

Smart Thermostats Lessons Learned

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ABSTRACT

Many studies and pilots have evaluated the savings for smart learning thermostats. However, actual program implementation data on participants, non-participants, and qualitative and quantitative feedback is lacking. This paper will present an analysis of a smart learning thermostat offering in a single family energy efficiency program that provides a free energy efficiency audit of the property, free energy savings measures including low flow showerheads, low flow faucet aerators, compact fluorescent light bulbs, programmable thermostats, and hot water pipe insulation. The program also allows the customer to upgrade to LED lightbulbs and a smart learning thermostat for a set co-pay amount. In this abstract, we will, focus on data about the customers themselves, leading to insights about who is participating and the factors surrounding that participation. It will provide details about customers who technically qualify for the program and are able to leverage the full value of a smart thermostat; they have a gas furnace, electric central air conditioning and available Broadband Wi-Fi, and it will break down and analyze the demographics of those customers. In addition, the paper will look into the characteristics of those who choose to invest in this technology versus those who do not. Finally, we will provide data on customer and technical issues encountered, such as the need for a separate (common) wire to provide power to the smart learning thermostats.

The paper will focus will on the customers. Who are they? Why do they participate? How are they different from customers who do not participate in this single family energy efficiency program and program participants who qualify for a smart learning thermostat but chose not to have one installed. Those are the interesting questions that have yet to be answered.

Objective

The objective is to examine the characteristics of single family homeowners who are purchasing and installing smart learning thermostats in a direct install program and compare them both to other program participants who are not choosing to install this technology and non-participants. The insights gained from this analysis will help to inform future program design, marketing, delivery, and implementation.

Background

The effort to offer smart learning thermostats within the existing residential single family portfolio was originally envisioned as a pilot to confirm the savings in the Midwest market. The goal was to launch a pilot with a substantial and statistically significant number of participants as the available research on smart thermostat savings revealed that most of the sample sizes from the existing studies (at that time) were small and not statistically significant.

While we were planning this pilot with our clients, they were getting pressure from stakeholders to accelerate the inclusion of this technology into their residential programs. As a result, an initial savings analysis was conducted on smart learning thermostats that had been installed as result of a demand response pilot. The results of this savings analysis provided confidence that the measure was cost effective from a total resource test perspective and would not negatively affect the existing energy efficiency programs and portfolio. Consequently, smart thermostats were integrated into the existing programs as an additional measure.

Description of Program

The existing single family direct install and assessment program has been in operation since June of 2011, and the smart learning thermostats were added to this program in July of 2015. This program provides for an assessment of the energy efficiency opportunities in a residential dwelling unit (single or multifamily under 3 units) along with free measures and installation of gas and electric devices including low-flow showerheads, low-flow faucet aerators, hot water pipe wrap, programmable thermostats, and CFLs. In the summer of 2015, Tier 1 smart strips and LED's (with a co-pay), along with the smart thermostats (with a co-pay of \$150) were added to the program.

Choice of Smart Learning Thermostat

For this effort, four smart learning thermostats that were commercially available in July of 2015 were evaluated for inclusion in the program. We did not consider other smart thermostats, i.e. Wi-Fi only enabled thermostats or thermostats controlled through a central software application that require a subscription or internet connectivity for customers to receive the benefit of the smart learning functionality.

The evaluations were conducted by a team that scored each of the smart learning thermostats on ease of use, ease of installation, manufacturer support, and data sharing capabilities. One of these four smart learning thermostats was eliminated as it had not been fully commercially released at the time of evaluation. Ultimately, the one that was chosen, scored higher in large part because of the inclusion of the power extender kit and the extra room sensor. The inclusion of the power extender kit reflects the difference of opinion between manufacturers on power sharing. One manufacturer believes that most of the time power sharing works perfectly and an independent power wire is only needed in limited circumstances. Another manufacturer does not support power sharing and requires the installation of an independent power wire when one is not present.

