



Power to the People: Automatic Meter Reading Supports Consumer Programs

Successes from NSTAR's Smart Grid Demonstration Project

Introduction

“Customers look at their utility bill a total of 9 minutes a year,” says Doug Horton, manager of Revenue Requirements at NSTAR, a Northeast Utilities company. Typically, “it’s just not something the average customer monitors daily.”

So, it can be hard to motivate customers to use less electricity, even if it means lowering their energy costs. With its project in the [Smart Grid Demonstration Program](#), NSTAR sought ways to incentivize consumers to participate in dynamic pricing and direct load control (DLC) programs.

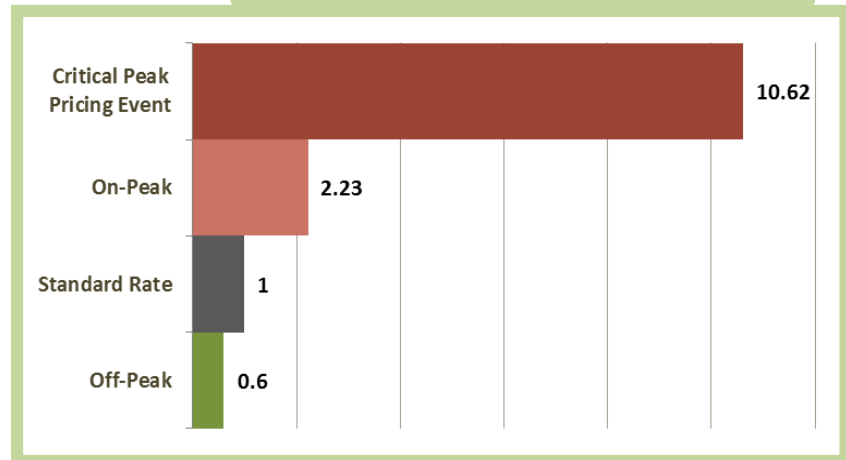
As part of the \$4.9-million project, which began in 2010 with \$2.4 million from DOE through the American Recovery and Reinvestment Act, NSTAR used e-mails, postcards, direct mailings, and bill inserts to recruit customers living in and near Boston.

Smart meters with two-way communications are the devices that utilities usually employ to bring these types of dynamic pricing programs to customers. NSTAR’s goal was to show that automatic meter reading (AMR) with one-way communications from the meter to the utility combined with consumer broadband could be another way to

support dynamic pricing programs. NSTAR’s objective was to provide much of the smart grid functionality of advanced metering infrastructure (AMI) without the large capital investment. Since the existing AMR infrastructure was only partly depreciated, it made economic sense to explore using current hardware.

NSTAR used pricing as an incentive for consumers to save energy, particularly at times of peak demand. Time-of-Use Pricing (TOU) is generally the category for these rates, where customers pay different pre-determined prices at different times of the day¹. On-peak prices are higher (Figure 1) and off-peak prices are lower than the “standard” rate customers are familiar with, so that customer bills are designed not to rise. The price schedule is

Figure 1. NSTAR’s new dynamic rates expressed as a multiple of the standard rate.



¹Energy Insights, “Time-of-Use and Critical Peak Pricing”, http://publications.aeic.org/lrc/12_Time-of-Use_and_Critical_Peak_Pricing.pdf, accessed 2/9/15

based on the season, day of the week and time of day, except for emergency conditions in which case “critical peak” prices (CPP) are assessed for certain hours on event days, in NSTAR’s case limited to a dozen times per year, during June 1 to September 30. CPP is usually thought of as a subset of TOU, but with higher prices due to emergency conditions. In NSTAR’s case, CPP rates were established by 5 PM of the day before the emergency event. Peak time rebates along with lower off-peak rates can also be used as an incentive to save, and also make CPP and TOU more palatable. NSTAR tested TOU/CPP pricing by placing participants into one of four groups (Figure 2):

