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Minnesota Power

# **Minnesota Power's Advanced Metering Infrastructure Project**

## **AMI Behavioral Research Pilot—Phase Two: Results from the Time-of-Day Rate with Critical Peak Pricing Pilot Program**

**SEPTEMBER 13, 2016**

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# Minnesota Power's Advanced Metering Infrastructure Project

*AMI Behavioral Research Pilot—Phase Two: Results from the Time-of-Day Rate with Critical Peak Pricing Pilot Program*

September 13, 2016

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Scott Pigg

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## EXECUTIVE SUMMARY

Minnesota Power's Smart Grid Investment Grant project (SGIG) involved the installation of advanced metering infrastructure (AMI) and explored the application of distribution automation. The project was aimed at improving customer understanding of their electricity usage, reducing operation and maintenance costs, and improving awareness of and response to distribution system outages.

As part of its Smart Grid Investment Grant, Minnesota Power designed a two-phase Consumer Behavior Study Plan (CBSP). The CBSP, branded as the Power of One® Choice Pilot, began in the spring of 2012 and was implemented in the Duluth/Hermantown area. Phase One of the research was designed to answer questions about residential customers' interest in, use of, and benefits derived from different levels of resolution of feedback on electricity consumption—monthly, daily, and hourly. The results of that effort were reported in *Minnesota Power's Advanced Metering Infrastructure Project: AMI Behavioral Research Pilot – Phase 1 Interim Results from a Consumer Enhanced Feedback Pilot*.

Phase Two of the research, which began in October 2014 and ran through October 2015, entailed offering a Time-of-Day Rate Pilot with a Critical Peak Pricing (CPP) component to a subset of Minnesota Power customers. The objectives of this phase included gauging customer interest and engagement in a time-based rate offering, evaluating participant response to price increases during CPP events, and understanding the operational requirements and impacts related to the rate offering. This report presents the results of the evaluation from this phase of the research project and summarizes Minnesota Power's (the Company's) experience and lessons learned from the pilot. The evaluation is primarily based on responses from multiple surveys of the program participants and a demand analysis of participants and a matched set of non-participants to determine if the CPP component resulted in customer demand reductions during six critical-peak events called during the pilot (one in the winter and five in the summer).

The rate design included the following three time-based price components which were implemented as adders (or discounts) to the standard five-tiered residential rate structure:

**Table 1. Time-of-Day Rate Design**

TOD Rate Adjusters	Energy Charge Adjustment	Applicable Hours
Off-Peak:	\$0.0299/kWh discount (~ 3 cents)	10 p.m. - 8 a.m. Mon-Fri; 24 hrs wknds & holidays
On-Peak:	\$0.01415/kWh increase (~ 1.5 cents)	8 a.m. - 10 p.m. Mon-Fri
Critical Peak Pricing:	\$0.77/kWh increase	Event based

Customers who enrolled were given access to an enhanced web portal with hourly usage feedback to help them better understand their usage and manage their electric bills while participating in the rate, and were asked to provide contact preferences (phone call, email or both) for day-ahead CPP event notifications. Minnesota Power offered the rate to nearly 31,000 customers in its Duluth/Hermantown area. The Company received over 500 customer calls related to the pilot offering and about 660 customers (2 percent) enrolled in the pilot rate during the five-week enrollment period. Actual enrollments and interest realized during this phase of the pilot greatly exceeded initial expectations. Minnesota Power also

experienced a low rate of attrition at the completion of the 12-month participation requirement. As of February 2016, four months after the participation requirement had ended, 589 (89 percent) of the 660 original participants remained on the rate, and only 13 participants had been removed by their request. The other 58 participants no longer on the rate were either customers who moved or qualified for the Customer Affordability of Residential Electricity (CARE) discount rate.

Customer surveys implemented throughout the pilot showed that participants had a high level of awareness of the pilot rate structure in general and the CPP aspect of the rate, were engaged in reducing electricity during events, and were generally satisfied with the rate. They felt they saved money on the rate and were able to shift some of their electrical use to avoid paying higher prices. The low rate of attrition experienced after the required 12-month period came to an end further confirms the high satisfaction customers reported regarding this rate.

The quantitative evaluation supports participant responses related to saving money and ability to shift energy use. The demand impact assessment found statistically significant reductions of roughly 17 to 28 percent in participants' electricity demand during four of the six CPP events. The winter event and the final summer event (which was a relatively cool summer day) did not result in statistically significant reductions in demand. The analysis showed no evidence of a rebound in load immediately following events. A comparison of pilot participants to a random sample of Minnesota Power residential customers in the Duluth/Hermantown area showed that participants disproportionately skew toward single-family homeowners and use, on average, 8 percent more electricity than the typical residential customer, so demand impacts may not be applicable to a wider pool of residential customers.

The experience Minnesota Power gained through this pilot project has provided valuable insight and a practical perspective on the many intricacies associated with such an offering, from communications to billing and metering to customer preferences and expectations. The initial pilot period ended in October 2015, at which point participants were notified that the Time-of-Day (TOD) Rate Pilot has been in effect for twelve months or more. All current participants were informed that they met the minimum of twelve months enrollment requirement and that Minnesota Power would be evaluating the rate for effectiveness, customer satisfaction, and overall design. Participants were notified that they could request to be removed from the rate or, if they would like to remain on the rate during this evaluation, no additional action was needed and the rate would automatically continue until further notice. They were asked to fill out a final survey regarding experience with the pilot. Although Minnesota Power is not currently accepting new enrollees in the pilot rate, in part due to some of the operational impacts that were discovered during the first 12 months of the pilot, Minnesota Power has proposed to continue the rate for current participants in the short term while making slight modifications in effort to gather further knowledge about how customers respond to price signals and different rate options.<sup>1</sup> The information and experience gained through this project will help inform future offerings as Minnesota Power continues to seek out ways to help customers make informed choices about not only how, but when, they use energy.

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<sup>1</sup> Docket No. E015/M-12-233, March 25, 2016

## MINNESOTA POWER'S CONSUMER BEHAVIOR STUDY

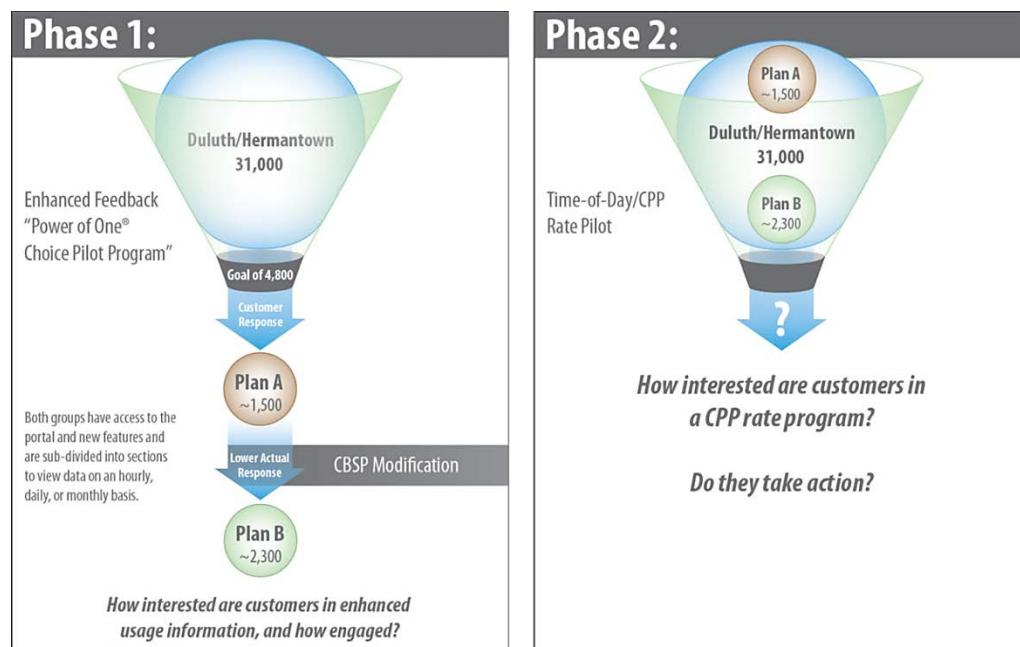
Minnesota Power developed a two-phase Consumer Behavior Study Plan (CBSP) to complement the component of their grant from the Department of Energy that placed advanced meters on customer homes in the Duluth/Hermantown area.

Phase One of the behavior study used a quasi-experimental design to identify customer interest in enhanced feedback and its impacts on electricity use. Phase Two focused on measuring customer interest in and reaction to time-based rates, associated load impacts of the critical peak pricing (CPP) rate, and the operational needs associated with this type of rate offering.

Initially, customers who participated in Phase One and had an advanced meter were invited to enroll in the Time-of-Day Rate (TOD) pilot program. A general solicitation followed, inviting eligible residential customers in the Duluth/Hermantown area who were originally recruited for, but did not participate in, Phase One. Ultimately, about 660 customers enrolled in Phase Two of the study.

While there have been some modifications to the CBSP, the core objectives have remained throughout. Minnesota Power sought to evaluate customer acceptance and response to different levels of resolution and timing of information feedback about their electricity consumption and to gauge interest in and response to a Time-of-Day with CPP Rate offering. Figure 1 illustrates the two phases of Minnesota Power's CBSP project.

**Figure 1. Consumer Behavior Study Plan Phases**



This report is a joint effort between Minnesota Power and Seventhwave. In the first and third sections, Minnesota Power describes the design, implementation and operational aspects of Minnesota Power's Time-of-Day Rate Pilot, including lessons learned. In the second section, Seventhwave presents findings from the pilot evaluation. Using survey responses and a quantitative assessment of load profile impacts, the evaluation answers the following research questions from the revised evaluation plan dated September 21, 2012:

- 1) What proportion of Minnesota Power customers in the Duluth/Hermantown area are interested in a Time-of-Day with Critical Peak Pricing rate plan?
- 2) How do Time-of-Day rate customers compare to Minnesota Power's general population of residential customers in terms of housing stock, demographics and electricity usage?
- 3) What effect (if any) does a Critical Peak Pricing rate have on average customer load profile during peak events?
- 4) What actions do customers take as a result of being on a Time-of-Day with Critical Peak Pricing rate?

## SECTION I: TIME-OF-DAY RATE PLAN WITH CRITICAL PEAK PRICING

### RATE DESIGN

Minnesota Power's Time-of-Day Rate Pilot began in October 2014 and ran through October 2015. Upon enrollment, participants agreed to remain on the Rate for a full year. For these customers, Minnesota Power implemented a two-period rate that augmented its existing five-tiered flat rate by applying on-peak and off-peak adjustments. The rate included a 14-hour on-peak period (8 a.m. to 10 p.m.) each weekday, during which the standard electric rate would be increased by approximately 1.5 cents per kWh. Off-peak hours were Monday-Friday from 10 p.m. to 8 a.m. and all day on weekends and holidays, during which the standard electric rate would be decreased by approximately 3 cents per kWh. In addition, the rate included an event-based CPP component that involved a \$0.77 per kWh rate increase during critical-peak event periods declared by the utility. The rate structure for the pilot program is shown in Table 2.

**Table 2: MN Power Time-of-day Rate with Critical Peak Pricing**

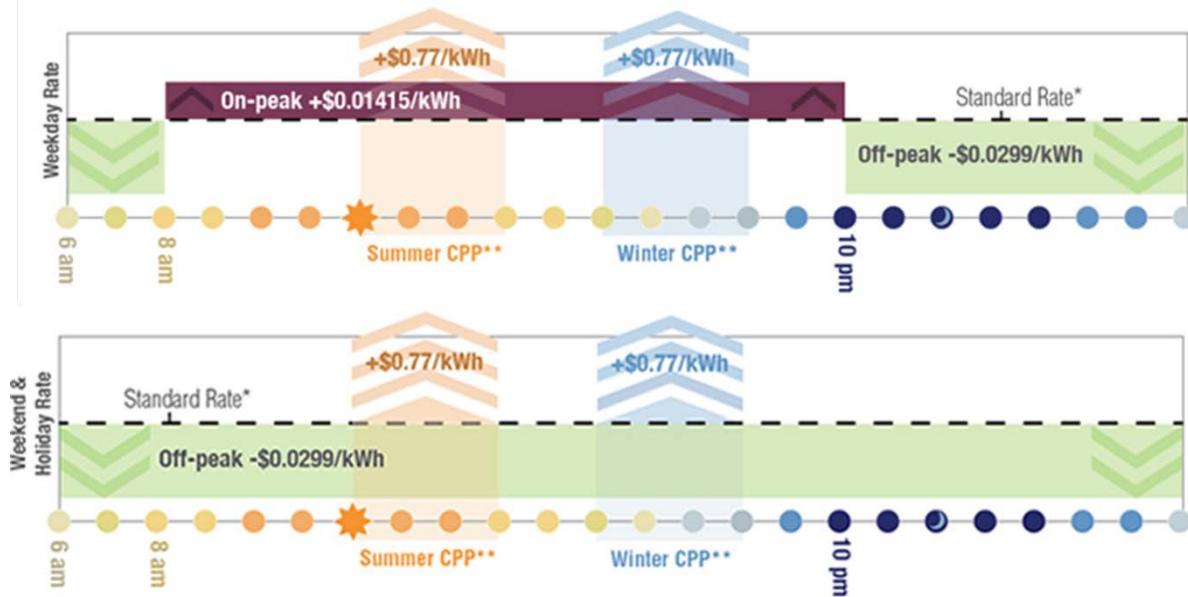
	Standard Rate	Off-peak Discount of \$0.0299	On-peak Increase of \$0.01415	Critical peak Increase of \$0.77
0-300kWh	\$0.05098	\$0.02108	\$0.06513	\$0.82098
301-500kWh	\$0.06735	\$0.03745	\$0.0815	\$0.83735
501-750kWh	\$0.08168	\$0.05178	\$0.09583	\$0.85168
751-1,000kWh	\$0.08445	\$0.05455	\$0.0986	\$0.85445
> 1,000kWh	\$0.08937	\$0.05947	\$0.010352	\$0.85937

Participants received day-ahead notice of CPP events, which were called at Minnesota Power's sole discretion.<sup>2</sup> Events were three hours long and typically motivated by increased demand for electricity among customers (such as air conditioners operating continuously during a hot summer afternoon) or decreased supply in the Midwest Independent System Operator (MISO) market or on Minnesota Power's system (such as a plant going offline); scenarios that are reflected in increased day-ahead regional wholesale electricity prices. Additionally, although the need did not present itself during the pilot, if MISO declared an emergency event due to a serious crisis on the power system, Minnesota Power could call an emergency CPP event for up to 8 hours. Under this scenario, Minnesota Power would have made reasonable efforts to give four hours notice.

Unlike the on-peak/off-peak periods which remained the same regardless of the season, the 3-hour CPP event window differed between summer and winter. Summer CPP events were declared between 12 p.m. and 3 p.m. and winter events between 5 p.m. and 8 p.m. The rate design assumed 100 hours of CPP, however, the only requirement for declaring events was that no more than 160 hours of CPP could be declared during the 12-month pilot. Figure 2 below depicts the Time-of-Day Rate periods and the corresponding rate adjustments.

<sup>2</sup> Circumstances for calling a CPP event are described in the tariff sheet, included as Appendix E in this report.

**Figure 2: Time-of-Day Rate Periods Illustration**



## RECRUITMENT

Participants for the Time-of-Day/CPP phase were recruited from among all participants with an advanced meter in the study, which included the nearly 500 participants from Phase One of the CBSP, as well as approximately 2,500 customers from a pool of customers with existing advanced meters. In addition, a general recruitment was made to the eligible residential customers in the Duluth/Hermantown area.

The eligibility requirements for participation in the pilot were:

- must be a residential customer located in an eligible zip code in the Duluth/Hermantown service area;
- must agree to remain on the rate for a minimum of 12 months;
- may not currently receive a discounted rate; and
- may need a meter upgrade if they chose to participate in the Rate.

Minnesota Power carefully considered recruitment timelines and rate effective dates. In consultation with DOE grant advisors, it was determined that an October start date would be most ideal to allow for recruitment lead time, follow up, and processing. There was also concern about the likelihood of a CPP event and the impact of it occurring too early in the participation process in terms of customer perceptions and satisfaction with the Rate overall.

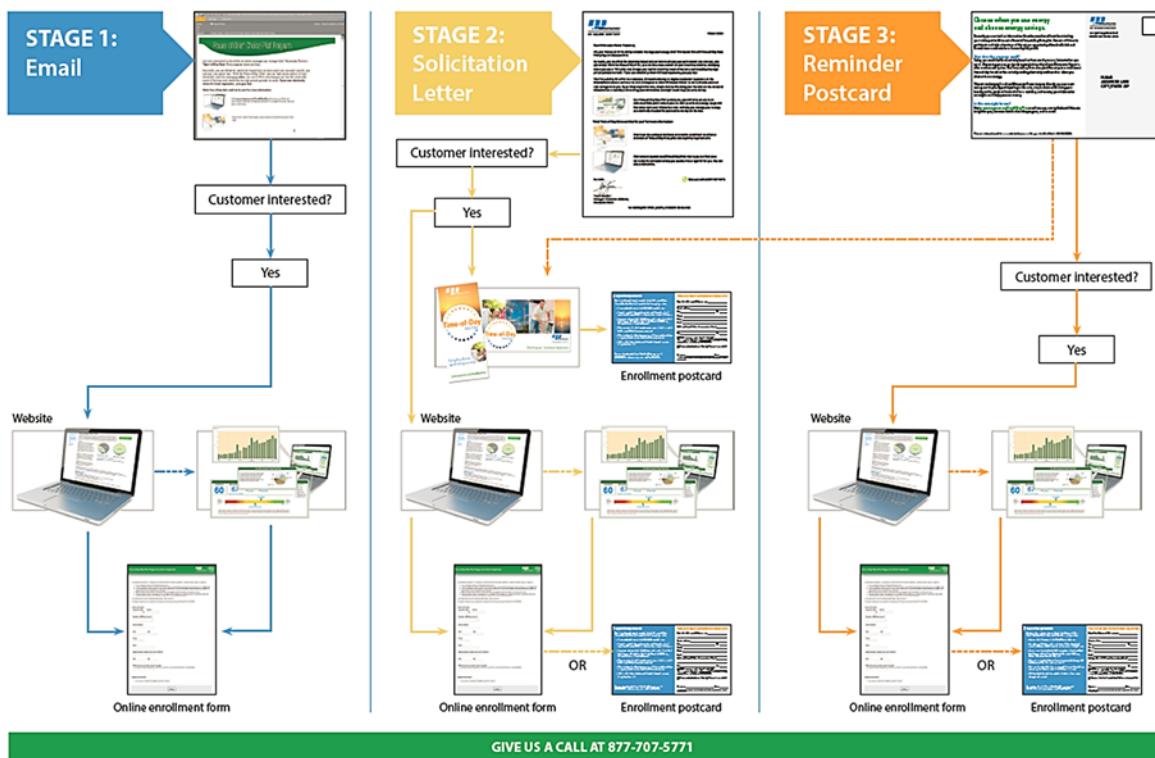
The recruitment period lasted just under five weeks with recruitment efforts beginning in early August 2014 and the enrollment period closing in early September 2014. It included multiple stages and communication channels, including:

- Recruitment email, letter, informational brochure and enrollment card
- Time-of-Day Web site with FAQs, calculator tool for rate impact estimation/scenario testing and “right fit” survey to help customers decide if the Rate is right for them

- Online enrollment application
- Reminder postcard
- TOD pilot-specific phone number
- Call Center fact sheet, script and FAQs

Figure 3 illustrates the recruitment process and samples of all materials are included in Appendix A.

**Figure 3: Time-of-Day Rate Recruitment Process**



Solicitation materials were an important aspect of recruitment for the pilot. Minnesota Power worked closely with the Minnesota Public Utilities Commission (MPUC) staff and the Department of Energy (DOE) grant advisors to ensure communications were comprehensive and clear. Notably, Minnesota Power earned a first place award under the category of Direct Mail at the annual Utility Communicators International conference in June 2015 for its Time-of-Day materials, where 224 entries from 24 utilities were evaluated by 48 judges from across the country.



## **ENROLLMENT AND ATTRITION**

Over 700 enrollments were submitted during the enrollment period, of which 660 were actually enrolled after accounting for customers who were not eligible due to location or participation in another discounted rate, and customers who changed their mind before the start of the Rate. Minnesota Power compiled statistics on various attributes of the final customer pool enrolled in the pilot. Of the 660 enrollees:

- 164 were also enrolled in budget billing;
- Roughly 71 accounts were flagged as having a landlord present, indicating these participants were renters;
- 26 accounts were on an all-electric rate;
- 41 accounts, or 6 percent, were low income customers, as determined by LIHEAP notation in the billing system; and
- 116 were also participants in Phase One of the Consumer Behavior Study – 81 of which were in a “voluntary” treatment group and the remaining 35 in an “assigned” treatment group.<sup>3</sup>

One of the requirements for enrollment in the Time-of-Day Rate Pilot was agreement to participate for a minimum of 12 months. This requirement was included in the recruitment materials and the list of eligibility requirements customers agreed to on the enrollment application. The Pilot took effect in October of 2014 and the 12-month participation requirement ended in October 2015.<sup>4</sup> During this timeframe, participant attrition could result from 2 scenarios: 1) if a customer was eligible for the Customer Affordability of Residential Electricity (CARE) discount rate they could choose to come off the Time-of-Day Rate to be placed on the CARE rate, or 2) if a customer moved from their current residence they were not required (and in some cases not eligible) to enroll in the Time-of-Day Rate at their new location. From the start of the Pilot through January 2016, when first-year evaluation efforts began, 10 participants came off the Rate due to enrollment in CARE and 48 customers came off the Rate due to relocations. In addition, from the completion of the 12-month enrollment period through January 2016, 13 participants had been removed from the Rate by request.

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<sup>3</sup> In Phase One, “voluntary” participants were those who actively responded to the solicitation for participation during recruitment while “assigned” participants were told they had access to the pilot tools and it was up to them to use the tools or not.

<sup>4</sup> The 12-month period went through October 2015 to allow for all participants to have a full twelve months of billing cycles under the Rate.

## SECTION II: TIME-OF-DAY RATE PILOT EVALUATION AND RESULTS

This section provides a characterization of pilot participants, an in-depth presentation of survey results and findings from the impact analysis of the CPP rate component on hourly electricity loads during events.

### TIME-OF-DAY RATE PILOT PARTICIPANTS

Research questions addressed:

- 1) *What proportion of Minnesota Power customers in the Duluth/Hermantown area are interested in a CPP rate plan?*
- 2) *How do CPP rate customers compare to Minnesota Power's general population of residential customers in terms of housing stock, demographics and electricity usage?*

In total, 660 customers enrolled in the pilot, representing about 2 percent of eligible residential customers in the Duluth/Hermantown area. Pilot participants were overwhelmingly single-family homeowners whose daily electricity consumption during the hottest and coldest months averaged about 8 percent higher than the typical Minnesota Power residential customer.<sup>5</sup> Part of this increased usage reflects the housing stock of pilot participants—single-family homes tend to use more electricity than units in multifamily buildings—and part is likely explained by the motivation of higher consumption households, which tend to have higher bills and more potential to shift usage, to self-select into a pilot program that provides opportunities to save on their electricity bills by managing when they use their electricity.