Differences in Source of Program Leads

The source responsible for engaging the customer and making them aware of the program (lead source) for each participant was collected when they contacted the program to schedule an assessment. We analyzed the data collected to determine the source of leads for all program participants compared to those choosing to have a smart learning thermostat installed through the program in order to evaluate whether the two groups respond to different lead generation efforts in the marketplace. From a high level comparison of Figures 1 and 2 below, we see that the program participants choosing the smart learning thermostat are responding at a proportionally higher rate to the marketing messages we are delivering (email, direct mail, bill inserts) than the overall participant population who is participating more from word of mouth and event activities. An additional step in this analysis will be to dive deeper into the data in order to determine if there are differences in the marketing mediums and tactics that each group is responding to.

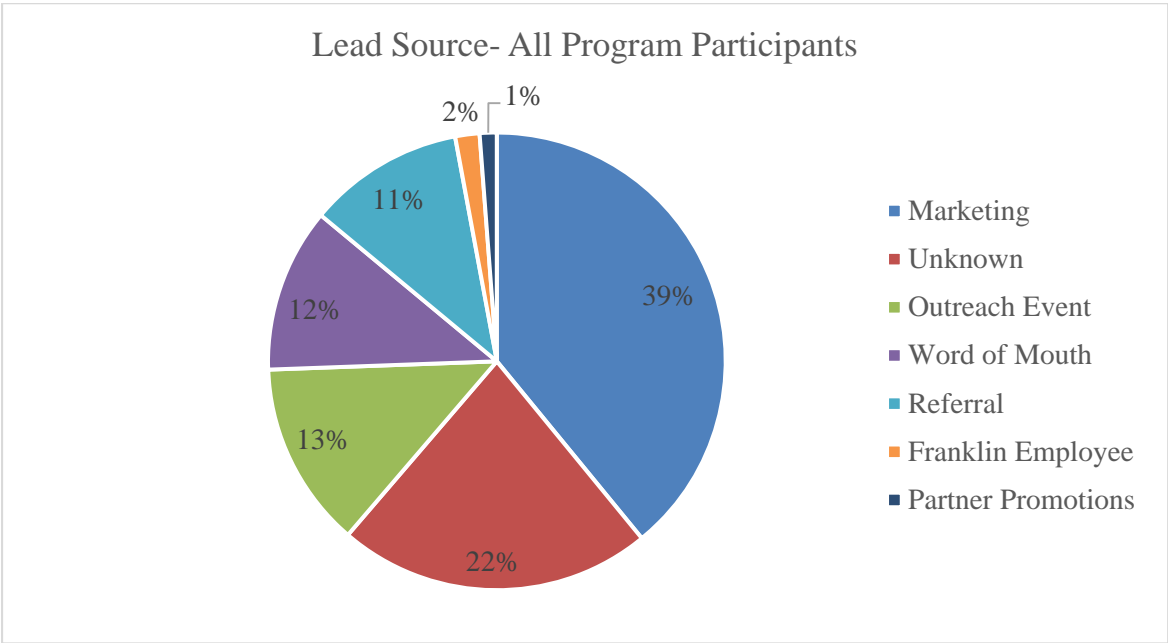


Figure 1. Lead source of all program participants since July 2015. *Source:* Program data

