MINNESOTA DEPARTMENT OF COMMERCE
DIVISION OF ENERGY RESOURCES

Energy Efficiency Opportunities for Homes with High Usage

Market characterization and customer engagement strategies

Conservation Applied Research & Development (CARD)
FINAL REPORT

Prepared for: Minnesota Department of Commerce, Division of Energy Resources

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COMM-20130501-73532 | April 25, 2016

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ACKNOWLEDGEMENTS

This project was supported in part (or in whole) by a grant from the Minnesota Department of Commerce, Division of Energy Resources, through the Conservation Applied Research and Development (CARD) program, which is funded by Minnesota ratepayers.

The authors would like to acknowledge the following utilities for their contributions: ComfortSytems, Minnesota Energy Resources, Minnesota Power and Rochester Public Utilities. Seventhwave staff who contributed to this project include Andrea Cherney, Andy Mendyk, Anna Svensson, Ashleigh Keene, Ben Auchter, Ben Brush, Cherie Williams, Heather Driscoll, Jaime Barbian, Jaimie Rule, Joe Kramer, John Viner, and Tracy LaHaise.

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Executive Summary

Homes with high electricity or natural gas usage account for a significant share of the energy consumption in the residential sector. High users have the potential to achieve greater savings from implementing energy efficiency measures than homes with average usage. To date, there have been limited efforts to specifically target high usage homes with energy conservation program marketing and implementation efforts.

In this study, we identify the factors that are the greatest contributors to high natural gas and/or electricity use (80th percentile or above) in Minnesota homes. We test the feasibility of combining high-resolution energy consumption data with tax assessor data to perform remote analysis of potential energy-saving opportunities, supporting the effective targeting of energy efficiency program strategies. We identify and quantify the conservation measures that comprise the greatest energy savings potential. We explore consumer perceptions about their energy bills and motivations to implement energy efficiency improvements. And we identify conservation program interventions that would effectively target the significant energy savings potential associated with this subsector of the residential market.

There were three phases to this research:

- **Market characterization**: Selected a sample of 100 Minnesota homes with high natural gas use, electricity use, or both. Recruited homeowners and conducted remote assessment of potential contributors to high usage. Performed site visits that included walk-through audits, blower door tests, and homeowner interviews. Identified energy conservation opportunities and estimated the associated energy savings potential.
- **Program scoping study**: Solicited input from utilities on existing conservation improvement program (CIP) efforts to target high users, and potential new program strategies that could be developed. Identified barriers to effectively capturing the savings potential associated with high users.
- **High User Pilot:** With support from the participating utilities, developed a small-scale pilot to test the effectiveness of usage-based messaging in the marketing of home energy conservation measures.

Since natural gas use is dominated by space-heating, home size is an important contributing factor to high usage. For utilities interested in targeting high gas users, controlling for home size will increase the efficacy of their targeting effort. This was less important on the electric side.

This study confirmed the significant energy savings potential associated with high users of electricity or natural gas. The savings potential is 15-20 percent of total natural gas consumption and 25 percent of electricity consumption. For both fuels, about two-thirds of the identified savings potential was related to building shell deficiencies or inefficient equipment; the remaining one third is attributable to behavioral opportunities such as limiting the use of electric space heaters. The greatest areas of energy savings potential include:

- Eliminate use of portable electric space heaters
- Offset all electric heat with ductless minisplit HP systems
- Eliminate continuous furnace-fan operation
- Upgrade interior lighting
- Replace electric water heater with gas

We tested the feasibility of using billing data, tax assessor data and satellite imagery to do a remote assessment of potential savings opportunities, then compared those assessments with the actual opportunities we identified during the site audits. We found that remote assessments worked best for identifying insulation and air sealing opportunities, use of electric space heaters, fireplace pilots and air conditioning use. The remote assessments did not work as well for other measures.

The characterization research also identified common barriers to energy efficiency among high users.

- Mistaken beliefs about electric space heater energy use
- Life gets in the way; efficiency is low on the list of priorities
- Preference for appliances/systems to which they are accustomed
- Reluctance to pursue early replacement of functioning equipment
- Budget constraints
- Concerns about not being able to recoup efficiency investments

The characterization study results indicate that the needs and opportunities presented by high users are best addressed through adjustments to existing programs rather than developing entirely new program offerings. Through discussion with participating utilities, we identified four program adaptations that could enhance utilities' ability to capture the energy efficiency potential of high-using households:

- **Extra support**: Offer high users additional support to overcome barriers to conservation measure implementation (extra support, hand-holding, follow ups, referrals, or bonus incentives).
- **Targeted messaging:** Focus on the specific areas of opportunity common among homes with high usage (electric space heaters, air sealing, furnace fan settings, etc.). When possible, differentiate the message based on the audience—high users in general or further stratifying by income, home age, heating fuel, or other criteria.
- **Feedback:** Provide usage-related data that helps customers be better informed about their energy usage and strategies for reducing usage.
- **Remote analytics**: Use billing data, home size data, and other available information to identify households and specific areas of energy savings opportunity within the home. Adapt feedback and messaging strategies accordingly.

The resources and timeframe available for pilot testing a high user targeting strategy were limited within the scope of this study. Still, the results are a useful indication that usage-based messaging alone may not have much effect on high users' participation in energy efficiency programs. Further study could test the effectiveness of more intensive program interventions like offering a higher level of energy conservation measure installation support to high usage households.

Four Minnesota utilities supported this research: ComfortSystems, Minnesota Energy Resources, Minnesota Power, and Rochester Public Utilities. The utilities helped us shape the research scope, provided customer energy consumption data, participated in the program scoping study, and implemented the targeted marketing campaign that comprised the pilot.

Introduction

High users account for a significant share of the energy consumption in the residential sector and have the potential to achieve greater savings from implementing energy efficiency measures. Some energy efficiency programs have targeted high users because of the greater savings potential and the relative ease with which they can be identified using billing data. Nevertheless, we know surprisingly little about high energy-using homes and how they differ or compare from households at large.

The primary objective for this study was to address this information gap and provide a more comprehensive understanding of the characteristics and energy-saving opportunities associated with residential high users. A secondary objective was to test the potential value of energy billing data—especially high-resolution data made possible by advanced meters—to perform remote analysis of potential energy-saving opportunities, prior to visiting the home for a site audit. Lastly, we sought to identify possible program strategies that would effectively target the significant energy savings potential associated with this subsector of the residential market. We conducted this research in three phases:

- Market characterization of homes with high energy use, including energy savings potential and customer attitudes about their energy usage and energy efficiency improvement opportunities.
- Identification of conservation program strategies that can be deployed to capture the energy savings potential associated with high usage homes.
- Pilot testing one high user engagement strategy and measuring the results.

This report summarizes the results of this research, including the following:

- End uses, practices, attitudes, and characteristics that distinguish high users.
- Common energy saving opportunities in high usage homes.
- Effective strategies to inform and encourage high users to engage in efficient choices and practices.
- Barriers that utilities face in developing program strategies for high users.

Characterization Methodology

To begin the characterization study, we first defined the population of high energy users. The participating utilities shared billing data for the 24 to 36 months preceding our study—generally for 2012 and 2013. We also acquired property tax data from county assessors that provided information on the age and square footage of the home. We merged the energy consumption data with the property tax records and screened to select single-family homes. Then we merged in weather data and ran algorithms to disaggregate space-heating and cooling consumption from overall consumption, and normalize each household's usage to 30-year weather norms.

Based on the intersection of usage data from participating utilities and the availability of tax assessor data on home size and age, the characterization research focused on four Minnesota communities: Rochester, Duluth, Little Falls[1] and Cloquet. We defined high usage as those homes using more than 12,000 kWh/year for electricity and 1,200 therms/year for natural gas, which translates as approximately the 80th percentile or above in energy usage. High-using households in our study were above this threshold for electricity or natural gas usage, or both. We stratified the dataset on evidence of electric heating and total energy use per square foot to ensure that our sample was diverse and did not oversample electrically-heated homes or large buildings.

We sent out a preliminary mailing that notified 400 randomly-sampled homeowners of their eligibility for participation in this study and provided details on the nature and purpose of the research. We followed up that mailing with phone calls to schedule a site visit for households that agreed to participate. We offered a $75 participation incentive to each home. Table 1 shows the number of site visits that were completed during the summer of 2014:

Table 1: Site visits to homes with high usage

City	Electric high user only	Natural gas high user only	Both electric and natural gas high user
Cloquet	7	3	0
Duluth	15	19	6
Little Falls	10	0	0
Rochester	12	19	9
Overall	44	41	15

[1] We did not have access to natural gas consumption data for homes in Little Falls so these homes were only included in the electric analysis.

The site visit consisted of three main components:

1. **Walk-through audit**: We catalogued all energy-using equipment and lighting in the home, including HVAC, water heaters, and appliances such as refrigerators, ovens, laundry, and electronics. We took note of insulation levels and window types. We also noted use of secondary refrigerators and freezers and other atypical energy-using equipment.
2. **Blower-door test**: This test measured air leakage levels by creating a pressure differential between the inside and the outside of the home. High levels of leakage suggest air sealing opportunities.
3. **Homeowner interview**: This 45-60 minute interview addressed homeowner perceptions of their energy usage and attitudes towards implementation of energy efficiency measures.

One unique aspect of the site visits was the development of household profiles prior to each site visit. The profiles were created by analyzing each home's energy usage data, providing insights into potential causes of high energy-usage before we even set foot in the home (i.e., patterns of high electrical usage in the summer suggesting increased usage of air conditioning). The results of this remote audit allowed our researchers to tailor their site visit approach to address specific household characteristics, allowing for a more customized and efficient process for determining contributing factors to high usage and identifying energy savings opportunities.

Following the site visits, we compiled the data for each home, assessed the technical applicability of each of 34 energy-saving opportunities, and estimated the potential natural gas and/or electricity savings from implementing these opportunities. The opportunities and savings-estimation methods are described in more detail in Appendix A. Finally, based on the homeowner interview, we judged the likelihood that each technical opportunity would be implemented by that household.

Characterization Results

Case Studies of Homes with High Energy Use

Before summarizing our results in the aggregate, we introduce specific home case studies below to show the diversity of family dynamics, household situations, and motivations behind the numbers. These case studies are not meant to provide conclusions about all high energy using households, but rather to offer a window into the personal stories that lie behind the data.

Case study #1: Electric high user

Older household, not worth it for them to make investments

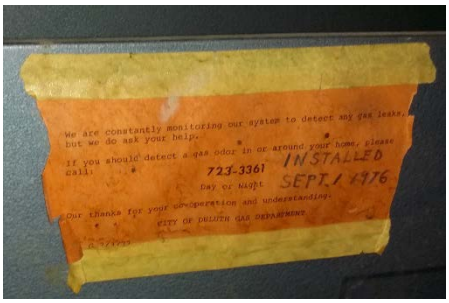
Figure 1: One of four electric space heaters

This older couple has lived for nearly 50 years and raised a large family in this modest three-bedroom Duluth home. Twenty years ago, they added a small living room which they heat primarily through an electric baseboard and a stand-alone electric space heater since no ductwork was added to the space. Their basement is also heated by a couple of space heaters. Interestingly, this household uses a fuel oil-fired furnace even though they have a natural gas line to fuel a fireplace. They realize that fuel oil costs make running their furnace expensive but they also feel like the cost of switching to a natural gas furnace is too high. So they simply run their furnace less and rely on the space heaters to provide added comfort. They have been in their home so long that they do not feel compelled to make many more investments in the future, because as they said "their book is closing" and they do not feel they will see any of the benefits of making changes. They seem to be open to some energy-related improvements. For example, the blower door test revealed a very leaky space connecting the attic to a pocket door, and they were interested in reducing that air leakage. This finding suggests that if these homeowners could be presented with evidence of a significant savings opportunity, they are open to making some changes.