Household and housing stock information gathered in the post-pilot survey were compared with statistics taken from responses to Minnesota Power's ongoing customer survey, Your Home Energy Report (YHER), and the 2014 American Community Survey (ACS) for the City of Duluth.<sup>6</sup> YHER respondents reflect a subset of the utility's residential customer base (further referred to as "energy-interested" customers) that is interested in knowing more about their electricity consumption, and possibly decreasing their use, and/or needs assistance with their energy costs. Customers were required to complete the YHER survey in order to access the Power of One® Portal that offers individualized usage statistics and efficiency recommendations, to receive an energy analysis from the utility, or to enroll in its low-income rate (CARE).<sup>7</sup> For comparison purposes, YHER respondents who also received the CARE discount rate were removed since they were not eligible for the Rate Pilot. ACS statistics serve as a proxy for a survey of Minnesota Power's Duluth residential market overall.

Household and housing stock characteristics between Rate Pilot participants and YHER respondents are fairly similar. Both groups are overwhelmingly made up of single-family homeowners and tend to include a smaller proportion of single-person households compared to the City of Duluth. This follows the general thinking that customers with higher energy costs (typically single-family homes) and greater control over their home efficiency (owners) are more likely to take advantage of programs like the Rate Pilot. In terms of households with at least one child (under 18) and/or a resident aged 65 or older, participating households appear to mirror the citywide distribution. Roughly one-quarter of households have at least one child and one-quarter have at least one resident aged 65 or older.

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<sup>5</sup> Participants' average use per day during the winter of 2013–2014 was  $7.8 \pm 2.8$  percent higher compared to that of a random sample of non-participating customers. Similarly, during the summer of 2014, it was  $7.9 \pm 1.8$  percent higher.

<sup>6</sup> United States Census Bureau / American FactFinder. Overview for City of Duluth, Minnesota. 2010 – 2014 American Community Survey. U.S. Census Bureau's American Community Survey Office, 2014. Web July 2016.

<sup>7</sup> In the MPUC December 3<sup>rd</sup>, 2012 Order, effective January 1, 2013 Minnesota Power was granted the flexibility to encourage rather than require customers to complete the YHER survey when enrolling in the CARE program.

In terms of primary heating fuel, roughly two-thirds of homes in each group heat with natural gas. Other heating fuels vary in prevalence across the three groups. Pilot participants are evenly distributed between electric, fuel oil, and propane while the energy-interested group is more heavily weighted toward fuel oil and Duluth residents skew toward electric heat. Differences in primary heating fuel reflect, to some extent, the differences in housing stock across the three groups.

**Table 3: Household & Housing Characteristics**

	Pilot Participants	Energy-Interested Customers	City of Duluth
<b>Household</b>			
Own	97%	93%	60%
Rent	3%	7%	40%
1 person	26%	18%	33%
2 people	44%	42%	33%
3+ people	33%	40%	33%
% with householder <18 yrs	23%	N/A	25%
% with householder ≥65 yrs	27%		23%
<b>Housing stock</b>			
TYPE	Single-family	99%	89%
	Multi-family	1%	5%
	Mobile home	0%	6%
HEAT FUEL	Natural gas	69%	64%
	Electricity	8%	8%
	Fuel oil	10%	15%
	Propane	9%	12%*
APPLIANCES	Electric sup. heat	49%	38%**
	Central air	36%	42%
	Room air	48%	46%
	Electric water heater	51%	45%
	Electric dryer	85%	96%***
	Electric range/oven	82%	75%
	Dehumidifier	83%	61%
	Forced air furnace	69%	49%

\* Single heat source household only

\*\* Percent of households with supplemental electric heat, among pool of households with more than one fuel

\*\*\* Percent of households with a clothes dryer (not necessarily an electric dryer)

## ENGAGEMENT AND SATISFACTION WITH THE TIME-OF-DAY RATE PILOT

Participants were asked to provide feedback about the Rate on four different surveys throughout the Time-of-Day Rate Pilot. The first three surveys were implemented after CPP events and were designed to help understand how customers responded to these events. The fourth survey was a post-pilot survey implemented after the required 12-month participation period and was designed to capture customer understanding of the Rate, level of satisfaction with the Rate, and behavior in response to both the overall Rate and specific components of the Rate. Overall, Minnesota Power's Time-of-Day Rate participants were engaged in the Rate and satisfied with the results. They felt they saved money on the Rate, and were able to shift some of their electrical use to avoid paying higher prices.

Participants requesting to be removed from the Rate were also asked to complete a brief survey indicating their reasons for requesting removal. The survey included four predefined common reasons for requesting removal and participants were instructed to check all that apply. Responders could also check “other” to write in additional or other reasons for their request. Of the 14 online requests<sup>8</sup> to be removed from the Rate received to date, 9 said they were not saving money. Six customers said that they didn’t want to worry about when to use electricity, six indicated it was too difficult to limit their use to off-peak times and two felt they did not have more control over their bill. Two customers reported changes in their schedules (spouse working from home, new baby and stay-at-home mom) as reasons for leaving the Rate and one expressed concern regarding the three consecutive September critical peak pricing events.

### **Post-Pilot Survey Results**

The post-pilot survey asked about participants’ understanding of the Time-of-Day Rate, its effect on their electricity bills, whether they changed how they used electricity as a result of the Rate and their satisfaction with the CPP notification process.

The post-pilot survey was sent to 613 participants in January 2016: 521 received an email invitation to take the survey online and 92 were sent a paper survey. We received 329 responses (54 percent response rate): 276 online and 53 paper.

While the post-pilot survey questions did not ask directly about engagement in and satisfaction with the Pilot, we could map these traits to responses from several of the survey questions. Table 4 shows the question responses we used to determine engagement in and satisfaction with the Time-of-Day Rate plan.

**Table 4: Survey Questions Mapped to Satisfaction and Engagement**

Question	Trait	
	Engagement	Satisfaction
Knowledge of rate plan	X	
Save money	X	X
Change in how electricity is used	X	
Lifestyle	X	X
Remain on rate plan (post pilot)		X
Ease of understanding the plan	X	X
Convenience		X
Reaction and response to CPP events	X	X

### **Engagement**

Overall, participants in the Time-of-Day Rate were knowledgeable about the Rate, found it easy to understand and were willing to adjust how they used electricity to keep their costs low. We used these criteria as a proxy for engagement in the Rate.

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<sup>8</sup> At the time attrition was initially evaluated (roughly four months after the end of the 12-month participation requirement) 13 requests for removal had been received. Since that time one additional request for removal was received resulting in a total of 14 participants who completed the removal request form to date.

## KNOWLEDGE OF RATE PLAN

To gauge customer awareness of the Time-of-Day Rate, we asked participants to pick the one description out of four possibilities that best defined how they were charged for electricity on the Rate. An overwhelming majority (89 percent) chose the description that accurately represented the Time-of-Day Rate, indicating a high level of awareness about how it works.

*I pay a higher price for electricity that I use between 8am and 10pm Monday through Friday; a lower price at night and on weekends; and a very high price when Minnesota Power calls a Critical Peak Pricing event.*

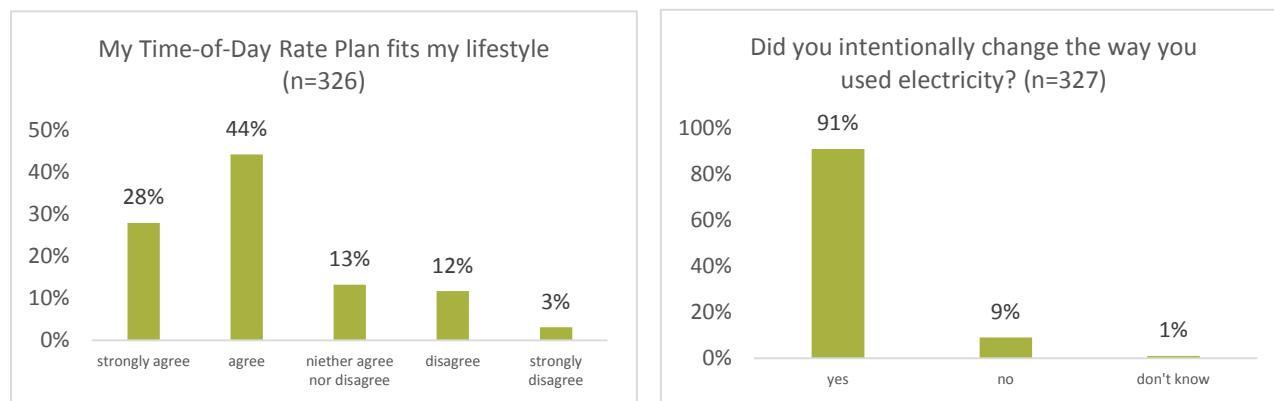
When asked whether they agreed or disagreed with the statement “my Time-of-Day Rate Plan is difficult to understand,” 82 percent disagreed or strongly disagreed with the statement. Only six percent agreed or strongly agreed with the statement.

## LIFESTYLE

Another indicator of engagement in the Time-of-Day Rate Pilot was participants’ response to the statement “my Time-of-Day Rate Plan fits my lifestyle.” Nearly three quarters of respondents (72 percent) agreed or strongly agreed that the plan fit their lifestyle. Because the rate requires active energy management decisions to avoid being charged higher fees, responses to the lifestyle statement may indicate customers who are engaged in managing their electricity use.

## CHANGED ELECTRICITY USE

Perhaps the best indicator of engagement with the Rate is whether participants intentionally changed the way they used electricity when they switched to the Time-of-Day Rate. Nearly all respondents (91 percent) indicated they made changes. These included: doing laundry and dishes at night or on weekends, lowering the furnace setting during the day or reducing air conditioning (AC) use in summer.



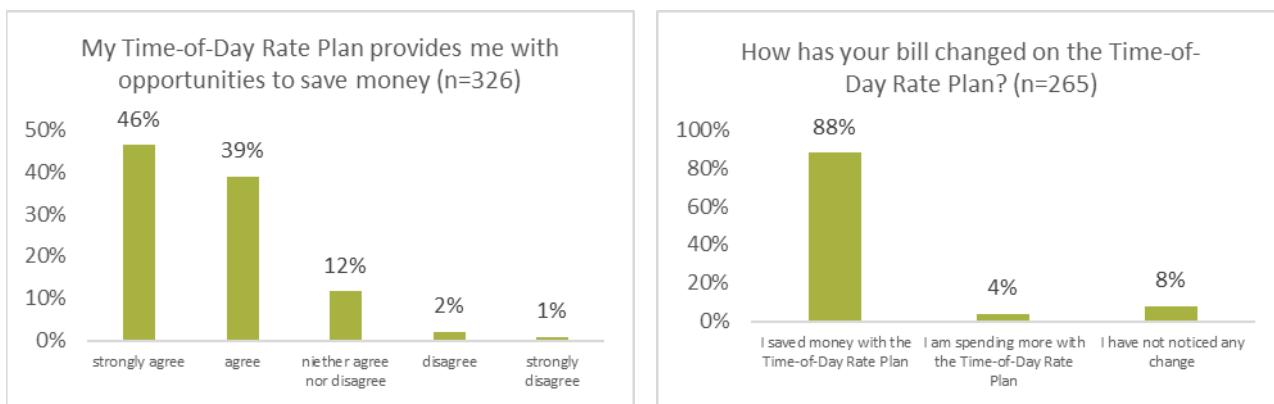
Additionally, participants were very engaged in changing their energy use when a CPP event was called. Based on results from the post-event surveys, approximately 75 percent of participants indicated that they took steps, beyond their normal practice, to reduce their electricity use during CPP events. Some of these actions included using only the lights and appliances needed at the time, waiting to do laundry and/or dishes until after the event, using less heat or air conditioning and using alternative cooking methods, such as grilling out.

## Satisfaction

We used responses to questions asking about saving money and reactions to the CPP events as indications of satisfaction with the Time-of-Day Rate. In addition to these questions, we looked at responses to a series of statements about the Time-of-Day Rate. As a result, we determined that customers on Minnesota Power's Time-of-Day Rate were very satisfied with the Rate and the CPP process.

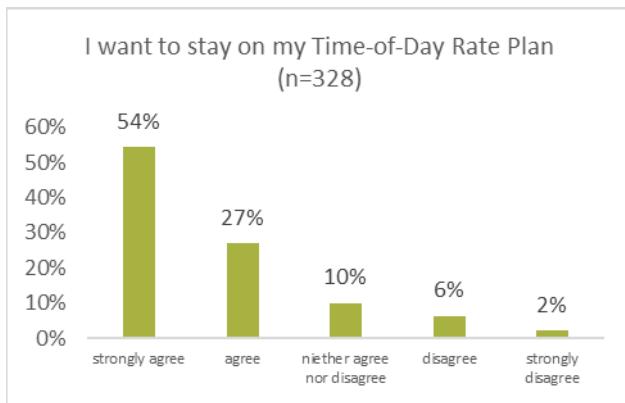
### SAVING MONEY

Respondents strongly agreed or agreed that the Time-of-Day Rate provides opportunities to save money (85 percent). Also, 88 percent of respondents reported saving money since going on the Time-of-Day Rate, compared to their old rate.



### REMAIN ON THE TIME-OF-DAY RATE

The best indicator that respondents are satisfied with the Time-of-Day Rate is their interest in remaining on the Rate after the pilot ended. Even though a little more than half of the respondents indicated that the plan is not always convenient, 81 percent strongly agreed or agreed with the statement "I want to stay on my Time-of-Day Rate Plan."



## REACTION TO CRITICAL PEAK PRICING EVENTS

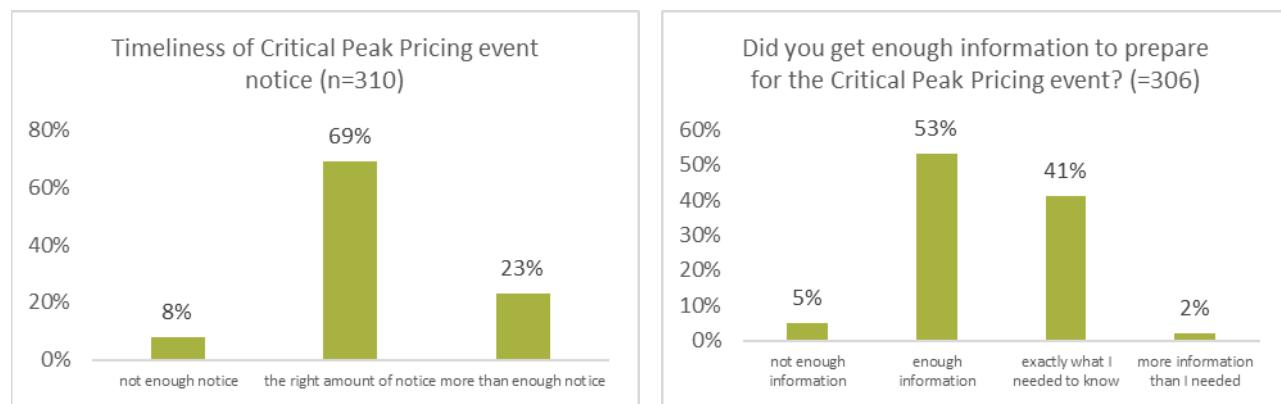
We asked several questions in the post-pilot survey to judge respondents' reaction to the CPP events that Minnesota Power called. We also surveyed participants immediately after three of the events.

## Post-pilot Reaction to CPP Events

The post-pilot survey included questions on participants' expectations of the number of events that might be called, satisfaction with the amount of notice given before an event was called and satisfaction with the amount of information provided to prepare for the event.

An equal number of respondents thought Minnesota Power called about as many CPP events as they expected (31 percent) or fewer than expected (31 percent). Another 26 percent had no expectation of how many CPP events might be called.

Respondents also thought Minnesota Power was timely in giving notice when calling a CPP event—92 percent felt they received the right amount—or more than enough—notice of the event. Respondents felt they received enough information to prepare for the events as well: only 5 percent felt they did not get enough information to prepare, while 94 percent got exactly what they needed, or got enough information.



## Post-CPP Event Reactions

We conducted short surveys immediately after three CPP events (winter and two summer events) to find out how program participants reacted to the events. Minnesota Power was interested in understanding participants' awareness of CPP, learning whether the notice of the event and information on preparing for the event were adequate, and what participants did to reduce their energy use to keep their costs low.

The winter CPP post-event survey was sent to a random sampling of 316 participants in February 2015: 224 received an email invitation to take the online survey and 92 were sent a paper survey. We received 145 responses (117 online and 28 paper for a 46 percent response rate). The summer CPP post-event surveys were sent after an event in July and an event in August 2015. A total of 622 participants received one or both of the summer CPP post-event surveys: 530 received an email invitation to take the online survey and 92 were sent a paper survey. We received 332 responses (281 online and 51 paper for a 53 percent response rate).

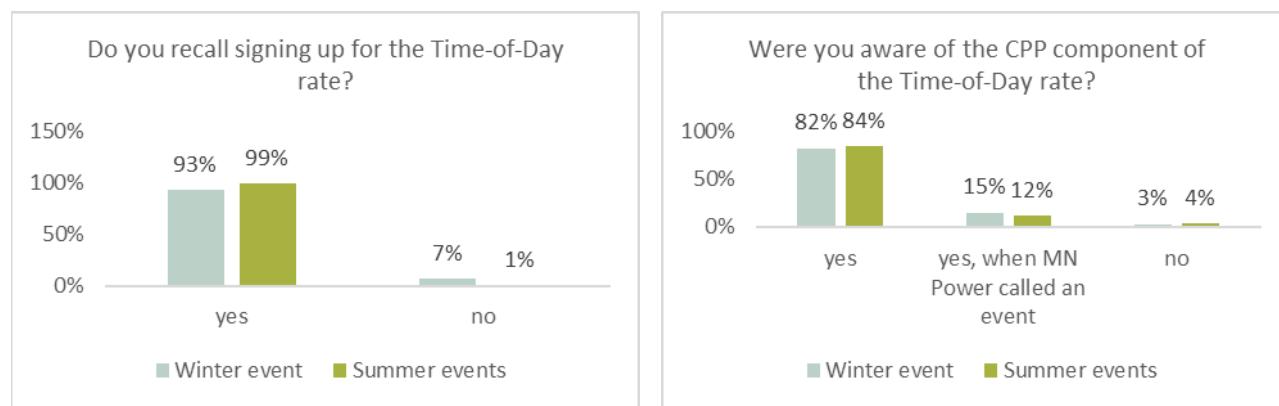
**Table 5: Post-CPP Event Survey Response Rates**

		Sent	Responses	Response Rate
Winter	Email	224	117	52%
	Mail	92	28	30%
	<b>Total</b>	<b>316</b>	<b>145</b>	<b>46%</b>
Summer	Email	530	281	53%
	Mail	92	51	55%
	<b>Total</b>	<b>622</b>	<b>332</b>	<b>53%</b>

#### PARTICIPANT AWARENESS OF CPP

Because rates went up substantially during a CPP event, Minnesota Power wanted to know whether the households that signed up for the Time-of-Day Rate were a) aware that they had signed up for the Rate and b) aware that the Rate was subject to CPP events. Program participants indicated they were aware that they had signed up for the Time-of-Day Rate, with 93 percent recalling signing up for the Rate when asked after the winter event and 99 percent recalling signing up when asked after two of the summer events.

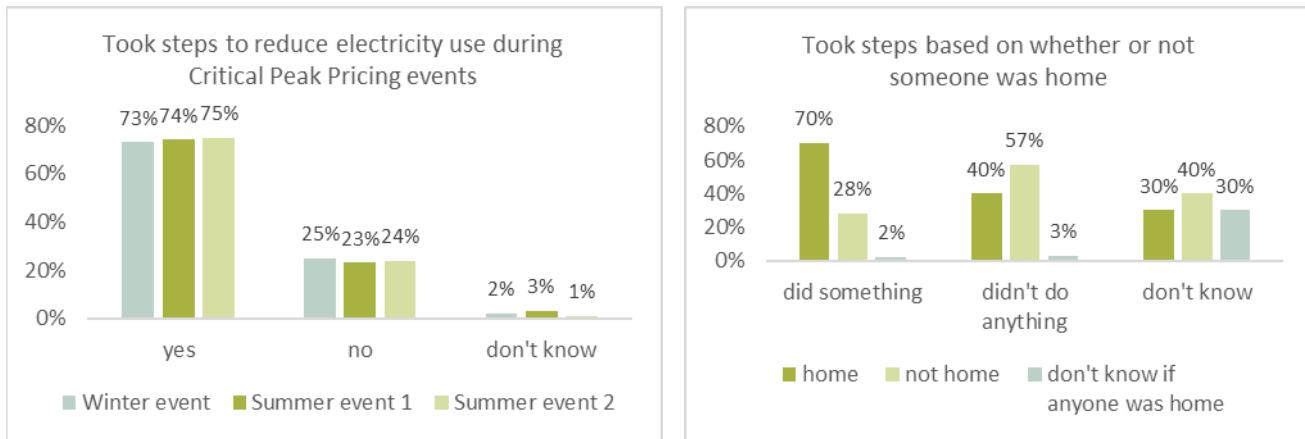
Although Minnesota Power was intentional about making customers aware of the CPP component which was explained thoroughly in the recruitment materials, welcome materials, and seasonal CPP reminder letters, somewhat fewer participants indicated they were aware of the CPP component. Still, more than three-fourths of respondents were aware of this component when asked after the winter event and two of the summer events (82 percent and 84 percent, respectively). A few participants learned of the CPP component when they received notice of a CPP event. When asked after the winter and summer events, 15 percent and 12 percent, respectively, said they were not aware of the component when Minnesota Power called an event.



#### PARTICIPANT RESPONSE TO CPP

One of Minnesota Power's study objectives was to better understand customer responsiveness to price signals and, therefore, wanted to know whether participants deliberately took steps beyond their normal practices to reduce their electricity use in response to the substantial rate increase during CPP events. Approximately three-fourths of respondents indicated that they took steps beyond their normal practice to reduce their electricity use during CPP events. Participants were also asked if anyone was home at any time during the CPP events. For the summer events, we looked at responses on taking steps to reduce use and whether participants were home during the event to get an understanding of the impact of a CPP

event on participants' energy usage habits. Participants who were home during the CPP event appear to be more likely to take steps beyond their normal practice than those participants who were away from home during the event. However, these results in no way indicate that participants who were away during a CPP event didn't reduce their energy use. It's quite possible that participants who were away from home had already implemented energy reduction strategies and they simply didn't do anything different than what they normally do when out of the house for a lengthy period of time.