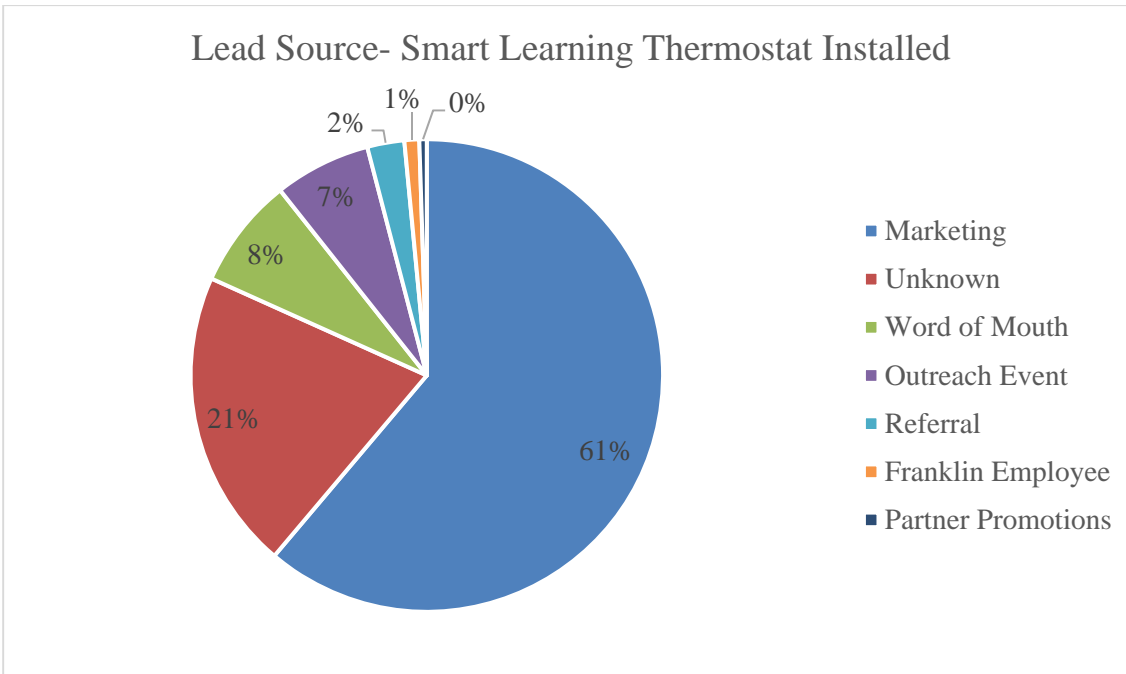


Figure 2. Lead source of customers who installed a smart learning thermostat. *Source:* Program data

Customer Qualification

In order to qualify for the smart learning thermostat, the customer is required to have a furnace, have broadband Wi-Fi and be both a gas and electric customer of the participating utilities, respectively. (The furnace requirement was a requirement to ensure ease of installation that is currently being revisited.) This information was collected on site during the assessment. There have been over 8,000 participants in the program since smart learning thermostats were added to the program. Of the participating customers, 48% qualified for a smart learning thermostat but chose not to have one installed and 8.3% installed one or more smart learning thermostat's.

Broadband Wi-Fi Availability

One of the potential issues with offering this technology is the concern it would create a technological divide between customers who have broadband Wi-Fi access and those who do not. Consequently, we collected information on the availability of Wi-Fi during each assessment to provide this data point.

Of the 8,283 program participants since August 3, 2015, 5,954 have broadband Wi-Fi, 2,092 do not have broadband Wi-Fi, and 247 are unknown. On a percentage basis this equates to 72% of the program participants with access to broadband Wi-Fi and 24% without access, and 2% unknown. (see Figure 3). When you overlay this availability on a map, we see that there is a greater percentage of customers without broadband Wi-Fi in lower income areas and areas

with higher population of senior citizens. This is consistent with expectations going in as a result of a review of the available survey information of the area.