Case study #2: Natural gas high user

Young, busy, and well-off family, no time or interest to maintain a big leaky house

Figure 2: Old and oversized boiler



This Duluth house is a large (3700 SF) and leaky brick home built in the 1920's, owned by a single father of three pre-teen and teen children. The home is heated by a very old and oversized boiler. When they first moved in about ten years ago, he did some energy-saving measures like window replacement, ceiling insulation and fireplace inserts. Even with those measures installed, his typical winter utility bill is around $1200 per month, and a recent cold January bill reached $1500. He and his family lead busy lives, and while he knows that his bills are higher than normal, energy issues and general household maintenance take a back-burner to his other priorities, raising kids and working. He is financially well-off, so the high energy prices do not hit him too hard although he does not like paying those winter bills. He also thinks it likely that he will move out of the house when his kids go off to college. Even though that transition is ten years off, he does not think investments today will yield much benefit to him. This high using household seems unlikely to participate in energy efficiency programs unless the program made it very easy to participate.

Case study #3: Electric high user

Secondary freezers and incandescent bulbs

Figure 3: Three secondary freezers in basement

This household is comprised of a retired couple that lives in Rochester. They have unusually high electricity usage, likely due to the three stand-up freezers in the basement that each were between 20-30 years old and brought from previous marriages. There is some sentimental value attached to the freezers and they do not want to downsize them. Additionally, the husband does not politically agree with the ban against incandescent lightbulbs, so he is stockpiling them

for when he cannot find them in stores. Finally, they run the furnace fan at all times with an electronic filter due to the wife's allergies. All of these potential contributors to high electric usage are unlikely to be modified because of their underlying beliefs and health concerns. While they expressed that they were open to saving energy, there are limits to what they would be willing to do.

Case study #4: Natural gas high user

A financially constrained single mother

Figure 4: Ceiling with limits for additional insulation

A single mom and her teenage daughter live in this modest Rochester home. They are financially constrained and much of the mother's income goes to support academic opportunities for her daughter. The boiler is original to the home built in 1969. She knows she probably should upgrade the boiler but simply cannot afford it. The ceiling of the split-level home is vaulted, and while she believes there is ceiling insulation because the exposed rafters in the garage have insulation, there are physical constraints to adding more insulation in the living spaces. She suspects that her bills are higher than normal and feels that if she had financial assistance to upgrade her boiler, she would replace it.

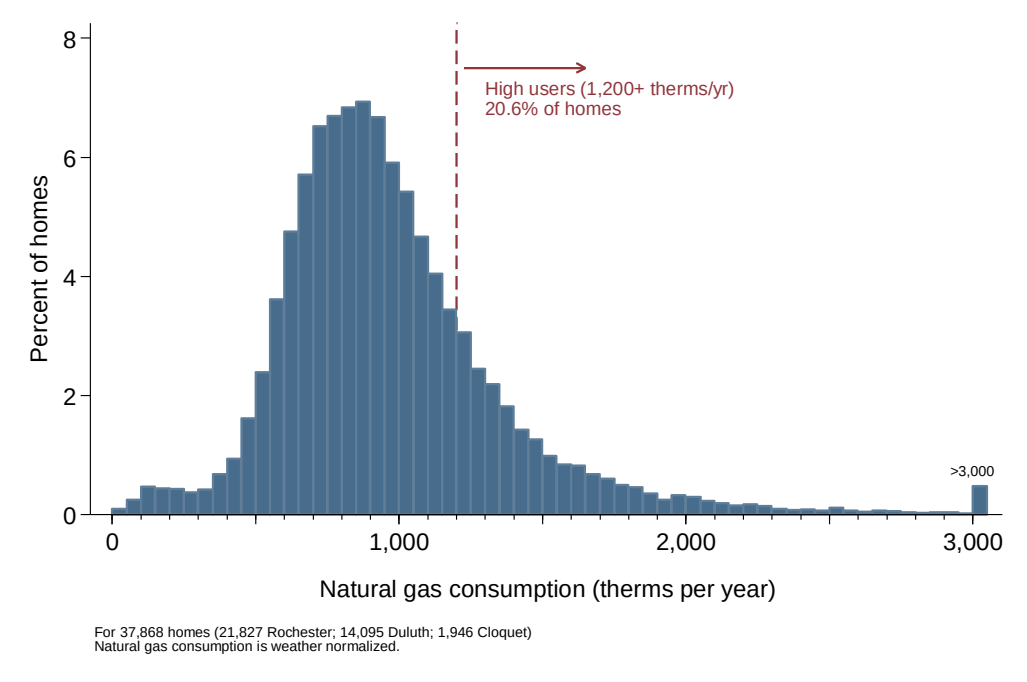
Relationship between Energy Use, Home Size and Home Age

Here we use the energy consumption dataset and tax data for four communities (Rochester, Duluth, Little Falls and Cloquet) to take a more detailed look at how home size and age relate to natural gas and electricity consumption. We describe the methodology for weather-normalizing energy consumption data in Appendix B.

Natural Gas

Figure 5 shows the combined distribution of annual weather-normalized natural gas consumption for the roughly 38,000 homes with natural gas consumption histories and property tax data in Rochester, Duluth and Cloquet (natural gas for Little Falls is provided by a utility that did not participate in the study). The median home uses about 900 therms of natural gas per year, and 95 percent of homes fall between about 350 therms and 2,000 therms per year. Despite differences in climate, the distribution of gas consumption is only slightly different among the three cities (Table 2).[2]

Figure 5. Distribution of natural gas consumption for Rochester, Duluth and Cloquet homes



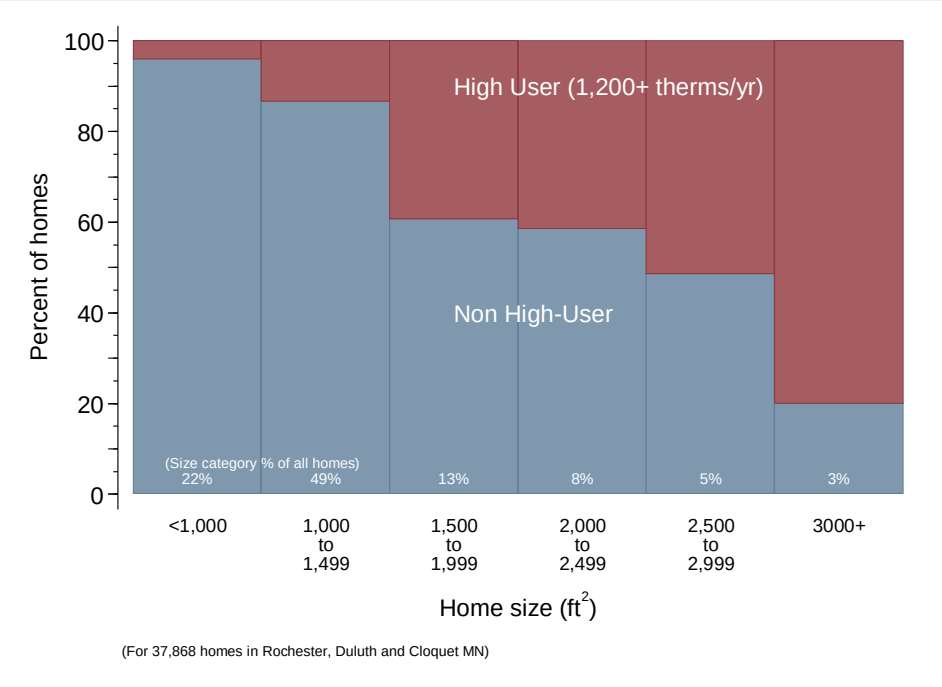
[2] Rochester has about 8,300 heating degree days (base 65F) in a typical heating season, which is about 15 percent less than Duluth's 9,600 heating degree days and about 12 percent less than Cloquet's 9,200 degree days.

Table 2. Distribution of weather-normalized natural gas consumption (therms/year) by city

City	Number of homes	5th percentile	25th percentile	50th percentile	75th percentile	*80th percentile*	95th percentile
Rochester	21,827	537	724	890	1,098	*1,162*	1,579
Duluth	14,095	311	722	937	1,210	*1,294*	1,875
Cloquet	1,946	457	697	899	1,135	*1,200*	1,623
Combined	37,868	479	722	906	1,137	*1,209*	1,705

Space-heating is typically a large fraction of natural gas consumption in the residential sector, so home size is likely an important contributing factor to high natural gas usage. Indeed, combining energy usage data with the property tax records on home size, we find a very strong correlation between the size of the home and the likelihood that it is a high user (Figure 6). Homes that are high natural gas users due to their size do not present significant savings opportunities for energy efficiency programs if they are otherwise well-insulated and have efficient heating systems. If a utility is interested in targeting high users, controlling for home size will increase the efficacy of their targeting effort.

Figure 6. Percent of homes classified as high users, by home size

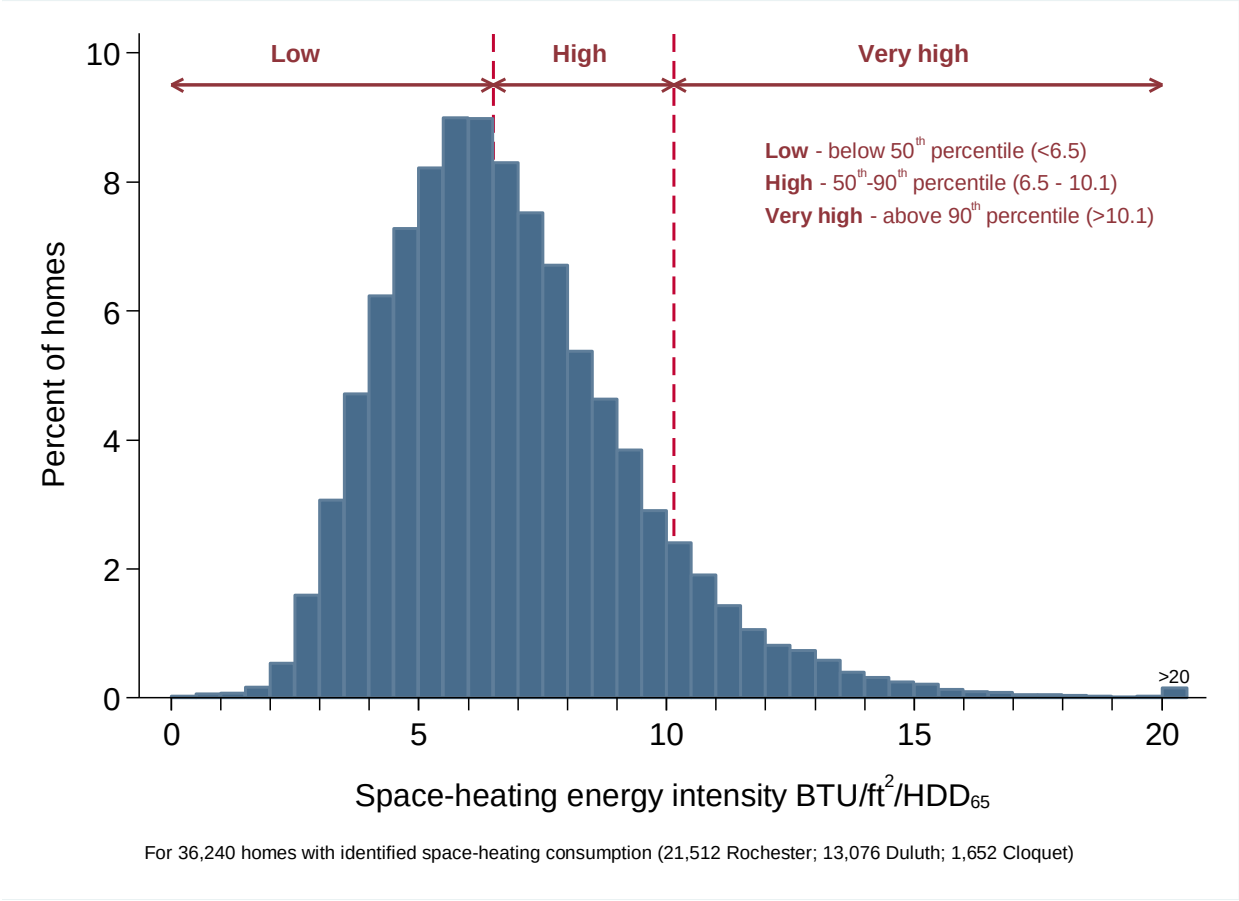


To remove house size as a confounding factor, we statistically separated space-heating gas consumption from other natural gas uses, and looked at space-heating consumption per square

foot of floor space.[3] We also incorporated long-term normal heating degree days into a heating-intensity index to put the three cities on equal footing in terms of climate.

