Residential Real-Time Pricing Program Achieves Savings for Utility and Customers

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ABSTRACT

In 2007, real-time electricity rates were offered to most residential customers in Illinois. These rates are based on market prices and vary over each hour of the year. The Ameren Illinois Utilities Power Smart Pricing Program has shown that a low-tech program with an emphasis on education is sufficient to enable most customers to respond beneficially to real-time pricing (RTP). As of October 2009, over 7000 customers were enrolled in the program.

This paper presents highlights of the design and implementation of the program, findings from the evaluation, and lessons learned on how customers respond to hourly pricing and price signals. The low-tech aspect of the program keeps program costs down and enables people who are on the have-not side of the digital divide to participate. The evaluation showed that customers: responded as expected to variations in hourly prices during the summer (price elasticity), reduced their peak demand on summer afternoons (load reductions), used less total energy over the summer months (conservation), and saved money on their bills when compared to the flat rate. A subset of 100 participants who used a PriceLight that signaled prices by different colors had a stronger response to electricity prices.

While many economists attest that hourly energy pricing brings economic efficiencies to the system, there are also many experts who believe that RTP is too complicated and too expensive for wide-scale implementation. The Power Smart Pricing program has shown that many customers will participate in and benefit from a low-tech RTP program design.

Introduction

Starting in 2007, real-time electricity rates were offered to all residential customers of large investor-owned utilities in Illinois. This alternative was both a significant change for residential customers (for whom the flat rate had been the norm for decades) and an exception to the more common dynamic rates being offered in the rest of the U.S, such as critical peak pricing or time-of use rates, which provide some variation in rates by blocks of time. In Illinois, real-time pricing rates are based on a direct pass through without markup of wholesale prices. These rates vary each hour, daily, throughout the year.

This paper describes the results of two years of the Power Smart Pricing (PSP) program for residential customers of Ameren Illinois Utilities (AIU). These results include highlights of the design and implementation of the program, findings from the evaluation, and lessons learned on how customers respond to hourly pricing. The effects of enhanced price signals from a home display device, the PriceLight, are also discussed. Marketing strategies are also presented to show how this unprecedented number of voluntary participants for a residential real-time pricing program was achieved.

Power Smart Pricing Program Design

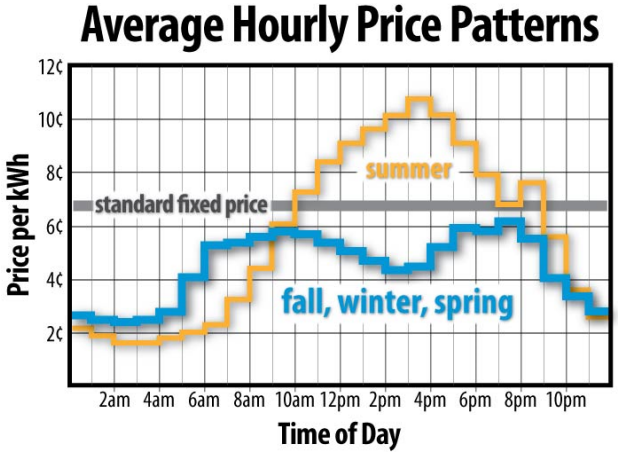
The Ameren Illinois Utilities Power Smart Pricing program is administered by CNT Energy, a nonprofit organization that developed and piloted a real-time pricing program from 2001 to 2006. The program had its origins in the effort to find a value proposition for consumers in the deregulation of the electric industry. Rates such as Time-Of-Use and Critical Peak Pricing have been the types of dynamic rates more commonly offered to consumers. However, these rates include an artificial leveling or averaging of prices that obscures the true market conditions, and consumers have to pay for the cost of that leveling. A rate that reflects real market prices has been endorsed by economists as a mechanism for bringing economic efficiencies to the system of pricing and paying for electricity. Real-time pricing places the appropriate value on on-peak power, a scarce and hence expensive resource. It also places an equally important value on off-peak power, an abundant and inexpensive resource.

The volatility and lack of certainty real-time prices entail is viewed as a deterrent to participation for the residential customer. However, in 2002 CNT Energy analyzed three years of historical energy data and found that prices followed generally predicable patterns. Moreover, passing these real-time prices on to consumers resulted in greater financial benefits than other dynamic rates.