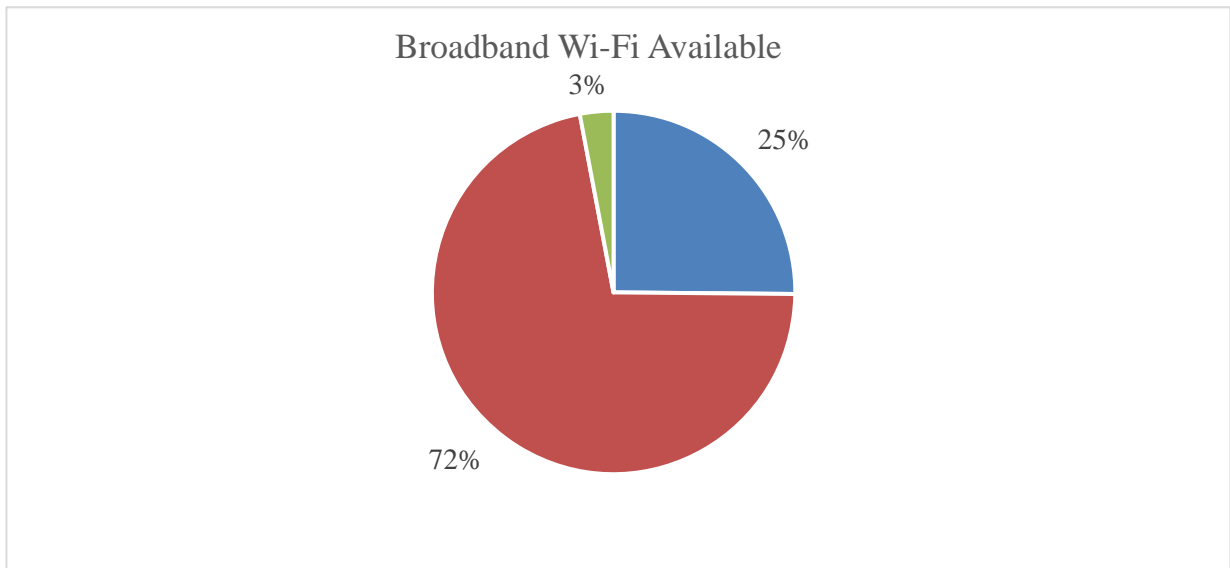


Figure 3. Percentage of participating customers since July 2015 with Wi-Fi. *Source:* Program data

Differences Between All Program Participants, Participants Installing a Smart Learning Thermostat, and those that Did Not Qualify

In order to gain more insight into the differences between all program participants, participants installing a smart learning thermostat, and those that did not qualify. We partnered with Faraday which is a company that provides a data platform that consolidates available customer information into an online platform from public sources. For this part of the analysis, we took our program participant information and combined it with information available from their platform so we could analyze the differences in the aforementioned participant groupings.

All Program Participants versus Participants Installing a Smart Learning Thermostat

There are significant differences between those that had the smart learning thermostat installed and our average program participant (see Table 1). Key differences are noted below:

- Smart learning thermostat customers are 11 years younger than the average program participant
- Smart learning thermostat customers home values are more than 2x the value of our average program participant
- Smart learning thermostat customers have a significantly higher credit score than our average program participant

- Smart learning thermostat customers are more educated than our program participant
- Smart learning thermostat customers head of household income is 1.67x higher than our average program participant
- Smart learning thermostat customers average home age is 17 years newer than the average program participant (a greater number of newer homes have central AC)

Table 1. Comparison of all participants with those that had smart learning thermostat installed

Demographic Pictures	All Participants	Smart Learning Thermostat Installed
Average Age	63	52
Year Home Built	1938	1955
Home Value	\$ 135,418	\$ 287,194
Credit Rating	Poor	Excellent
Education	Associates Degree	College Degree
Head of Household Income	\$ 52,500	\$ 87,500
Net Worth	\$ 75,000	\$ 175,000

We also have data that shows that smart learning thermostat customers have resided at their home for half of the time that our average customer and smart learning thermostat customers are clustered in wealthier areas.

Customer That Did Not Qualify for Discounted Smart Learning Thermostat

We then dug a little deeper into the data to see if there were any key differences between the customers who did not qualify (DNQ) for the smart learning thermostat installation, all participants, and those that installed a smart learning thermostat. Key highlights are below and other significant data points are presented in Table 2.

Some key demographic differences among these three groups:

- Average home value for DNQ customers was \$126,029
 - DNQ home value was slightly lower than the general participant home value
 - DNQ home value was less than half of smart learning thermostat participant home value
- DNQ customers were on average 69 years old
 - 6 years older than the average participant
 - 17 years older than the average smart learning thermostat participant
- DNQ individuals live in homes that haven't been upgraded to newer HVAC systems.
- Prominent groups amongst this list are also likely lower income and senior citizen

Demographic Differences Between All Program Participants, Participants Installing a Smart Learning Thermostat, and those that Did Not Qualify

Table 2. Comparison of customers who installed smart learning thermostat, all participants, and those that did not qualify.