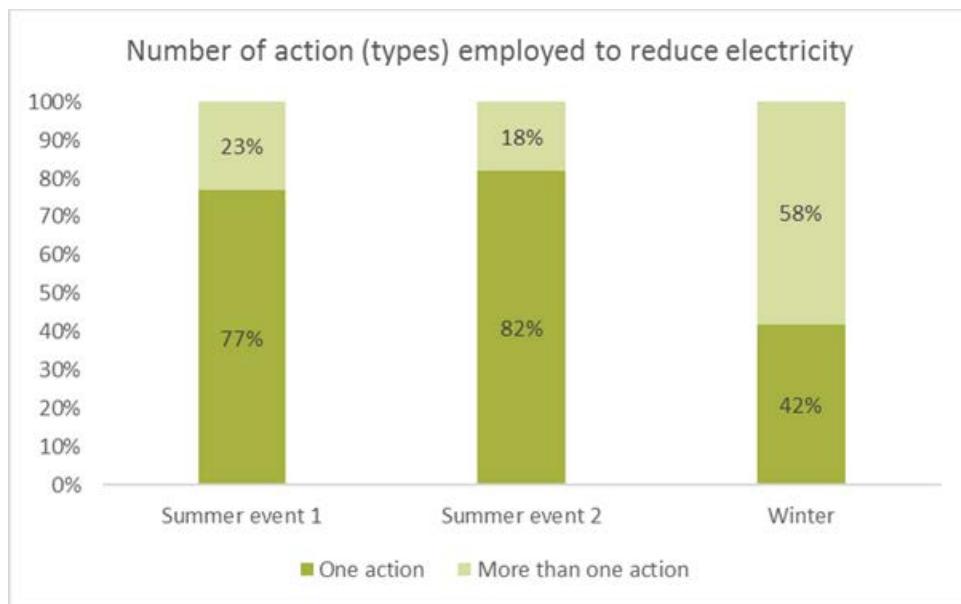


Participants who indicated that they deliberately changed their energy use during CPP events were asked what their household did differently. Their responses can be categorized as shown in Table 6.

**Table 6: Actions Taken to Reduce Electricity Use**

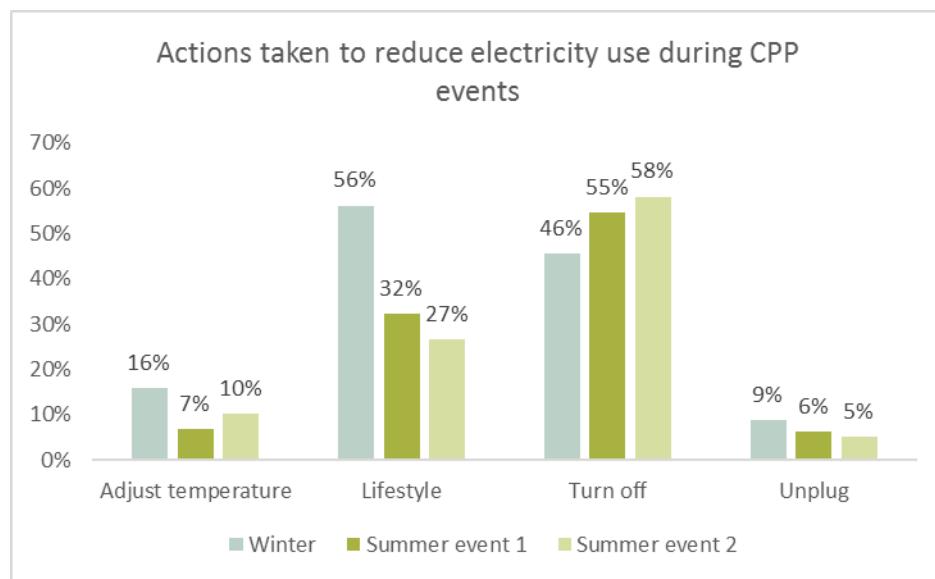
Category	Actions
Adjust temperature	Changed thermostat setting to reduce heating or cooling use
Turn off	Turned off lights, air conditioners, heat, electronics
Unplug	Unplugged energy using devices
Lifestyle	Adjusted behavior (went out, cooked outside, didn't watch TV, used alternative fuels, postponed some activities)

A portion of respondents reported taking actions during the CPP events that fell into more than one category. For example, some reported turning off lights and waiting until after the event to do laundry. Or they may have turned off their air conditioning during a summer CPP event and gone out to do errands. However, for the summer CPP events, the majority of respondents who reported taking steps to reduce their use, took actions that fell into only one category (77 percent for summer event 1 and 82 percent in summer event 2). In contrast, more than half (58 percent) of the respondents for the winter CPP event reported taking actions that fell into more than one category.



Turning off electricity-using equipment comprised the largest category of steps that respondents took to reduce their energy use during summer CPP events. During the summer events, many respondents indicated that they actually turned their air conditioning off during the event rather than just adjusting the temperature at which it would turn on. Lifestyle changes was the next largest category of steps taken in response to the summer CPP events. Adjusting temperature settings and unplugging devices were reported by a minority of respondents.

In contrast to the summer events, more respondents reported making lifestyle changes during the winter CPP event. Turning things off was the second most-reported action. While adjusting temperature settings and unplugging devices were reported by a minority of respondents, somewhat more reported adjusting temperature settings during the winter event than did during the summer events.



For all three CPP events, a few respondents reported taking extreme actions to keep their electricity use low. Surprisingly, a number of respondents for the winter event indicated that they made a cold supper to avoid using electricity for cooking:

- Ate salads (which I prepared in early AM) instead of cooking dinner (we have an electric stove).
- No electricity for making dinner.
- Did not cook, including stove, oven, microwave, etc.
- Made a cold supper ... salad and such instead of using oven and/or stove.
- Did not cook.
- No cooking.

Changing cooking behavior also figured into the actions respondents took during the summer CPP events. Several reported that they grilled out rather than cooking indoors.

Other extreme actions reported include:

- Turned off water heater.
- Ran a couple things off a 12V inverter.
- Well, we had 40 students for supper, so I turned all the heat off.
- Hid in the dark. It was hot.
- Unplugged large freezer unit.
- It was hot so I napped on the front porch for the entire period. No phone, no lights, no electrical devices, not a single luxury.
- Shut off everything but refrigeration.

## DEMAND ANALYSIS

In addition to customer engagement and satisfaction, reducing peak demand during periods of anticipated system-wide stress was a primary objective of Minnesota Power's Time-of-Day Rate Pilot Program. This section assesses the demand impacts of the pilot to address the research question,

*What effect (if any) does a CPP rate have on average customer load profile during peak events?*

### CPP Events During the Rate Pilot

Of the six CPP events called during 2015, one occurred during the winter and five during the summer. The winter event was in the evening and the summer events in the early afternoon, all on weekdays. Characteristics of each CPP event, including day of the week, hours when the CPP rate was in effect, and daily average and maximum temperatures are provided in Table 7.

As discussed earlier in the report, the decision for calling a CPP event was largely determined by day-ahead regional wholesale electricity prices. Wholesale prices are influenced by a variety of factors, some on the supply side (a plant going offline) and some on the demand side (air conditioners operating continuously during a hot summer afternoon).

Three out of the five summer events coincided with particularly hot days in Duluth, but two were on days when the maximum temperature was only in the 70s. This is important in the context of assessing demand reduction because, in contrast to events on hot days, participants are unlikely to be running their air conditioning and thus have fewer “levers to pull” in terms of conserving their usage during the event.

**Table 7. Event Characteristics**

Event	Date	Day of the week	Time window	Daily average temperature (°F)	Daily maximum temperature (°F)
1	2.19.2015	Thursday	5p-8p	-6.3	4.4
2	7.27.2015	Monday	12p-3p	75.4	84.9
3	8.14.2015	Friday	12p-3p	79.0	91.4
4	9.01.2015	Tuesday	12p-3p	74.3	82.9
5	9.02.2015	Wednesday	12p-3p	67.8	73.7
6	9.03.2015	Thursday	12p-3p	63.0	71.6

### Reduction in Household Demand During Events

The key challenge associated with estimating the impact of the CPP pricing on customer loads during events is determining what customer demand would have looked like had no event been called. The difference between these counterfactual reference loads and actual observed loads on event days is the impact of the CPP pricing on customer demand.

Expanding on our original analytical approach, we looked at this question from several angles, including: (a) identifying proxy days that were similar to event days in terms of weather but for which no event was called; (b) using seasonal regression models to predict a typical load profile for each participant against which actual load on event days could be compared; and, (c) using a matched group of non-participants to account for other unaccounted for factors that might affect the analysis. It should be noted here that this rate pilot was not designed with a randomized control trial component, meaning any Minnesota Power customer who wanted to participate in the pilot (and met participation criteria) was put on the Time-of-

Day/CPP rate. No *pre-defined control group* of non-participants was constructed. In the absence of a formal control group, we selected a group of AMI metered, non-participating customers whose consumption aligned closely with that of participants prior to the pilot to serve as a comparison group. We assume that differences in electricity consumption between participants and the comparison group during CPP events are largely explained by the difference in electricity rates; however, there may be unobserved factors that influence both a customer's decision to participate in the pilot as well as their consumption.

A more complete explanation of the various analytical approaches—which did not always yield similar results—and comparison group selection can be found in Appendix C. Here we summarize what we consider to be the most reliable and straightforward approach: a comparison of event days to similar proxy days that also include a comparison-group adjustment to account for unobserved differences between the two days.

Table 8 shows average counterfactual household demand for participants during each event and the average estimated net load reduction, which was calculated using a difference-in-differences approach (i.e., first calculating the difference in load between the event day and proxy day for each event for both participants and non-participants, then subtracting the average non-participant load change from that of the participants). The confidence intervals for the resulting estimated net load reduction are at a 95 percent confidence level.

**Table 8. Average Reduction in Demand During Events**

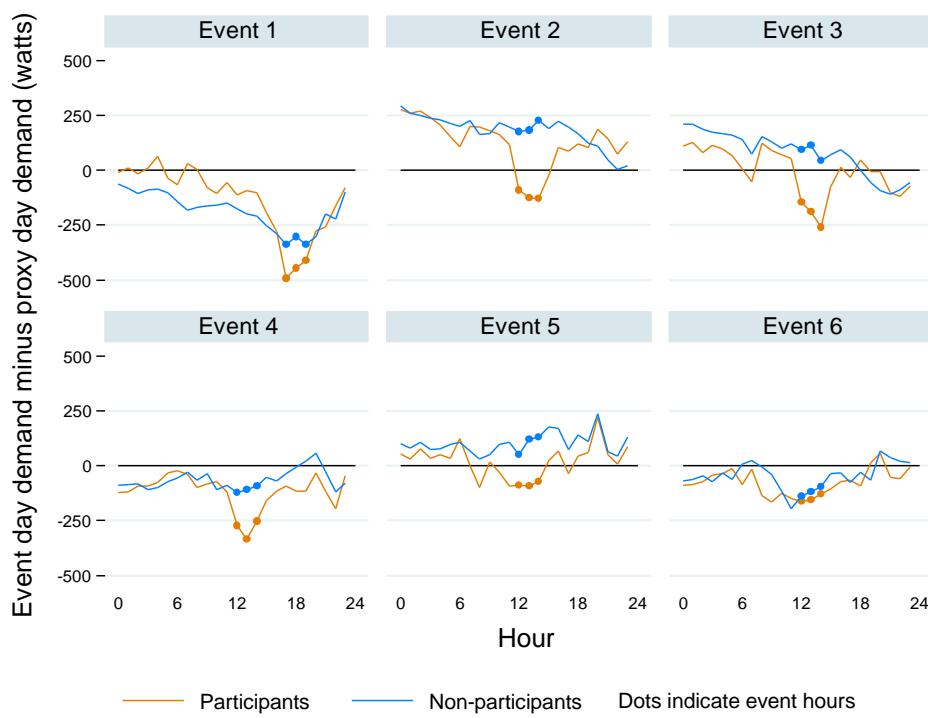
Event	Season	Average counterfactual demand* (watts)	Average net reduction (watts)	Average net reduction (%)
1	Winter	1,708 ± 129	123 ± 129	7% ± 8%
2	Summer	1,096 ± 82	310 ± 105	28% ± 10%
3	Summer	1,203 ± 86	281 ± 104	23% ± 9%
4	Summer	1,083 ± 76	179 ± 101	17% ± 9%
5	Summer	805 ± 57	184 ± 85	23% ± 11%
6	Summer	847 ± 67	30 ± 83	4% ± 10%

\* Average demand during the 3-hour event window on the respective proxy days.

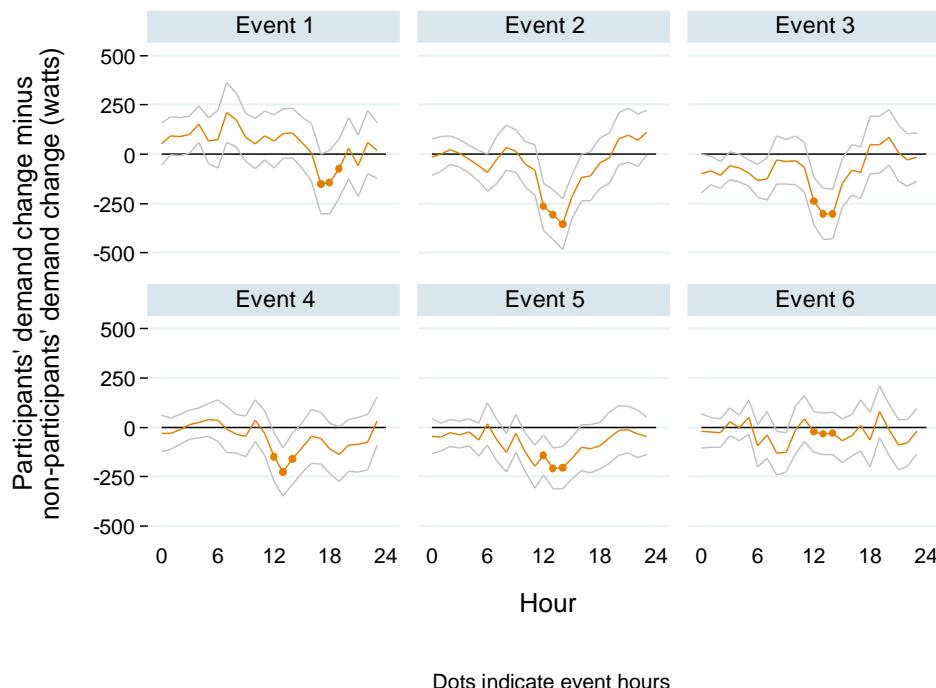
For four of the five summer events (Events 2 through 5), pilot participants reduced their hourly demand by a statistically significant amount with point estimates between 17 and 28 percent. The single winter event and the final summer event do not show statistically significant load reductions (we discuss these in more detail shortly).

Figure 4 and Figure 5 depict the results graphically for the event periods and the hours surrounding each event. Figure 4 shows the calculated difference in hourly load between the event day and its assigned proxy day separately for participants and non-participants. Figure 5 shows the hourly estimated *net* change in load (i.e., the difference between participants and non-participants), along with calculated 95 percent confidence intervals for the estimated net impact.

**Figure 4: Difference between event day and proxy day demand: comparing participants and non-participants**



**Figure 5: Estimated net change in hourly demand, with 95% confidence intervals**



Events 2, 3 and 4 all show a clear and substantial relative drop in hourly load precisely during the three-hour event windows (Figure 4), which strongly suggests that customers were responding to the CPP rate. The reduction estimates for the winter event and the final summer event are smaller and not statistically significantly distinguishable from zero at a 95 percent confidence level. A negligible reduction is not particularly surprising for the final summer event because that day was relatively cool (though the prior event day was only slightly warmer) and it was the third event among three consecutive event days, when participants may have experienced event fatigue, and relaxed their efforts to cut back their electricity usage.

The demand reduction associated with the winter event is more difficult to interpret. As Figure 4 shows, participants demonstrated a substantial reduction in load during the event hours—but non-participants also showed a significant drop, though not as sharply defined as that for the participants. The concurrent load reduction by non-participants reduces the estimated net impact of the event on participant loads to the point where it is statistically indistinguishable from zero at a 95 percent confidence level (though it would be statistically significant at a 90 percent confidence level). Moreover, in contrast to the summer events, the winter event is one where the alternative method using a comparison-adjusted regression approach yields a different result ( $205 \pm 84$  watts). We are thus left with the conclusion that for the single winter event, while there are some indications of an impact, it is difficult to gauge its magnitude.

Overall, these demand reductions fall within the range of findings from other TOU-CPP demand impact estimates. Faruqui and Sergici<sup>9</sup> assessed 15 dynamic electricity pricing experiments and programs from the 1990s and early 2000s. They found that a CPP component on an underlying time-variant rate reduces peak demand by 13 to 44 percent, depending on the degree of the price increase and the existence of enabling technologies, such as smart thermostats.

One question that arises in the context of CPP is the extent to which participants shift their electricity load to non CPP hours. On average, we do not see strong indications of this phenomenon. As indicated in Figure 4 participants generally track with non-participants for hours outside of the event window, and estimated net changes in load are mostly statistically insignificant outside the event period itself (Figure 5). If participants were shifting load to periods before or after the event, we would expect to see statistically-significant increases in load during these periods.

We also attempted to look at net load impacts between households with and without certain high-consumption electricity end uses—central air conditioning, electric space heaters and electric water heating, based on participant survey responses. The results suggest that greater demand reduction is achieved by participants with one or more of these end-uses, compared to households that lack them. However, these data are only available for about half of the participant population, and the estimates have relatively large uncertainty ranges, rendering the observed differences statistically insignificant.

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<sup>9</sup> Ref: Faruqui, A. and S. Sergici (2010). "Household Response to Dynamic Pricing of Electricity: A Survey of 15 Experiments." Journal of Regulatory Economics 38: 193-225.

## **SUMMARY OF FINDINGS**

Roughly 2 percent of Minnesota Power's residential customers in the Duluth/Hermantown area enrolled in the utility's Time-of-Day Rate Pilot. On average, this subset of customers tended to use more electricity than the typical residential customer.

Pilot participants were engaged in the rate and satisfied with the results. They felt they saved money on the rate and were able to shift some of their electric use to avoid paying higher prices. Four out of five participants report that they would like to remain on the rate.

The impact assessment finds fairly strong evidence that participants reduce their load by 17 to 28 percent during summer CPP events when the weather is warm. The results for cooler summer days—and for the single winter event—are more equivocal. Events on cool summer days eliminate the ability of participants to adjust their use of air conditioning, which is a substantial electrical load. Estimated load reductions for the single winter event varied based on the analysis method, making these results uncertain. It seems likely that there was some customer response during this event, but we cannot accurately gauge its magnitude.

On average, actions that participants take during event days seem to result in reductions in electricity demand rather than load shifts to other hours. We have no evidence of participants shifting their electricity use to non-event hours on event days.

## SECTION III: NARRATIVE OF EXPERIENCE AND INSIGHT

As referenced in its initial proposal, Minnesota Power (the Company) was mindful of the lessons learned by other companies in the pursuit of a “smarter grid.”<sup>10</sup> The Smart Grid Investment Grant presented a measured opportunity to gain direct insight and experiences associated with deploying advanced metering infrastructure not only from operational, technical and systems integration perspectives, but from a customer interface perspective as well. This narrative describes the practical experience and lessons learned for Minnesota Power.

### CUSTOMER RESPONSE

Phase One of the CBSP tested customer responsiveness to a program offering that involved enhanced feedback and tools. As discussed earlier, Minnesota Power experienced a lower than anticipated response rate to the Enhanced Feedback phase of the CBSP and ultimately revised its CBSP. In contrast to Phase One, Minnesota Power saw a higher than anticipated response rate to the Time-of-Day Rate offering. This could have been in part due to the positive press coverage received about the Rate offering. For example, on August 14, 2014, a local television station (WDIO) did an interview about the offering. On August 20, 2014, the Duluth News Tribune ran an article about it.<sup>11</sup> An uptick in calls was seen immediately following the coverage. This positive coverage was welcome, but also came with challenges in that the offering was described by the media as “off-peak” rates or a “discount” program. Minnesota Power was very careful to explain to customers that, while a discount was possible for usage shifted from on-peak to off-peak, there was also the potential for a rate adder through increased on-peak usage or CPP events.<sup>12</sup> This is also suspected as a contributor to longer call times.

The Company thought that customers may be deterred by the high CPP rate adder and/or the long on-peak period. While customers certainly had questions about this, Minnesota Power provided tools to help customers understand how the Rate functioned and to get a sense for how that could fluctuate under different usage scenarios.<sup>13</sup> A popular tool was an online calculator that customers could access through the Web site or, if they had signed up for the Power of One® Choice Portal in Phase One, they could access it there (See Figure 6). When accessing the calculator through the Portal, customers could select a month from recent history and their usage would be prepopulated in the calculator for the specified month. In addition, Minnesota Power staff, particularly the project lead, spent time walking customers through the Rate and looking at their specific usage patterns. Online tools and dedicated staff for inquiries are highly recommended as best practice approaches for these types of offerings.

<sup>10</sup> “Policy and decision makers are interested in more information about customer acceptance, retention, and response before moving forward with expanded deployments of AMI-enabled new rates and technologies.” See: US DOE. (2015) *Interim Report on Customer Acceptance, Retention, and Response to Time-Based Rates from the Consumer Behavior Studies*. Smart Grid Investment Grant Program. Available at <http://energy.gov/oe/downloads/interim-report-customer-acceptance-retention-and-response-time-based-rates-consumer>.

<sup>11</sup> <http://www.duluthnewstribune.com/content/minnesota-power-offers-peak-rates-duluth-hermantown-test-program>

<sup>12</sup> “Successful recruitment strategies typically involve a variety of success factors including the quality and persuasiveness of invitation materials, clarity of messages, thoroughness in following up and following through on customer questions and problems, and having the ability to anticipate and prevent common glitches from cascading into major problems.” See: US DOE. (2015) *Interim Report on Customer Acceptance, Retention, and Response to Time-Based Rates from the Consumer Behavior Studies*. Smart Grid Investment Grant Program. Available at <http://energy.gov/oe/downloads/interim-report-customer-acceptance-retention-and-response-time-based-rates-consumer>.

<sup>13</sup> “Setting realistic expectations for customers about the requirements of participation, performance of the devices, and potential bill savings was a key element of success as was the need to avoid the use of confusing messages See: US DOE. (2015) *Interim Report on Customer Acceptance, Retention, and Response to Time-Based Rates from the Consumer Behavior Studies*. Smart Grid Investment Grant Program. Available at <http://energy.gov/oe/downloads/interim-report-customer-acceptance-retention-and-response-time-based-rates-consumer>.

**Figure 6: Online Calculator Tool for Time-of-Day-Rate**

Calculate your Savings +

Use the calculator below to see how the Time-of-Day Rate could affect your monthly bill.