A pilot real-time pricing program that enabled participants to fully participate in the energy market by using real-time prices was designed and operated from 2003-2006. This pilot's success led to a mandate passed by the Illinois legislature (Public Act 94-0977[1]), requiring all large investor-owned utilities to offer an optional real-time pricing program to their customers. In 2007, Ameren Illinois Utility contracted with CNT Energy to administer their real-time pricing program for residential customers, branded Power Smart Pricing.

Power Smart Pricing is marketed to customers who "want to save money" and are willing to "shift some of their electrical usage to off-peak hours." Although electricity prices do vary hourly throughout the day and year, they also follow fairly predictable hourly and seasonal patterns (Fig.1). During the fall, winter, and spring, energy prices are usually lower than the standard flat rate, at most hours of the day. Customers can accumulate additional savings by shifting some of their usage from the slightly higher-priced hours to other hours during the week, or weekends, when prices are also lower.

Figure 1. Graph of hourly energy prices, based on historical data.



[1] A copy of Illinois Public Act 94-0977 can be found at:
http://www.ilga.gov/legislation/publicacts/fulltext.asp?Name=094-0977&GA=094

The highest priced hours usually occur in summer, primarily during hot weather, in the mid to late afternoon hours (see graph). Reducing electricity usage during these times of peak system loads is a primary goal of real-time pricing for both the consumers and the utility. Consumers are incented to reduce usage during this time to avoid the high prices. For the utility, reducing peak load has system benefits. In the short term, system reliability can be enhanced and additional costs to procure expensive peak power can be avoided. In the longer term, successfully reducing peak load can save on system maintenance costs, postpone the need to build additional capacity, and produce environmental benefits.

The PSP program was intentionally designed as a "low-tech" program. The PSP program uses standard interval meters which are capable of tracking the time of day their electricity is used. These meters are an upgrade for most customers but they are a less expensive technology than "smart meters" with two-way communications capability often used in dynamic pricing programs. These meters' data is used to calculate the energy charges, and then combined with delivery and transmission charges that are similar to those charged to customers on the flat rate. Customers can review their hourly energy use on a monthly basis, after the meter is read and the bill is posted, but the program does not offer "real-time" access to energy use data. While this information has been shown to provide value to customers, the hardware and software costs of this access are considerable.

A second low-tech aspect of the program is the notification system, described below. A program that does not rely on high cost technologies for communicating events translates into lower system costs and allows for greater participation from customers of all economic levels.

Program implementation

CNT Energy began to enroll participants in 2007. All residential customers had the opportunity to learn about the program from utility bill inserts. These short fliers direct customers to the Power Smart Pricing website or to call the toll-free number for further information. CNT Energy also uses direct mail to solicit participation. These mailings include an authorization form and return envelope, to simplify the sign-up process. CNT Energy's research into the demographics of customers who are enrolled in the program is used to target mailings to zip codes that include residents with similar profiles. These demographics include higher than average income and higher levels of education.

The enrollment process consists of a series of transactions between the customer, CNT Energy, and AIU, who owns and is responsible for meter reading and maintenance. After the customers' information on the authorization form is verified, AIU and CNT Energy initiate a series of data transactions that authorizes the meter exchange and the transfer of the customer to the new rate. The process is usually completed within one month.

Customers are prepared for their participation in PSP by letters or emails informing them of how the new rate works and when their enrollment will be effective. All participants receive a program guide and quarterly "Update" newsletters throughout the year. Ongoing customer education is an essential part of the program. All program materials are available in hardcopy print format, but customers can receive all information by email if they choose the "go paperless" option, suggested as an environmental alternative. Thirty-one percent of customers choose this option.

In the explanations of how PSP works, CNT Energy, as program administrator, explicitly does not advise customers to monitor electricity prices on an hourly and ongoing regular basis. This practice is not encouraged for two reasons. First, prices are typically low throughout much of the year, thus tracking of hourly variations is a time-consuming task that does not yield corresponding financial returns. CNT Energy recommends customers simply "keep the price pattern in mind" and shift appliance usage when possible to

accrue savings. Second, CNT Energy monitors prices for participants, and informs them when prices reach a pre-determined level. Participants are alerted via a phone or email message, specifying the hours when electrical usage should be reduced or shifted.