The resulting metric has a bell-shaped distribution (Figure 7).[4] We placed homes into three categories according to this metric: low (below the 50th percentile), high (50th to 90th percentile) and very high (above the 90th percentile). Compared to other homes, high users of natural gas are much more likely to have high space-heating energy intensity and are less likely to be below the median (Table 3). Nonetheless, about one in three high users is below average in terms of space-heating energy intensity: these homes tend to be both larger (median living area of about 2,600 ft²) and newer (median year of construction of 1992) than other high-usage homes.

Figure 7. Distribution of space-heating energy intensity (BTU/SF per heating degree day)



For 36,240 homes with identified space-heating consumption (21,512 Rochester; 13,076 Duluth; 1,652 Cloquet)

[3] For natural gas, space heating can be readily—though not completely reliably—separated from other end uses based on its strong correlation with outdoor temperature.

[4] We omit from this analysis four percent of homes in the population that either have no space-heating gas consumption, or for which space-heating usage could not be reliably disaggregated.

Table 3. Space-heating energy intensity for non-high users and high users of natural gas

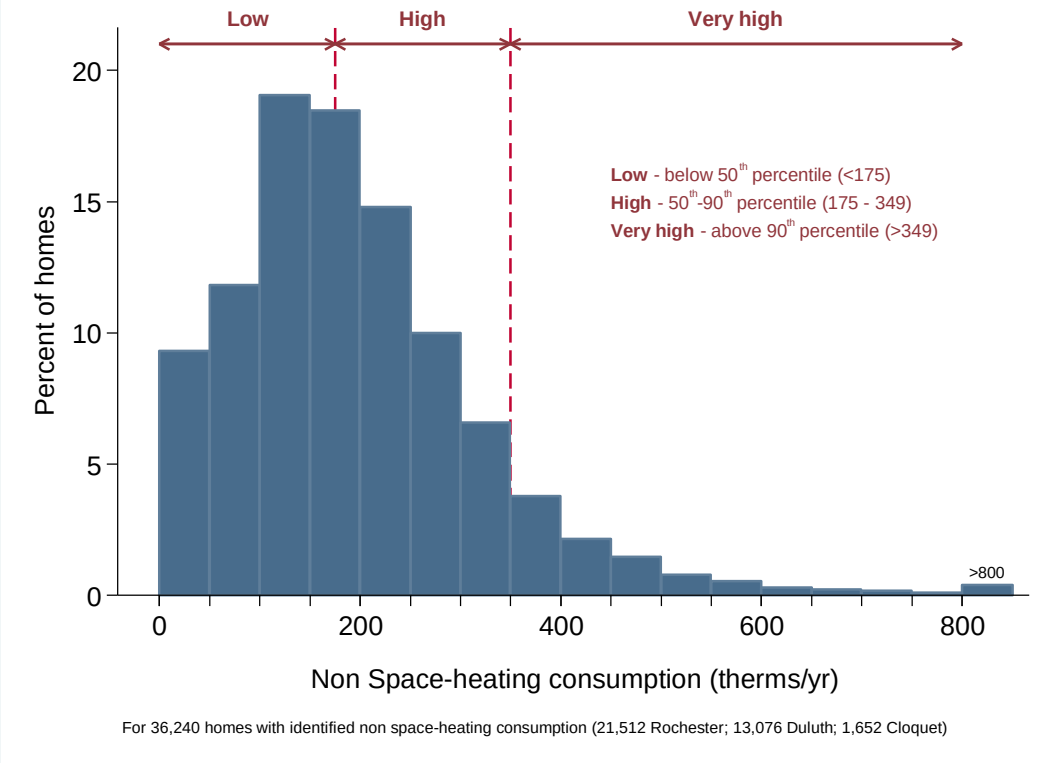
Space-heating energy intensity category	Not a high user (<1,200 therms/yr)	High User (1,200+ therms/yr)	All homes
Low	55%	32%	50%
High	40%	42%	40%
Very High	6%	27%	10%
Total	100%	100%	100%

Space-heating energy intensity categories are: Low – below 50th percentile (6.5 BTU/ft^2/HDD$_{65}$); High – 50th to 90th percentile (6.5-10.1); Very High – above 90th percentile (>10.1).

N=36,240. (1,628 homes with no—or poorly determined—space-heating consumption omitted).

Similarly, we examined how consumption for gas appliances other than space-heating contributes to high overall natural gas consumption. The median home in the sample uses about 175 therms annually for uses such as water heaters, gas ranges and gas dryers, with most homes consuming between 50 and 350 therms per year for these uses (Figure 8).

Figure 8. Distribution of non-space-heating natural gas consumption (therms/year)



For 36,240 homes with identified non space-heating consumption (21,512 Rochester; 13,076 Duluth; 1,652 Cloquet)

Compared to the overall population, high users of natural gas are more likely to have high consumption for end uses other than space heating (Figure 8), suggesting that baseload uses other than space heating (water heating, ranges and dryers) can also be a contributing factor to high natural gas consumption.

Table 4. Baseload (non-space-heating) consumption for high users and non-high users of natural gas

Baseload use category	Not a high user (<1,200 therms/yr)	High User (1,200+ therms/yr)	All homes
Low	56%	27%	50%
High	39%	45%	40%
Very High	5%	28%	10%
Total	100%	100%	100%

Non space-heating use categories are: Low – below 50th percentile (175 therms/yr); High – 50th to 90th percentile (175-349); Very High – above 90th percentile (>349).

N=36,240.

In terms of home age, Table 5 shows that homes built after 1980 are less likely to have high heating energy intensity. Not coincidentally, the first Minnesota energy code came into existence in the late 1970s. The most energy-intensive homes from a heating standpoint were built in the 1930s, though high heating-intensity homes can be found in all home age categories.

Interestingly, newer homes are about twice as likely to have high consumption for natural gas uses other than space heating (Table 6). The reasons for this are not entirely clear, but could be due to a higher incidence of gas fireplaces, larger household sizes, higher saturation of gas ranges and dryers, or a combination of these factors.

Table 5. Natural gas heating energy intensity by home age

Year built	n	Heating energy intensity (Btu/ft^2/HDD$_{65}$) Median value	Proportion of homes by heating-intensity category: Low (< 50th percentile)	High (50th-90th percentile)	Very high (> 90th percentile)
<1900	884	6.75	41%	45%	13%
1900s	1,058	6.63	43%	46%	11%
1910s	2,774	6.83	39%	48%	13%
1920s	3,681	6.90	39%	48%	13%
1930s	1,145	7.70	28%	51%	21%
1940s	2,298	6.98	40%	46%	14%
1950s	5,318	7.26	32%	54%	14%
1960s	4,031	7.70	28%	53%	19%
1970s	2,949	6.97	40%	49%	12%
1980s	2,954	5.61	68%	30%	2%
1990s	4,137	5.20	79%	20%	1%
2000+	4,985	4.75	86%	13%	1%
Overall	36,214	6.34	50%	40%	10%

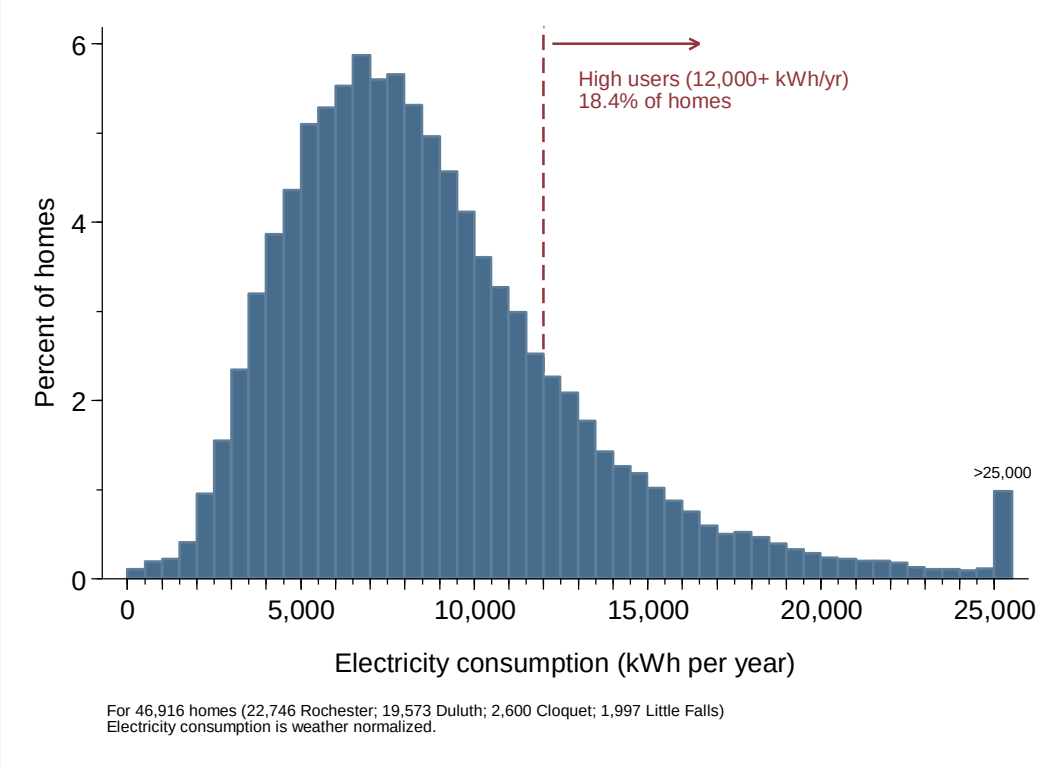
Table 6. Natural gas consumption for uses other than space heating, by home age

Year built	n	**Baseload consumption (non space heating)** (therms/year) Median value	Proportion of homes by usage category: Low (< 50th percentile)	High (50th-90th percentile)	Very high (> 90th percentile)
<1900	884	150	62%	32%	6%
1900s	1,058	165	56%	37%	8%
1910s	2,774	157	59%	35%	6%
1920s	3,681	150	62%	33%	5%
1930s	1,145	146	63%	32%	5%
1940s	2,298	147	62%	33%	4%
1950s	5,318	147	63%	32%	5%
1960s	4,031	166	55%	38%	7%
1970s	2,949	187	47%	45%	8%
1980s	2,954	193	44%	46%	10%
1990s	4,137	243	27%	53%	21%
2000+	4,985	234	31%	48%	21%
Overall	36,214	178	50%	40%	10%

Electricity

Figure 9 shows the combined distribution of annual weather-normalized electricity consumption for the roughly 47,000 homes in the four communities. The median home uses about 7,980 kWh per year, and 95 percent of homes fall between about 2,700 and 20,200 kWh per year. As with natural gas, despite differences in location and community size, the four cities are remarkably similar in the distribution of electricity consumption for single-family homes (Table 7).[5]

Figure 9. Distribution of electricity consumption



[5] Rochester has about 490 cooling degree days (base 65F) in a typical summer, Duluth has 200, Cloquet has 260 and Little Falls has 520.