Demographic Pictures	All Participants	DNQ	Smart Learning Thermostat Installed
Average Age	63	69	52
Year Home Built	1938	1947	1955
Home Value	\$135,418	\$126,029	\$287,194
Credit Rating	625	658	725
Education	Associates Degree	Associates Degree	College Degree

Customer Purchasing Decisions

During the assessment we also collected data on when the customers decided to purchase a smart learning thermostat. Over half the customers who qualified and chose to have the smart learning thermostat installed indicate that they made the decision to moved forward before making the appointment (Figure 4).

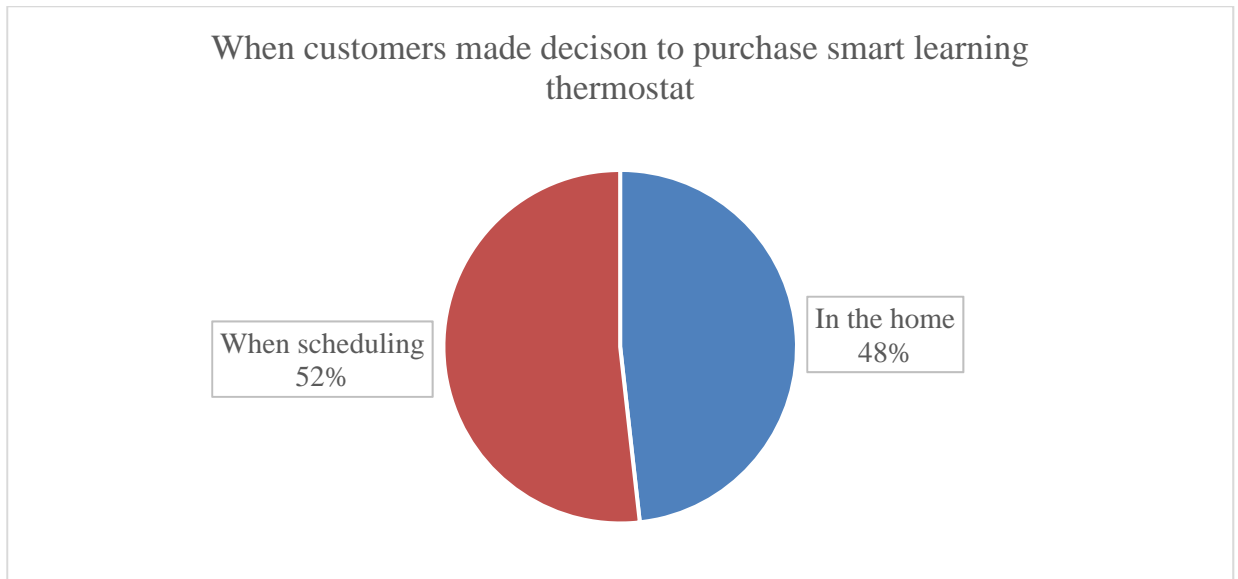


Figure 4. When customers made a decision to purchase the smart learning thermostat. *Source:* Program data

When customers were scheduling the assessment we captured whether they specifically requested a smart learning thermostat. Customers that specifically requested the smart learning thermostat before their appointment were much more likely to follow through and have the smart learning thermostat installed (Figure 5).