Reducing summer peak electricity use and avoiding high prices are critically important aspects of the Power Smart Pricing Program, for both utilities and participants. Consequently, preparing customers to effectively manage their usage on hot summer days is one of the key aspects of the customer education. Market prices are received from the system operator MISO in the late afternoon for the following day and promptly posted to the PSP website. If there are going to be high price hours (defined as those exceeding a pre-determined level) the next day, a "High Price Alert" message is delivered to enrollees via email or automated phone call. Customers are prepared to respond during these hours with strategies and techniques that have been provided to them via ongoing communications and a special summer readiness kit.

Hourly electricity prices are available on a daily basis for those who choose to monitor them, and 37 percent of participants report doing so "daily or almost every day". Prices are listed online at the AIU website and on the PSP homepage, in numerical and graphical formats. Several on-line tools have also been developed for computer users to monitor energy prices while they are logged onto the Internet. These include Google and Vista gadgets that display prices graphically, and an application that displays the current price on the computer's web browser toolbar. Participants can also follow PSP on the social messaging tool Twitter, where a daily summary of the highest and lowest hourly prices are "tweeted". Finally, the hourly energy prices are recorded in total daily and available via a call to the program's toll-free number, so customers without access to computers can obtain these data. This slightly monotonous computer-generated message continues to be viewed as an essential service by participants who lack internet access. In the most recent customer survey, seven percent of respondents reported calling the PSP line regularly.

A subset of participants was offered an additional tool, the PriceLight, a specially programmed version of the Ambient Orb. The orb technology is designed to provide "ambient" data via an unobtrusive yet constant conveyance of information. The PriceLight was programmed to change colors hourly, using a blue/green/yellow/red spectrum to give a visible indication of current electricity prices. The orb device had considerable popular appeal to customers, which presented difficulties in program administration. News articles often feature the orb, which led to a common misconception that orbs are necessary and required in order to use real-time prices. Widespread distribution of the orb was not practical for two reasons. One was technological – the orb operates using pagers, and the service area coverage is very limited in central and southern Illinois. The second reason was the cost of the technology. In addition to the hardware purchase price, a monthly subscription fee was required for each orb unit. Previous research into how much customers were willing to pay for the orb or other communication found a majority picked a price point of $25, which represents only a fraction of the total cost of the unit.

CNT Energy received funding from the Illinois Clean Energy Community Foundation to subsidize the distribution of 100 PriceLights. A randomly selected sample of participants, within the area that could receive the pager signal, was offered the opportunity to utilize the orb. Participants were asked to deposit $35, $25 of which would be refunded upon the return of the PriceLight after one year. Despite the careful explanation of why only a small number of orbs were available, customers who were not randomly selected did express some dissatisfaction. This comment from the annual customer satisfaction survey was representative: "I'm very dissatisfied that I did not receive the orb. I am suspicious of the process – I think you have to know someone."

Results of the Impact Evaluation

Enrollment in PSP in 2007 was limited due to legislative uncertainty regarding an unrelated debate about rate increases, and marketing of the program did not begin until the fall. Therefore a formal third-party evaluation of program results was not conduced. An evaluation of the first full year of the program (2008) was completed early in 2009. The evaluation was based on a statistical analysis of the hourly load data for both program participants and the AIU load research customers. The evaluation showed that customers: responded as expected to variations in hourly prices during the summer (price elasticity), reduced their peak demand on summer afternoons (load reductions), used less total energy over the summer months (conservation), and saved money on their bills when compared to the flat rate. Those with the PriceLights showed an even greater response to price changes on all days throughout the summer season.

Methodology

Four different analysis approaches were used in the impact evaluation.

- To evaluate **price elasticity** a regression model was developed that statistically modeled hourly energy use as a function of the hourly price of electricity and the hourly weather conditions. The statistical analysis for the price response models was based on the development of an econometric model that combined weather data with the interval meter data. For this analysis, data were available both across households (i.e., cross-sectional) and over time (i.e., time-series).

  Given that there was an expected difference in response by season, two separate models were developed for summer and winter. The models were estimated using the hours 10:00 a.m. through midnight to avoid the noise from low price movement periods in the nighttime. Not only is price volatility low during the night, but most customers are asleep at that time and behavioral response to changing prices is unlikely.