Table 7. Distribution of weather-normalized electricity consumption (kWh per year), by city

City	Number of homes	5th percentile	25th percentile	50th percentile	75th percentile	80th percentile	95th percentile
Rochester	22,746	3,720	6,160	8,250	10,900	*11,660*	16,550
Duluth	19,573	2,970	5,250	7,490	10,480	*11,430*	17,380
Cloquet	2,600	3,700	6,240	8,740	11,890	*12,790*	19,400
Little Falls	1,997	3,740	6,150	8,350	11,350	*12,290*	17,720
Combined	46,916	3,350	5,760	7,980	10,820	*11,680*	17,130

Overall, home size is a stronger predictor of high electricity use than home age (Table 8): nearly half of large homes (>2,500 ft^2) are high electricity users. Regression modeling of electricity consumption as a function of home size and age suggests that each 1,000 ft^2 of living space adds about 2,100 annual kWh to electricity consumption, and that homes built in 1980 or later use 1,000 to 1,600 kWh per year more than homes built before World War II, even after controlling for the fact that newer homes tend to be larger.

Homes have many more electric appliances than natural gas appliances, and space heating is a dominant end-use in only a minority of homes. Moreover, many households have air conditioning but may use it only sporadically during Minnesota's short cooling season. All of this means that compared to natural gas, we have less ability to reliably disaggregate space-heating and cooling consumption from other end-uses represented in monthly electric billing data.

Caveats aside, our algorithms indicate that about 15 percent of homes in the overall sample show signs of electric space-heating usage, which could include anything between regular use of one or more portable space heaters to a fully electrically-heated home. However, only about three percent of homes use 5,000 kWh per year or more for space heating, indicating that all-electric homes are rare in this population.

On the cooling side, the data suggest that about half of the homes in the sample have annual cooling consumption of 100 kWh or more, with median consumption coming in at about 900 kWh per year. About one in ten homes uses more than 1,500 kWh per year for air conditioning. New homes are about twice as likely to show evidence of cooling consumption compared to older homes (60% versus 30%).[6] Homes with cooling consumption at or above the 1,500 kWh/yr level are most likely to be larger new homes that almost certainly make regular use of a central air conditioner.

[6] Note that nearly all newer homes are built with central air conditioning, but some households do not use it enough to be evident in monthly utility billing data.

Table 8. Incidence of electric high users (>12,000 kWh/yr), by home age and size category

		Home size category			
		Small (<1,000 ft^2)	Moderate (1,000-2,500 ft^2)	Large (>2,500 ft^2)	Overall
Year built	n	n=10,475	n=33,256	n=3,185	n=46,916
<1900	1,695	11%	18%	31%	17%
1900s	1,852	12%	19%	31%	19%
1910s	4,201	10%	15%	39%	15%
1920s	5,280	10%	15%	44%	15%
1930s	1,567	9%	17%	63%	16%
1940s	3,098	8%	18%	60%	16%
1950s	6,909	9%	17%	59%	15%
1960s	4,817	11%	16%	45%	16%
1970s	3,636	16%	22%	51%	22%
1980s	3,456	10%	19%	42%	18%
1990s	4,695	10%	19%	47%	23%
2000+	5,710	9%	23%	52%	27%
Overall	46,916	10%	18%	47%	18%

Energy Saving Opportunities

Turning to the smaller sample of 100 homes that received site visits, the data gathered from that research effort allowed us to assess the applicability of 34 energy-saving measures in seven categories for each home (see Appendix A for details). We discuss here the results for natural gas and electric high users separately. Readers should bear in mind, however, that some homes had high usage of both natural gas and electricity, and are thus included in both discussions.

Natural Gas High Users

Overall, results show that the 56 high natural gas users in the site-visit sample have the potential for an average of 236 therms/year worth of savings, or about 14 percent of total natural gas consumption. However—as with the larger sample of homes from which the site visit sample was drawn—home size and age tends to confound the assessment: some high users are simply larger and newer homes. When we break out natural gas savings potential by heating energy intensity, homes with high heating energy intensity show substantially more savings potential (in both absolute and percentage terms) than homes with lower heating energy intensity (Table 9). Not surprisingly, newer homes tend to be concentrated among homes with low heating energy intensity. These findings suggest that there is high value in matching utility billing data to information on square footage and home age in order to effectively target older homes with high heating energy intensity for utility conservation programs.

Table 9. Natural gas savings potential by heating energy intensity

Heating energy intensity category	n	Percent of homes built in 1980 or later	Mean natural gas savings potential	
			Annual therms	%
Low (<50th percentile)	24	58%	138	9.7
High (50th-90th percentile)	22	5%	259	16.2
Very High (>90th percentile)	10	10%	418	20.0
Overall	56	29%	236	14.1

Looking at the estimated savings potential in more detail, most of the gas savings potential comes from opportunities to reduce space-heating consumption through improved insulation, high efficiency heating systems, and thermostat management (Table 10). When collapsed into two broad categories encompassing technical (e.g. insulation) and behavioral (e.g. thermostat settings) opportunities, the analysis suggests that about 70 percent of the total savings potential lies with technical measures and 30 percent lies with behavioral opportunities.

Table 10. Energy savings opportunities among natural gas high users (n=56)

End-use category	Measure	Opportunity?				Estimated gas savings		
		Yes	No	NA[a]	Unk[b]	mean therms/yr	median percent	% of total[c]
Shell	Air sealing	82%	13%	0%	5%	57	3%	17%
	Ceiling insulation	36%	61%	0%	4%	45	2%	6%
	Wall insulation	25%	66%	0%	9%	107	8%	10%
	Other insulation	27%	45%	14%	14%	53	2%	5%
	Window replacement	0%	100%	0%	0%	0	0%	0%
HVAC	Replace (gas) heating system	38%	63%	0%	0%	186	10%	26%
	Heat pump to offset elec. heat	*0%*	*0%*	*100%*	*0%*	*0*	*0%*	*0%*
	Upgrade central air conditioner	*16%*	*50%*	*34%*	*0%*	*0*	*0%*	*0%*
	Replace room air conditioner	*7%*	*18%*	*73%*	*2%*	*0*	*0%*	*0%*
	Duct sealing	5%	52%	34%	9%	32	2%	1%
	Reduce use of elec. space heaters	*18%*	*82%*	*0%*	*0%*	*-74*	*-3%*	*0%*
	Change use of furnace fan	*29%*	*30%*	*41%*	*0%*	*0*	*0%*	*0%*
	Turn off fireplace pilot	23%	9%	41%	27%	52	3%	4%
	Manage air conditioning use	*20%*	*68%*	*13%*	*0%*	*0*	*0%*	*0%*
	Thermostat setback	79%	20%	0%	2%	63	4%	18%
	Manage HRV use	4%	14%	82%	0%	37	3%	0%
Water heating	Gas water heater upgrade	16%	73%	11%	0%	100	7%	6%
	Heat pump water heater	*2%*	*0%*	*98%*	*0%*	*-35*	*-3%*	*0%*
	Low-flow showerhead	5%	39%	0%	55%	23	1%	0%
	Temperature reduction	13%	32%	0%	55%	23	1%	1%
	Manage hot-water use	18%	70%	0%	13%	80	4%	5%
Appliances	*Refr/Frzr replacement*	*36%*	*64%*	*0%*	*0%*	*-2*	*0%*	*0%*
	Refr/Frzr removal/unplug	*27%*	*48%*	*25%*	*0%*	*0*	*0%*	*0%*
	Washer replacement	*4%*	*84%*	*0%*	*13%*	*3*	*0%*	*0%*
	Dehumidifier replacement	*13%*	*54%*	*34%*	*0%*	*0*	*0%*	*0%*
	Manage dehumidifier use	*18%*	*48%*	*34%*	*0%*	*0*	*0%*	*0%*
	Manage laundry use	7%	75%	0%	18%	3	0%	0%
Lighting	*Upgrade interior lighting*	*68%*	*32%*	*0%*	*0%*	*-28*	*-2%*	*0%*
	Upgrade exterior lighting	*66%*	*30%*	*0%*	*4%*	*0*	*0%*	*0%*
	Sensors for exterior lighting	*29%*	*66%*	*0%*	*5%*	*0*	*0%*	*0%*
	Manage lighting use	*27%*	*71%*	*0%*	*2%*	*-5*	*0%*	*0%*
Electronics	*Computer power management*	*11%*	*54%*	*14%*	*21%*	*-6*	*0%*	*0%*
	Manage use of electronics	*21%*	*48%*	*0%*	*30%*	*-11*	*-1%*	*0%*
Ad hoc	Ad hoc opportunities	5%	95%	0%	0%	3	0%	0%

Measures shown in italics and lighter typeface are not generally expected to provide natural gas savings.
[a] Not applicable
[b] Unknown—did not assess at time of site visit.
[c] Percent of aggregate total among measures with positive natural gas savings.

We can also put the savings opportunities alongside home size to assess how these factors together contribute to high natural gas consumption. For each home we judged whether home size, technical savings opportunities and behavioral savings opportunities were each a primary or contributing factor to making the home a high user of natural gas. The results (Figure 10), suggest that while home size is the largest primary factor in explaining high natural gas consumption, untapped savings opportunities are at least a contributing factor in a large majority of cases. This finding suggests that even without the ability to screen on home size and age, simply targeting high users will yield homes with significant opportunities for savings.

Figure 10. Contributing factors to high natural gas consumption

Electric High Users

Analysis of savings opportunities for the 59 high electric users in the sample indicates that these homes have the potential to achieve about 3,650 kWh worth of annual savings, or about 25 percent of total electricity consumption. In contrast to homes with high usage of natural gas, savings opportunities for electricity are more diverse, though reduced use of electric space heaters and improved lighting efficiency make up a third of the total potential (Table 11).

In contrast to the natural gas results, we found little correlation between home size and age and the magnitude of total identified electricity-saving opportunities. There is a strong association between the presence of built-in electric heat in the home (which involved five homes in the site visit sample) and savings opportunities, but this is due mainly to the fact that we judged homes with electric heat to be good candidates for mini-split heat pumps to offset some of the electric-resistance load.