Shift in Use	On-peak	Off-peak	Estimated Critical peak	Standard rate	Time of Day	Kilowatt-hours	Estimated energy cost*
No shift; you continue using electricity as indicated in the above inputs during a month with no critical peak events.	338	413	0	\$49.18	\$41.63		
You shift 5 percent of the on-peak electricity use you listed above to off-peak hours during a month with no critical peak events.	321	429	0	\$49.18	\$40.88		
You shift 5 percent of the on-peak electricity use you listed above to off-peak hours during a month with 2 hours of critical peak	318	429	2	\$49.18	\$42.66		

*\*Estimated critical peak impacts illustrated here are based on average residential usage during typical CPP hours and assume no shift in usage during event hours. Minnesota Power will notify all participants prior to an event, giving you the opportunity to shift your energy use during this time to minimize the effect of the increased rate on your bill.*

The Time-of-Day Rate augmented Minnesota Power's existing five-tiered rate (see Table 1). This presented an educational challenge in that customers first needed to understand how the five-tiered rate works before they could appreciate what the Time-of-Day Rate might mean for them. To understand the five-tiered rate, customers would need to know how much energy they use on a monthly basis and if that varied by month or season. Ideally, they would also know what their hourly usage patterns are. This was part of the reason Minnesota Power's original CBSP design entailed a TOD Rate recruitment of "market-prepped" customers, or those who had already been exposed to their hourly usage information. To some degree, the various tools Minnesota Power developed, such as the calculator, helped to overcome the challenge. The complexity of the five-tiered rate in combination with the Time-of-Day Rate and the absence of historical hourly data for most customers were likely contributors to the higher call volume and longer duration of calls during the recruitment phase of the Pilot.

In preparation for recruitment, Minnesota Power set up a dedicated phone line for customers interested in the Time-of-Day Rate which routed directly to the project lead. Calls not answered by the project lead flowed to a small dedicated group of Call Center representatives who received detailed training on the Time-of-Day Rate. This was done intentionally in an attempt to minimize impact on Call Center staff and decrease the number of transfers needed to connect customers with a resource who could answer detailed questions about the Rate, as identified as a lesson learned and best practice recommendation through the SGIG process. If none of the dedicated Call Center representatives were available to answer the phone, the customer could leave a voicemail which was directed back to the project lead. All Call Center representatives received a high level overview of the Rate and could answer basic questions; if the question were more in-depth they would transfer the customer to the project lead.

Minnesota Power received over 500 phone calls from customers interested in the Pilot. The majority of these customers were calling to better understand whether the Rate was a good fit for them, if they were eligible, or simply to enroll over the phone. Throughout the enrollment and Pilot period, customer contact details related to the Pilot were documented if calls involved looking up the customer's specific account information. This was done by making notes on the customer's account in Minnesota Power's Customer Information System (CIS). A precise total for actual call volumes is difficult to estimate as basic inquiries that did not require account review were not always noted in an effort to reduce response times for other callers. Of the contacts recorded, there were only 14 that involved complaints or dissatisfaction. Of these calls, four were related to response time to questions enrollees had about the start date and details of the Pilot. Three complaints were related to issues accessing the Web site at the start of the Pilot. Two complaints were related to perceived bill impacts or lack of savings. Four were related to confusion and timing of removal requests after the 12-month requirement period was complete. Finally, one complaint was received with concerns about health issues related to "smart meters." For simple Time-of-Day related inquiries or contacts that did not necessitate getting account information, records are not available.

Due to a higher than anticipated level of interest in the Rate, and given the complex nature of the Rate and the questions it prompted, a number of callers were unable to speak to a representative on their first call. Minnesota Power had a limited number of resources available to help handle the initial high call volume, which led to response times that were longer than desirable. Due to message queues, some customers called multiple times before receiving a response. Recorded call volumes reached over 20 calls per day on the dedicated line during peak call days with average call times ranging from 5 to 25 minutes. Frequently, calls came through while another call was still in progress which created a queue of voicemails that needed response. Furthermore, the dedicated lead was not always available due to other responsibilities which added to the queue of voicemails.

More than 700 enrollments were received during the five-week enrollment period via mail-in applications, online submissions, and phone enrollments. After accounting for the 36 enrollees who were not eligible to participate, and roughly 21 customers who changed their mind and unenrolled before the Pilot began in October, there were a total of 660 participants at the start of the Pilot. There were approximately 16 customers that were in credit and collections status at the time of enrollment. Minnesota Power did not deny participation, but these accounts required special handling to ensure the arrearage amounts were transferred over correctly before enrolling them in the Rate. Also, Minnesota Power worked with customers eligible for the Customer Affordability of Residential Electricity (CARE) program to help them decide which rate option was the best fit for them. Generally speaking, it was more advantageous and impactful from a potential bill savings perspective for income-eligible<sup>14</sup> customers to take advantage of the CARE discount. Actual Rate enrollment dates varied based on several factors such as: billing cycle, the need for meter exchanges, credit and collections status, and receipt of a read from the meter for the Time-of-Day Rate buckets (on-peak, off-peak, and CPP) to ensure billing could process properly. Enrollment dates ranged from October 1, 2014 – October 22, 2014.

Most customers were excited for a new opportunity to save money and many customers were interested in the environmental and community benefits they believed the program would produce. Very few customers expressed concerns about "smart meters" and there was general familiarity with the concept of "off-peak programs." At community events, customers have approached Minnesota Power staff asking if the Rate will be continued and indicating they really like the option. There was some initial customer confusion, though not widespread, about the program. Some customers thought it was simply a discount program, while others thought they'd have to do all their laundry, dishes, and showers in the evening or on weekends. There also was some slight misunderstanding that the higher rates would go into effect even

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<sup>14</sup> Income-eligible customers are generally those who qualify for Low Income Home Energy Assistance Program (LIHEAP) funds.

if the customer didn't enroll—customers thinking it was an “opt-out” as opposed to an “opt-in” program. A few customers were concerned that this was a load control program where Minnesota Power would control their electricity, heat, or other appliances. After the initial enrollment period, call volume has been minimal. Consistent with the findings of the survey results, customer response to the Time-of-Day Rate has remained positive.

## PARTICIPANT COMMUNICATIONS, TOOLS, AND NOTIFICATION PROCESSES

Throughout the Pilot, a variety of tools and communication channels were employed to help participants succeed on the Rate. Customers enrolled in the Rate were sent a welcome packet with a Welcome Guide, response card for notification preferences for Critical Peak Pricing Events, and a refrigerator magnet for easy reference to the rate periods and the Time-of-Day phone number and Web site. The Web site included detailed information about the Rate, FAQ's, a variety of resources to help participants manage their energy use, and a message center where customers could find important pilot-related notices and reminders as well as recent and scheduled CPP event times. These materials are included in Appendix A for reference.

Those who had not been a part of the Enhanced Feedback phase of the CBSP were given access to the Power of One® Choice Portal where they could access hourly and daily usage information, set notifications for energy usage thresholds, and create energy markers to track events or activities affecting their usage. While Minnesota Power has some online tools and communications, the CBSP represented its first major effort toward an online portal where customers could access energy usage information, particularly daily and hourly level information. In the first phase of the CBSP, understanding customer interest in and use of the portal was the primary focus of the project. In Phase Two, the portal was leveraged as a tool to help Time-of-Day Rate participants manage their energy consumption in order to take advantage of the discounted rate period (off-peak) and avoid high usage during increased rate periods (on-peak and CPP). One insight gained from both phases is that while customers may find a Web portal easy to navigate and user-friendly, they may not come back to the site without prompting or reminders to take advantage of functionality. Minnesota Power plans to expand and build on the portal offering as an online tool for more of its customers, taking into consideration the insights gained from these Consumer Behavior Study projects.

The Company made every effort to ensure participants received the information necessary for managing the impacts of CPP events on their bills. In addition to providing informational materials on the Web site and in the Welcome Package at the start of the Rate that would be available for easy reference throughout the pilot, CPP reminder letters were also sent during the summer and winter CPP seasons. In February 2015, participants were sent a reminder letter about the possibility of winter Critical Peak Pricing Events. The letter included information about the related times and potential duration for events, what the rate would be during an event, how notifications would occur, a reminder of notification preferences on file, reference to the Time-of-Day Web site and Message Center, and energy-saving tips. Similarly, in July of 2015, another reminder was sent with all the same types of information along with updated tips for summer. These letters are included as Appendix A. In addition, Customer Service representatives were provided with talking points and reminders about the process for CPP events.

Minnesota Power was also intentional about optionality in terms of customer preferences regarding event notifications in an attempt to ensure all participants received timely notice of CPP events. The welcome packet instructed participants they could provide notification preferences (up to three phone numbers and two email addresses) where they would receive the day-ahead alerts for CPP events by completing and returning a mail-in postcard (included with the welcome materials) or by submitting a form on the Time-of-Day Web site. Participants were also permitted to submit changes to their preferences through the

online form or by calling Minnesota Power throughout the duration of the Pilot. While offering this optionality helped ensure customer satisfaction and engagement, absent a formal preference center solution, there was considerable maintenance and manual effort to manage communication preferences and the notification process when events occurred during the Pilot.

At the end of the 12-month period of required participation, participants received a communication notifying them that the Pilot had entered the evaluation phase and asking them to complete the included post-Pilot survey (refer to Appendix A) which would help inform the evaluation. This was sent via email to 523 participants and by mail to 83 participants who did not provide an email address. The communication also informed customers they could continue on the Rate for the duration of the evaluation phase (no action needed to do so) but their participation requirement had been met and remaining on the Rate was now optional. Participants who wished to be removed were instructed they could do so by calling Minnesota Power or submitting the request for removal form located on the Time-of-Day Web site.

This Pilot provided great insight into what customers want or are willing to do as it relates to their energy service and about the importance of ongoing communications, something the Company is sure to leverage as future offerings are considered. Minnesota Power’s CBSP provided firsthand experience for why it is increasingly important to have a centralized “preference center” where customers can indicate and update communications preferences for various service offerings.<sup>15</sup> Not only is this crucial for rate offerings like the Time-of-Day Pilot that require participants receive special alerts, it is also becoming a necessity for maintaining customer engagement and satisfaction. More and more customers want input about what information they receive, when they receive it, how often they receive it, and through which communication channel (e.g., text message, email, phone call, online). Absent such a solution, customers may be less likely to actively participate in managing their energy consumption and electric bills. Based on its experience with the CBSP, Minnesota Power intends to explore a preference center solution in an effort to realize efficiencies and operational benefits while expanding engagement opportunities with customers.

## **BILLING AND METERING**

In order to properly meter and bill customers that elected to be on the Time-of-Day Rate Pilot, a number of implementation steps needed to occur. These included meter exchanges and programming, billing system changes and monitoring, and meter communications. Experiences with each relative to this Pilot are described below.

### **Meter Exchanges**

Every Time-of-Day Rate customer had their meter exchanged prior to the active start date of the Pilot. New meters were programmed at Minnesota Power’s service center to display correct reading information according to the Time-of-Day Rate usage buckets—on-peak, off-peak, and CPP. Using new meters ensured all participants would have the newest firmware and configurations for the Pilot Project period.

Each new meter installed for the Pilot required a programming update and retest to add a Time-of-Day Rate schedule when exchanged at the location. Each meter contains a calendar and clock so that it knows the difference between weekdays, weekends and holidays. The Company programs a schedule into the meter so it knows at what time to put its energy allocation into what bucket. Minnesota Power gleaned from Superior Water Light and Power’s metering experience in its Time-of-Day program that older

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<sup>15</sup> <https://www.esource.com/Blog/ESource/12-30-14-Preference-Centers>

meters that were ordered with a Time-of-Day schedule preprogrammed in them could not be used for Pilot customers. The main reason for this is that the older meters would sometimes revert back to the original Time-of-Day schedule that was programmed into them at the factory. The Company was not able to definitively pinpoint the reason for this reversion, but it was discovered that if the meter only ever knew a single Time-of-Day schedule, then this issue did not occur. Consequently, reprogramming and retesting was required for all of the installed Time-of-Day meters, which was a bit more labor-intensive than installing factory programmed meters. Comparatively, for a customer on a standard residential rate, no reprogramming is required.

There were a number of customer inquiries in the field when meters were being exchanged. In response, Minnesota Power developed talking points for meter technicians to have on hand in the field along with Time-of-Day Rate educational materials. These summarized the FAQs from the Web site, but were shortened to emphasize questions that the meter technicians indicated were most commonly received.

### **Billing System Changes**

For the purposes of this report and ease of analysis, Minnesota Power has referenced October 2014 as the effective start date of the Pilot Project. Customer start dates actually varied from October 1, 2014, to October 22, 2014, due to customer enrollment processes and customer-specific conditions. Enrollment could take several days to complete, depending on the specific instance.

The rate change process was extremely labor-intensive for the Company's CIS Administration (CIS Admin). There were several aspects of the transition which contributed to the labor-intensive nature of this process. The first issue was that every Time-of-Day Rate customer required a new service agreement. In order to complete these agreements, CIS Admin was required to complete a start and stop service order for over 600 Time-of-Day Rate customers in order to change their rate. Every Time-of-Day Rate customer also required a new meter configuration in CIS. Further, CIS Admin updated every meter to recognize the appropriate bucketing of usage relative to the Rate, specifically meters were programmed to look for Total, On, Off and CPP pricing reads. These pricing reads are required in order to gather all information necessary to bill under the Rate for each of the periods and/or events—On is for on-peak, Off is for off-peak and CPP is for an event. The Total served as a check to ensure the combination of the usage buckets matched the overall total.

### **Meter Communications**

Signal strength was a significant issue during the first year of the Pilot. The AMI system functions on a radio frequency communication and meters encounter challenges when located indoors, which is often the case with apartment buildings. Another instance where it becomes challenging is when meters are located far away from a tower location in a weaker signal area.

Initially, there was a selection process where the customer's meter was exchanged and verification of signal integrity was conducted to gauge the likelihood that the meter would receive communications signals, particularly in light of anticipated CPP events. While the initial thought was that these customers would potentially be screened out on the basis of lower signal integrity levels, it was decided that all customers within the Pilot area (Duluth/Hermantown) should have equal enrollment opportunity regardless of their meter location. Also, from a pilot perspective, a larger pool of participants provides for greater insights regarding the Rate and its impacts. Instead of limiting participation based on lower signal integrity, the Company decided it would take steps to boost the signal integrity and then monitor the effectiveness of those efforts as part of the Pilot. In practicality, this effort to enroll all interested

customers caused downstream issues regarding field activities and billing. Some issues encountered included:

- Lack of communication from meters which caused lack of meter reads for billing. Field activities by Company personnel were required to get visual reads from the meters. Due to these missed reads, approximately 500 truck rolls were necessary to secure the required meter reads for billing.
- Some meters were inaccessible to Company personnel and not only required manual reads but also appointments to be read.
- Approximately 800 bills out of roughly 8,000 (~10%) required manual billing by CIS Admin due to a lack of communication from the meters during the initial 12-month period.

Currently, Minnesota Power does not have a cost effective means to improve signal quality to the smaller pockets of hard-to-reach meters. Smaller radio units<sup>16</sup> designed to provide solutions to these types of situations are in development with the AMI meter provider, but there are no release dates set for them thus far. Currently, the Pilot is fully deployed with the large radio units<sup>17</sup> on towers, but the Company is still a few years away from outfitting its entire service territory with these tower sites.

Lack of communication from the meters resulted in inconsistent CPP reads. During CPP events, the Company broadcast the scheduled times to the meters. Some meters with poor communications rarely, if at all, received this broadcast. As such, the approximate percentage of customers charged CPP Rates for at least one event was 76 percent for winter events and 95 percent for summer events. There were several CPP events in the summer which increased the percentage of customers billed for a CPP event in those months. However, it isn't possible to determine the exact number of successes for each event because some events were called within the same billing cycle. The CPP bucket is cumulative from one billing period to the next for monthly billing purposes. As such, individual events are not tracked within the billing system.

**Table 8: Meter Signal Response Rates**

Date	Time	Event Type	# Meter Signals Sent	Successful Responses	Success Rate
2/19/2015	5pm - 8pm	Winter	654	516	79%
7/27/2015	12pm - 3pm	Summer	619	353	57%
8/14/2015	12pm - 3pm	Summer	619	521	84%
9/1/2015	12pm - 3pm	Summer	619	508	82%
9/2/2015	12pm - 3pm	Summer	619	516	83%
9/3/2015	12pm - 3pm	Summer	619	541	87%

Table 8 shows the estimated signal response rate for each event. It should be noted that these numbers represent the number of meters that both received the CPP event signal and successfully sent a signal back. It is likely that more meters successfully received the CPP signal but they were unable to report

<sup>16</sup> There is a lower wattage radio unit in development that is capable of handling only up to approximately 1,500 endpoints. It is designed to be an outdoor unit on a pole. No pricing has been set but it is being engineered as a small spot-filler solution and should be much more cost effective for smaller meter pockets versus a full radio unit designed to be on tower infrastructure. Tentative release dates are hopeful for late 2016. A second radio unit is also in development. This is an indoor unit designed to interact with up to a few dozen meters and either repeat its signals out, or if paired with additional communications equipment, send and receive messages directly back to the AMI system. There are no dates set for product release.

<sup>17</sup> These units are physically much larger and have much bigger processing units and capabilities. These units are capable of handling approximately 40,000 end points. There is no pricing or information available on the smaller units yet but experience foretells that these larger units, which are typically located on tower infrastructure, are going to be several times more expensive once fully deployed versus their smaller counterparts.

back. This means that the percentage of customers billed for CPP events is likely higher than what the signal response rate suggests.

One of the challenges of converting a meter for a Time-of-Day Rate is that instead of just needing a supervisory read, which comes in from the meter every few hours, the data for the amount of usage in the different buckets comes in on what is called a tier file. This file is only transmitted from the meter once a day at midnight. The meter attempts to get the message multiple times but with the size of the data packet being much larger, and the whole meter population attempting to get these read packets in, meters in weaker signal areas often struggle to transfer this tier file packet.

Minnesota Power does not currently have a meter data management system (MDM), in large part because the AMI saturation rate has been too low to justify this type of investment, though such a system may have helped with some of the errors and reporting issues encountered during the Pilot. The Company has been exploring other interim solutions in light of the experience with the Time-of-Day Rate while an MDM business case is explored and as AMI deployment expands.

## CONCLUSION

Phase Two of Consumer Behavior Study project was designed to help Minnesota Power gather insight into customer acceptance of and response to a Time-of-Day Rate offering with a Critical Peak Pricing component while gaining practical operational experience in implementing and maintaining time-based rate options. This evaluation characterized Pilot participants; assessed engagement, satisfaction and response to the Rate offering; and estimated peak demand impacts of the CPP rate component.

The CPP impact portion of the study incorporated two within-subject approaches to developing baselines and made use of a comparison group of non-participants with AMI meters to more accurately estimate demand reductions. Results indicate that the 77 cent CPP rate increase was associated with demand reductions between 17 and 28 percent during particularly warm weather. Lack of evidence indicating increased consumption surrounding event hours suggest load reductions are largely the result of actions decreasing consumption rather than shifting consumption to non-CPP hours. Analysis of the single winter event was less conclusive. Although there was some indication of load reduction during the event, the results were not statistically significant at the 95 percent confidence level and the different analytical approaches yielded different results. Additional observations and further analysis is needed regarding winter CPP impacts.

Customer interest and engagement were evaluated based on recruitment and enrollment activity, participant responses to several surveys implemented throughout the Pilot, and post-participation requirement attrition. Overall, customers indicated through their survey responses and willingness to enroll and remain on the Rate, high levels of satisfaction with the Rate. Two percent of eligible residential customers enrolled in the Pilot, which was higher than anticipated. Minnesota Power also saw very little drop off after participants met the 12-month participation requirement and many survey respondents indicated strong preferences for remaining on a time-of-use rate.

Survey responses and load impacts reflect a high level of engagement among participants. Nine out of ten participants who responded to the post-pilot survey reported they intentionally changed the way they used electricity after enrolling in the Rate and three out of four indicated they specifically took steps to reduce electricity during CPP events. A number of participants reported taking fairly extreme actions including turning off major appliances (such as refrigerators and water heaters) and in some cases, turning everything off. Although the load impact analysis was not conclusive for the winter event, summer event findings were in line with customer reported behavior.

These findings suggest there may be a strong appetite among Minnesota Power customers for time-based rate options as well as a general willingness to modify behavior in response to price signals in order to better manage their electricity costs. However, the Company's operational experience with the Rate has introduced numerous metering and billing considerations, many of which do not currently have automated or systematic solutions in place. At this time, the systems and infrastructure necessary for a successful system-wide Time-of-Day Rate offering are not fully deployed or in effect. Minnesota Power has communicated in its most current Integrated Resource Plan<sup>18</sup> its intent to expand advanced metering infrastructure (AMI) conversion and the related communications infrastructure, which would be foundational elements for a broader offering. Further, Minnesota Power is evaluating investment in a Meter Data Management System (MDM). This investment would provide much more efficient and automated validation, editing, and estimating (VEE) functions that would help to address many of the billing and metering challenges encountered during the Rate Pilot.

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<sup>18</sup> Appendix G, Minnesota Power's Application for Approval of its 2015-2029 Integrated Resource Plan, Docket No. E015/RP-15-690, September 1, 2015 .

Balancing current system realities with the desire to offer customers dynamic pricing options, Minnesota Power requested continuation of the Rate for the existing pool of customers (pilot participants) with slight modifications to ensure revenue neutrality, as required by the Minnesota Public Utilities Commission. It is Minnesota Power's view that there are further insights to gain from this Pilot that will help inform future customer rate options and program offerings.

## APPENDIX A—RECRUITMENT MATERIALS AND PARTICIPANT COMMUNICATIONS

&lt;insert date&gt;

Dear Minnesota Power Customer,

Are you interested in the ability to better manage your energy bills? Minnesota Power's **Time-of-Day Rate Pilot** program does just that.

Currently, you are billed for electricity based only on how much you use each month: you use less, you spend less. With the Time-of-Day Rate Pilot, you can take more control of your electricity costs by managing when you use it. This pilot rate charges you less for electricity most of the time and identifies the high priced periods to avoid. **If you use electricity when it's least expensive, you pay less.**

The Time-of-Day Rate Pilot is a voluntary 12 month offering to eligible residential customers in the Duluth/Hermantown service area and is designed to allow Minnesota Power to more directly pass our cost savings on to you. By participating in this rate, simple choices like doing your laundry on the weekend instead of on a weekday and running your dishwasher overnight could help you save money.

As a Power of One® Choice Pilot participant, you already have access to an enhanced Web portal where you can view your hourly energy usage and find other tools and information that help you manage your energy use. In the Time-of-Day Rate Pilot you will continue to have access to the portal making it easier for you to find ways to save money.

**Think Time-of-Day Rate could be for you? For more information:**



Check out the enclosed brochure and mail-in enrollment card for an overview of Time-of-Day Rate Pilot and eligibility requirements.

Visit [www.mnpower.com/TimeOfDayPilot](http://www.mnpower.com/TimeOfDayPilot) where you can find even more details and tools to help you decide if it's a right fit for you. You can also enroll online.

Log in to your Power of One® Choice Portal to view your hourly energy usage and access tools to see if Time-of-Day Rate can save you money.



Give us a call at 877-707-5771

Sincerely,



Tina S. Koecher  
Manager—Customer Solutions,  
Minnesota Power



&lt;insert date&gt;

Dear Minnesota Power Customer,

Are you interested in the ability to better manage your energy bills? Minnesota Power's **Time-of-Day Rate Pilot** program does just that.