  In addition, two separate models were estimated for each season. The first model estimated an overall elasticity. This is the elasticity that can be compared to overall elasticity results from other studies. The second model for each season took a deeper look at the different factors that may be contributing to the overall elasticity: high price alert days, the presence of a PriceLight, weekend, year, and cold weather.
- To evaluate **load reductions,** average load curves for PSP participants were compared with a control group based on the load research customer sample for eight different day types: Regular Summer Weekdays, Regular Summer Weekend Days, High Price Alert Summer Weekdays, High Price Alert Weekends, Regular Shoulder Month Weekdays, Regular Shoulder Month Weekend Days, Regular Winter Weekdays, and Regular Winter Weekend Days.

  The basis of the typical load curves developed for PSP participants was the same collected and cleaned hourly load data that was used for the development of the elasticity models. The goal of the load curve comparison was to make a control group that very closely matched to the characteristics of the participant group. In this way, the observable difference in the load curves for the two groups was most likely to represent the impact of the PSP program on the participants' energy use. i.e., if not for the program, the two load curves would be the same because the two groups are similar. Load research data was available for several customer types within several geographic regions. These load curves were weighted to reflect the composition of the PSP participant group.

- To evaluate the **conservation effect**, the basic approach used was to compare weather-normalized average monthly use from the pre-participation period to the post-participation period for each individual customer. In this type of regression each customer acts as their own control and there is no control group to compare to. A fixed effects regression model was developed using billing records, weather data, participant data and pricing data.

  The regression model was run in two ways: by season (winter, summer, shoulder); for the whole year and including standard weather-related variables. Additional models were run to check for any possible effects from participation in the CFL program and the PriceLight program or in the CFL program run by AIU during the same period..
- To evaluate **bill savings,** participant bills were recalculated to show what they would have been under the appropriate Ameren flat rate. The recalculation took into account the line items in the Electric Supply portion of the bill. Within that section, several line items (the Market Value Adjustment, the Supply Cost Adjustment and the General Assembly Rate Relief Credit) remained the same.

  The hourly energy charges were replaced by multiplying the monthly kWh by the appropriate summer/non-summer flat rate tariff, and the Transmission Service Charge was recalculated to be on a kWh basis rather than a kW-day basis. The recalculated flat rate bills did not include the $2.25 PSP Participation Charge or the RTP Supplier Charge (which are special charges only for PSP participants and pay for several unbundled energy costs such as capacity and ancillary services).

  The recalculations of bills focused on recreating a bill for the same usage as the PSP bill. It did not take into account the conservation effect that suggests an average overall decrease in annual consumption because that amount is an indirect observation, not clearly stated on actual bills.

Analysis results

The metrics of elasticity, load reduction, conservation, bill savings and the PriceLight effect are discussed below.

Elasticity A cornerstone of the impact evaluation of the PSP program is understanding how much PSP participants changed their use of electricity in response to hourly electricity prices. This relationship can be quantified by estimating the price elasticity of demand for electricity. Price elasticity is defined as the percentage change in demand associated with a percentage change in price. For example, a price elasticity of -10% implies that a 100% increase in price will reduce demand by 10%. The key result from the elasticity modeling done for 2008 is that Power Smart Pricing participants did indeed respond to variation in hourly prices during the summer season. The overall elasticity was –4.3%.

This finding is consistent with the own-price elasticity estimates found in similar studies that looked at price response rates for residential electric customers.

On average, customers showed additional price response on weekends compared to weekdays.

There is additional information about the hourly demand impacts of the PSP program that can be gained by comparing typical load curves for PSP participants to load curves for a control group of similar customers that did not participate in the program. The difference in these load curves is a good indicator of the hourly impacts of the program by season in 2008.

Load Reduction Overall, the load curve comparisons show that PSP participants:

- Regularly have lower daytime use and higher nighttime use in summer, with an average load reduction of 0.15 kW per customer from Noon to 5 p.m.;
- Have accentuated response on High Price Alert Days, showing an average load reduction of 0.23 kW per customer from Noon to 5 p.m. on those days;
- Have the same daily use pattern as regular customers in spring and fall;
- Have slightly more nighttime use in winter; and
- Show weekend response patterns that shadow the corresponding weekday patterns while overall use is higher.