1. **Enhanced Information:** Customers pay the standard rate but have increased access to information about their electricity consumption and rates.
2. **Peak Time Rebate:** Customers pay the standard rate and receive a \$5 rebate for participating in “critical peak” events, which allows NSTAR to control their air-conditioning load during the events.
3. **Time-of-Use (TOU) Rate Plus Critical Peak Pricing (CPP)—With DLC:** Customers pay

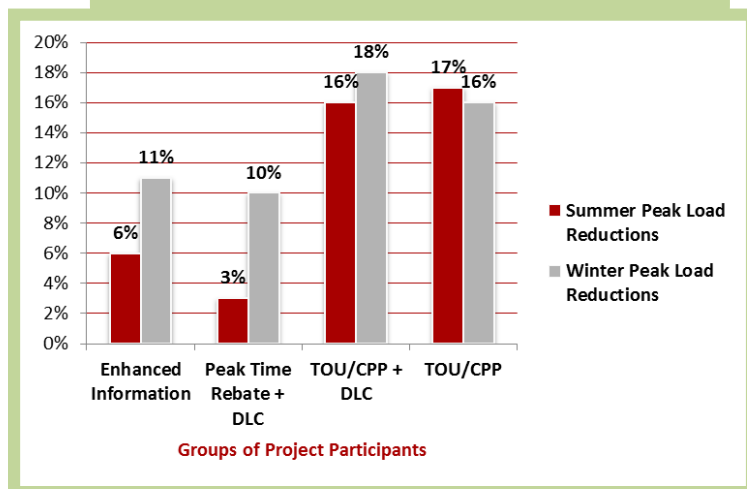
TOU and CPP rates, and they receive thermostats that allow NSTAR to control their air-conditioning load during the events.

4. **TOU Rate Plus CPP—Without DLC:** Customers pay TOU and CPP rates but do not receive thermostats.

NSTAR obtained data from the pilot project with slightly over 2,700 volunteer residential customers by leveraging its currently installed AMR technology. This was combined with customer’s existing broadband connection and additional hardware and data services from a third party vendor to provide both near real time consumption information to the customer and a two-way communications capability.

Doing so was “orders of magnitude” cheaper than deploying AMI would have been, says Horton. “We were happy that the program actually demonstrated that [AMR technology] can be used for time-of-use and critical-peak-pricing programs, without spending a tremendous amount of capital.” The project was successful in demonstrating the basic functionality of utilizing such an approach to leverage existing AMR in lieu of going to AMI. However, at the end of the pilot, NSTAR still identified the need to increase the data collection necessary to support a standalone TOU billing process in a potential future wider deployment. Also, how to effectively implement such an “AMR in lieu of AMI” approach for a significantly larger customer roll-out still needs to be investigated.

Figure 2. Summer and winter peak load reductions. Participants enrolled in the TOU and CPP pricing programs, with and without DLC, reduced their peak loads more than those enrolled in other programs.



Conserving Energy

These pricing programs mimic those that NSTAR’s commercial and industrial customers already participate in. “When we started the pilot, we were trying to see if residential customers could benefit from it,”

says Horton. AMR with broadband functionally worked as a substitute for AMI. But primarily, only certain customers benefited, and by the end of the project, 43 percent of customers were no longer accessing and responding to the energy-use information they were provided. By understanding how Massachusetts customers behaved during the pilot, better solutions can be deployed in the future in the pilot region and nationwide. The customers who benefited most from the program were those who have more discretionary loads, which can more easily be adjusted to take advantage of TOU and CPP pricing structures. These loads are typically air conditioning, but they can also include dryers and dishwashers.