Currently, you are billed for electricity based only on how much you use each month: you use less, you spend less. With the Time-of-Day Rate Pilot, you can take more control of your electricity costs by managing **when** you use it. This pilot rate charges you less for electricity most of the time and identifies the high priced periods to avoid. **If you use electricity when it's least expensive, you pay less.**

The Time-of-Day Rate Pilot is a voluntary 12 month offering to eligible residential customers in the Duluth/Hermantown service area and is designed to allow Minnesota Power to more directly pass our cost savings on to you. By participating in this rate, simple choices like doing your laundry on the weekend instead of on a weekday and running your dishwasher overnight could help you save money.



As a Time-of-Day Rate Pilot participant, you will have access to an enhanced Web portal where you can view your hourly energy usage and find other tools and information that will help you manage your energy use and make it easier for you to save money on the rate.

**Think Time-of-Day Rate could be for you? For more information:**



Check out the enclosed brochure and mail-in enrollment card for an overview of Time-of-Day Rate Pilot and eligibility requirements.



Visit [www.mnpower.com/TimeOfDayPilot](http://www.mnpower.com/TimeOfDayPilot) where you can find even more details and tools to help you decide if it's a right fit for you. You can also enroll online.

Sincerely,

Tina S. Koecher  
Manager—Customer Solutions,  
Minnesota Power



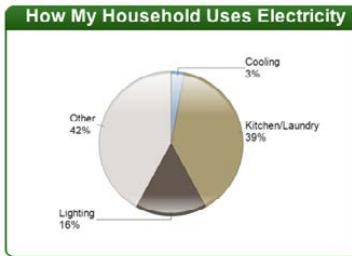
Give us a call at 877-707-5771

**Is this a Right Fit?**

The Time-of-Day Rate is designed for people who are able to manage when they use electricity. By shifting energy usage to off-peak hours, participants can benefit from the discounted rate. Those customers who can reduce their electricity usage during on-peak and CPP event hours can save money by avoiding the highest-priced periods. Understanding how and when you use the most energy enables you to gauge how well you can manage your bill under this rate.

**Here are some ways to help you decide:**

- Complete the survey (right) to see your potential for saving.
- Visit [www.mnpower.com/TimeOfDayPilot](http://www.mnpower.com/TimeOfDayPilot) to estimate your Time-of-Day bill costs with the savings calculator. You can also access an appliance calculator to find out which of your household appliances and activities use the most energy.
- Visit the Power of One® Portal ([www.mnpower.com/portal](http://www.mnpower.com/portal)) to review your energy usage and get customized recommendations on ways to save energy.

*How do I sign up?*

Signing up to participate in the pilot is an easy, two-step process.

Once enrolled, you will receive an enrollment package with more details about when the rate starts and the next steps.

**Potential for Savings Survey**

For each question you answer 'yes', give yourself one (1) point in the box on the left. Add up your points and find out your potential cost savings.

- Are you a residential customer in a single family home?
- Do you tend to use less energy during daytime weekday hours compared to weekends?
- Can you shift dishwashing activities to off-peak hours?
- Can you shift electric clothes washing and drying to off-peak hours?
- If you have A/C, can you adjust your summer thermostat setting 2 or 3 degrees higher during on-peak hours?
- If you have electric heat, can you adjust your winter thermostat setting 2 or 3 degrees lower during on-peak hours?
- Are you willing to shift other types of electric usage to off-peak hours to conserve energy?
- Do you have access to the internet in your home?

**Total Points**

Cost Savings Potential on Electric Bill\*

- 0-3 Points = little or no potential for savings
- 4-8 Points = greater potential for savings on your electric bill

\*Individual customer savings will vary based on specific usage patterns.

1. First, read through this program brochure and complete the Potential for Savings Survey (above) to help determine if the Time-of-Day Rate is right for you.
2. Next, complete the enclosed enrollment form and drop it in the mail, or fill out the form online at [www.mnpower.com/TimeOfDayPilot](http://www.mnpower.com/TimeOfDayPilot)



AN ALLETE COMPANY

# Time-of-Day Rate Pilot



*Everyday choices  
equal energy savings.*



AN ALLETE COMPANY

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

[www.mnpower.com/TimeOfDayPilot](http://www.mnpower.com/TimeOfDayPilot)

# TAKE CONTROL OF YOUR ENERGY USE AND SAVE ➤

*What's it all about?*



Time-of-Day Rate is an optional 12-month pilot program designed to give you more control of your electric bill. Currently, you are billed for electricity based on how much you use each month. To more accurately reflect the cost of providing electricity and allow us to ultimately pass our cost savings on to you, the Time-of-Day Rate Pilot charges different rates during different times of day. The pilot will be open to eligible Minnesota Power customers in the Duluth/Hermantown service area for a limited period of time.

## Time-of-Day Rate Advantages

### *Take Control and Save on Your Bill*

On the Time-of-Day Rate, electricity used during some time periods (off-peak periods) will receive a discounted rate and some will have a slightly higher rate (on-peak periods). This rate structure gives you the opportunity to save money by shifting some of your electricity usage to off-peak periods.

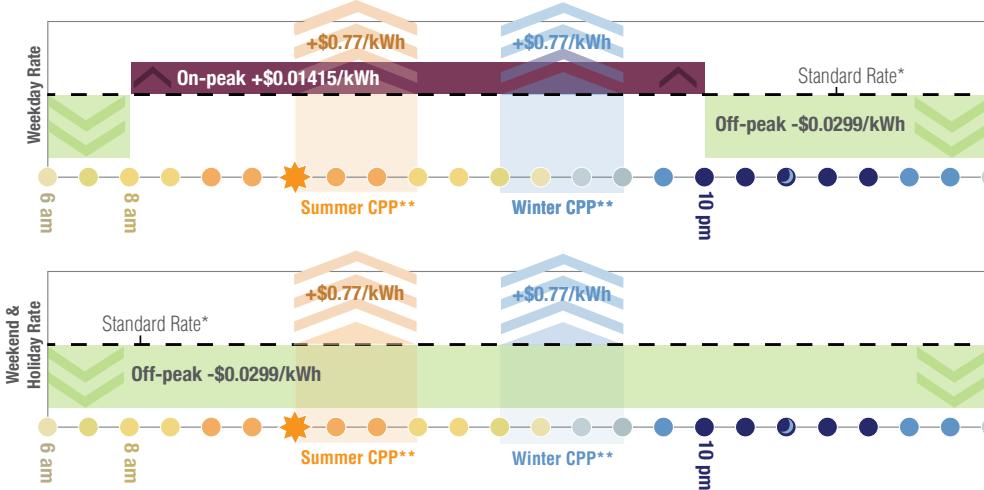
Participants will have access to an enhanced web portal with tips and tools to help manage energy use.

## Make a Difference

When there is a high demand for electricity, Minnesota Power may need to buy energy at a higher cost or from less environmentally friendly sources. Helping you understand the most efficient times to use energy and providing you ways to help manage your time of use allows Minnesota Power to better plan for a cleaner, more affordable energy future.

## Here's how it looks:

This chart shows the adjustments that would be applied to your standard rate\* at different times of the day. Although summer and winter CPP times are included in the chart, these periods do not occur regularly.



## Critical Peak Pricing (CPP) Event Windows

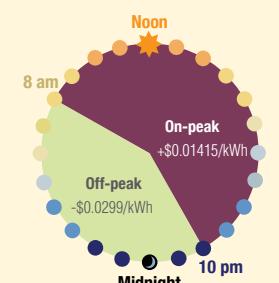
No more than 160 hours can be declared during the 12-month pilot.

**Summer CPP	12:00–3:00 p.m.
**Winter CPP	5:00–8:00 p.m.
Emergency Event	8 hours maximum at any time

**Here's how it works:** You will receive a discounted rate for all energy consumed during off-peak time periods.

**Off-peak hours** are Monday–Friday from 10 p.m. to 8 a.m., and all day and night on weekends and holidays. The standard electric rate will be discounted by \$0.0299 per kWh.

**On-peak hours** are the hours that electricity usage is typically the highest—Monday–Friday from 8 a.m. to 10 p.m. During those hours, the standard rate will be increased by \$0.01415 per kWh.



**Weekdays**



**Weekends & Holidays**

Occasionally during summer and winter months when demand for electricity gets particularly high, Minnesota Power may declare a **Critical Peak Pricing (CPP)** event. During these events you will be charged an additional \$0.77 per kWh. These events are limited to a total of 160 hours during the 12-month pilot and will generally be limited to three-hour windows in the summer (12:00 p.m.–3:00 p.m.) and winter (5:00 p.m.–8:00 p.m.). Minnesota Power will notify you by 8 p.m. the day prior to a planned event. *If the power system is experiencing a serious crisis, an emergency CPP event may be called. Reasonable effort will be made to give four hours notice of the event.*

Participants will be notified of CPP events by phone and/or email and by messaging on the website. By notifying you ahead of time, you will be provided the opportunity to plan to use less energy during these events and minimize the effect of the increased rate on your bill.

## Tools to take control

As a Time-of-Day Rate Pilot participant, you will have access to an enhanced web portal where you can view your hourly energy usage and find other tools and information that will help you manage your energy use and make it easier for you to save money on the rate.





Pilot Program - Enrollment Application

### Eligibility Requirements

By signing this application, I am applying for the Minnesota Power Time-of-Day Rate Pilot. I understand that by doing so, I agree that:

- I am a residential customer in the Duluth/Hermantown area.
- I must be enrolled in the rate for a minimum of 12 months unless I move from Minnesota Power's service territory or to an ineligible area.
- I may not participate in this pilot while on another reduced rate (Dual Fuel, Customer Affordability of Residential Electricity (CARE) rate, Seasonal Service or Controlled Access).
- This rate requires hourly data and my meter may need to be upgraded by Minnesota Power (at no extra cost to me).
- This rate is based on when I use energy and if I am not able to shift my energy use, I could pay more than I pay with my current rate.
- I will periodically be asked to provide feedback via online surveys during the pilot period.

For questions about the Time-of-Day Rate Pilot program, call 877-707-5771 or visit [www.mnpower.com/TimeOfDayPilot](http://www.mnpower.com/TimeOfDayPilot)

### Time-of-Day Rate Pilot Enrollment Application

Name(s) on Minnesota Power account \_\_\_\_\_

Service address \_\_\_\_\_

City \_\_\_\_\_ Zip \_\_\_\_\_

County \_\_\_\_\_

Phone \_\_\_\_\_

Email \_\_\_\_\_

Mailing address (if different from service address) \_\_\_\_\_

City \_\_\_\_\_ Zip \_\_\_\_\_

MN Power account number (must be included) \_\_\_\_\_

Your account number is located on your bill. If you cannot find it, contact Minnesota Power at 1-877-707-5771.

I have read and understand the eligibility requirements (left).

Signature: \_\_\_\_\_ Date: \_\_\_\_\_

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



# Time-of-Day

*Rate Pilot*



AN ALLETE COMPANY

Everyday choices equal energy savings.

## Choose when you use energy and choose energy savings.

Recently you received an informational brochure and enrollment form inviting you to take part in Minnesota Power's Time-of-Day Rate pilot. There is still time to participate and take advantage of this unique opportunity offered to Duluth and Hermantown residents for a 12-month pilot period.

### How does the program work?

Today, you are billed for electricity based on how much you use, but not when you use it. Measuring your usage hourly instead of monthly allows Minnesota Power to offer another rate option. The Time-of-Day Rate charges different prices at different times of day based on the cost of providing electricity and based on when you choose to use energy.

This rate is designed to allow Minnesota Power to more directly pass our cost savings on to you. By participating in this rate, simple choices like doing your laundry on the weekend instead of on a weekday and running your dishwasher overnight could help you save money.

### Is this rate right for me?

Visit [www.mnpower.com/TimeOfDayPilot](http://www.mnpower.com/TimeOfDayPilot) or call 877-707-5771 to find out if this rate is right for you, for more details about the program, and to enroll.



AN ALLETE COMPANY

30 West Superior Street  
Duluth MN 55802-2093



NAME  
ADDRESS LINE  
CITY,STATE ZIP



### Questions?

We're here to help. In addition to this Welcome Guide, you can also find information on the Time-of-Day Rate Pilot at [www.mnpower.com/TimeOfDayPilot](http://www.mnpower.com/TimeOfDayPilot) or by calling us at 877-707-5771.

Customers may file a complaint with the Minnesota Public Utilities Commission (MPUC) Consumer Affairs Office (CAO). MPUC's mediators are available Monday through Friday from 9:00 a.m. to 4:00 p.m. to answer any questions you may have before completing and submitting the complaint form. Please email consumer.puc@state.mn.us with your inquiry or call 651.296.0406 or 1.800.657.3782. For more details, you may visit the MPUC website at <http://mn.gov/puc/consumers>.

### Data Reporting and Privacy

Minnesota Power follows its standard operational privacy guidelines and practices for all customers, including those participating in this rate. This voluntary rate is being offered as part of a Department of Energy (DOE) grant.

Reporting of certain data, along with customer usage information, is required of Minnesota Power under the terms of the grant. A unique customer study identification number will be assigned for any customer level data, in accordance with DOE guidance documents. Individual customer names, account numbers, and addresses will not be included in reports to the DOE. For more details about the data reporting requirements and privacy of the Time-of-Day Rate Pilot, refer to Minnesota Power's rate book at [www.mnpower.com/TODRateBook](http://www.mnpower.com/TODRateBook) or call 877-707-5771.



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

# Time-of-Day Rate Pilot

## Welcome Guide

[www.mnpower.com/TimeOfDayPilot](http://www.mnpower.com/TimeOfDayPilot)

IN THIS GUIDE:

## ABOUT THE RATE

ALL ABOUT PEAK | ON-PEAK & OFF-PEAK RATES | UNDERSTANDING  
CRITICAL PEAK PRICING EVENTS | PEAK PERIODS & RATES SUMMARY

## ABOUT YOUR BILL

TIME-OF-DAY RATE BILL COMPARISON |  
WHAT TO EXPECT ON YOUR BILLS

## UNDERSTANDING YOUR ELECTRIC COSTS

APPLIANCE OPERATION COSTS | SEASONAL CHANGES

## RESOURCES

POWER OF ONE® CHOICE PORTAL & YOUR HOME ENERGY  
REPORT | HOURLY USAGE VIEWS & TOOLS | TIME-OF-DAY WEBSITE

# ABOUT THE RATE

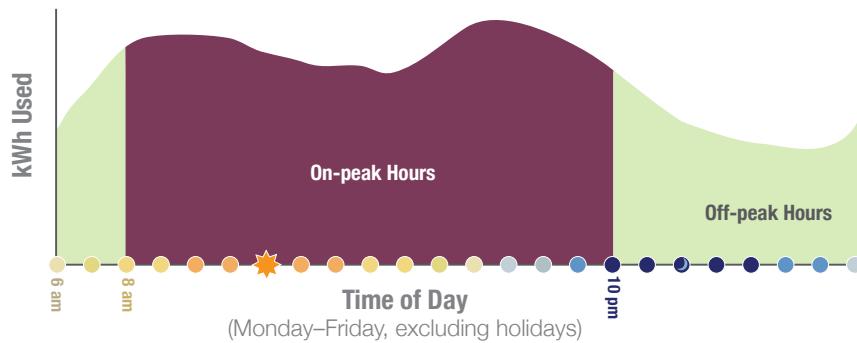
ALL ABOUT PEAK | ON-PEAK & OFF-PEAK RATES | UNDERSTANDING  
CRITICAL PEAK PRICING EVENTS | PEAK PERIODS & RATES SUMMARY

## ALL ABOUT PEAK

### What is “peak” and why does it matter?

Customer choices about how and when they use energy affect how Minnesota Power provides that energy and at what cost. By choosing to use energy during times when the cost to provide energy is less, and by conserving energy overall, you can help keep energy rates affordable, benefit the environment and save energy.

“Peak periods” (or on-peak hours) are times when demand for electricity is the highest. This usually occurs on weekdays during the daytime when businesses are open and people are using electricity for their daily routines. During these times our cost to provide electricity is greater. If peak demand gets too high, those costs can rise very quickly.



Through the use of advanced metering infrastructure (AMI), we are able to see when energy is consumed in our service territory, which helps us to better understand peak demand and when it occurs. This infrastructure paired with the Time-of-Day Rate enables us to pass savings on to you when you reduce the amount of energy consumed during on-peak times. By conserving energy throughout the day on weekdays and modifying some of your biggest energy using activities, you could see direct savings on your bills!

## ON-PEAK & OFF-PEAK RATES

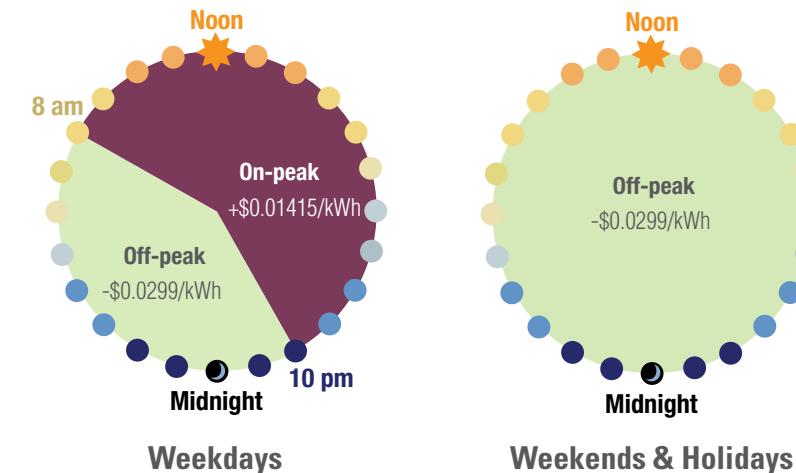
Under our Time-of-Day Rate, you have the potential to save money by shifting your electricity usage from on-peak hours to off-peak hours. Usage during off-peak hours will receive a discounted rate and energy used during on-peak hours will cost more. Your effort to reduce electricity usage during on-peak times allows Minnesota Power to ultimately pass our cost savings on to you.

<b>Off-Peak Hours</b>	Mon–Fri 10pm–8am All Day Sat & Sun, Holidays*	\$0.0299/kWh Discount (about 3 cents)
<b>On-Peak Hours</b>	Mon–Fri 8am–10pm	\$0.01415/kWh Increase (about 1.5 cents)

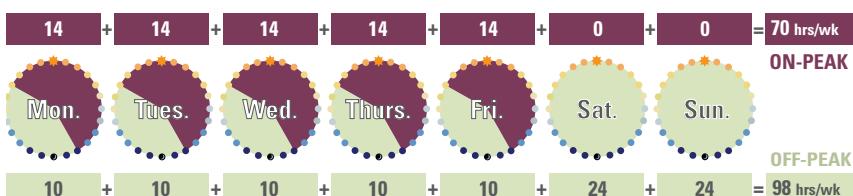
\*New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, and Christmas Day

**Off-Peak** hours are Monday–Friday from 10 p.m. to 8 a.m. and all day on weekends and holidays (New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, and Christmas Day). The standard electric rate will be **discounted by \$0.0299 (about 3 cents) per kWh**.

**On-Peak** hours are the hours during which electricity use is typically the highest—Monday–Friday from 8 a.m. to 10 p.m. During those hours, the standard rate will be **increased by \$0.01415 (about 1.5 cents) per kWh**.



**Check it out:** During a typical week, 98 hours are off-peak and only 70 hours are on-peak. This means about 60% of the hours during the 12-month pilot will be off-peak hours.



## UNDERSTANDING CRITICAL PEAK PRICING (CPP) EVENTS

Occasionally during summer and winter months when demand for electricity gets particularly high, Minnesota Power may declare a Critical Peak Pricing (CPP) event.

**Rate:** During these events you will be charged an additional \$0.77 per kWh.

**When:** Standard CPP events will generally be limited to three-hour windows in the summer and winter (see chart below).

However, if the power system experiences a serious crisis, Midcontinent Independent System Operator (MISO) may declare an emergency CPP event. Emergency events are rare and are not limited to specific windows of time but may last no longer than 8 hours.

### Critical Peak Pricing (CPP) Event Windows

No more than 160 hours can be declared during the 12-month pilot.

Summer CPP	12:00–3:00 p.m.
Winter CPP	5:00–8:00 p.m.
Emergency Event	8 hours maximum at any time

**Notification:** Minnesota Power will notify you by 8 p.m. the day before a standard CPP event and make every reasonable effort to give 4 hours notice of an emergency event.

You will be notified of the events via phone call and/or email message depending on the preferences you provide. You can also check [www.mnpower.com/TimeOfDayPilot](http://www.mnpower.com/TimeOfDayPilot) to see if there is a scheduled event.

### Providing your CPP Event Notification Preferences

To better ensure you receive CPP event notifications so that you can plan ahead, please submit your preferred contact information using one of the following methods:

1. Go online at [www.mnpower.com/TimeOfDayPilot](http://www.mnpower.com/TimeOfDayPilot) to submit a CPP notification preferences form.

**OR**

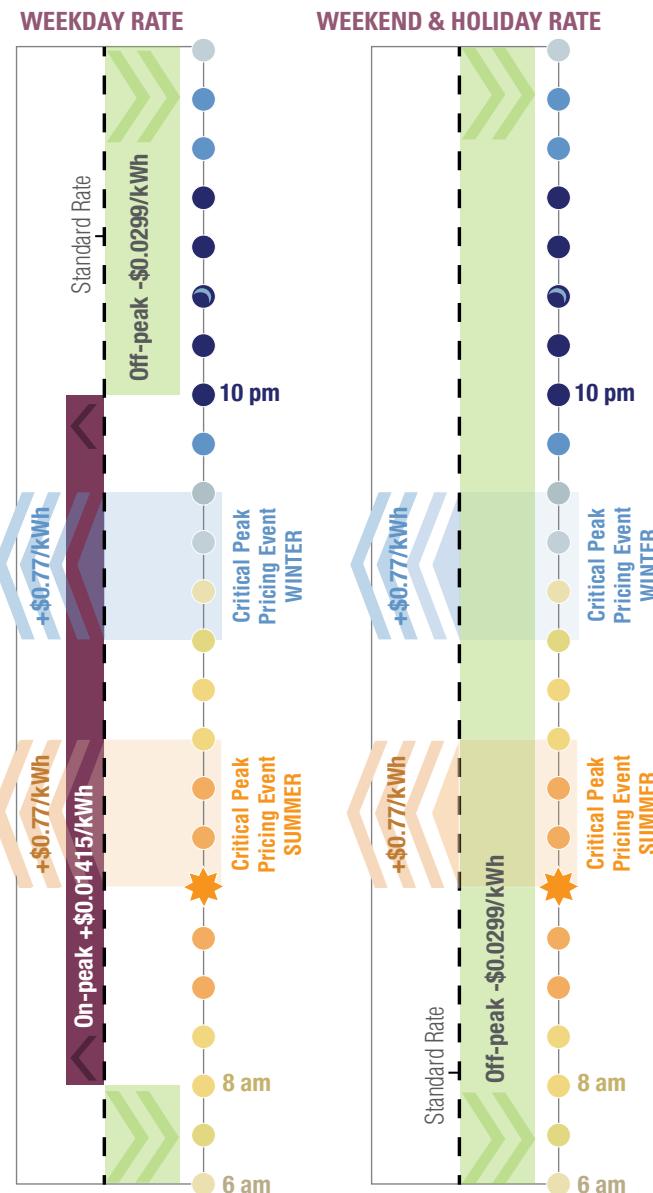
2. Complete and return the “My Notification Preferences” card included in your Welcome Package using the envelope provided.

