthly usage data;
- Total number of enhanced feedback views: a count of all views per participant;
- Number of feedback views per month: a count of all views per participant, per month;
- Number of feedback viewers per month: a count of all participants who viewed the feedback feature at least one time during a given month;
- Total number of viewers per portal feature: a count of participants who accessed select features of the portal to provide comparisons for assessing feedback views.

BILLING ANALYSIS

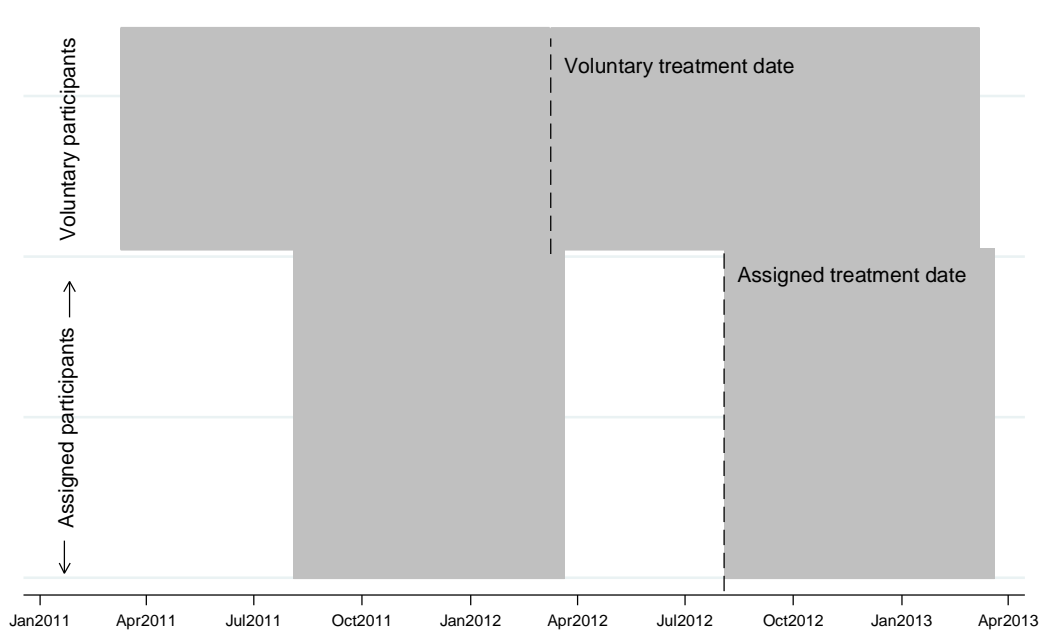
To assess whether or not exposure to enhanced usage feedback (versus standard monthly usage feedback) results in lower electricity consumption among pilot participants, we analyzed utility billing records spanning March 2011 through March 2013 for the 3,706 pilot participants (out of 3,785) for whom the data were available. After accounting for participants who had dropped out of the pilot within the two-year time frame (284 or 7.6 percent) and one with insufficient billing records, the resulting billing sample included 3,421 participants, of which 40 percent were voluntary and 60 percent were assigned to the pilot program. We compared usage along two lines: by access to enhanced feedback and by exposure to it.

Access to enhanced feedback

As originally planned, we compared changes in electricity consumption between participants in the two treatment groups with those in the control group. This comparison indicates the differences inherent in access to higher resolution usage feedback. We employed two separate statistical approaches to this part of the analysis: difference-in-difference (DID) calculations and estimation of a mixed (fixed- and random-effects) model.

For both approaches we divided the billing data into pre- and post-treatment periods, where the date at which participants first had access to their enhanced usage feedback serves as the treatment date for each status subgroup. The treatment date was March 9, 2012 for voluntary participants and August 3, 2012 for assigned participants. For the DID calculations, we trimmed the dataset such that the pre- and post-periods spanned the same calendar months in each period, within pilot status subgroups (voluntary and assigned), allowing for balanced calculations. The visual below illustrates the billing data used in the DID analysis. Periods are longer for voluntary participants given their earlier entrance into the pilot program and earlier treatment dates.