Based on data spanning 2012 and 2013, customers who paid the standard rate (taking into account those who both did and did not have DLC) reduced their peak load by about 8 percent. Customers who paid the TOU and CPP rates, however, reduced their peak load by double that amount (Figure 1). Customers enrolled in the DLC program saw load reductions of 20 percent when NSTAR instituted a critical event and took temporary control of their programmable communicating thermostats, while customers who paid the TOU and CPP rates but *did not* have DLC reduced their consumption by 9 percent during such events. Finally, customers on the TOU and CPP rates averaged approximately a

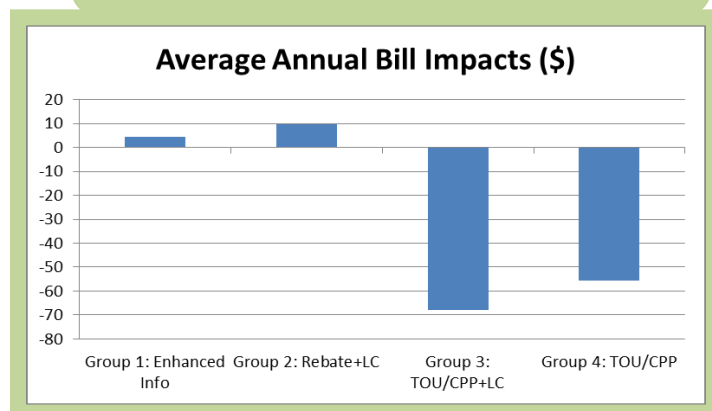
4 percent bill reduction, in contrast to customers enrolled in the enhanced-information and peak-time-rebate programs, whose bills increased. The enhanced-information group’s bills increased 0.3 percent, consistent with an increase in usage of 0.3 percent, while the peak-time-rebate group saw bills increase by 0.6 percent with an increase in usage of 2.5 percent. A summary of average annual bill impacts is shown in Figure 3. Although interesting, these bill increases were determined by NSTAR to be statistically insignificant, given the size of the pilot program.

Engaging Customers

But sustaining customers’ motivation to change their routines in this way—to throw in a load of laundry at a new, off-peak time—is difficult. “That was one of the challenges when we initially proposed the project—how to keep customers engaged over time,” says Anil Rabari, NSTAR’s manager of Communication Engineering. To accomplish this, NSTAR sent out emails and newsletters to remind customers of the benefits of energy conservation. They also focused on devices that customers would rarely, if ever, have to think about. These devices included programmable communicating thermostats (PCTs), home-area networks, and in-home displays. Customers in the DLC programs, for example, could let NSTAR reset their PCT during critical events. They only had to take action if they wanted to override those energy-saving settings. Horton describes this technology as “set it and forget it. The more you can make it like that, the higher the likelihood of success.”

DLC customers usually did “forget it”, allowing the utility program to operate as designed. The vast majority of participants opted out of four or fewer of the 15 critical events that NSTAR declared (Figure 4). On average, only 11 percent of customers who were at home during a critical event found the temperature change to be

Figure 3. Average Bill Impacts (\$) by pricing program. Participants enrolled in the TOU and CPP pricing programs, with and without DLC, reduced their annual electric bills.



significantly uncomfortable, according to NSTAR’s surveys. In contrast, 44 percent were made only somewhat uncomfortable—or not at all—and roughly the same number didn’t even notice the change.

Customers also responded favorably to TOU and CPP rates. The rates were structured so that peak use cost twice as much as usual (in comparison to the standard rate) and use during critical events cost 10 times as much.

“I thought there would be more dissatisfaction with the critical peak pricing rate, but it actually seemed that [customers] embraced that,” says Horton. “Those who were in the program liked that they could see the difference in prices during different times of day.”