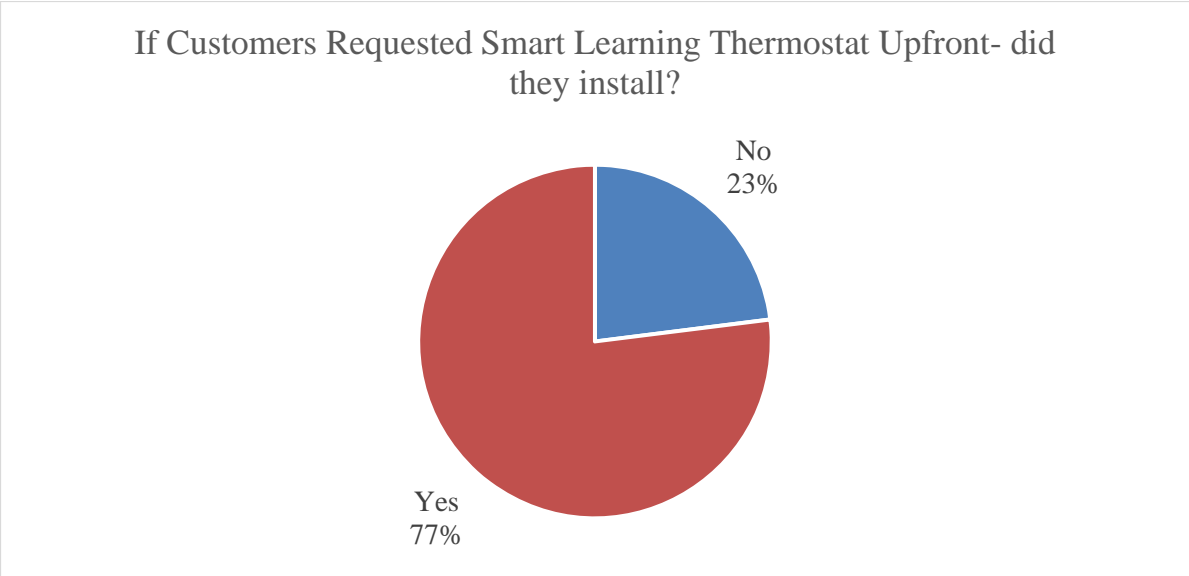


Figure 5. If customers indicated during scheduling that they wanted a smart learning thermostat installed - did they follow through. *Source:* Program data.

Of those customers who qualified to purchase the discounted smart thermostat and chose to not move forward with the installation, 88% reported that they were satisfied with their current thermostat or felt that the smart learning thermostat was too expensive (Figure 6).

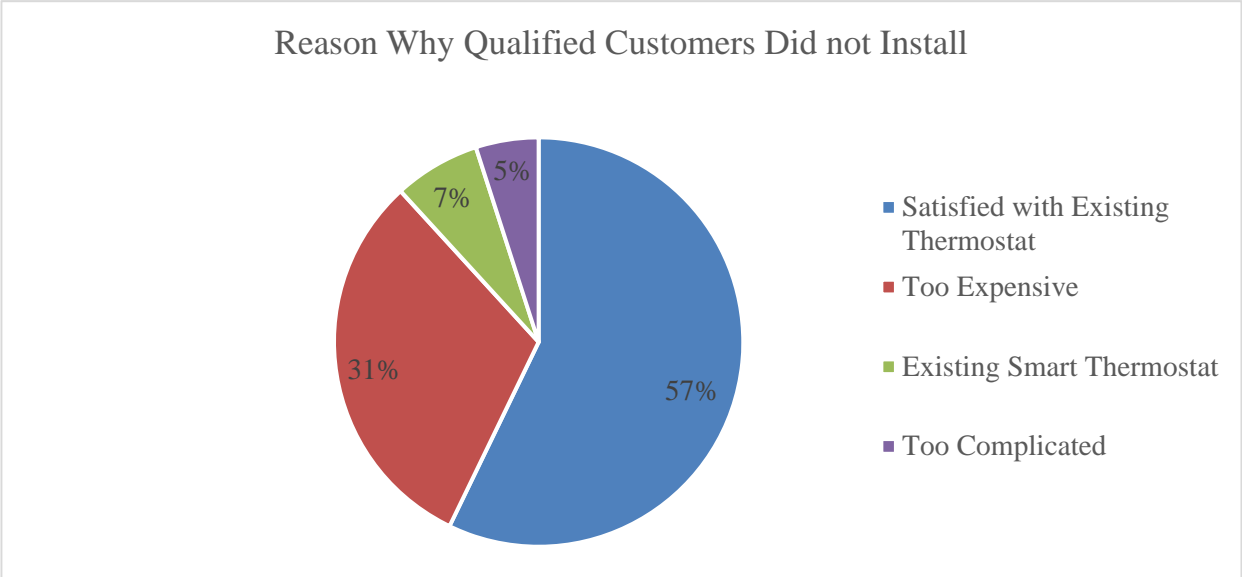


Figure 6. Reason why qualified customers did not have a smart learning thermostat installed. *Source:* Program data.