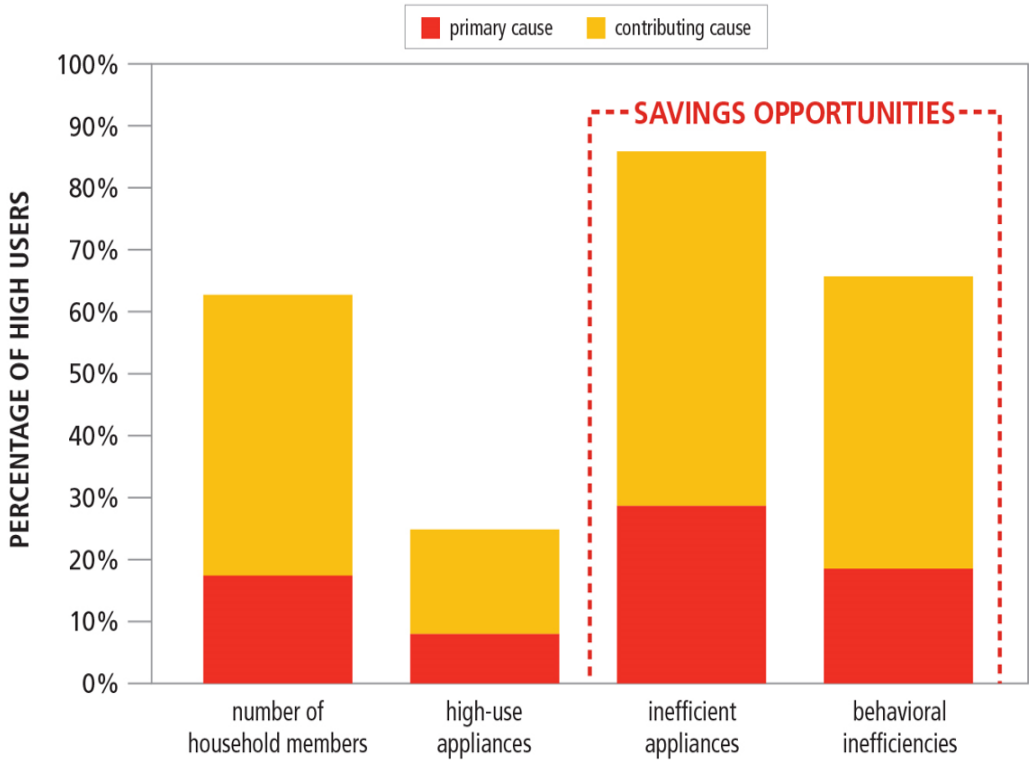
Table 11. Energy savings opportunities among electricity high users (n=59)

End-use category	Measure	Opportunity?				Estimated electricity savings		
		Yes	No	NA[a]	Unk[b]	mean kWh/yr	median percent	% of total[c]
Shell	Air sealing	47%	41%	8%	3%	13	0%	0%
	Ceiling insulation	20%	66%	8%	5%	136	0%	1%
	Wall insulation	15%	68%	8%	8%	423	0%	2%
	Other insulation	7%	44%	36%	14%	0	0%	0%
	Window replacement	2%	90%	8%	0%	750	3%	0%
HVAC	*Replace (gas) heating system*	*17%*	*66%*	*17%*	*0%*	*0*	*0%*	*0%*
	Heat pump to offset elec. heat	10%	0%	90%	0%	3,385	19%	9%
	Upgrade central air conditioner	20%	51%	29%	0%	598	4%	3%
	Replace room air conditioner	3%	25%	71%	0%	125	1%	0%
	Duct sealing	3%	75%	15%	7%	165	1%	0%
	Reduce use of elec. space heaters	27%	73%	0%	0%	2,098	11%	16%
	Change use of furnace fan	24%	54%	22%	0%	1,014	4%	7%
	Turn off fireplace pilot	*12%*	*8%*	*54%*	*25%*	*0*	*0%*	*0%*
	Manage air conditioning use	29%	64%	7%	0%	368	2%	3%
	Thermostat setback	53%	44%	3%	0%	41	0%	1%
	Manage HRV use	0%	19%	81%	0%	0	0%	0%
Water heating	*Gas water heater upgrade*	*8%*	*54%*	*37%*	*0%*	*-24*	*0%*	*0%*
	Heat pump water heater	17%	0%	83%	0%	1,700	12%	8%
	Low-flow showerhead	8%	19%	0%	73%	96	0%	0%
	Temperature reduction	12%	15%	0%	73%	0	0%	0%
	Manage hot-water use	20%	73%	0%	7%	393	0%	2%
Appliances	Refr/Frzr replacement	42%	58%	0%	0%	679	4%	8%
	Refr/Frzr removal/unplug	34%	53%	14%	0%	652	4%	6%
	Washer replacement	12%	78%	0%	10%	441	3%	1%
	Dehumidifier replacement	8%	61%	29%	2%	128	1%	0%
	Manage dehumidifier use	19%	53%	29%	0%	163	1%	1%
	Manage laundry use	14%	80%	0%	7%	385	3%	1%
Lighting	Upgrade interior lighting	71%	29%	0%	0%	880	5%	17%
	Upgrade exterior lighting	68%	25%	0%	7%	235	2%	4%
	Sensors for exterior lighting	17%	80%	0%	3%	100	1%	0%
	Manage lighting use	32%	68%	0%	0%	151	1%	1%
Electronics	Computer power management	10%	64%	14%	12%	233	2%	1%
	Manage use of electronics	27%	56%	0%	17%	553	4%	4%
Ad hoc	Ad hoc opportunities	5%	95%	0%	0%	1,457	5%	2%

Measures shown in italics and lighter typeface are not generally expected to provide electricity savings.
[a] Not applicable.
[b] Unknown—did not assess at time of site visit.
[c] Percent of aggregate total among measures with positive electricity savings.

In addition to the presence of electric heat, we also found that inefficient appliances and behavioral inefficiencies were two main contributing causes of electric high usage (Figure 11). Examples of these factors include, respectively, inefficient refrigerators/freezers and electric space heaters. We found that two other factors—number of household members and high use appliances (like a family that cooks more than average with electric stoves or ovens) —also was a leading cause for a household to be an electric high user, although these factors are difficult to change from a utility conservation program perspective.

Figure 11. Contributing factors to high electricity use



Remote Assessment of Opportunities

In preparation for each site visit, we conducted a review of the available data for each home, which included the electric and/or natural gas usage histories, property-tax data on square footage and home age, and publicly-available imagery of the home. As part of the review, we made preliminary ad hoc assessments of possible savings opportunities. For example, higher-than-average natural gas consumption during the summer months might indicate high hot-water consumption and a gas water heater. Or a substantial cooling signature in the electric data might indicate an opportunity to replace an inefficient air conditioner and/or change thermostat management practices. We recorded these ad hoc remote assessments with the opportunities later determined based on the site visits. Here, we compare the two to look at the predictive value of remote assessments.

Table 12 summaries the results for opportunities that we attempted to predict remotely. The left-hand section of the table shows the two-way classification in terms of whether the opportunity was predicted as a Yes or No from the remote assessment, and whether it was determined to be a Yes or No from the site-visit data. In other words, from left to right the table shows the true-positive, true-negative, false-positive and false-negative rates. The p-value and statistical significance columns show whether we can reasonably conclude that the remote assessments performed any better than chance. The results suggest that remote assessments for insulation, air sealing, use of electric space heaters, fireplace pilot lights and managing air

conditioning use all were better than simply randomly guessing, but the remote assessments of other opportunities were not.

There are a number of ways to measure the predictive ability of a binary classification like that of predicting the existence of an energy-saving opportunity. The right-hand section of the table focuses on three of these:

Positive predictive value: This value measures the degree to which an opportunity identified in the remote assessment actually is found to exist during the site visit. A value of 100 percent in this column would indicate that if we determine remotely that there is a given opportunity, it will always turn out to be present in reality. We may miss some instances of the opportunity, but if we flag it remotely we will not be disappointed. Among the measures with statistically-significant positive predictive value, air sealing and fireplace pilot lights have particularly high positive predictive values.

Sensitivity: Sensitivity refers to the ability of the remote assessment to correctly identify opportunities that actually exist. A value of 100 percent here means that we can perfectly identify all instances of a given opportunity remotely. Ceiling insulation, air sealing and managing air conditioning use have the highest sensitivity scores among the measures we looked at because the data strongly indicates their presence.

Accuracy: Accuracy refers to the overall ability of the remote assessment to classify opportunities correctly as either being present or not. However, while a high value means that the remote assessment is accurate, it may be misleading if the opportunity is rare. For example, gas water heater upgrade has an 86 percent prediction accuracy from the remote assessment, but was only identified in the on-site data as being present in 13 percent of the cases—and the remote assessment's ability to identify those cases was poor.

Table 12. Predictive accuracy of remotely-assessed energy-saving opportunities

		Correctly classified		Incorrectly classified				Prediction performance statistics		
Opportunity per remote assessment?		Yes	No	Yes	No	Fischer's exact p-value	Significance level[a]	Positive predictive value	Sensitivity	Accuracy
Opportunity per site visit?		Yes	No	No	Yes					
Opportunity Type	n	a	b	c	d			a/(a+c)	a/(a+d)	(a+b)/(a+b+c+d)
Ceiling insulation	90	20%	56%	16%	9%	0.000	***	56%	69%	76%
Wall insulation	86	8%	69%	9%	14%	0.038	**	47%	37%	77%
Other insulation	83	1%	80%	2%	17%	1.000		33%	7%	81%
Any insulation	94	29%	46%	11%	15%	0.000	***	73%	66%	74%
Air sealing	89	44%	33%	2%	21%	0.000	***	95%	67%	76%
Upgrade gas heating system	94	7%	60%	12%	21%	0.570		39%	26%	67%
Upgrade central air conditioner	94	5%	68%	14%	13%	0.745		28%	29%	73%
Duct sealing	86	0%	87%	9%	3%	1.000		0%	0%	87%
Reduce use of electric space heaters	94	11%	62%	15%	13%	0.024	**	42%	45%	72%
Turn off fireplace pilot in summer	71	11%	75%	3%	11%	0.088	*	80%	50%	86%
Thermostat setback	93	6%	32%	4%	57%	0.737		60%	10%	39%
Manage A/C use	94	20%	48%	28%	4%	0.001	**	42%	83%	68%
Upgrade gas water heater	94	1%	85%	2%	12%	0.304		33%	8%	86%
Manage hot water use	84	7%	42%	38%	13%	0.421		16%	35%	49%
Refr/frzr removal or replacement	94	29%	26%	11%	35%	0.188		73%	45%	54%
Reduce dehumidifier use	94	1%	74%	5%	19%	1.000		17%	5%	76%
Upgrade lighting	94	11%	16%	3%	70%	0.709		77%	13%	27%

Excludes cases where the opportunity could not be assessed during the site visit.

[a]***= statistically significant at a 99% confidence level; **= statistically significant at a 95% confidence level; *= statistically significant at a 90% confidence level;

Overall, the results of this exercise suggest that insulation and air sealing opportunities can be readily identified remotely, but equipment replacements cannot. This is not surprising, because high heating energy intensity in an older home generally indicates the presence of building shell improvement opportunities. Perhaps more surprising is that the exercise suggests some ability to identify the use of portable space heaters and fireplace pilot lights that are left on in the summer.

Homeowner Motivations

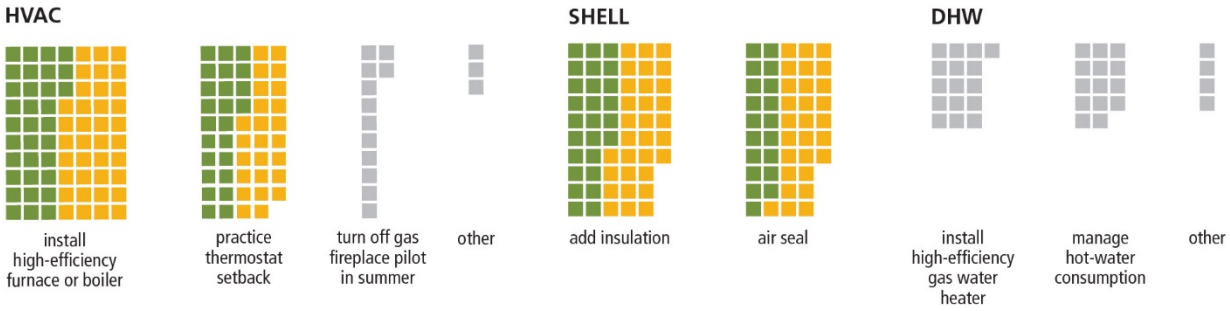
The interviews we conducted with homeowners at the conclusion of the site visits revealed attitudes and motivations regarding energy issues. The field researchers inquired about perceptions of homeowners' energy bills and familiarity with energy savings measures. We asked about previous participation in energy conservation programs and motivations to participate in those programs in the future.