If your notification preferences change during the pilot, you will have the ability to update them online or by calling 877-707-5771.

## PEAK PERIODS & RATES SUMMARY

### Here's How it Looks

This graph shows the adjustments that will be applied to your bill at different times of the day. The **Critical Peak Pricing** periods depicted in blue and orange are **events** that can be called periodically. These events will not occur regularly and you will receive advance notification if an event occurs.



On the Time-of-Day Rate, your basic rate structure does not change. Instead the adjustments are added to or subtracted from the standard tiered rates based on the time periods in which you used the electricity.

The chart below shows how much you will actually pay per kWh on the Time-of-Day Rate for each time period and each rate tier. (For more information about the standard rate tiers see the "About Your Bill" section of this guide.)

Rate Tier	Standard Rate	Off-peak Rate with a discount of \$0.0299	On-peak Rate with an increase of \$0.01415	Critical Peak Rate with an increase of \$0.77
0-300kWh (\$/kWh)	\$0.05098	\$0.02108	\$0.06513	\$0.82098
301-500kWh (\$/kWh)	\$0.06735	\$0.03745	\$0.0815	\$0.83735
501-750kWh (\$/kWh)	\$0.08168	\$0.05178	\$0.09583	\$0.85168
751-1,000kWh (\$/kWh)	\$0.08445	\$0.05455	\$0.0986	\$0.85445
>1,000kWh (\$/kWh)	\$0.08937	\$0.05947	\$0.010352	\$0.85937

## ABOUT YOUR BILL

TIME-OF-DAY RATE BILL COMPARISON |  
WHAT TO EXPECT ON YOUR BILLS

## TIME-OF-DAY RATE BILL COMPARISON

The sample bills below explain the basic components of your electric bill and illustrate which components will change or be added to your Time-of-Day bill compared to your standard bill.

1. Total kWh used during a billing period

2. Your standard electric bill consists of two major components:

- Service charge:** This is the minimum monthly fee which covers the cost of connection to our system.
- Tiered rates:** Minnesota Power has a tiered rate system. This means that the amount you are charged per kWh varies depending on your monthly usage. There are five separate rate tiers; the more electricity you use, the more you pay per kWh.

To see how the Time-of-Day Rate adjustments change the tiered rates for each period, refer to the chart at the end of the "About the Rate" section of this guide.

Energy Usage	\$/kWh
0-300kWh (\$/kWh)	\$0.05098
301-500kWh (\$/kWh)	\$0.06735
501-750kWh (\$/kWh)	\$0.08168
751-1,000kWh (\$/kWh)	\$0.08445
> 1,000kWh (\$/kWh)	\$0.08937

1.

### Standard Residential Rate Bill Example

Meter #	Start Date	Start Read	Read Code	End Date	End Read	Read Code	Usage	
	12/13/11	0	regular	1/15/12	1050	regular	1050	1,050 Kilowatt Hours (kWh) used

2.

Service Charge		8.00
300 kWh @ \$0.05116	15.35	
200 kWh @ \$0.06753	13.51	
250 kWh @ \$0.08186	20.47	
250 kWh @ \$0.08463	21.16	
50 kWh @ \$0.08955	4.48	
Total Energy Charge for 1,050 kWh	74.97	
Affordability Surcharge	0.65	
Renewable Adjustment 1,050 kWh @ \$0.00149	1.56	
Transmission Adjustment 1,050 kWh @ \$0.00033	0.35	
Resource Adjustment	16.4	
Minnesota Sales Tax (6.875%)	7.01	
<b>Total charge this service agreement</b>	<b>108.94</b>	

1. Total kWh used during each Time-of-Day period

2. The two main components of your bill (Service charge & Tiered rates) will stay the same.

**Tiered rates:** On the Time-of-Day Rate, your basic rate structure does not change. Instead, new line items for the Time-of-Day period adjustments are added below the standard energy charge calculation.

3. Below the line for Total Energy Charge, your Time-of-Day bill will include three new line items displaying the Time-of-Day Rate adjustments based on the time periods in which you used the electricity. These adjustments will be applied to the Total Energy Charge:

- On-peak** will show total kWh used during on-peak hours multiplied by the \$0.01415 on-peak adjustment.
- Off-peak** will show total kWh used during off-peak hours multiplied by the -\$0.0299 off-peak adjustment. Because this adjustment is a discount, this line will always be negative.
- Critical Peak Pricing** will show the total kWh used during Critical Peak Pricing events if any occurred during the current billing period. If there were no Critical Peak Pricing events during the billing period, this line will be 0.

### Time-of-Day Rate Bill Example

TOD	Meter #	Start Date	Start Read	Read Code	End Date	End Read	Read Code	Usage	
ON		12/13/11	0	regular	1/15/12	480	regular	480	480 Kilowatt Hours (kWh) used
CPP		12/13/11	0	regular	1/15/12	12	regular	12	12 Kilowatt Hours
OFF		12/13/11	0	regular	1/15/12	558	regular	558	558 Kilowatt Hours (kWh) used

1.

2.

3.

Service Charge		8.00
300 kWh @ \$0.05116	15.35	
200 kWh @ \$0.06753	13.51	
250 kWh @ \$0.08186	20.47	
250 kWh @ \$0.08463	21.16	
50 kWh @ \$0.08955	4.48	
Total Energy Charge for 1,050 kWh	74.97	
ON Peak 480 kWh @ \$0.01415	6.79	
OFF Peak 558 kWh @ -\$0.0299	-16.68	
Critical Peak 12 kWh @ \$0.77	9.24	
Affordability Surcharge	0.65	
Renewable Adjustment 1,050 kWh @ \$0.00149	1.56	
Transmission Adjustment 1,050 kWh @ \$0.00033	0.35	
Resource Adjustment	16.4	
Minnesota Sales Tax (6.875%)	6.96	
<b>Total charge this service agreement</b>	<b>108.24</b>	

## WHAT TO EXPECT ON YOUR BILLS

### Your First Time-of-Day Bill

Depending on your bill cycle, your first Time-of-Day bill will either:

- Include electric usage consumed before your Time-of-Day Rate took effect (started) and show prorated Time-of-Day costs,
- Or you will receive a separate closing bill for the end of September and your next bill will only include Time-of-Day rates and usage.

### Historical Usage

The historical usage shown on your monthly bill will reset as a result of changing rates. To view historical usage, you can log into the Power of One® Choice Portal and fill out or update the Your Home Energy Report survey to receive a customized report that includes historical usage. (For more details about the portal and customized report, see the Resources section of this guide.)

### Other Notes About Your Bill

- Your bill cycle and payment due date may have changed when the rate began in October.
- Length of billing period (number of days included on the current bill) can cause variations in your bill. In general, for every day's difference in the billing period, your consumption can increase or decrease by about 3%.

## UNDERSTANDING YOUR ELECTRIC COSTS

APPLIANCE OPERATION COSTS | SEASONAL CHANGES

## APPLIANCE OPERATION COSTS

Understanding how much energy your appliances use will help you determine the best way to manage your energy usage while on the Time-of-Day Rate. While use of some appliances can't be shifted, such as a refrigerator, you can save by using appliances like a clothes washer, dryer or dishwasher during off-peak hours, and by managing how much or when appliances like dehumidifiers and heating and cooling systems run.

You may also want to think about investing in ENERGY STAR® qualified appliances. ENERGY STAR appliances incorporate advanced technologies and use 10 to 50 percent less energy than standard appliances. Minnesota Power offers rebates on energy-efficient appliances. Learn more at [www.mnpower.com/rebates](http://www.mnpower.com/rebates)

### Average Home Energy Costs

The chart on the right gives you a basis for estimating appliance operating costs. These figures are based on energy consumption of typical appliances, their average use and Minnesota Power's average residential customer cost of 9.1 cents per kilowatt-hour (kWh). Your cost per kWh may vary depending on how much energy you use and when you use it. Your appliances and use patterns will also vary.

If you want to estimate what it costs to operate your specific appliances, you can find calculators and appliance information at [www.mnpower.com/TimeOfDayPilot](http://www.mnpower.com/TimeOfDayPilot). You can also calculate these costs yourself if you have the right information.

### Calculating the Cost of an Appliance

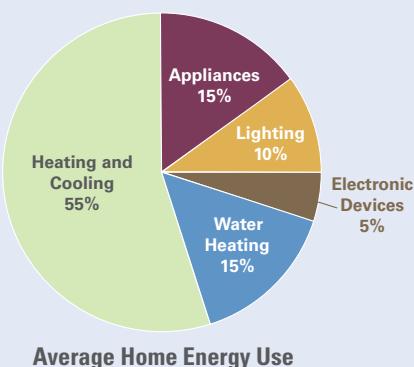
All electric appliances have the "wattage" or "amperage," and "voltage" indicated somewhere on the unit (amps x volts = watts). You can use this figure to determine your cost of operation. For example, you can determine how much it would cost to operate an electric space heater with 1,500 watts for 3 hours using the following calculations:

$$1,500 \text{ watts}/1,000 = 1.5 \text{ kW}$$

$$1.5 \text{ kW} \times 3 \text{ hours} = 4.5 \text{ kWh}$$

$$4.5 \text{ kWh} \times 9.1 \text{ cents/kWh} = 40 \text{ cents}$$

The "Average Home Energy Use" pie chart is based on average residential usage. For a better understanding of how your household uses electricity, you can complete a Your Home Energy Report (YHER) survey and receive a customized report based on the answers you provide about your household. Find out more in the "Resources" section of this guide.

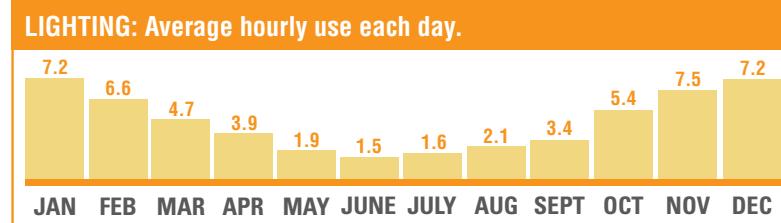


HOUSEHOLD SERVICES	AVERAGE MONTHLY KWH	AVERAGE MONTHLY COST
Washer (average is 12 hours/month)	9	\$0.82
Dryer (average is 16 hours/month)	104	\$9.46
Water heater (52 gallon, quick recovery) 100 kWh (base running) tank + 100 kWh per person (double for infants)	400	\$36.40
Water heater (energy efficient model or one with blanket) 50 kWh + tank add 100 kWh per person (double for infants)	350	\$31.85
Range (family of 4)	75	\$6.83
Refrigerator (conventional)	60	\$5.46
Refrigerator/freezer (upright, 2 door, 14 cubic feet)	95	\$8.64
Refrigerator/freezer (side by side)	152	\$13.38
Freezer (15 cubic feet, manual defrost)	76	\$6.92
Freezer (15 cubic feet, frost free)	147	\$13.83
Dishwasher (with heating unit)	26	\$2.37
Oil burner (use low/average/high based on outside temp)	60	\$5.46
Furnace fan (use low/average/high based on outside temp)	100	\$9.10
Supplementary electric heaters (watts x hours)	300	\$27.30
Room A/C (depends on size, use and weather conditions)	228	\$20.75
Central A/C	360	\$32.76
Television (Tube)	56	\$5.10
Television (Plasma)	72	\$6.55
Television (LCD)	27	\$2.46
Television (LED)	24	\$2.18
OTHER APPLIANCES		
Dehumidifier (depends on size of unit and hours of operation)	255	\$23.21
Auto engine heater (watts x hours)	75	\$6.83
LIGHTING		
5 room house (winter months)	50	\$4.55
8 room house (winter months)	80	\$7.28
Standard outdoor 100 count holiday lights	150	\$13.65
Midsized LED 100 count holiday lights	3	\$0.27
OTHER HIGH-USE ITEMS		
Roof and gutter cables (usually 7 watts per foot, multiply watts x hours)	82	\$7.46
Home computer and printer	28	\$2.55
Electric blanket	22	\$2.00

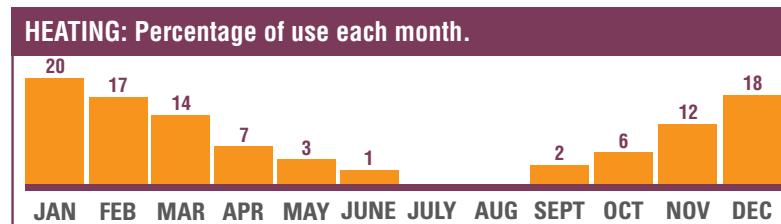
## SEASONAL CHANGES

During the Time-of-Day Rate pilot, it is a good idea to think about how your household's usage will change as the seasons change and how that may affect your on-peak and off-peak usage. Cold weather requires more heat and use of furnace fans, humidifiers, roof and gutter cables, supplementary heaters and auto engine heaters. It can also mean shorter daylight periods and more lighting. Hot weather can mean increased energy usage due to air conditioners, fans, refrigerators, and dehumidifiers. It can also mean longer daylight periods and less lighting.

The charts below show average use factors for lighting and heating and how they vary seasonally.



On the Time-of-Day Rate, being aware of how you use your lights and remembering to turn off the lights you aren't using can help you avoid some on-peak costs.



Similarly, paying more attention to your thermostat can pay off. Lowering the temperature a couple of degrees during the day while you are gone and the sun is out can help you save on the Time-of-Day Rate.

For more seasonal energy-saving tips, visit the Time-of-Day website at [www.mnpower.com/TimeOfDayPilot](http://www.mnpower.com/TimeOfDayPilot).

## RESOURCES

**POWER OF ONE® CHOICE PORTAL & YOUR HOME ENERGY REPORT | HOURLY USAGE VIEWS & TOOLS | TIME-OF-DAY WEBSITE**

## POWER OF ONE® CHOICE PORTAL & YOUR HOME ENERGY REPORT (YHER)

The Power of Choice® Portal offers access to information and features designed to help you get the most for your energy dollar. The first step is to complete (or update) a Your Home Energy Report (YHER) survey. Based on the answers you provide about your home, you'll receive a free Your Home Energy Report with customized recommendations and tools you can use to better understand when and how you use energy. This is a great way to start understanding how you can manage and reduce your electric consumption and bills on the Time-of-Day Rate.

As a pilot participant, your completion of the survey will also help us better understand our customers and offer more meaningful programs in the future.

**The sample to the right highlights some of the customized feedback you will find in the Your Home Energy Report (YHER).**

### Complete the Survey

There are two ways to complete the survey:

#### 1. Visit the Power of One® Choice Portal at [www.powerofonechoice.com](http://www.powerofonechoice.com)

The first time you enter the Power of One® Choice Portal you will be prompted to complete the survey. (If you're already a portal participant, you can click the "Update Now" button to update your survey.)

If you are a first-time user, meaning you've not registered to complete the Your Home Energy Report survey in the past or been a part of the Power of One® Choice Portal, you will need to register. On the login screen, click on **Register**. You will need an email address and your Minnesota Power account number (located on your electric bill). After you've registered, you will only need the email address and password that you chose to sign in.

Once you have completed the survey, you can view your customized report and access other helpful tools and resources.

#### 2. Request a Paper Survey

If you do not have access to the internet or an email address, you can call 218-355-2052 and request to have a paper copy of the survey mailed to you. Once you complete and return the survey, you will receive a printout of your report in the mail.

### Sample Your Home Energy Report (YHER)

#### 1 How Your Household Uses Energy

You will be able to see estimates on where you use energy in your home based on data you provide and the results of energy load monitoring studies.

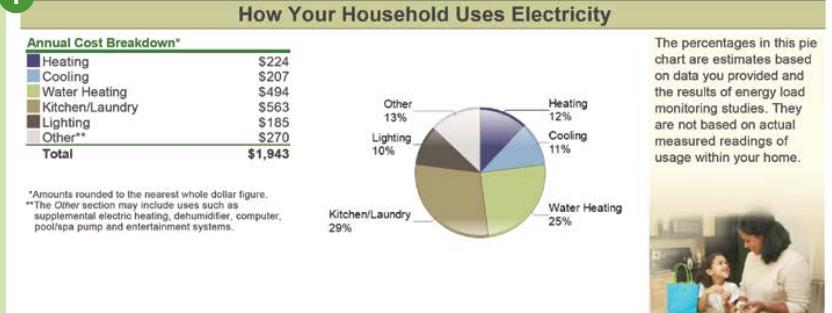
#### 2 Month-to-Month Electricity Usage and Electric Charges

You'll get a list of your electric usage and electric charges by month so you can see when you use energy and compare month to month. (See next page for details on viewing your **hourly** usage.)

#### 3 Customized Tips

You will also receive energy-saving tips that are right for you, based on your answers in the Your Home Energy Report survey.

1

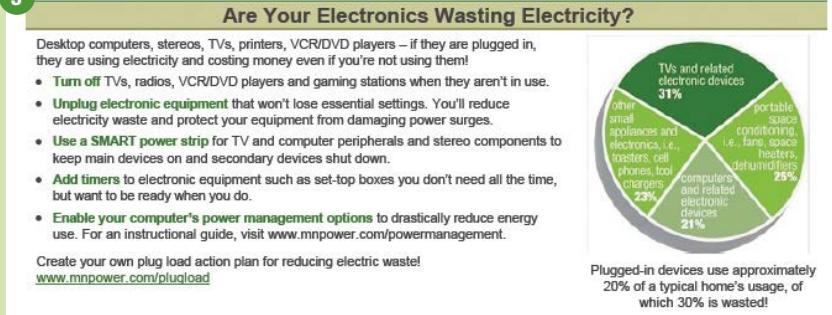


2

### Your Home's Month-To-Month Electricity Usage And Electric Charges

Bill Month	Electricity Usage (kWh)	Electric Charges*	Bill Month	Electricity Usage (kWh)	Electric Charges*
May 2012	1,363	\$139.97	May 2013	1,156	\$118.24
Jun 2012	1,665	\$172.50	Jun 2013	1,601	\$170.85
Jul 2012	2,513	\$272.27	Jul 2013	2,065	\$225.36
Aug 2012	2,557	\$280.48	Aug 2013	1,265	\$131.81
Sep 2012	1,638	\$177.57	Sep 2013	2,255	\$244.17
Oct 2012	1,378	\$145.91	Oct 2013	926	\$94.51
Nov 2012	1,390	\$144.70	Nov 2013	1,276	\$135.80
Dec 2012	1,421	\$114.29	Dec 2013	1,573	\$173.12
Jan 2013	2,290	\$191.10	Jan 2014	1,903	\$215.64
Feb 2013	2,297	\$183.33	Feb 2014	1,546	\$175.81
Mar 2013	1,835	\$146.28	Mar 2014	1,451	\$166.19
Apr 2013	1,540	\$163.84	Apr 2014	1,107	\$91.14
Total	21,887	\$2,132.24	Total	18,124	\$1,942.64

3



## Power of One® Choice Portal

Once you've registered and completed the YHER survey, you'll go right to the Power of One® Choice Portal Home Page when you log in. Here you will find your hourly usage chart and customized, useful features based on your survey answers.

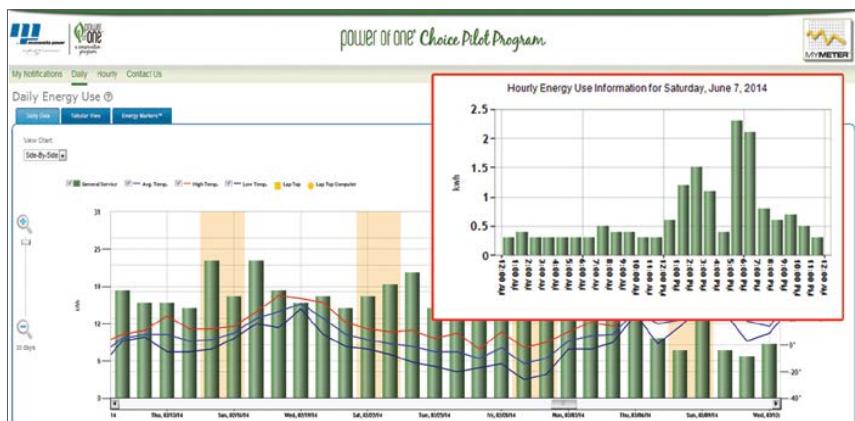
The Power of One® Choice Portal has several sections: My Home, My Report History, My Action Plan, My Profile, My Requests, and FAQ. There are also a number of links and tips throughout the site to help guide you through.

### Update Your Report

On the My Report History tab, you can view saved Your Home Energy Reports. You can also click on Update Survey to update your answers and receive a new report.

## HOURLY USAGE VIEWS & TOOLS

**You can view more details about your hourly energy usage by clicking the energy usage chart.** A separate window will open and bring you to the MYMETER tool within the Power of One® Choice Portal. Energy usage information is updated daily.



The MyMeter tool has several usage-related features that can help you manage your bills, including:

- **Hourly Usage:** graphical and tabular views of your historical hourly usage
- **Daily Usage:** graphical and tabular views of your historical daily usage; the daily view also gives you the option of including historical temperature data alongside your usage history
- **My Notifications:** set energy usage thresholds and receive notifications when you reach them
- **Energy Markers:** insert energy markers to help you track events or activities affecting your energy usage

## TIME-OF-DAY WEBSITE

Another great resource for more information throughout the pilot is the Time-of-Day website. On the website you will find:



### Information about the Program

- Program overview and details about the rate
- Frequently Asked Questions
- Tips for making the most of the Time-of-Day Rate

### Time-of-Day Message Center

Here you can find the most up-to-date messages, alerts and notifications about:

- Critical Peak Pricing events
- Portal outage/maintenance periods
- Upcoming and current surveys
- New tools for Time-of-Day participants

### Links to More Energy-Saving Tips and Tools

You can also find more energy saving resources and tools including:

- Appliance Calculators
- Fuel Cost Calculators
- Heating and Cooling Guide
- And more ...

### Ability to Change CPP Event Notification Preferences

On the Time-of-Day website, you can also update your CPP event notification preferences if they change during the pilot by submitting a notification preference form.

# Welcome Package



<b>Monday–Friday</b>	On-peak: 8am–10pm Off-peak: 10pm–8am
<b>Saturday, Sunday, Holidays*</b>	Off-peak: All day & night

\*New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, and Christmas Day

[www.mnpower.com/TimeOfDayPilot](http://www.mnpower.com/TimeOfDayPilot) | 877-707-5771

## Critical Peak Pricing Event Notifications

To better ensure you receive Critical Peak Pricing event notifications so that you can plan ahead, please submit your preferred contact information using one of the following methods:

1. Go online at [www.mnpower.com/timeofdaypilot](http://www.mnpower.com/timeofdaypilot). There you can provide up to four email addresses and four phone numbers.
2. Fill in your preferences on the right, detach the card and mail back using the envelope provided.