In 2007 and the beginning of 2008, Power Smart Pricing utilized Midwest Independent System Operator (MISO) day ahead prices (DAP) as advisory prices for participants and billing was done based on actual MISO real time prices (RTP). Starting on June 1, 2008, participant usage was billed on DAP instead of RTP. A comparison of DAP and RTP during the summer of 2008 indicates that customer response to DAP prices creates load reductions at the right time to avoid high RTP prices on the system. Demand response is being influenced at the correct times by the DAP rates.

Conservation In addition to identifying the price elasticity that occurred as a result of the program – instantaneous change in demand in relation to price – the conservation effect of the program was also examined. The conservation effect is defined as the percentage change in total energy use. For example, an annual conservation effect of 5% would mean that total weather-normalized annual electric energy use for participants is 5% less in the year following their joining the program when compared to the years before.

The key result from the conservation effect modeling is that Power Smart Pricing participants reduced their average energy use by 6.0% during the summer season and by 0.9% during the shoulder months. However, they increased their average energy use by 3.0% during the winter months. This created an overall annual energy savings of 1.5% per year.

Bill Savings In 2008 the aggregate bill savings for PSP participants was $181,482.11 which represented a 9.0% total savings compared to what the same bills would have been under the flat rate. Average annualized savings (which account for the growing participation level across the year) were $92.65 or 7.7%.

This estimate of bill savings does not include the additional savings that comes from the conservation effect of the program. Including the estimated conservation effect of 186 kWh per customer at roughly ten cents/kWh for energy and distribution, there is an additional $18.60 that the average PSP participant avoided paying in 2008. If that savings had been included, the average annualized savings would have risen from 7.7% to 9.1%. For 1,347 participants, that represents an additional annualized aggregate bill savings of $25,054.20.

Factors contributing to elasticity The detailed elasticity model which examined the factors contributing to the overall estimate of elasticity for summer showed that High Price Alert Days, the PriceLight, weekends and the year were all statistically significant factors at the 98% confidence level or greater. This indicates that:

- Customers did pay attention to High Price Alerts and increased their price response on those days.
- Customers with PriceLights showed an even greater response to price changes, and this effect shows up across all days throughout the summer season.
- On average, customers showed additional price response on weekends compared to weekdays.

Interestingly, results show that response was greater in 2007 compared to 2008. The exact reason for this is unknown, but it could be related to the fact that there was greater price volatility in 2007. During the summer of 2007, the top 1% of hours had prices that ranged from 19 cents to 31 cents. In summer 2008, the prices ranged from 17 cents to 21 cents for the top 1% highest price hours. The higher prices in 2007 may have encouraged a greater price response in that year.

Making Hourly Energy Prices Work for Customers

Among the as-yet not-definitively answered questions about dynamic pricing is how many customers will choose this option over the standard rate. As a program that is available and has been marketed to all residential electricity customers, the Power Smart pricing program can provide some insight into this question. CNT Energy's comprehensive approach to marketing is discussed below.

Marketing Strategies

A customer's decision to participate in Power Smart Pricing depends on many factors. Some are specific to the individual customer and difficult or impossible to affect, such as how motivated a customer is to save money on their utility bill and how comfortable that individual is with innovation, or trying something new. However, effective and persuasiveness marketing messages can help remove barriers to participation for many customers.

The first enrollees in Power Smart Pricing could be described as consistent with the "Innovators" and "Early Adopters" categories of Roger's diffusion of innovation schema.[2] They share higher educational and income levels. CNT Energy hopes to reach the next group of potential customers, the "Early Majority" (those who adopt an innovation after a varying degree of time significantly longer than the innovators and early adopters). As one step in this process, CNT Energy held a series of focus groups to test-market messages. The findings included a recommendation to increase the prominence of the money-saving message (seen as the most important aspect of the program) and identification of a friend or neighbor as the ideal spokesperson for the program. CNT Energy's marketing has been redesigned to incorporate these results.

Because switching from paying for electricity at a standard fixed rate to a variable and potentially riskier market-based rate represents a change in behavior, recommendations from trusted individuals, particularly friends and family, are especially persuasive. CNT Energy facilitates this process by a "Refer-A-Friend" program. Any participant who refers a customer who ultimately enrolls in the program receives a $20 Home Depot gift card for every successful referral. Apart from this program, the percentage of enrollees who say they were referred by "word of mouth" has doubled, from five to ten percent.