Installation Smart Learning Thermostats

We asked the installers to provide feedback on the installation time for a smart learning thermostat itself, without the third wire. They reported that the installation time for the unit itself is on par with the installation time for a standard programmable thermostat. However, the installation of the third C-wire and the customer education component add a significant amount of time to the time required in the home. In general, installations for experienced installers fall into the 45 – 60-minute range with the following times required for each step based upon installer feedback, field analysis and a comparison of average site visit times:

- Standard thermostat installation takes 20-25 minutes
- PEK installations (C-wire) take an average of 5-10 minutes
- Customer education takes about 20-25 minutes depending on customer savvy

Surprisingly, we found that a separate power wire was needed in 68% of the installations. One of the most common installation issues is that we continue to encounter metal junction boxes that require us to modify the installation process by using aftermarket metal cover plates. Originally we had thought this would be limited (1 or 2 per 100 installations). Our experience so far indicates this occurs in 1 out of 15-20 installations and this can add significant time to the installation time.

Distribution of Thermostats Installed

We looked at our installation data to determine the distribution of the number of smart learning thermostats installed per home. A majority of the customers had one smart learning thermostat installed, with less than 10% choosing more than one. Installers reported that these customers had separate zones and/or separate heating systems that they wanted to control (Table 3).

Table 3-Number of smart learning thermostat's installed in each home

Number of customers that received 1 smart learning thermostat	494
Number of customers that received 2 smart learning thermostat's	35
Number of customers that received 3 smart learning thermostat's	3
Number of customers that received 4 smart learning thermostat's	1

Anecdotal Feedback

Selling Points

The installers have noted that the two main selling points for the smart learning thermostats are:

- i. The remote sensor
- ii. Being able to control and monitor using the app on a smart phone

Customer Questions

Customers continue to research the smart learning thermostat before we arrive and are ready at the door with questions about the product. The most common questions reported by the installers are as follows:

- (1) What is the difference between the different the smart learning thermostat?
- (2) Which smart learning thermostat is better?
- (3) Why don't you offer other smart stats?
- (4) How much energy will I save?
- (5) What other key features does the smart stat offer?
- (6) If my Wi-Fi is interrupted/disabled can I control the smart stat manually?
- (7) Can my wife also connect to the smart stat with her phone?
- (8) What is the warranty for the smart learning thermostat?
- (9) How many sensors can I connect to the smart learning thermostat?
- (10) How long will the battery last in the remote sensor?
- (11) Where can I buy additional sensors?

Future Savings Analysis

After we have complete heating and cooling season data, respectively, we want to supplement the existing savings analysis with additional analysis on the smart learning thermostats installed as part of this effort. Some of the items we want to evaluate include the following:

- 1) What are the savings from the smart learning thermostats, or more specifically?
 - a. Percent savings versus standard programmable thermostats
 - b. Percent savings versus non programmable manual thermostats
 - c. Savings difference from alternative manufacturers over the same time period

Conclusions

Our analysis has confirmed some of our expectations. We anticipated the availability of Wi-Fi to be a barrier of qualification, particularly for lower income and older customers. We also hypothesized that on average the customers choosing to install a smart learning thermostat would be younger, with higher income and have a higher level of education.

We can use this data and our analysis to help improve the program. We can look at ways to effectively target and message those groups that are more likely to install this technology. We can also use this data to make changes to the program to help expand the proportion of customers that will choose this technology. For example, we are planning to increase the rebate amount to bring down the initial cost for all customers and looking for a way to effectively deliver this to lower income customers. We have also have learned that if we do a better job at educating and informing customers of the benefits of smart learning thermostats upfront, that they are more likely to follow through and have one installed. Unfortunately, the digital divide as a result of broadband Wi-Fi is a greater societal issue, but we plan to install some smart learning thermostats in homes without Wi-Fi to determine if the smart learning capabilities will drive cost effective savings in these households.

The analysis will continue to be refined as we add more data. Over time, we will see if the market for this technology is evolving, while determining what additional changes we can make to our approach to help with this transformation. We are still in the early stages of smart or intelligent devices that will help us to automate functions that were previously dependent on behavioral intervention and expect the cost of these products will come down and the functionality will increase.