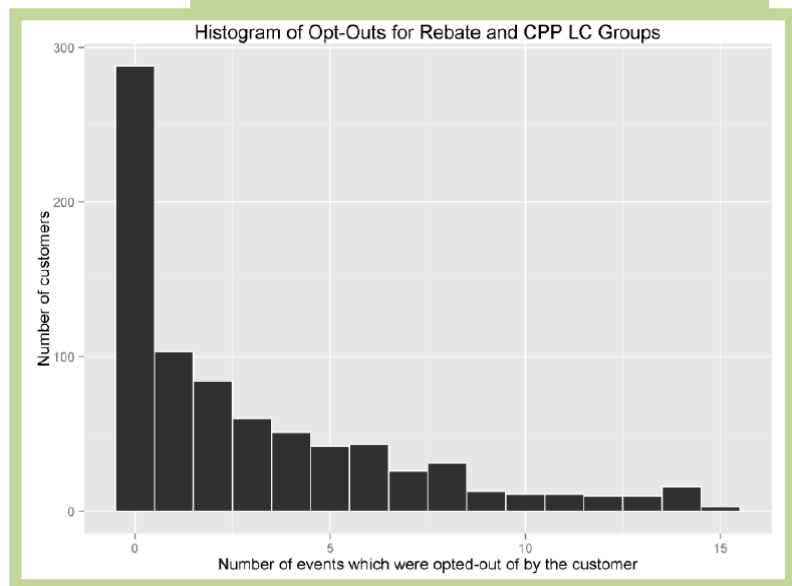
Rabari was likewise surprised. He “thought people would be startled” by the CPP rate. NSTAR intentionally made the CPP rate high so that customers would have a compelling reason to take action. And, given that TOU and CPP customers’ load reductions matched NSTAR’s expectations, the price incentive worked as designed.

Lessons Learned

Indeed, DLC worked in ways that were consistent with past utility experiences. NSTAR had hoped, though, that smart grid technology could expand the pool of willing customers. This was not the case. Some insights gained from this project were that DLC cannot be scaled up to all customers without ironing out technical problems and inconveniences, and that incentives for consumers must be relatively high. The pilot project suggests that more customers will stay with the program if they get the AMR data on their home energy portal consistently and in any easy-to-use fashion.

Furthermore, keeping customers who initially were enthusiastic about the program to continue reducing their peak energy use was difficult. The peak periods occurred on every non-holiday weekday. Among participants, interest in the program waned as the project neared its end (as evidenced by declining energy impacts and reduced use of in-home displays, for instance). And, over the course of the project, 43 percent of participants stopped actively participating. NSTAR also gathered data on customers who did not volunteer to participate when contacted. These customers were unlikely to be persuaded, with half saying there was nothing NSTAR could do to convince them to sign up.

Figure 4. Number of critical events that DLC customers opted out of. Courtesy of NSTAR.



Horton puts it this way: “We had customers at the end of the pilot who were still raving about the experience they had, and we had other customers who were apathetic.” For that reason, NSTAR concludes that teasing AMI-like features out of AMR may only be worthwhile if the initiative targets customers who will most reliably and dramatically reduce their energy use. Specifically, this kind of initiative would target customers with relatively large discretionary and controllable loads such as central air conditioning or pool pumps.

NSTAR also emphasizes the importance of keeping customers engaged in the initiative. Mobile apps may be one way to do that, and so might push notifications—two means of communication that weren't in wide use when NSTAR began its project. Additionally, wireless technologies such as home area networks have improved since then, and removal of data gaps to support TOU and CPP rates can be done with off-the-shelf data caching devices. A similar project launched in the future could potentially incorporate those technologies.

“The concept would be the same,” says Rabari, “but the technology would be different.”

Further Reading

For more information on [NSTAR's project](#) or the [Smart Grid Demonstration Program](#) in general, visit smartgrid.gov.

Under the American Recovery and Reinvestment Act of 2009, the U.S. Department of Energy and the electricity industry have jointly invested over \$1.5 billion in 32 cost-shared Smart Grid Demonstration Program projects to modernize the electric grid, strengthen cybersecurity, demonstrate energy storage, improve interoperability, and collect an unprecedented level of data on smart transmission, distribution operations, and customer behavior.