CNT Energy also works to develop relationships with groups that have interests in areas such as energy efficiency, the environment, and affordable housing, and to cooperate with these organizations to inform their constituencies about PSP. One particularly valuable association has been with the Citizens Utility Board, a consumer watchdog group.

CNT Energy also attempts to maximize the number of exposures customers have to the PSP program, as increased familiarity reduces the perception of risk. To facilitate this process, CNT Energy uses a variety of media to reach potential consumers. As part of the enabling legislation that authorized the program, CNT Energy has the option to purchase two bill inserts a year. This insures that all customers have

[2] Evert Rogers defines diffusion of as "the process by which an innovation schemais communicated through certain channels over time among the members of a social system." Adopters of any new r idea can be categorized as innovators (2.5%), early adopters (13.5%), early majority (34%), late majority (34%) and laggards (16%),

the opportunity to be informed about the PSP option. The response rate attributable to the bill inserts is small, less than one percent. The direct mail campaigns, which are targeted to zip code demographics that fit the profile of the participants (higher than average income and education), are customized, as possible; with comments from local participants. The response rate for these mailings ranges from 1.5 to two percent.

CNT Energy has recently begun advertising on the Internet, via Google and Facebook Adwords. CNT Energy also works to place news stories featuring Power Smart Pricing participants. An increase in requests for information and enrollments accompanies the publishing of these articles.

The comprehensive approach to marketing and communications continues with ongoing participant education and support.

Participant Support and Education

Different participants have differing needs for the quantity and type of information that they want to receive. CNT Energy has established a variety of resources to assure that participants' expectations are met. All participants receive a program guide and ongoing education via quarterly newsletters. For those who want more, the CNT Energy maintains a blog that is updated with energy and energy efficiency information twice a week, in addition to the Power Smart Pricing website. Postings to this blog from participants are published, subject to moderation by CNT Energy staff. Power Smart Pricing also has a presence on the social media platforms of Facebook and Twitter.

All participants, (even those who have requested only electronic communications) are sent a paper hardcopy of the summer readiness kit, to reinforce the importance of that communiqué. The most recent summer readiness kit was a poster that could be displayed on refrigerators, with a schematic of a house, an explanation of how summer priced patterns differed from the rest of the year, and recommendations of different energy saving or switching techniques.

Another communication that is mailed in hardcopy to all participants is the annual report on participants' savings. This includes a monthly listing of the comparison of their bills on the PSP rate to what they would have paid on the flat rate, along with a summary of all participants' performance, for comparison purposes.

CNT Energy also communicates with individual participants through the in-house call center. This access to a "real person" is often cited by participants as a source of their satisfaction with the program. A substantial number of participants also communicate with CNT Energy via email. While responding to individual customers is time-consuming, the content of these communications provides valuable insight to customers' opinions and concerns. A customer satisfaction survey is also fielded annually.

Part of the evaluation of the PSP program was examining contributing factors to successful participation in the program. The PriceLight was identified as probably helping customers save more energy, although the level of savings cannot be determined with acceptable precision. Further study is necessary in order to make a cost/benefit analysis (i.e., does the cost of the popular PriceLight yield savings that justify its expense?). A new development in the PriceLight story worth noting is that in the past summer, one of unusually low and stable prices, participants were convinced their PriceLights were broken because the same blue color was constantly displayed. Participants had been so conditioned to check prices via the PriceLight that they did not go to the web to see that the prices were in fact consistently low. This occurrence has even resulted in some participants returning their PriceLights, with the explanation that they don't need them any longer.

Participation in AIU's compact fluorescent lighting (CFL) energy efficiency program was also examined as a contributing factor. PSP participants were much more likely to buy CFLs from AIU than residential customers on the flat rate (4% versus <1%). Additional savings for PSP customers who

participated in the CFL program were also estimated, but the incremental CFL savings could not be identified at a statistically significant level. This finding suggests that PSP participants could represent consumers with an increased interest and capacity for achieving greater energy efficiency in their utility use.