You can choose to receive notifications by phone, email, or both. If you'd like alerts to be sent to multiple devices or other members of the household, you have the option of providing more than one email address and/or phone number.

If you do not submit your notification preferences by completing the online form or returning this card, your preferences will default to the phone number and/or email address you provided on the enrollment application.

**Notification of Events:** Minnesota Power will notify you by 8 p.m. the day before a standard event and make every reasonable effort to give four hours notice of an emergency event.

## My Notification Preferences

Name on Minnesota Power account:

--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Minnesota Power account number (must be included)

--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Your account number is located on your bill. If you cannot find it, contact Minnesota Power at 1-877-707-5771.

**Please check the notification method(s) you prefer.**

- Please send me notifications by phone.

Phone #1:

--	--	--	--	--	--	--	--	--	--	--	--	--	--

Phone #2:

--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

- Please send me notifications by email.

Email #1:

--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Email #2:

--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

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



February 5, 2015

FIRST LAST  
ADDRESS  
CITY STATE ZIP

# Time-of-Day

Rate Pilot

[www.mnpower.com/TimeOfDayPilot](http://www.mnpower.com/TimeOfDayPilot)

Thank you for participating in our Time-of-Day Rate Pilot. We'd like to remind you that Critical Peak Pricing (CPP) events may occasionally be called as part of the Time-of-Day Rate Pilot when demand for electricity gets particularly high. During the winter season, this is most likely to happen when we see very cold temperatures.

As February and March tend to be fairly cold, there will be potential for CPP events in the next couple of months. Please take a moment to review the following information.

## Reminders About Critical Peak Pricing (CPP) Events

### Winter CPP Event Times and Durations

Standard winter CPP events will be limited to **3 hours and take place between 5 p.m. and 8 p.m.**

If the power system experiences a serious crisis, an **emergency CPP** event may be declared. Emergency events are rare and are not limited to specific windows of time but may last no longer than 8 hours.

### CPP Event Rate

During these events you will be charged an additional \$0.77 per kWh.

### Notifications

Minnesota Power will make every reasonable effort to notify you by 8 p.m. the day before a **standard CPP** event.

If an **emergency CPP** event is declared, Minnesota Power will make every reasonable effort to notify you at least 4 hours in advance. (*See reverse side for information on the fastest way to receive event notifications.*)

We will periodically send **test notifications**. The message will clearly indicate that it is a test message and that no action is required. You can also check the Message Center on the Time-of-Day website to confirm that a test notification was sent. **Please note, we will be sending test notifications within the next several days.**

### Time-of-Day Website and Message Center

The Time-of-Day website is also a great resource for information about events. The Time-of-Day Message Center will always have updated information about current and recent events.

[www.mnpower.com/TimeOfDayPilot](http://www.mnpower.com/TimeOfDayPilot)

## CPP Event Notification Methods

- Check the **Message Center** on the Time-of-Day website periodically. This will be updated as soon as an event has been scheduled and is the most reliable resource for getting event information.
- Remember to watch for email and phone notifications. These will be sent using the contact information you provided.\*
  - **Email** is the fastest way to receive event notifications when an event is called. Generally, you can expect to receive an email notification for a standard event in the late afternoon to early evening. The subject line will read: **Time-of-Day Notice: CPP Event Scheduled for (Date of Event)**
  - **Phone call** notifications may take up to a **couple of hours longer to receive than email notifications**. When you receive an event notification by phone, you will hear an automated recording which will include the date and time of the event. Please note that if you answer the call the recording will play through one time, otherwise the recording will be left as a voicemail message.

Please check the accuracy of the preferences we currently have on file for you.

### Your current CPP notification preferences:

Email: EMAIL1  
EMAIL2

Phone: PHONE1  
PHONE2  
PHONE3

To change your notification preferences, visit the Time-of-Day website or call us at 877-707-5771.

**Note: When submitting new notification preferences online, you must fill out all the information as it will overwrite your current preferences.**

*\* If you did not submit your notification preferences by completing the online form or returning the CPP notification preference card, your preferences defaulted to the phone number and/or email address you provided on your enrollment application.*

## Tips for Reducing Your Consumption During Critical Peak Pricing Events

- Avoid running any major appliances during a CPP event (dishwashers, clothes washers, dryers, electric ovens, etc.)
- Turn down the thermostat and avoid using supplemental electric space heaters. Take advantage of the programmable features on your thermostat if available or change your temperature settings ahead of time.
- Turn off the lights when you're not using them.
- Reduce your plug load by turning off set-top boxes, gaming systems, computer stations, etc., and consider using smart power strips. To find tips for plug load management and using smart power strips, visit [www.mnpower.com/plugload](http://www.mnpower.com/plugload)
- Avoid activities that require using a lot of hot water (taking showers, washing dishes, etc.)
- Consider making a meal that requires less electricity to prepare.
- Make it a family night—you can reduce the number of lights and electronics in use by gathering the family in the same room to watch a movie or play board games.
- Get a better understanding of which appliances you should avoid using in your home during a CPP event by taking advantage of the appliance calculator and other tools in the Resources section of the Time-of-Day website.

## Questions or Concerns?

Check the Time-of-Day website at [www.mnpower.com/TimeOfDayPilot](http://www.mnpower.com/TimeOfDayPilot) for more information. If you have more questions or you believe you are receiving this information in error, call us at 877-707-5771.



July 29, 2015

# Time-of-Day Rate Pilot

[www.mnpower.com/TimeOfDayPilot](http://www.mnpower.com/TimeOfDayPilot)

Dear Time-of-Day Participant,

Thank you for participating in our Time-of-Day Rate Pilot. With the recent warm temperatures, there is an increased potential for summer Critical Peak Pricing (CPP) events. Take a moment to review the reminders and updates below. You may also refer to the website at [www.mnpower.com/TimeOfDayPilot](http://www.mnpower.com/TimeOfDayPilot) for more information about events.

## Reminders About Summer Critical Peak Pricing (CPP) Events

### Summer CPP Event Times and Durations

**Standard** summer CPP events will be limited to **3 hours and take place between 12 p.m. and 3 p.m.**

If the power system experiences a serious crisis, an **emergency CPP** event may be declared. Emergency events are rare and are not limited to specific windows of time but may last no longer than 8 hours.

### CPP Event Rate

During these events you will be charged an additional \$0.77 per kWh.

### Notifications

Minnesota Power will make every reasonable effort to notify you by 8 p.m. the day before a **standard CPP** event.

If an **emergency CPP** event is declared, Minnesota Power will make every reasonable effort to notify you at least 4 hours in advance. (*See reverse side for information on the fastest way to receive event notifications.*)

We may periodically send **test notifications**. The message will clearly indicate that it is a test message and that no action is required. You can also check the Message Center on the Time-of-Day website to confirm that a test notification was sent.

### Time-of-Day Website and Message Center

The Time-of-Day website is also a great resource for information about events. The Time-of-Day Message Center will always have updated information about current and recent events.

[www.mnpower.com/TimeOfDayPilot](http://www.mnpower.com/TimeOfDayPilot)

## CPP Event Notification Methods

- Check the **Message Center** on the Time-of-Day website periodically. This will be updated as soon as an event has been scheduled and is the most reliable resource for getting event information.
- Remember to watch for email and phone notifications. These will be sent using the contact information you provided. (*Note: If you did not submit your notification preferences by completing the online form or returning the CPP notification preference card, your preferences defaulted to the phone number and/or email address you provided on your enrollment application.*)
  - **Email** is the fastest way to receive event notifications when an event is called. Generally, you can expect to receive an email notification for a standard event in the late afternoon to early evening. The subject line will read: **Time-of-Day Notice: CPP Event Scheduled for (Date of Event)**
  - **Phone call** notifications may take up to a couple of hours longer to receive than email notifications. When you receive an event notification by phone, you will hear an automated recording which will include the date and time of the event. Please note that if you answer the call the recording will play through one time, otherwise the recording will be left as a voicemail message.

To change your notification preferences, visit the Time-of-Day website or call us at 877-707-5771.

**Note:** When submitting new notification preferences online, you must fill out all the information as it will overwrite your current preferences.

## Tips for Reducing Your Consumption During Critical Peak Pricing Events

- Let family members who may be home during the day know about the event and remind them to avoid energy-using activities during the event period as much as possible.
- Turn up or turn off the thermostat and avoid using fans unnecessarily. Take advantage of the programmable features on your thermostat if available or change your temperature settings ahead of time.
- Use curtains, blinds, or shades to keep the sunlight out and the cool air in.
- Turn off the lights when you're not using them.
- Avoid activities that require using a lot of hot water (taking showers, washing dishes, etc.).
- Avoid running any major appliances during a CPP event (dehumidifiers, dishwashers, clothes washers, dryers, electric ovens, etc.)
- Get a better understanding of which appliances you should avoid using in your home during a CPP event by taking advantage of the appliance calculator and other tools in the Resources section of the Time-of-Day website.
- Reduce your plug load by turning off set-top boxes, gaming systems, computer stations, etc., and consider using smart power strips. To find tips for plug load management and using smart power strips, visit [www.mnpower.com/plugload](http://www.mnpower.com/plugload)

## Questions or Concerns?

Check the Time-of-Day website at [www.mnpower.com/TimeOfDayPilot](http://www.mnpower.com/TimeOfDayPilot) for more information. If you have more questions or you believe you are receiving this information in error, call us at 877-707-5771.

## APPENDIX B—SURVEY INSTRUMENTS

### MINNESOTA POWER TIME-OF-DAY RATE PILOT: POST-PILOT SURVEY

1. Thinking of the ways you have been charged for electricity, which of the following best describes the Time-of-Day Rate Plan you participated in over the last year?

- I pay the same price for electricity no matter when I use it
- I pay a higher price for electricity that I use between 8am and 10pm everyday
- I pay a higher price for electricity that I use between 8am and 10pm Monday through Friday; a lower price at night and on weekends; and a very high price when Minnesota Power calls a Critical Peak Pricing event
- I pay a higher price for electricity when Minnesota Power calls a Critical Peak Pricing event; otherwise I pay the same price all the time
- I don't know

2. Since joining the Time-of-Day Rate Plan, which of the following best describes how you feel your Minnesota Power bill has changed compared to your bills on your previous rate?

- I saved money with the Time-of-Day rate compared to my old rate
- I have not noticed any change
- I am spending more with the Time-of-Day rate compared to my old rate
- I don't know if the Time-of-Day rate has made a difference

3. Did you intentionally change the way you used electricity in any way since you shifted to the Time-of-Day Rate Plan?

- yes
- no
- don't know

If no Is Selected, Then Skip To Thinking about the Time-of-Day Rate p...If don't know Is Selected, Then Skip To Thinking about the Time-of-Day Rate p...

4. What did you do differently?

5. Thinking about the Time-of-Day Rate Plan in general, please indicate your agreement or disagreement with each of the following statements.

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
My Time-of-Day Rate Plan provides me with opportunities to save money	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My Time-of-Day Rate Plan is difficult to understand	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My Time-of-Day Rate Plan is fair	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Participating in the Time-of-Day Rate Plan helps Minnesota Power plan for a clean, affordable energy future	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My Time-of-Day Rate Plan fits my lifestyle	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My Time-of-Day Rate Plan is not always convenient	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Minnesota Power should offer a Time-of-Day Rate Plan to all of its customers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I want to stay on my Time-of-Day Rate Plan	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

6. Your Time-of-Day Rate Plan lets Minnesota Power call a Critical Peak Pricing event a limited number of times per year during which your electric rates are higher than they would normally be for a few hours. Which of the following best describes your opinion of the frequency of these Critical Peak Pricing events?

- I don't recall Minnesota Power calling any Critical Peak Pricing events
- Minnesota Power called fewer Critical Peak Pricing events than I expected
- Minnesota Power called about as many Critical Peak Pricing events as I expected
- Minnesota Power called more Critical Peak Pricing events than I expected
- I didn't have any expectation of how many Critical Peak Pricing events would be called

If I don't recall Minnesota Po... Is Selected, Then Skip To Do you have any suggestions for Minne...

7. Thinking about the notifications you received from Minnesota Power when Critical Peak Pricing events were declared, which of the following best describes your opinion of the timeliness of the notifications?

Was it:

- not enough notice
- the right amount of notice
- more than enough notice
- I did not receive any notice of a Critical Peak Pricing event

If I did not receive any notic... Is Selected, Then Skip To How did you know what steps you could...

8. Now, thinking about the information that was included in the notifications you received when Critical Peak Pricing events were declared, was it:

- not enough information to prepare for the event
- enough information to prepare for the event
- exactly what I needed to know to prepare for the event
- more information than I needed to prepare for the event
- I don't know

If exactly what I needed to kn... Is Selected, Then Skip To How did you know what steps you could...If more information than I nee... Is Selected, Then Skip To How did you know what steps you could...

9. What additional information would you want Minnesota Power to provide on the Critical Peak Pricing event notice to help you prepare for the event?

10. How did you know what steps you could take to reduce your electricity usage during Critical Peak Pricing events? (Check all that apply.)

- already had a good sense of what I can do to reduce electricity usage
- received suggestions from Minnesota Power
- looked for suggestions from Minnesota Power's Power of One website
- looked for suggestions elsewhere
- other - please specify \_\_\_\_\_
- none of these

11. Do you have any suggestions for Minnesota Power about the Time-of-Day rate?

12. The following questions are about you and your household. They are for classification purposes only.

13. What fuel does your home's primary heating system use?

- natural gas
- electricity
- propane
- fuel oil
- something else (specify): \_\_\_\_\_
- don't know

14. Do you use any of the following in your home?

	Yes	No
Forced air furnace for your primary heating system	<input type="radio"/>	<input type="radio"/>
Electric space heater(s) for supplementary heat	<input type="radio"/>	<input type="radio"/>
Central air conditioner	<input type="radio"/>	<input type="radio"/>
Room air conditioner(s)	<input type="radio"/>	<input type="radio"/>
Electric water heater	<input type="radio"/>	<input type="radio"/>
Electric clothes dryer	<input type="radio"/>	<input type="radio"/>
Electric range or oven	<input type="radio"/>	<input type="radio"/>
Dehumidifier(s)	<input type="radio"/>	<input type="radio"/>

15. Is your home a:

- single-family home
- townhome
- condominium
- apartment
- don't know

16. Do you own or rent your home?

- own
- rent
- don't know

17. How many people in each of the following age categories live in your household?

- under 18 years old
- 18 through 64
- 65 and above

18. Please indicate your age:

- 18 - 24
- 25 - 34
- 35 - 44
- 45 - 54
- 55 - 64
- 65 - 74
- 75 and over
- don't know
- refused

19. Thank you for participating in the Time-of-Day Rate Pilot and for sharing your valuable feedback!

The pilot is now in the evaluation phase which will help inform the future of the Time-of-Day Rate Pilot. Participants who wish to remain on the rate through this phase can do so with no additional actions needed. At this time, participants may request to be removed from the pilot rate by submitting the Request for Removal form found at [www.mnpower.com/TimeofDayPilot](http://www.mnpower.com/TimeofDayPilot) or by contacting Minnesota Power at 877-707-5771.

## **MINNESOTA POWER TIME-OF-DAY RATE PILOT: POST-CPP EVENT SURVEY**

1. Your household is signed up for the Time-of-Day Rate Pilot that provides discounts for electricity used during off-peak times and applies higher rates during on-peak times. Do you recall signing up for this rate?

- yes, I signed up
- yes, another household member signed up and told me about it
- no

If no Is Not Selected, Then Skip To Were you aware that your pilot rate i...

2. Do you recall hearing anything about “Critical Peak Pricing events” that apply to your Minnesota Power account?

- yes
- no

If no Is Selected, Then Skip To Thank you. Those are all the questio...If yes Is Selected, Then Skip To When was the last time you recall Min...

3. Were you aware that your pilot rate is also subject to occasional Critical Peak Pricing events, during which your costs for electricity can increase for a short period of time?

- yes, I did know about the Critical Peak Pricing component of the rate pilot
- yes, but not until Minnesota Power announced a Critical Peak Pricing event
- no

If no Is Selected, Then Skip To Thank you. Those are all the questi...

4. When was the last time you recall Minnesota Power calling a Critical Peak Pricing event?

- within the past few days
- a week or two ago
- three or more weeks ago
- I recall an event but I don't remember when it occurred
- I don't recall an event

If I don't recall an event Is Selected, Then Skip To Thank you. Those are all the questio...

5. How did you find out that Minnesota Power had called a Critical Peak Pricing event? (Check all that apply.)

- received an email from Minnesota Power
- checked the Minnesota Power website
- received a telephone call from Minnesota Power
- received a voicemail message from Minnesota Power
- a household member told me
- other - please specify \_\_\_\_\_
- don't know / don't recall

6. When did you find out that a Critical Peak Pricing event had been called?

- the day before the event took place
- on the day of the event but before it started
- during the event
- after the event was over
- don't know / don't recall

7. Was anyone home at any point during the Critical Peak Pricing event?

- yes
- no
- don't know

8. Did you (or other members of your household) take any steps to reduce your electricity usage in your home during these Critical Peak Pricing hours beyond your normal practices?

- yes
- no
- don't know

If yes Is Not Selected, Then Skip To Thank you. Those are all the qu...

9. What did your household do differently during the critical peak pricing period?

10. Thank you. Those are all the questions we have today. We will send you another brief survey at the end of winter to ask a few more questions about your experience with your time-of-day rate.

## APPENDIX C—REFERENCE LOADS, COMPARISON GROUP AND DEMAND ESTIMATES

### DEVELOPING REFERENCE LOADS

To calculate the amount by which pilot participants reduced their demand during a CPP event, we need to estimate how much electricity they would have used had there been no event, which we refer to here as the reference load. We developed household-level reference loads using participants' own demand data from non-event days by two different approaches, an expansion on the planned methodology, as outlined in the 2012 Study Plan. The first approach, included in the original plan, uses observed loads from a similar non-event day—a proxy day—that is matched to the event day in terms of day type (i.e., weekday), season, temperature, and humidity. The second estimates counterfactual hourly loads based on customer-specific regression models of hourly load profiles and was added as a check on impact results from the proxy-day method. In this appendix, we describe these approaches—along with the development of a matched set of non-participants to control for other unobservable influences on electricity demand—in more detail.

#### Proxy-day matching

There are many potential methods for selecting proxy days to serve as reference loads. For this project, we used an approach modified from a Malahanobis distance calculation that uses time dependent metrics based on outdoor air temperature and relative humidity. Each metric was weighted based on its importance to matching a proxy date to the CPP date. Outdoor air temperature was weighted more heavily for the proxy date selection to prioritize days with similar temperatures, as were days nearer to event days.

Malahanobis distance is commonly used in cluster analysis to determine if a point (vector) belongs to a class (cluster). Since our sample doesn't include a random sample of cluster points we reduce the standard calculation to a weighted Euclidean distance of the form:

$$d(y,x) = \sqrt{\sum_{i=1}^N w_i (y_i - x_i)^2}$$

where  $N$  is the number of comparison points (times) throughout the day,  $w$  is a weighting factor,  $y$  is the metric for the event day, and  $x$  is the metric for the proxy day.

For each day we used the following daily metrics:

- mean dry bulb temperature
- maximum dry bulb temperature
- minimum dry bulb temperature
- relative humidity
- enthalpy

Temperature, relative humidity and enthalpy were also calculated for key times throughout the day: 5am, noon, and 8pm.

$d(x,y)$  was calculated in relation to event days for each non-event day throughout the same season. Days with the lowest  $d(x,y)$  values were considered candidate proxy days. Visual inspection and linear regression (proxy versus event day) was used in the final selection. Weights were adjusted manually for

each metric starting with 0 and increasing to 4 until consistent results were produced. Maximum daily temperature and noon temperature were consistently given higher weights.

Table 9 presents the date, daily average temperature and daily maximum temperature for each event day and its proxy day. As noted earlier, the winter event corresponded with a particularly cold day and three of the five summer events took place on hot days, with maximum temperatures above 80 degrees. Two summer events, however, were on fairly mild days, when average temperatures were in the 60s and maximum temperatures only reached the low 70s.

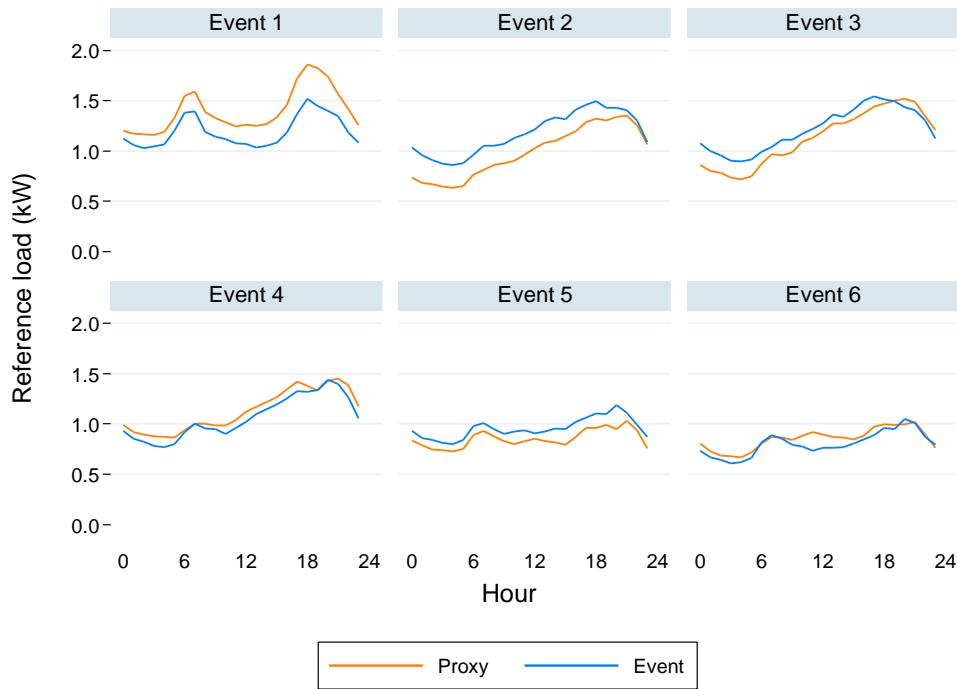
**Table 9: Event and proxy dates and temperatures**

Event days		Proxy days	
Date	Ave/max daily temp (°F)	Date	Ave/max daily temp (°F)
2.19.2015	-6 / 4	1.05.2015	-8 / 0
7.27.2015	75 / 85	7.23.2015	74 / 84
8.14.2015	79 / 91	8.13.2015	78 / 90
9.01.2015	74 / 83	7.28.2015	76 / 84
9.02.2015	68 / 74	7.14.2015	65 / 70
9.03.2015	63 / 72	7.06.2015	63 / 67

#### VALIDATION

To test the validity of using proxy-day loads as estimates for event-day demand in the absence of a rate increase, we compared non-participants' average proxy- and event-day hourly demand for each event. We would expect the two to be similar since non-participants were not incentivized to adjust their electricity usage during CPP events. Figure 6 illustrates the range of similarity between proxy- and event-day load profiles across the six events. The largest discrepancy is on the day of the winter event (1) and the smallest on the day of event 4. To prevent erroneously attributing these discrepancies to the CPP rate, we subtract the differences evident in Figure 6 from the demand impacts measured only among pilot participants. This technique is called difference-in-differences and it is discussed in more detail in the next section—Comparison Group Selection.