Figure 30: Pre- and post-treatment periods for DID calculations, by pilot status



The DID approach compares the pre-to-post change in electricity usage between the hourly and daily treatment groups, as each differs from the pre-to-post change exhibited by the control group. It follows the form:

$$net(mean(\Delta kWh_T)) = (mean(kWh_{T1} - kWh_{T0}) - mean(kWh_{C1} - kWh_{C0}))$$

where kWh_{T1} is the annualized electricity consumption for treatment group T following access to enhanced feedback and kWh_{T0} is the annualized electricity consumption for treatment group T prior to access to enhanced feedback. kWh_{C1} and kWh_{C0} are the parallel consumption values for the control group. The above calculation was conducted separately for each treatment group. This provides an apples-to-apples comparison between the net, or marginal, change in usage among hourly and daily participants, after access to enhanced usage feedback was made available.

The regression model approach estimates the change in average monthly customer usage for each of the treatment groups, relative to the control group, while accounting for temporal (i.e., monthly) and cross-sectional (i.e., customer) level fixed effects. The following specification was estimated separately for voluntary and assigned participant subgroups:

$$kWh/month_{ij} = \beta_0 + \sum(\beta_j(Month_j)) + \beta_D(Daily) + \beta_H(Hourly) + \gamma_i(Customer_i) + \varepsilon_{ij}$$

where:

- $Month_j$ is a series of dummy variables indicating the calendar month-year combination spanning from April 2011 through February 2013 (the omitted month is March 2011);
- $Daily$ is a dummy variable indicating participation by customer i in the Daily feedback treatment group;
- $Hourly$ is a dummy variable indicating participation by customer i in the Hourly feedback treatment group;
- $Customer_i$ is a unique dummy variable for each pilot participant; and
- ε_{ij} is the error term.

Results from maximum likelihood estimations of this model are presented, by pilot group status, in the following two tables. Treatment group coefficient values are relative to the control group.

Table 8: Regression results from mixed model estimation, voluntary participants

Log likelihood = -227677.83 Wald chi2(25) = 4246.03
 Prob > chi2 = 0.0000

upm	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
month						
apr2011	-139.3208	10.17508	-13.69	0.000	-159.2636	-119.378
may2011	-213.016	10.17508	-20.94	0.000	-232.9588	-193.0732
jun2011	-306.6077	10.17508	-30.13	0.000	-326.5505	-286.665
jul2011	-266.6416	10.17508	-26.21	0.000	-286.5844	-246.6988
aug2011	-154.3812	10.17508	-15.17	0.000	-174.324	-134.4384
sep2011	-203.9093	10.17508	-20.04	0.000	-223.8521	-183.9665
oct2011	-260.9117	10.17508	-25.64	0.000	-280.8545	-240.9689
nov2011	-280.5549	10.17508	-27.57	0.000	-300.4977	-260.6121
dec2011	-143.5942	10.17508	-14.11	0.000	-163.537	-123.6514
jan2012	-24.38256	10.17508	-2.40	0.017	-44.32535	-4.439769
feb2012	-79.35785	10.17508	-7.80	0.000	-99.30063	-59.41506
mar2012	-64.76687	14.69368	-4.41	0.000	-93.56596	-35.96779
apr2012	-210.1403	11.01853	-19.07	0.000	-231.7362	-188.5443
may2012	-247.7425	11.01853	-22.48	0.000	-269.3384	-226.1465
jun2012	-314.5707	11.01853	-28.55	0.000	-336.1666	-292.9748
jul2012	-201.3088	11.01853	-18.27	0.000	-222.9047	-179.7129
aug2012	-91.74149	11.01853	-8.33	0.000	-113.3374	-70.14556
sep2012	-209.5237	11.01853	-19.02	0.000	-231.1196	-187.9277
oct2012	-274.7152	11.01853	-24.93	0.000	-296.3111	-253.1193
nov2012	-275.422	11.01853	-25.00	0.000	-297.018	-253.8261
dec2012	-133.1361	11.01853	-12.08	0.000	-154.732	-111.5402
jan2013	3.540368	11.01853	0.32	0.748	-18.05556	25.1363
feb2013	-49.90902	11.01853	-4.53	0.000	-71.50495	-28.31309
Daily	4.575475	7.291514	0.63	0.530	-9.71563	18.86658
Hourly	-3.743178	7.331095	-0.51	0.610	-18.11186	10.6255
_cons	981.1799	14.4919	67.71	0.000	952.7763	1009.583