Back to the drawing board

Utility programs are subject to the tariffs under which they are authorized, and the process of adjusting these tariffs is cumbersome enough that changes are not readily made. However, two unforeseen disincentives that arose for PSP led to the decision to make adjustments to the rate on two occasions. The process of identifying and addressing these situations was a result of the cooperative working relationship between CNT Energy and Ameren Illinois Utilities, and the resulting improvements benefited the program and customers. These changes underscore the importance of thinking about tariffs dynamically and realizing that they may need periodic adjustments to keep their intentions in line with the expectations of customers.

The first adjustment was a change in the way that the charge for capacity was calculated. Electricity costs consist of charges for the energy (calculated either at a flat rate or variable hourly rate, for PSP customers), for delivery and transmission costs, and for capacity and other ancillary services. Early analysis of PSP bills revealed that the combination of the various calculations for the capacity charges were confusing to customers and in some cases, amounted to higher costs than was reasonable. CNT Energy reviewed the situation with AIU, who quickly made adjustments in the rate that were clearer and more equitable. The changes were even made retroactive and some customers received bill credits as a result.

The second adjustment was changing the electricity commodity prices that Power Smart Pricing customers were charged from real-time prices to day-ahead prices. During the first year of the program, the description of how the hourly electricity rates were charged required a lengthy and careful explanation. Day-ahead hourly prices, available in the early evening for the following day, provided a reasonable forecast of the actual hourly prices that would be charged on usage, on an hourly basis. Day-ahead prices were the basis for the determination of High Price Alert days, when customers receive a notification of hours to expect high prices on the following day. On the actual day electricity service was being used and metered, "real-time" prices were updated and posted but with a time lag that made it difficult, if not impossible, for customers to appropriately respond. The actual prices participants were charged (the settlement prices) were subject to final adjustments after all the accounting related to purchased electricity were reconciled.

In reality, the variation between day-ahead, real-time and settlement prices was minimal over time. Hourly prices for High Price Alert days in 2008 were studied and it was found that two-thirds of the time day-ahead prices were higher than the actual real-time prices, but this relationship needs to be studied in additional years before anything definitive can be said about which is likely to be higher and what the average difference is. But for customers already experiencing some trepidation over the switch to a variable rate, the uncertainties built into use of the time-delayed real-time settlement price created additional anxiety. Real-time prices were only available to those customers who had Internet access, and for many practical purposes, customers could not monitor electricity prices and act on that information by making decisions on their energy usage. These inherent difficulties, plus the fact that AIU actually purchased most of its electricity on the day-ahead market, led to the decision to change the billing pricing unit from real-time to day-ahead prices in 2008.

Studies of the data show that day-ahead prices are actually very slightly higher than real-time prices on average, so the customers actually paid more under this new pricing structure. However, there are fewer extremes in the day-ahead prices (both up and down) and most customers perceive the ability to have certainty and plan for energy usage as a benefit. The evaluation of PSP also showed that participants' demand response to the day-ahead prices created load reductions at times that avoided high real-time prices.

A tiny minority of customers disagreed with this change, arguing they'd been treated unfairly when they lost access to real-time prices. These customers were particularly aggrieved by their observation that negative prices – which occasionally occur when there is excess capacity on the system, and customers are paid to use electricity – are more common in real-time accounting. However, the vast majority of customers are satisfied with the day-ahead prices. In program materials, the phrase "hourly energy pricing" is now being used to explain how the program works, in place of real-time pricing.

Another occasional complaint from potential customers is that the PSP program requires a one-year participation commitment. This term was established in order to avoid the expense of installing new meters for short-term commitments, and to prevent customers from enrolling for the low-price months and withdrawing when summer, and higher prices, came around. The explanation that the program involved rewarding customers for avoiding peak usage, and that it would be unfair to take advantage of the "good times" and avoid the challenges, was sufficient for some customers. But focus groups cited a "trial period" as a feature that would make them more willing to try the program, and the reluctance to be "locked in" to a rate is voiced by many customers. The fact that over 99 percent of PSP customers remain on the program after their year commitment has passed does not alleviate this fixation. Revising the terms of the program to accommodate these requests, perhaps with a fee for early withdrawal, might be a solution that would attract cautious applicants. One aspect of this requirement is that Ameren does not yet have a fully deployed two-way automatic metering infrastructure, and rather has a mixture of traditional meters and one-way automatic meter reading meters. As a result meters must individually be replaced as customers enroll in the program. Come the day Ameren has a full two-way system, the process of switching customers on and off of the program will have to be revisited and revised.