**Figure 6: Comparing non-participants' proxy day and event day demand**



### Individual customer regression models

As an alternative to the proxy-day approach, we also explored using customer-specific regression models based on observed hourly demand on non-event days to predict reference loads on event days. The regression model approach allows for greater flexibility in determining reference loads, but is limited in its accuracy to the availability and detail of the underlying data. For this approach, non-event, weekday hourly usage data for each customer is regressed against various time-related predictors (month, day of the week, time of day, etc.) and weather metrics (temperature and cooling/heating degree days). We postulated a number of plausible models, and fit the data for each customer to all of these. The model with the best fit for a given customer was selected to predict the customer's reference load using time characteristics and weather data associated with the event day.

Table 10 through Table 12 present model specifications, input descriptions and the frequency with which each model was selected as the best fit model for participants and non-participants by season.

**Table 10: Model specifications**

#	Models	Season
1	$W_{ijk} = \beta_{0i} + \beta_{1ij}HR_j + \beta_{2ik}DOW_k + \varepsilon_i$	Summer/Winter
2	$W_{ijk} = \beta_{0i} + \beta_{1ij}HR_j + \beta_{2ik}DOW_k + \beta_{3i}CDH + \varepsilon_i$	Summer
3	$W_{ijk} = \beta_{0i} + \beta_{1ij}HR_j + \beta_{2ik}DOW_k + \beta_{3i}CDH + B_iTLAGS + \varepsilon_i$	Summer
4	$W_{ijk} = \beta_{0i} + \beta_{1ij}HR_j + \beta_{2ik}DOW_k + \beta_{3i}HDH + \varepsilon_i$	Winter
5	$W_{ijk} = \beta_{0i} + \beta_{1ij}HR_j + \beta_{2ik}DOW_k + \beta_{3i}HDH + B_iTLAGS + \varepsilon_i$	Winter

**Table 11: Model input descriptions**

Variables	Description
$W_{ijk}$	Hourly demand in watts for the $i^{th}$ customer during the $j^{th}$ hour of the day on the $K^{th}$ day of the week. Usage data was constrained to non-holiday weekdays between 6/15/2015 and 9/4/2015 for summer models, and between 1/5/2015 and 3/20/2015 for winter models.
$HR_j$	Index variable for $j^{th}$ hour of the day
$DOW_k$	Index variable for the $k^{th}$ day of the week (weekdays only)
CDH	Cooling degree hours based on a reference temperature of 65°F
HDH	Heating degree hours based on a reference temperature of 60°F
TLAGS	Vector of six hourly temperature (°F) lags for the preceding 1-6 hours
$\epsilon_i$	Error term for the $i^{th}$ customer

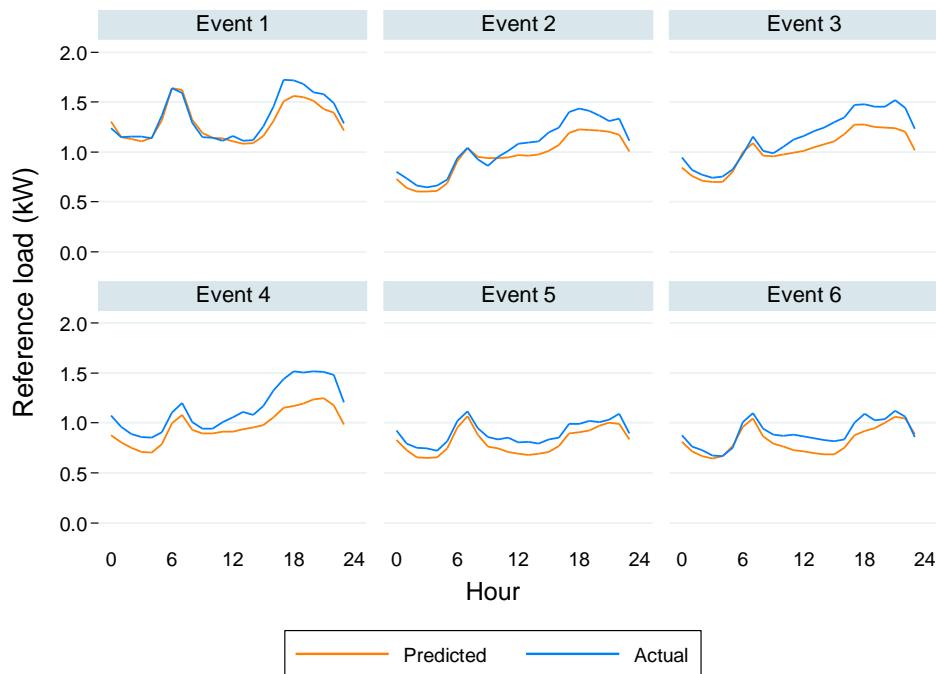
**Table 12: Model selection rates**

Season	Model #	Participants		Non-participants	
		% for whom model was best model	Average R <sup>2</sup>	% for whom model was best model	Average R <sup>2</sup>
Summer	1	34	0.20	33	0.18
Summer	2	16	0.22	17	0.18
Summer	3	50	0.26	50	0.25
Winter	1	14	0.26	12	0.24
Winter	4	54	0.31	55	0.30
Winter	5	32	0.37	34	0.37

#### VALIDATION

Similar to validity test for proxy-day reference loads, we tested the accuracy of modeled demand estimates as well. Here, we compare participants' modeled and actual proxy-day demand for each event. The discrepancies evident in Figure 7 are not particularly surprising, given R<sup>2</sup> statistics in the range of 0.2 to 0.4. The winter event prediction is the closest to actual, likely a reflection increased homogeneity of electricity use during the winter months, when air conditioning is not in use, and during evening hours, when most people are home. Still, the overall low explanatory power of our models and the somewhat systematic divergence between modeled and actual demand during hot summer afternoons and evenings (events 2-4) led us to rely primarily on the proxy-day approach to determining reference loads.

**Figure 7: Comparing participants' modeled and actual proxy-day demand**



## COMPARISON GROUP SELECTION

Using a comparison group to adjust impact estimates helps to account for unobserved influences on electricity consumption—beyond those accounted for by the proxy days or regression models. To account for these unobserved influences, we subtract the difference in demand between event days and the reference load from either the proxy-day or regression-model approach for that comparison group, from the similarly-calculated difference for participants. This is known as a difference-in-differences approach.

The critical aspect of selecting a comparison group is that it be matched as closely as possible to the characteristics of the treatment group. Ideally, we would employ a true control group in which volunteers for the pilot rate would be randomly assigned to either go on the rate or not. In that situation we could be confident that there were no systematic differences between the two groups. However, since Minnesota Power's Rate Pilot was not designed to be a randomized control trial, this approach was not available. Participants self-selected into the Pilot, many of which had participated in the earlier, associated Consumer Behavior Study Pilot (CBSP). Moreover, demographic, appliance-holdings and other data were only available for the subset of Pilot participants who responded to the survey, and were not at all available for non-participants. We thus could only match non-participants to participants on the basis of electricity consumption, which we did from a pool of approximately 2,100 Duluth/Hermantown customers for whom we could obtain hourly usage data (customers with AMI meters, many of whom were also part of the CBSP).

The matching process was implemented separately for each event. Participants were randomly ordered and individually matched to a non-participant whose modeled event day load profile was most similar. Profile similarity was evaluated by measuring the difference in demand between a participant and non-participant for each hour of the day and then calculating the root-mean-square error (RMSE) across all demand differences. The non-participant who yielded the smallest RMSE for a given participant was selected for the comparison group and then removed from the pool of potential partners for other participants.

The matching process generated a comparison group whose average usage profile is aligned closely to that of participants. The two groups' average hourly demand during event-similar windows (i.e., weekday afternoons in the summer and weekday evenings in the winter) during the course of the pilot differed by about 1 percent.

**Table 13: Non-event day demand during the pilot**

	Summer		Winter	
	Mean hourly demand (watts, with 95% CI)	N	Mean hourly demand (watts, with 95% CI)	N
Participants	1,019 ± 5	600	1,285 ± 18	601
Non-participants	1,009 ± 5	1,391	1,294 ± 18	600
Delta (as a % of non-participant)	10 ± 7 (1.0% ± 0.7%)		9 ± 25 (0.6% ± 1.9%)	

Average pre-pilot usage between participants and the comparison groups was less similar. Based on monthly billing data, we estimate that participants used 2-3 percent more electricity per day compared to non-participants prior to the start of the pilot. One possible explanation is that higher users self-selected into the pilot in order to reduce their electricity cost.

**Table 14: Pre-pilot usage**

	Summer		Winter	
	Mean kWh per day (with 95% CI)	N	Mean kWh per day (with 95% CI)	N
Participants	19.8 ± 0.4	558	26.8 ± 0.6	547
Non-participant AMI	19.5 ± 0.2	1,248	26.0 ± 0.3	541
Delta (% of non-participants)	0.3 ± 0.41 (1.5% ± 2.1%)		0.8 ± 0.7 (3.1% ± 2.7%)	

## DEMAND ESTIMATES

The load profiles, and thus demand reduction estimates, resulting from the two analytical approaches described above diverge without the comparison group adjustments, but are in general agreement for four of the six events when adjusted for changes in the comparison group (see Table 15). This suggests that both proxy-day and regression approaches fail to account for some extraneous factors that are picked up by the comparison group.

The regression models generally under-predict loads for participants on non-event proxy days and for the comparison group on both event days and non-event days. The inherent variability of electricity demand at the household level resulted in poor model fits for the customer-specific regressions ( $R^2$  values ranged from 0.07 to 0.66). This suggests that the regression approach is less useful than the proxy-day approach.

We should note here, however, that while we have greater confidence in the demand impacts based on the proxy-day approach, it is still possible that use of the comparison group does not fully account for

extraneous factors that affect differences in loads between event days and proxy days. This could affect accuracy of the calculated impacts.

**Table 15:Summary of results: Demand and change-in-demand**

	Event 1	Event 2	Event 3	Event 4	Event 5	Event 6
<b>PARTICIPANTS</b>						
Average hourly demand during event hours on...	Event day, actual	1,264 ± 104	969 ± 74	992 ± 80	789 ± 55	712 ± 49
	Event day, modeled	1,501 ± 104	1,026 ± 61	1,080 ± 69	941 ± 55	764 ± 39
	Proxy day, actual	1,708 ± 129	1,096 ± 82	1,203 ± 86	1,083 ± 76	805 ± 57
	Proxy day, modeled	1,540 ± 108	968 ± 55	1,045 ± 65	936 ± 53	687 ± 37
	Change in demand, event - proxy	-450 ± 88	-115 ± 76	-196 ± 78	-287 ± 67	-84 ± 57
	Change in demand, event - modeled	-236 ± 63	-57 ± 61	-88 ± 67	-153 ± 49	-52 ± 37
<b>NON-PARTICIPANTS</b>						
Average hourly demand during event hours on...	Event day, actual	1,445 ± 122	1,281 ± 86	1,324 ± 88	1,087 ± 76	928 ± 63
	Event day, modeled	1,476 ± 104	1,052 ± 63	1,124 ± 71	929 ± 51	787 ± 41
	Proxy day, actual	1,802 ± 127	1,071 ± 80	1,248 ± 88	1,171 ± 82	833 ± 57
	Proxy day, modeled	1,543 ± 108	982 ± 57	1,065 ± 65	940 ± 53	709 ± 37
	Change in demand, event - proxy	-327 ± 94	195 ± 73	85 ± 69	-108 ± 76	100 ± 63
	Change in demand, event - modeled	-31 ± 57	229 ± 55	200 ± 57	158 ± 49	141 ± 43
Net change (participants minus non-participants) using ...						
Proxy day approach		-123 ± 129	-310 ± 105	-281 ± 104	-179 ± 101	-184 ± 85
...as % of participants' proxy demand		-7% ± 8%	-28% ± 10%	-23% ± 9%	-17% ± 9%	-23% ± 11%
Modeled load approach		-205 ± 85	-286 ± 82	-288 ± 88	-311 ± 69	-193 ± 57
...as % of participants' modeled demand		-14% ± 6%	-28% ± 8%	-27% ± 8%	-33% ± 7%	-25% ± 7%

## APPENDIX D—SUMMARY OF DATA

### CUSTOMER USAGE DATA

Minnesota Power provided customer account, premise and rate information for 3,451 customers with installed advanced metering infrastructure (AMI). Of these, 643 were currently or had previously been on the Time-of-Day rate. The customer data was combined with hourly usage data (supplied by Accelerated Innovations) spanning January 2012 to January 2016 for 2,881 AMI customers, including 615 Time-of-Day Rate Pilot participants, who had active accounts as of January 1, 2016. Minnesota Power has been installing AMI meters during meter replacements since 2008, with an increase in installations in 2012, at the start of Phase I of the CBSP, and in 2014, at the start of the Rate Pilot. Most Pilot participants did not have an AMI meter prior to the Rate Pilot.

For the demand analysis, we filtered out customers on the general service rate (1 percent of accounts) and a handful of instances where the mapping between account, meter and usage data was unclear. The resulting dataset had 605 Rate Pilot participants and 2,262 non-participants. The pool of non-participating AMI customers was further trimmed to mirror, as closely as possible, the participant group in terms of group size and non-CPP event day usage, serving as a comparison group for in the demand analysis. For a detailed description of the non-participant trimming process, see Comparison Group Selection in Appendix A. Hours with usage values of zero or missing values were dropped from the dataset, along with data for four dates that were deemed to have “bad data” based on visual inspection<sup>19</sup>.

In addition to hourly consumption data, monthly billing data spanning January 2013 to January 2016 was compiled for three groups of customers: Pilot participants, non-participant AMI customers and a randomly selected group of 2,000 residential customers (including AMI customers and participants) in the Duluth area. These data were used for two comparisons: 1) average pre-pilot usage among participants versus the comparison group, which adds context to the difference in demand reduction between the two groups during CPP events; and 2) average pre-pilot usage between participants and the typical Minnesota Power residential customer in the Duluth area. The latter comparison helps to describe the differences between self-selecting Rate Pilot participants and the larger pool of residential customers.

### WEATHER DATA

Hourly weather statistics for the Duluth International Airport were obtained from the National Oceanic and Atmospheric Administration’s (NOAA) National Centers for Environmental Information and were used to select dates for proxy reference loads. The time window for weather data was January 2013 through December 2015 and statistics included:

- mean dry bulb temperature
- maximum dry bulb temperature
- minimum dry bulb temperature
- relative humidity
- enthalpy

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<sup>19</sup> Excluded dates were February 14, April 16, June 26 and 23 December, all from 2015.

## DEMOGRAPHIC DATA

Demographic data for pilot participants, an energy-interested subset of Minnesota Power's residential customer base (i.e., customers who completed the Your Home Energy Report (YHER) survey) and the City of Duluth were compiled from a variety of sources and used to better understand the type of customer who self-selected into the Rate Pilot. The table below outlines the types and sources of data collected.

Data Types	Data Sources
Type of home	Rate Pilot participants → Post-pilot survey (329 responses)
Ownership	
Age information on householders	Energy-interested customers → YHER survey (8,087 responses since 2009, excludes applicants for Minnesota Power's low-income rate)
Primary heating fuel	
Use of various mechanical systems	City of Duluth → 2010-2014 American Community Survey

## APPENDIX E—TIME-OF-DAY RATE TARIFF SHEET

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## **PILOT RIDER FOR RESIDENTIAL TIME-OF-DAY SERVICE**

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### **APPLICATION**

Applicable to customers taking service under Residential Service Schedule 20 (General) or Schedule 22 (Space Heating), for single-family dwellings in the following ZIP code areas: 55805, 55806, 55807, 55810, 55811, 55812, 55720, 55733, 55779, 55803 and 55808. All provisions of the Residential Service Schedule shall apply to the Residential Time-Of-Day service under this Rider except as noted below. This is a voluntary experimental Rider and will be available only to customers participating in the Consumer Behavior Study Plan ("CBSP"). Participating Customers shall be required to remain on this Rider for a minimum of 12 months and after that may be removed from this Rider upon their request.

### **RATE MODIFICATION**

Customers will be billed at the Residential Service rate, plus the following Energy Charge Adjustments shall apply:

	<u>Energy Charge Adjustment</u>
All Off-Peak kWh	-2.990¢/kWh
All On-Peak kWh	1.415¢/kWh
Critical Peak Pricing kWh	77.000¢/kWh

### **SERVICE CONDITIONS**

On-Peak and Off-Peak Period Defined: The On-Peak Periods shall be defined as 8:00 a.m. to 10:00 p.m., Monday through Friday, inclusive, excluding holidays and Critical Peak Pricing periods as defined below. The Off-Peak Periods shall include all other hours. Holidays shall be those days nationally designated and celebrated as New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving and Christmas.

Critical Peak Pricing Declaration and Notification: The Company at its sole discretion will determine when to declare a Critical Peak Pricing period. Normal Critical Peak Pricing periods will be declared in the summer during only the following hours: from 12:00 p.m. to 3:00 p.m. of each day that the Company declares to be a critical peak day and in the winter during only the following hours: from 5:00 p.m. to 8:00 p.m. for each day the Company declares to be a critical peak day.

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Marcia A. Podratz  
Director - Rates

## **PILOT RIDER FOR RESIDENTIAL TIME-OF-DAY SERVICE**

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The Company may declare a maximum of 160 hours of Critical Peak Pricing periods per calendar year.

The Company shall make reasonable efforts to notify Customers of normal Critical Peak Pricing periods in advance by 8:00 p.m. on the prior day for normal events and at least four hours prior to emergency events. Normal Critical Peak Pricing periods will generally occur on high demand days for meeting the peak electric loads and system energy requirements of the Company. Emergency Critical Peak Pricing periods will occur at times when the Midwest Independent Transmission System Operator (Midwest ISO or MISO) determines the reliability of the system is at risk and the MISO issues an Energy Emergency Alert Level 2 Event (EEA 2). The maximum duration for an emergency Critical Peak Pricing period will be eight (8) hours.

Critical Peak Pricing period notifications for normal and emergency events will be made electronically via the Company's Web site and email as well as through the Interactive Voice Response ("IVR") automated calling system; however, it is the Customer's responsibility to receive such notice, check the Company's Web site or call a phone number specified by the Company to determine if a critical peak day has been declared.

### **SPECIAL RULES**

1. Any Customer choosing to be served on this Rider thereby waives all rights to any billing adjustment arising from any claim that the bill for the Customer's services would be cheaper on any alternative rate schedule for any period of time.
2. If Customer served under this Rider moves to a different dwelling within the 12-month period as specified in the Application section above, the Customer has the option to retain time-of-day billing at the new premise or decide to discontinue time-of-day billing.

### **PRIVACY PROVISION**

The Company follows its standard operational privacy guidelines and practices for all customers, including those participating in this Rider. The Company complies with the State and Federal laws and regulations governing utility customer data use such as the Federal Power Act, the Minnesota Public Utilities Act, and the Minnesota State Statutes (such as Chapters 47 and 248 B.).

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**PILOT RIDER FOR RESIDENTIAL TIME-OF-DAY SERVICE**

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The Company routinely collects data about and from its Customers through various sources as part of the normal course of providing services. Customer personal information, account and usage details, billing information, and program participation details are secured and retained in internal and online databases in accordance with the Company's standard operational guidelines which maintain administrative, technical, and physical safeguards to protect the privacy and security of the information. These safeguards include but are not limited to encryption, password protection, and secured files and buildings.

***Smart Grid Investment Grant Reporting:***

This voluntary experimental Rider is being offered as part of a CBSP under a Smart Grid Investment Grant ("SGIG") through the United States Department of Energy ("DOE"). Reporting of certain data, along with customer usage information, are required of the Company under the terms of the grant. A description of this data, permissible uses, and how it will be retained is as follows.

The DOE provides Metrics and Benefits guidance documents that will be used as part of the evaluation and reporting of benefits for the CBSP, including this voluntary experimental Rider. These guidance documents are available at smartgrid.gov. Minnesota Power will not disclose individually identifiable information and will mark all reported Customer data as CONFIDENTIAL. In so doing, the DOE provides assurance that it will protect such data to the extent allowed by Federal law. In accordance with DOE regulation 10 C.F.R. 1004.11, the Company, as a grant recipient, shall be given opportunity to submit its view as to whether information is subject to any exemptions to public release as prescribed by law. Unless compelled by a court of competent jurisdiction, there may be no public release of this data to the public without the written consent of the Company and the DOE.

A unique customer study identification number will be assigned for any customer level data, in accordance with DOE guidance documents. Individual customer account names, numbers, and addresses will not be included in reporting to the DOE. All customers who sign up for this Rider will be informed that they will be doing so as part of a DOE-funded study. Information is requested of pilot participants through survey instruments delivered via a secure on-line portal. In addition, through the deployment of advanced metering infrastructure, more granular usage information is collected through the metering software.

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## **PILOT RIDER FOR RESIDENTIAL TIME-OF-DAY SERVICE**

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### *Survey and Portal Data:*

To participate in the pilot, Customers are asked to set up a user ID and password through a secure on-line portal called the Power of One® Choice Portal. This is an enhanced adaptation of the Company's existing Power of One® Portal offered through its conservation program and features new tools and information about energy usage information for pilot participants. As part of the pilot, the Company asks all customers to complete the Your Home Energy Report ("YHER") questionnaire as an initial step. Results from the questionnaire generate an YHER which serves as an educational tool offered to residential customers as part of the Company's conservation program. This survey asks questions about the Customer's dwelling, including size and age of home, heating and cooling systems, and appliance holdings. In addition to the standard YHER questions, DOE-specified questions relating to education, income, energy awareness, and the pilot program are included for pilot participants. No questions or responses are required. Additional feedback surveys and communications will be delivered through the portal during the course of the pilot.

Survey responses, online portal activity including a daily count of page views, click-through data for websites, and other customer engagement statistics will be collected and reported.

### *Energy Consumption Data:*

Energy consumption and tariff data will be reported for a period of up to 12 months prior to the commencement of the Rider and during the participation period. This data includes:

- a. Date and hour of each day, with time zone;
- b. Hourly interval meter usage data for 0-12 months prior to commencement of the Rider (depending upon the date of meter installation relative to start of Rider) and during the participation period;
- c. Hourly weather data from the nearest weather station for 12 months prior to commencement of the Rider and during the participation period;
- d. Tariff sheet reference (i.e., which tariff sheet(s) each customer was on and the date range that the customer was on that tariff sheet for the 12 months prior to the commencement of the Rider);
- e. Start date of billing cycle;
- f. Monthly electricity bill (i.e., \$ amount) for 12 months prior to commencement of the Rider;
- g. Electricity usage from the monthly bill for 12 months prior to commencement of the Rider and during the participation period; and

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- h. For each event, the type of notification, number of notification channels, number of hours in advance, and success or failure (e.g., for customer #492, for the critical event on 5/03/2012, notified via email – email bounced, notified via phone – no answer).

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