The vast majority of participants (91%) said they had implemented at least one energy efficient measure or upgrade in the past, ranging from changing out lightbulbs to adding insulation, and the majority of those households (78%) expressed that they had positive experience in doing so. Only six percent spoke of the energy efficiency measure in generally negative terms. This suggests an openness or general willingness for home improvements that will help them save energy.

To better understand a homeowner's motivation to take action on energy saving measures, the field researchers chose three opportunities identified in the walk-through to focus on during the interview. The participants were asked whether they would earnestly consider, might consider or would be unlikely to consider implementing those three measures. Their self-reported willingness was analyzed against how they responded to other questions throughout the interview to determine the homeowner's overall level of willingness. Additionally, we applied this level of willingness to those opportunities which were identified in the walk-through but were not specifically asked about during the interview.

In Figure 12 (natural gas) and Figure 13 (electricity), we graphically show the range of energy savings measures with the willingness of the homeowner to consider each measure illustrated by the change in color. For natural gas opportunities, there was greater relative willingness to install a high-efficiency heating system or practice thermostat setbacks as compared to air sealing. The lower willingness to air seal may be attributed to a lack of understanding of what an air sealing project entails.

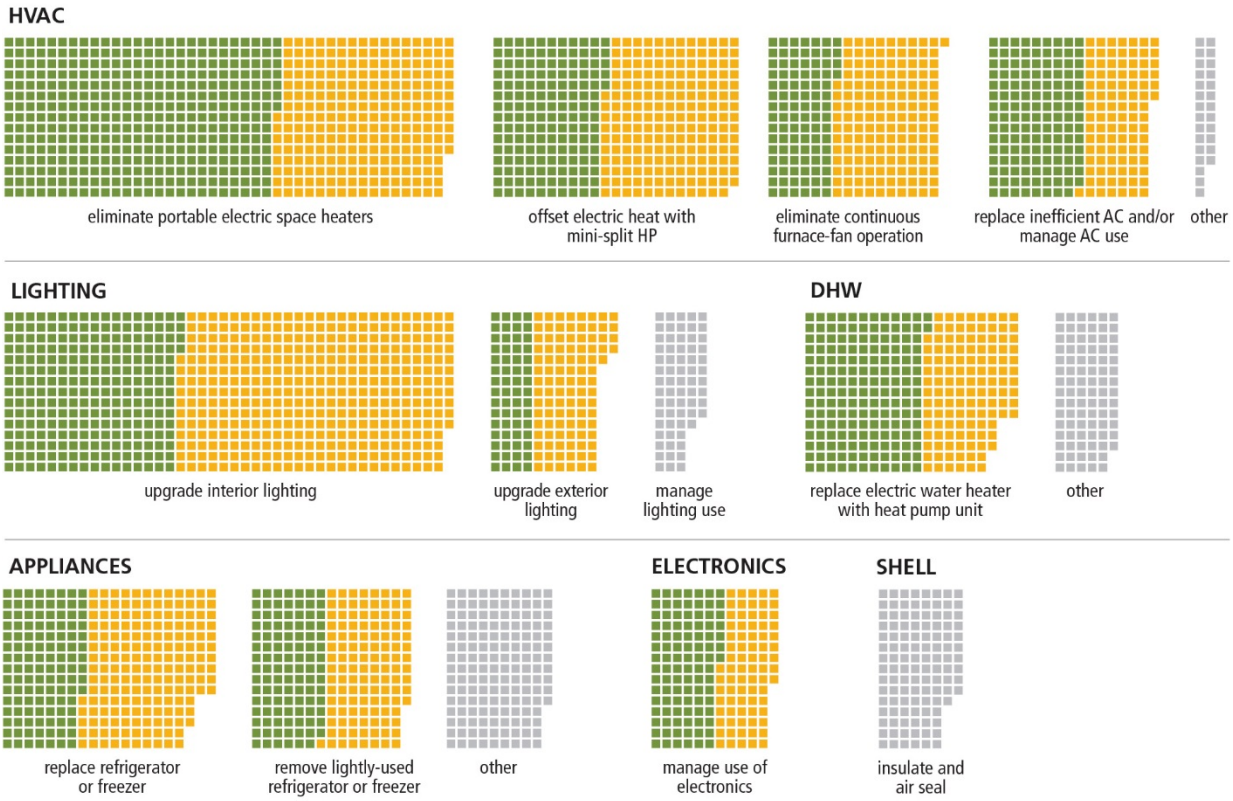
Figure 12: Natural gas savings opportunities and household willingness



* One square = Technical potential (therms/year/home)
** Green indicates increase household willingness to implement the measure. Yellow indicates low or no willingness to implement the measure. Measures with only grey color indicates too low sample size for behavioral analysis.

For electric opportunities, many participants expressed a willingness to implement the measures, but there is some variation on the level of willingness between measures. For example, there was a relatively higher level of willingness to reduce electric space heater usage as compared to upgrading interior lighting even though they had a similar amount of savings. For some homeowners, the dislike of compact fluorescent lighting was attributed to light-quality preferences and dislike of government intervention (referencing the law banning incandescent lightbulbs). To point out two other measures with a similar amount of savings, participants expressed more willingness to replace an inefficient AC or manage AC usage rather than eliminate continuous furnace-fan operation, even though turning off the furnace fan is more easily implemented; some homeowners felt strongly about using the furnace fan because a contractor told them it is something they should do or they feel they should run it to balance their household air flow. These preferences are revealed in the relatively willingness to implement a measure.

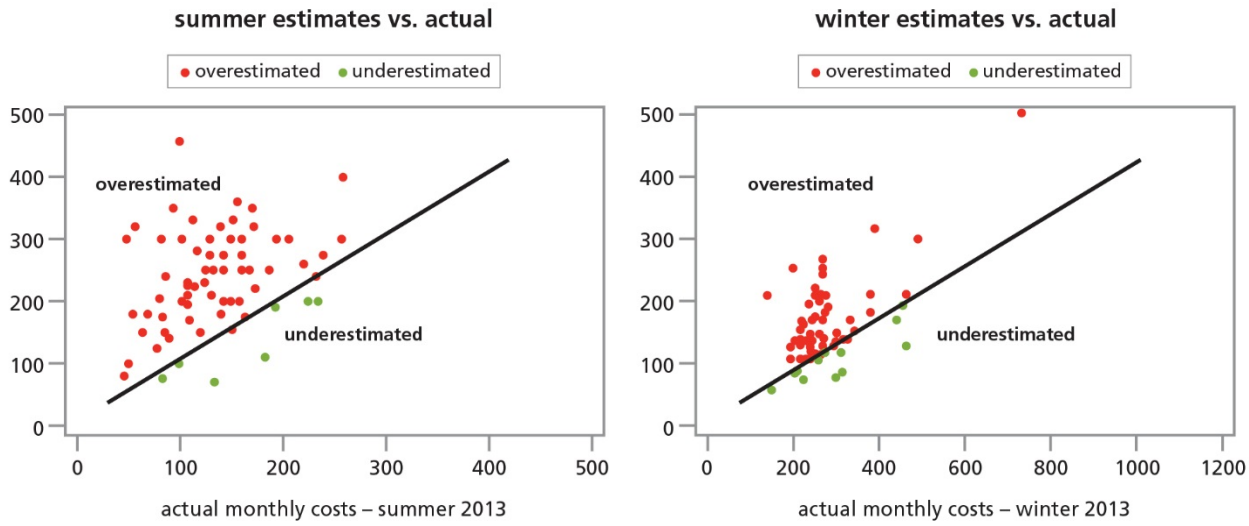
Figure 13: Electricity savings opportunities and household willingness



* One square = Technical potential (therms/year/home)
** Green indicates increase household willingness to implement the measure. Yellow indicates low or no willingness to implement the measure. Measures with only grey color indicates too low sample size for behavioral analysis.

An interesting finding from our research pertained to homeowners' perceptions about their utility bills. At the outset of the site visit, we asked participants what they paid in utility bills for a typical summer and a typical winter month. We asked explicitly for a one-month period because people tend to think of their payments in monthly increments. We then compared their responses to what the household actually paid. Figure 14 shows that households systematically overestimated their bills, suggesting that even while they pay more than the average household for utilities, they do not accurately know how much they actually pay.

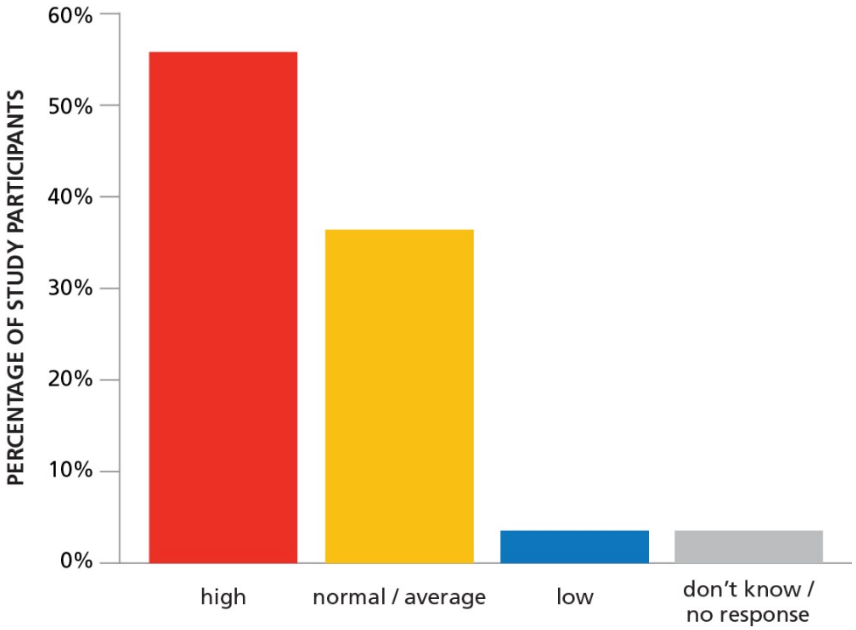
Figure 14: Comparison between estimated and actual utility costs



After we asked participants about their average monthly costs, we followed up with a question about how they felt about that amount, to assess whether the costs seemed low, high, or somewhere in-between. As Figure 15 shows, while many households think their bills are high (54%), a significant number think their bills are normal (37%) or low (4%). Not surprisingly, those participants that tended to assess their costs as high were low-income households or households that reported difficulty in paying bills, households that experienced substantially lower costs in another home, or households that had received comparative information about how much others spend[7].

[7] The Rochester homes received a Home Energy Report through RPU during the time of this study.

Figure 15: Does the homeowner think their utility bills are high, normal, or low?



These findings suggest that there are opportunities for utilities to provide education around relative magnitude of energy bills and offer consumers concrete strategies to reduce high energy bills.

Program Scoping Methodology

The second phase of the High User Study applied findings from the market characterization research to identify high user-targeted program strategies that Minnesota utilities could pursue under their CIP initiatives. This research was conducted in collaboration with the partnering utilities: Minnesota Power, ComfortSystems, Minnesota Energy Resources and Rochester Public Utilities.

In spring 2015, Seventhwave convened a series of discussions with participating utilities and a representative from the Department of Commerce to develop a framework for assessing the viability of different high user-targeting strategies. We held two group calls with all of the participating utilities, followed by a series of separate discussions with the northern Minnesota utilities (Minnesota Power and ComfortSystems) and the southern Minnesota utilities (Rochester Public Utilities and Minnesota Energy Resources). The utilities helped us brainstorm a comprehensive list of possible program enhancements, and then evaluated which enhancements were of greatest interest from their perspective and which ones had significant barriers to implementation. The goal of this collaboration was to test the effectiveness of one or two high user-targeted program interventions through a small-scale pilot study in summer/fall 2015.