Discussion

The Power Smart Pricing program has shown that residential customers are capable of understanding and utilizing a dynamic hourly energy price structure. Survey responses from these customers show high percentages of satisfaction with the program, with 71 percent of customers reporting that they find participating in PSP "quick and easy". While most participants are fairly passive monitors of energy prices, some actively enjoy the process of monitoring hourly energy prices, viewing it as a way to "shop for energy bargains". Customers who consistently follow the hourly energy prices have achieved savings rates as high as 35 percent.

But the majority of customers are much less active in their behaviors, and still save an average of fifteen percent. This savings rate is apparently satisfactory, as more than 99 percent of participants remain on the rate after the required one-year term of enrollment.

The equivocation in these statements arises from the fact that the majority of enrollees manage their participation in PSP without any special attention or instructions from the program administrators. These customers are exceptional as a group because of their "low-maintenance" status. Reading the program guide is apparently sufficient to enable most customers to successfully navigate the PSP program. This results in lower administration costs for both customer acquisition and maintenance.

Despite these successes, enrollment in the PSP program has grown more slowly than the timetable originally anticipated when residential real-time pricing was mandated in the state of Illinois. This slow growth is perhaps not unexpected given the context – 100 years of public policy has separated consumer electric rates from the real costs of generation. Electricity prices in the Midwest are also relatively inexpensive, especially when compared to natural gas and the costs for home heating. Switching to a new rate, especially one where paying more for the same commodity is possibility, represents a risk to customers. The longer the program is in operation, the more data about the program's operations will be available.

Through this process, the perception of the riskiness of the program may be moderated. In addition, the resources for marketing the program have been limited and techniques such as gift cards incentives for enrollment that are often used to attract customers to new services have not been utilized. Time will tell how widely adopted the innovation of dynamic pricing will become.

However, it is important to keep in mind that wide-scale adoption of real-time pricing is not required for the program to have a positive impact on the electrical system. In the process of approving real-time rates in Illinois[3], the Illinois Commerce Commission heard testimony about the possible net economic benefits to the residential community as a whole. The models presented used participation rates of ten percent of residential customers. The actual relationship between peak demand reductions and the larger wholesale electricity market will be studied as part of the evaluation that will take place in 2011, after four years of operations.

Conclusions

The Power Smart Pricing program has helped residential consumers save money on their electricity bills, and encouraged conservation and energy-efficiency behaviors. The low-tech structure of the program results in lower costs for deployment and administration. With sufficient participation, the peak load management that occurs may have additional benefits to the electrical system: increased system reliability, delay or avoidance of additional capital investments, and environmental benefits.

While the real value of the reduction in peak electricity use, energy efficiency and conservation from PSP participants for the electrical system has yet to be fully determined, hourly energy rates do represent a more equitable distribution of the costs of electricity. As the electrical grids of the U.S. become smarter, and the pressures of responsibly utilizing scarce resources become stronger, these early adopters of dynamic pricing will be the source of valuable lessons.

References

Brattle Group. 2007. *Quntifying Demand response Benefits in PJM.* Cambridge, MA: Brattle Group. Prepared for PJM Interconnection, LLC and Mid-Atlantic Distributed Resources Initiative.

Isaacson, M. and Klotz-Chamberlin, R. 2008. "Real-Time Pricing: will a Glowing Orb Lead the Way?" *Home Energy,* March-April 2008.

Rogers, E. M. 1983. *Diffusion of innovations (3rd ed.)* New Jersey: Free Press.

Star, A., Evens, E., Isaacson, M., Kotewa, L. *Making Waves in the Heartland: How Illinois' Experience with residential Real-Time Pricing Can Be a National Model.* Proceedings of the ACEEE 2008 Summer Study Session in Buildings, 2-281 – 2-291. Washington, D.C.: American Council for an Energy Efficient Economy

Violette, D. and Klos, M. 2009. *Power Smart Pricing 2008 Annual Report. Boulder, CO:*. Summit Blue Consulting.

[3] Illinois Commerce Commission Docket # 06-0617