Random-effects Parameters	Estimate	Std. Err.	[95% Conf. Interval]	
customerid: Identity				
sd(_cons)	466.439	9.019484	449.092	484.4562
sd(Residual)	266.7421	1.076379	264.6408	268.8601

LR test vs. linear regression: chibar2(01) = 39032.56 Prob >= chibar2 = 0.0000

Table 9: Regression results from mixed model estimation, assigned participants

Log likelihood = -341184.96 Wald chi2(25) = 5119.37
 Prob > chi2 = 0.0000

upm	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
month						
apr2011	-111.892	7.150622	-15.65	0.000	-125.9069	-97.877
may2011	-166.5794	7.150622	-23.30	0.000	-180.5943	-152.5644
jun2011	-246.4951	7.150622	-34.47	0.000	-260.5101	-232.4801
jul2011	-225.7942	7.150622	-31.58	0.000	-239.8092	-211.7793
aug2011	-135.9886	7.150622	-19.02	0.000	-150.0036	-121.9737
sep2011	-150.4018	7.150622	-21.03	0.000	-164.4168	-136.3869
oct2011	-199.5049	7.150622	-27.90	0.000	-213.5199	-185.49
nov2011	-218.8295	7.150622	-30.60	0.000	-232.8445	-204.8146
dec2011	-105.9712	7.150622	-14.82	0.000	-119.9861	-91.95621
jan2012	-23.85476	7.150622	-3.34	0.001	-37.86972	-9.839793
feb2012	-69.05619	7.150622	-9.66	0.000	-83.07115	-55.04123
mar2012	-64.24824	7.150622	-8.98	0.000	-78.26321	-50.23328
apr2012	-170.7566	7.150622	-23.88	0.000	-184.7715	-156.7416
may2012	-202.5311	7.150622	-28.32	0.000	-216.5461	-188.5162
jun2012	-245.241	7.150622	-34.30	0.000	-259.256	-231.226
jul2012	-157.4876	7.150622	-22.02	0.000	-171.5025	-143.4726
aug2012	-68.56355	7.837443	-8.75	0.000	-83.92466	-53.20244
sep2012	-153.9934	7.837443	-19.65	0.000	-169.3545	-138.6323
oct2012	-197.2626	7.837443	-25.17	0.000	-212.6237	-181.9015
nov2012	-207.8362	7.837443	-26.52	0.000	-223.1973	-192.4751
dec2012	-99.55223	7.837443	-12.70	0.000	-114.9133	-84.19112
jan2013	-8.827906	7.837443	-1.13	0.260	-24.18901	6.533201
feb2013	-55.80134	7.837443	-7.12	0.000	-71.16245	-40.44024
Daily	9.103163	5.528405	1.65	0.100	-1.732312	19.93864
Hourly	-5.028238	5.573044	-0.90	0.367	-15.9512	5.894728
_cons	811.6157	10.85514	74.77	0.000	790.34	832.8914

Random-effects Parameters	Estimate	Std. Err.	[95% Conf. Interval]	
customerid: Identity				
sd(_cons)	434.5955	6.870646	421.3357	448.2725
sd(Residual)	228.764	.7455039	227.3075	230.2299

LR test vs. linear regression: chibar2(01) = 65911.45 Prob >= chibar2 = 0.0000

We ran the regression analysis with a modest screen of outlying data points. Estimation results in the following two tables are based on the same model as that presented above; however, 158 customers who experienced an extremely large change in usage (a coefficient of variation greater than 0.5) have been excluded. The results shift only slightly and do not change our general findings.