Since only four Minnesota utilities were directly involved in this research project, it was important to solicit input from other utilities in the state on how they view the opportunity to develop targeted offerings for residential high users. In December 2015 we conducted short telephone surveys with nine utility program managers about their existing program efforts as well as barriers and opportunities for developing new offerings targeting residential high users.

Program Scoping Results

To recap, the characterization study identified the largest areas of savings potential for high-using households:

- Eliminate use of portable electric space heaters (offset 2,000 kWh/year)
- Offset all electric heat with ductless minisplit HP system (offset 3,000 kWh/year)
- Eliminate continuous furnace-fan operation (1,000 kWh/year)
- Upgrade interior lighting
- Replace electric water heater with gas

The characterization research also identified common barriers to energy efficiency within the high user cohort.

- Mistaken beliefs about electric space heater energy use
- Life gets in the way; efficiency is low on the list of priorities
- Preference for appliances/systems to which they are accustomed
- Reluctance to pursue early replacement of functioning equipment
- Budget constraints
- Concerns about not being able to recoup efficiency investments

These findings led to the following recommendations for program designers to consider:

- Focus on the biggest energy-savings opportunities.
- Explore available data to gain insights before engaging the customers (e.g., analytics to identify possible causes of high usage so messaging/approach can be targeted).
- Speak to the audience: tailor messaging to address concerns and opportunities common among high users.
- Pick one or more key barriers (cost, hassle factor, etc.) and offer solutions.

One of the key conclusions from the characterization research was that meeting the needs and opportunities presented by high users is best addressed through adjustments to existing programs rather than developing entirely new program offerings. Through the brainstorming discussions with participating utilities, we identified a number of program adaptations that could enhance utilities' ability to capture the energy efficiency potential of high-using households. We grouped these adaptations into four broad categories:

- **Extra support**: Offering high users more hand-holding, follow ups, referrals, or bonus incentives to drive action.
- **Targeted messaging:** Focusing on specific areas of opportunity in high user households (space heaters, air sealing, furnace fan settings, etc.). When possible, differentiating the message based on the audience—high users in general or further stratifying by income, home age, heating fuel, or other criteria.
- **Feedback:** Providing usage-related data that helps customers be better-informed about their energy usage and strategies for reducing usage.
- **Remote analytics**: Using billing data, home size data, and other available information to identify households and specific areas of energy savings opportunity within the home. Adapting feedback and messaging strategies accordingly.

Next we reviewed a number of CIP programs that the participating utilities are already offering and brainstormed possible enhancements to target the energy savings potential of high using households. Results of this brainstorming session are captured in Table 13.

Table 13: Program enhancements targeting high usage households

Program Intervention	Enhancements for high-using households
Home energy audits	Use remote analytics to identify and target high users as well as possible contributing factors to high usage
	Streamline the audit approach to target the biggest areas of savings potential
	Develop leave-behind materials to address specific informational/perception barriers (e.g., space heaters don't use much energy)
	Increase the amount of post-audit follow up that high using households receive (check in calls, ask about barriers to installing measures, referrals to rebate offers, etc.)
Equipment rebate programs	Target marketing to homes with high usage
	Conduct remote analytics to identify contributing factors and adapt messaging and program offers accordingly
	Develop materials addressing common informational barriers
	Conduct additional follow-ups for high users to promote rebate offerings
	Develop specific offerings around low-cost measures
Neighborhood or community-based initiatives	Use remote analytics to identify and target neighborhoods with concentrations of high users
	Develop program materials targeting major opportunities: electric space heaters, second fridge, furnace fan settings, air sealing, etc.
	In-person house-to-house canvassing with "quick audit" targeting likely causes of high usage
	Offer measure packages targeting common energy efficiency opportunities in high using households; streamlined installation offers (neighborhood blitz)

Program Intervention	Enhancements for high-using households
Customer service support	Offer enhanced customer service support (e.g., a dedicated high user hotline) that is marketed to high users
	Offer efficiency information/measures through other customer support channels like appliance service calls offered by gas utilities
	Use call center to conduct post-audit follow up outreach to encourage action (measure installation & rebate applications)
	Provide extra support to help customers identify the right program for their needs and/or find contractors to install the measures identified in an audit

The participating utilities also identified possible barriers to implementing the high user program strategies outlined above:

- Lack of data on housing square footage makes energy intensity calculations a more labor-intensive effort.
- Lack of resources to support more customer-intensive efforts (remote analytics, dedicated high user hotline, extra follow ups with high users).
- Equity concerns associated with developing specialized offerings for sub-sets of residential customer group.
- Geographic distribution of high-using households makes targeted efforts cost-prohibitive.

In Table 14, we summarize survey responses from the nine Minnesota utilities who participated in a brief telephone survey regarding their current residential market segmentation efforts, and perceived barriers and opportunities for targeting residential high users.

Table 14: Utility survey on high user program strategies

Survey question	Response category	# of "yes" responses
Residential segmentation approaches used	High user	2
	Low income	2
	Rate class	1
	PRIZM code (demographics, consumer behavior)	1
	None	3

Survey question	Response category	# of "yes" responses
High user program strategies pursued	High bill diagnostics	2
	Load management	1
	Time of use rates	1
	Targeted audits	1
	Targeted marketing	1
	None	5
Barriers to high user segmentation	Funding/resource constraints	4
	Limited customer data	2
	Equity concerns	1
	"Big brother" concerns	2
	Customer base too small	1
Resources needed	Additional customer data	4
	Remote analytics	1
	Past conservation program participation data	1

Only two of the nine utilities mentioned current efforts to segment residential customers by usage. One of those utilities said they specifically target high users with an efficiency program offer—in this case, a targeted energy audit program. Other utilities mentioned they have strategies for addressing customers' high bill complaints such as performing diagnostics to determine the cause, or referring them to load management or time of use rates that could help lower their bills. The most commonly-cited barrier to segmenting the residential market by usage was limited time, funds, and internal resources to spearhead such an effort. This was particularly an issue among the smaller utilities we spoke to. In terms of additional resources that would be most helpful should they wish to pursue a high user segmentation strategy in the future, four of the nine utilities mentioned the need for additional data about their customers—particularly data on home size, number of occupants, age of home and other characteristics that could contribute to usage patterns.

Pilot Methodology

Once the four participating utilities provided input on a range of possible program interventions for high using households, the next step was to select a strategy that could be tested with a small-scale pilot study in fall/winter 2015. All four utilities were interested in promoting their home energy audit offerings. None of the utilities had previously tried usage-based segmentation strategies to promote energy audits. All of the utilities were interested to see if alerting customers to their relative usage would drive greater interest in home energy audits. In northern Minnesota, ComfortSystems and Minnesota Power decided to promote the online survey, Your Home Energy Audit (YHER). In southern Minnesota, Rochester Public Utilities and Minnesota Energy Resources elected to promote their Neighborhood Energy Challenge (NEC), an informational workshop that includes a heavily discounted home energy audit offering for participants.

Both the northern and southern Minnesota pilots tested whether informing customers that they are high users would elicit higher demand for home energy audits. An oversized, fold-over and tabbed postcard was delivered to randomly-assigned treatment and control groups selected from the original high-user analysis sample. The treatment group messaging informed customers that their homes have high usage compared to similar homes and encouraged participation in their utilities' home energy audit program—YHER for Duluth-area customers and NEC for Rochester-area customers. The control group received a similar postcard, but without any mention of the customer's relative energy use. The utilities designed the postcards which were cobranded with the logos of the electric and gas utility. Copies of the treatment group postcards are shown in Appendix D. Pilot size and criteria are summarized in Table 15.

Table 15: Pilot size and criteria

	Rochester	**Duluth**
Treatment	2,102 homes	1,221 homes
Control	2,100 homes	1,205 homes
Criteria	• Only households with gas service from MERC and electric service from RPU • Top 20% of usage per square foot for either electric or gas consumption • Omits customers that have received an audit or rebate for furnace/insulation/DHW • No distinction with regard to home age	• Only households with gas service from ComfortSystems and electric service from Minnesota Power • Top 20% of estimated annual energy cost based on $0.091/kWh and $0.722/CCF • Did not omit customers who have already completed a YHER audit (# of completed surveys is small) • No distinction with regard to home age or size

Postcards were mailed in November 2015. Minnesota Power later provided information on customers who had completed a YHER between November and mid-January, 2016. Minnesota Energy Resources provided information on Rochester customers who received an energy audit or installed other incentivized measures from 2013 through mid-February, 2016.

Pilot Results

In terms of stimulating demand for home energy audits (either online or on-site), data from the pilot indicate that the postcards did not have an appreciable effect. There was no statistically significant difference between the treatment and control groups for either utility (Table 16). Less than one percent of postcard recipients completed an energy audit in the 2.5 (Duluth) or 3.5 months (Rochester) following the mailing, indicating that the postcards themselves had little or no impact on demand for energy audits in that timeframe. And, since few audits were completed in either group during the pilot period, the small differences in implementation rates between the treatment and control groups are not statistically significant.

Table 16. Audit implementation rates for pilot participants

Duluth			Rochester		
Completed YHER?	Treatment (n=1,221)	Control (n=1,205)	Received energy audit?	Treatment (n=2,100)	Control (n=2,102)
No	1,214	1,202	No	2,098	2,098
Yes	7 (0.57%)	3 (0.25%)	Yes	2 (0.10%)	4 (0.19%)
Fischer's exact p=0.343*			Fischer's exact p=0.687*		

*Values less than 0.05 connote a statistically significant difference.

The Rochester program participation data allow for additional analysis related to the pilot. The number of residential energy audits provided to Rochester customers has varied between zero and 60 per month since 2013, with no appreciable uptick as a result of the postcard mailing (Figure 16).

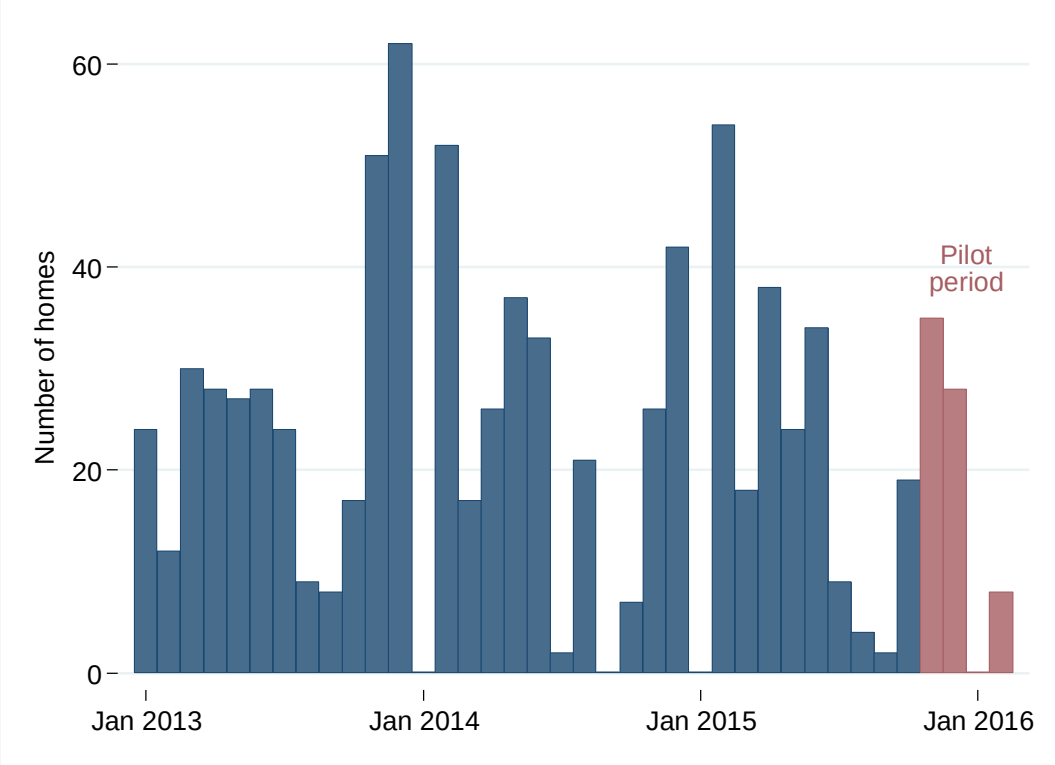
Similarly, analysis of measure implementation rates during the pilot period shows no difference between the treatment and control groups (Table 17), indicating that providing information about energy consumption on the postcards had no effect on installation of program-eligible energy-saving measures.