Table 10: Regression results from mixed model estimation (excluding outliers), voluntary participants

Log likelihood = -222706.7 Wald chi2(25) = 4225.13
 Prob > chi2 = 0.0000

upm	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
month						
apr2011	-139.8235	10.11591	-13.82	0.000	-159.6503	-119.9967
may2011	-211.0436	10.11591	-20.86	0.000	-230.8704	-191.2168
jun2011	-302.6257	10.11591	-29.92	0.000	-322.4525	-282.7989
jul2011	-260.7016	10.11591	-25.77	0.000	-280.5285	-240.8748
aug2011	-147.1845	10.11591	-14.55	0.000	-167.0113	-127.3577
sep2011	-196.3312	10.11591	-19.41	0.000	-216.158	-176.5044
oct2011	-254.4312	10.11591	-25.15	0.000	-274.258	-234.6044
nov2011	-276.1726	10.11591	-27.30	0.000	-295.9994	-256.3458
dec2011	-139.9849	10.11591	-13.84	0.000	-159.8118	-120.1581
jan2012	-21.88746	10.11591	-2.16	0.030	-41.71428	-2.060634
feb2012	-77.47892	10.11591	-7.66	0.000	-97.30574	-57.6521
mar2012	-68.69879	14.66001	-4.69	0.000	-97.43189	-39.96569
apr2012	-207.8793	10.96575	-18.96	0.000	-229.3717	-186.3868
may2012	-244.8065	10.96575	-22.32	0.000	-266.299	-223.314
jun2012	-310.8924	10.96575	-28.35	0.000	-332.3848	-289.3999
jul2012	-196.6174	10.96575	-17.93	0.000	-218.1099	-175.1249
aug2012	-86.8789	10.96575	-7.92	0.000	-108.3714	-65.38642
sep2012	-205.4547	10.96575	-18.74	0.000	-226.9472	-183.9623
oct2012	-271.0307	10.96575	-24.72	0.000	-292.5232	-249.5382
nov2012	-272.3471	10.96575	-24.84	0.000	-293.8396	-250.8546
dec2012	-130.3459	10.96575	-11.89	0.000	-151.8383	-108.8534
jan2013	7.5108	10.96575	0.68	0.493	-13.98168	29.00328
feb2013	-46.92258	10.96575	-4.28	0.000	-68.41506	-25.4301
Daily	7.701297	7.262826	1.06	0.289	-6.533582	21.93617
Hourly	-2.976018	7.294589	-0.41	0.683	-17.27315	11.32111
_cons	979.0045	14.60079	67.05	0.000	950.3874	1007.621

Random-effects Parameters	Estimate	Std. Err.	[95% Conf. Interval]	
customerid: Identity				
sd(_cons)	467.3034	9.121906	449.7625	485.5284
sd(Residual)	262.5734	1.070188	260.4842	264.6793

LR test vs. linear regression: chibar2(01) = 39047.14 Prob >= chibar2 = 0.0000

Table 11: Regression results from mixed model estimation (excluding outliers), assigned participants

Log likelihood = -317148.55 Wald chi2(25) = 5079.05
 Prob > chi2 = 0.0000

upm	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
month						
apr2011	-107.2617	7.028307	-15.26	0.000	-121.0369	-93.48646
may2011	-156.1229	7.028307	-22.21	0.000	-169.8981	-142.3477
jun2011	-232.3148	7.028307	-33.05	0.000	-246.09	-218.5396
jul2011	-206.085	7.028307	-29.32	0.000	-219.8602	-192.3097
aug2011	-112.3698	7.028307	-15.99	0.000	-126.145	-98.59455
sep2011	-126.9226	7.028307	-18.06	0.000	-140.6978	-113.1473
oct2011	-178.2321	7.028307	-25.36	0.000	-192.0073	-164.4569
nov2011	-198.4641	7.028307	-28.24	0.000	-212.2394	-184.6889
dec2011	-85.11111	7.028307	-12.11	0.000	-98.88634	-71.33588
jan2012	-3.527695	7.028307	-0.50	0.616	-17.30292	10.24753
feb2012	-51.40739	7.028307	-7.31	0.000	-65.18262	-37.63216
mar2012	-46.9843	7.028307	-6.69	0.000	-60.75953	-33.20907
apr2012	-152.5358	7.028307	-21.70	0.000	-166.311	-138.7606
may2012	-183.1568	7.028307	-26.06	0.000	-196.9321	-169.3816
jun2012	-225.0239	7.028307	-32.02	0.000	-238.7992	-211.2487
jul2012	-136.04	7.028307	-19.36	0.000	-149.8152	-122.2647
aug2012	-46.52042	7.696804	-6.04	0.000	-61.60588	-31.43496
sep2012	-132.3224	7.696804	-17.19	0.000	-147.4079	-117.2369
oct2012	-177.3097	7.696804	-23.04	0.000	-192.3952	-162.2243
nov2012	-191.2568	7.696804	-24.85	0.000	-206.3422	-176.1713
dec2012	-82.81654	7.696804	-10.76	0.000	-97.902	-67.73108
jan2013	8.219492	7.696804	1.07	0.286	-6.865967	23.30495
feb2013	-39.60488	7.696804	-5.15	0.000	-54.69033	-24.51942
Daily	7.95297	5.412247	1.47	0.142	-2.654839	18.56078
Hourly	-4.743943	5.493931	-0.86	0.388	-15.51185	6.023964
_cons	803.9177	11.18158	71.90	0.000	782.0022	825.8332

Random-effects Parameters	Estimate	Std. Err.	[95% Conf. Interval]	
customerid: Identity				
sd(_cons)	438.4414	7.155371	424.6391	452.6924
sd(Residual)	217.5372	.7327517	216.1057	218.9781

LR test vs. linear regression: chibar2(01) = 65779.36 Prob >= chibar2 = 0.0000

Exposure to enhanced feedback

As described in the sections on portal use and electricity consumption effects, not everyone in the pilot viewed their usage feedback via the online portal—i.e. one-half of voluntary participants and over 90 percent of assigned participants never even accessed the online portal, and slightly more were never exposed to the feedback feature. To the extent possible, we attempted to describe usage changes based on exposure to usage feedback; however, this was not the research question for which the pilot was designed and thus we were not able to conduct a full statistical analysis. Instead, we focused the second part of the billing analysis on comparing changes in consumption between active participants (looked at their enhanced feedback at least one time) and inactive participants (never saw their enhanced feedback). We could not compare these estimates to changes among Minnesota Power customers who did not have access to the portal (i.e. non-pilot participants).

To conduct a true assessment of the net impacts of portal use (regardless of feedback resolution), we would need randomly assigned treatment (those with access to the portal) and control (those without

access to the portal) groups. Allocation of the active and inactive participants in the Minnesota Power pilot program were dependent on a self-selection process among only customers who were offered access to the portal; hence, a statistical comparison of these groups' usage changes over the span of the pilot would be biased.

PORTAL SATISFACTION ANALYSIS

The analysis of user satisfaction with the portal and their perceived energy usage were based on responses provided to an online survey in April 2013, which we requested all participants for whom Minnesota Power has valid e-mail addresses to complete. Table 6 shows the pool of available participants and their response rates by treatment and control group. The majority of available e-mail addresses were from voluntary participants in these groups, but we supplemented with assigned participants whenever their e-mail addresses were available. Invitations were sent via e-mail and followed with reminders to non-respondents.

Analysis of satisfaction generally comprised examining the frequencies of response options grouped by substantive responses and responses that indicated an inability to evaluate.

For respondents' overall satisfaction with the pilot, we also examined the differential between each respondent's rating of the pilot with his or her rating of Minnesota Power overall.

We compared self-reported spending on electricity in the prior 12 months (from the survey) to actual usage levels we had for the same time period from billing records. However, we needed to convert usage billing data usage levels from kilowatt-hours to dollar terms. We did that by applying increasing block rates to average monthly consumption, multiplying that cost by 12 months, and adding an \$8.00 fixed fee to get an annual cost estimate. Then, we compared self-reported usage to actual.

APPENDIX C: SURVEY INSTRUMENT

[Note: This is the complete instrument fielded online in April 2013. Active participants in the treatment groups received all of these questions. Inactive participants and those in the control group were skipped past the questions that did not apply to them (i.e. questions about the use of features or features to which they did not have access, respectively).]

Power of One Survey

Power of One Choice Pilot Program Participant feedback survey - spring 2013

Thank you for taking a few minutes to give us feedback on the Power of One® Choice pilot program. We value your feedback regardless of how much (or little) you have logged into the pilot so far.

1)

Please indicate whether you agree or disagree with the following statements about your experience with the pilot portal so far.

	disagree	neutral	agree	no basis for opinion yet
The user's guide gave me a good sense of what I would find in the portal.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Getting into the portal is easy.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The portal's features are easy to find.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I can get to the interesting content quickly.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

2)

The next few questions will ask about specific features of the pilot's online portal.

How extensively have you used...

	wasn't aware of this feature	haven't used this feature	looked at it once or twice	looked at it several times
Recommended Energy-Saving Actions through the Your Home Energy Report	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

3)

How useful did you find this feature?

Recommended Energy-Saving Actions provided in Your Home Energy Report

- ☐ not at all useful
- ☐ somewhat useful
- ☐ very useful
- ☐ don't know

4)

How extensively have you used...

	wasn't aware of this feature	haven't used this feature	looked at it once or twice	looked at it several times
Power of One® Action Plan ("workbook")	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

5)

How useful did you find this feature?

Power of One® Action Plan ("workbook")

- ☐ not at all useful
- ☐ somewhat useful
- ☐ very useful
- ☐ don't know

6)

How extensively have you used...

	wasn't aware of this feature	haven't used this feature	looked at it once or twice	looked at it several times
Historic Usage Chart	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

7)

How useful did you find this feature?

Historic Usage Chart of your household's electricity consumption

- ☐ not at all useful
- ☐ somewhat useful
- ☐ very useful
- ☐ don't know

8)
How extensively have you used...

	wasn't aware of this feature	haven't used this feature	looked at it once or twice	looked at it several times
Energy Marker	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

9)
How useful did you find this feature?

Energy Marker

- ☐ not at all useful
- ☐ somewhat useful
- ☐ very useful
- ☐ don't know

10)
How extensively have you used...

	wasn't aware of this feature	haven't used this feature	looked at it once or twice	looked at it several times
Notifications and Thresholds	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

11)
How useful did you find this feature?

Notifications and Thresholds

- ☐ not at all useful
- ☐ somewhat useful
- ☐ very useful
- ☐ don't know

12)
Overall, how satisfied are you with the Power of One® Choice Pilot?

	1 - very dissatisfied	2	3	4	5	6	7	8	9	10 - very satisfied
overall satisfaction	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

13) Without looking at your bills, how much would you estimate your household spent on electricity in the past 12 months?

14) Which of the following statements best reflects your feelings about your level of electricity consumption?

- ☐ I am satisfied with how low our/my usage is.
- ☐ I think our/my usage is reasonable, but could probably be improved.
- ☐ I think our/my usage is a bit on the high side, and I wish we/I would use less.
- ☐ Our/my usage is way too high; we/I really need to reduce our electricity consumption.

15)

What three appliances or devices in your home do you think use the most electricity?

1: _____
 2: _____
 3: _____

16) Overall, how satisfied are you with Minnesota Power?

	1 - very dissatisfied	2	3	4	5	6	7	8	9	10 - very satisfied
overall satisfaction	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

17) If you have any other comments about the Power of One Choice Pilot, please share them with us here.

Thank you for your feedback!!