Table 17. Rochester measure implementation rates for the pilot sample during the pilot period

Measure group	Treatment (n=2,100)	Control (n=2,102)	Fischer's exact p-value*
Building shell	0.05%	0.10%	1.000
Hearth product	0.05%	0.00%	1.000
Heating system	0.90%	0.71%	0.606
Heating system tune-up	1.24%	1.57%	0.363
Thermostat	0.81%	0.81%	1.000
Domestic hot water	0.29%	0.33%	0.790

*Values less than 0.05 connote a statistically significant difference.

Figure 16. Rochester energy audits by month



The resources and timeframe available for pilot-testing a high user targeting strategy were limited within the scope of this study. Still, the results are a useful indication that simply adapting the marketing or messaging strategy for high users may not have much effect. Further study could test the effectiveness of more significant program interventions like offering a higher level of energy conservation measure installation support to high usage households.

Conclusions and Recommendations

This study confirms the significant energy savings potential associated with high users of electricity or natural gas. For natural gas, the study identified an average of more than 200 therms/year worth of natural gas savings (about 15 percent of total consumption) for homes with consumption above the 80th percentile. Since natural gas use is dominated by space-heating consumption, home size is an important factor for this fuel: some homes are high users of natural gas simply because they are large. This study shows that it is quite feasible to merge utility billing data with readily-available property-tax information on a large-scale basis so that home size (and age) can be factored into the assessment of natural gas consumption. When the targeting screen is set to older homes with high heating energy intensity, the savings potential rises to more than 400 therms per home, or about 20 percent of total consumption. These homes are thus especially good candidates to be targeted by energy efficiency programs.

Energy-saving opportunities for high electric users are more difficult to predict from utility and property-tax data because of the much wider array of electric end-uses, as well as the fact that high electricity use is less highly correlated with home size and age. Nonetheless, the study shows an average savings potential of more than 3,600 kWh/year for high users, which is about 25 percent of annual electricity consumption. For both electricity and natural gas, about two-thirds of the identified savings opportunities were related to building shell deficiencies or inefficient equipment; the remaining one third is attributable to behavioral opportunities such as limiting the use of electric space heaters.

Our research into customer attitudes and perceptions about their high energy use was illuminating. In many ways, high-using homes are no different than everyone else. We found widespread concern about energy bills, particularly when homeowners were told through Home Energy Reports about how their relative usage compares to others. While some customers seemed skeptical about comparative usage information, it definitely gets their attention.

We also found that most of the homeowners had already taken some steps to reduce energy use. Ninety-one percent of the homes we visited had made energy efficiency improvements in the past, including buying ENERGY STAR qualified appliances, replacing lighting and adding insulation. Consumers need targeted information about what efficiency improvements will be most impactful, not a laundry list of 101 ways to save. Focusing on a few measures as key opportunities "for customers like you" would point high-using customers to solutions that would help them save energy.

Lastly, we found that getting people to tackle larger energy efficiency projects is challenging given the complexities involved. Customers are daunted by navigating the market for contractors, choosing among the options presented, and finding the funds for a project that may take more than a few years to pay back. Given the greater savings potential associated with high users, it may be cost-effective for utility programs to offer additional hand-holding, financing, and follow up to help customers overcome these hurdles.

Based on these findings we developed the following recommendations for program designers to consider:

- Focus on the biggest energy-savings opportunities.
- Explore available data to gain insights before engaging the customers (e.g., analytics to identify possible causes of high usage so messaging/approach can be targeted).
- Speak to the audience: tailor messaging to address concerns and opportunities common among high users.
- Pick one or more key barriers (cost, hassle factor, etc.) and offer solutions.

Targeting the energy savings potential of high usage homes does not require the invention of entirely new program offerings. Instead, utilities can develop enhancements to existing programs to increase participation rates among high users.

- **Extra support**: Offering high users more hand-holding, follow ups, referrals, or bonus incentives to drive action.
- **Targeted messaging:** Focusing on specific areas of opportunity in high user households (space heaters, air sealing, furnace fan settings, etc.). When possible, differentiating the message based on the audience—high users in general or further stratifying by income, home age, heating fuel, or other criteria.
- **Feedback:** Providing usage-related data that helps customers be better informed about their energy usage and strategies for reducing usage.
- **Remote analytics**: Using billing data, home size data, and other available information to identify households and specific areas of energy savings opportunity within the home. Adapting feedback and messaging strategies accordingly.

With support from the participating utilities, this study included a small-scale pilot to test the effectiveness of usage-based messaging in the marketing of home energy audits. We did not see that informing customers of their high usage had a statistically significant effect in terms of increasing demand for audits. There remains opportunity to test the effectiveness of other programmatic strategies aimed at capturing the savings potential of high users, such as enhanced targeting efforts supported by remote analytics, or higher levels of program support (incentives and/or technical assistance) for homes with high usage.

To date, only a small number of Minnesota utilities are pursing program strategies that target residential high users, and several utilities told us they are interested in doing more. The most commonly-cited challenge that utilities mentioned was data limitations. Particularly among smaller utilities, they do not have easy access to information about home size or occupant numbers and demographics, nor do they have the internal resources to develop those datasets. There are also equity concerns about offering enhanced services for a sub-set of the residential customer base. Special offerings could certainly be marketed specifically to certain customer groups, but there is a strong ethic around making sure that any customer who wanted to take advantage of such offerings be permitted to do so.

Appendix A: Energy Saving Measures

ID	Measure	Applies to	Savings estimates
1	Air sealing	Measured air leakage of 1,500 CFM50 or higher.	0.025*CFM50-25 therms/year heating savings. Fractional cooling savings estimated as 0.05*(0.5-500*CFM50), and applied to observed annual cooling consumption.
2	Ceiling insulation	Observed underinsulated ceiling areas.	Area-based reduced heat loss estimate based on existing and upgraded ceiling-insulation R-values, and area that can be insulated. Adjusted for local heating degree days. R-value based estimated fractional reduction in cooling consumption times observed usage, assuming that ceilings account for 15% of cooling load.
3	Wall insulation	Observed lack of wall insulation.	0.085 therms (or 2.1 kWh, if electric heat) per year of heating savings per net square foot of wall area. Net wall area estimated as 0.85*38*sqrt(floor area), and adjusted for homes with some wall already insulated. Also, adjusted for local heating degree days. 20% assumed reduction in observed cooling usage.
4	Other insulation	Observed opportunity for floor insulation, foundation insulation or insulation in other areas.	Estimated heating savings of 1% to 10%, depending on nature of opportunity.
5	Window replacement[8]	Observed predominantly single-pane windows.	Estimated 5% heating savings

[8] The five percent value is an estimate of heating impact for replacing all or nearly all single-pane windows with higher-efficiency ones based on typical percentage of heating load represented by windows. This measure only came up for one home in the study, so we did not develop a more detailed algorithm that accounted for total window area.

ID	Measure	Applies to	Savings estimates
6	Heating system replacement	Observed non-condensing gas heating system.	Estimated 13% savings on observed heating savings, adjusted for savings from implementation of shell measures.
7	Displace electric heat with heat pump	Electric resistance heat and opportunity to offset with mini-split.	Assume 33% reduction in observed electric heating consumption.
8	Central air conditioner efficiency upgrade	Existing central A/C at or below SEER 10	Estimated 33% reduction in observed cooling consumption (based on replacement with SEER 15 model).
9	Room air conditioner efficiency upgrade	Existing older room A/C	Estimated 25% reduction in observed cooling consumption.
10	Duct sealing	High pressure-pan readings in homes with ducts outside conditioned space.	Ad hoc estimates of 2% to 5% heating savings and 10% to 15% cooling savings, based on pressure-pan readings.
11	Reduce use of electric space heaters	Households reported to portable electric space heaters	Ad hoc estimates of electricity usage attributable to space heaters, based on review of monthly billing data. Includes assumed increase in gas heat to compensate for reduced space heater usage.
12	Reduce use of furnace fan	Households practicing continuous-fan operation at any time during the year without stated need for continuous filtration.	Ad hoc estimates of 300 to 2,600 kWh/year per furnace, depending on reported extent of continuous-fan operation and type of furnace.
13	Turn off fireplace pilot	Households with gas fireplaces observed to have an operating pilot in the summer.	1,250 Btu/hr reduction in gas consumption over 150-day summer and shoulder season.
14	Manage air conditioning use	Households identified by interviewer as having an opportunity to reduce use of air conditioning	25% reduction in observed air conditioning use, after accounting for upgrade opportunities.

ID	Measure	Applies to	Savings estimates
15	Thermostat setback	Households reported to practice no (or less than 5F) thermostat setback in the heating or cooling season (if central cooling is present).	1% heating savings per F of additional nighttime setback potential (where potential is difference between 5F and current setback); 0.5% per F of heating daytime potential; 2% per F of cooling daytime setback potential (no savings for nighttime cooling). Above applied to observed heating and cooling consumption from billing data.
16	Manage HRV use	Home with HRV that runs more than 20% of the time and air leakage of 2,000 CFM50 or higher.	Ad hoc estimates based on assumed 90 watts operating power, 125 to 200 cfm ventilation rate and 70% heat exchanger effectiveness.
17	Gas water heater upgrade	Households with standard tank water heater that is 10+ years old, and estimated hot-water gas consumption of 250+ therms/yr	Assume 33% savings on estimated gas consumption for hot water (based on observed non-heating gas consumption, adjusted for presence of gas range and/or gas dryer).
18	Heat pump water heater	Households with standard electric water heater, 2+ household members, non-electric space heat, and non-conditioned basement	Assume replacement with heat-pump water heater with 1,700 kWh/year of electricity savings and 35 therms/year gas heating penalty.
19	Showerhead replacement	Homes with measured showerhead flow rate of 2.25 gpm or higher (Measurements made only in homes with high suspected hot-water energy consumption based on prior analysis of utility billing data.)	12 therms (gas water heater) or 275 kWh (electric) per year for existing showerhead flow of 2.25 gpm, scaled to actual flow. Assumes 1.5 gpm replacement.

ID	Measure	Applies to	Savings estimates
20	Hot water temperature reduction	Measured hot-water temperature of 130F or higher. (Measurements made only in homes with high suspected hot-water energy consumption based on prior analysis of utility billing data.)	Minnesota Technical Reference Manual algorithm for temperature reduction
21	Manage hot-water use	Households identified by interviewer as having an opportunity to reduce use of hot water.	25% savings on estimated water heating energy consumption, after accounting for technical improvements to water heating energy efficiency.
22	Refrigerator/freezer replacement[9]	Refrigerators or freezers that are not removal candidates and are 15+ years old	50 to 800 kWh/year savings, depending on type and age. Also includes estimated gas heating penalty for reduced electricity consumption during the heating season.
23	Refrigerator/freezer remove or unplug	Existing secondary refrigerator or freezer that is plugged in and less than half full (refrigerator) or nearly empty (freezer)	350 to 1,450 kWh/year, depending on type and age.
24	Clothes washer replacement	Existing clothes washer is 15+ years old for household with 2+ members.	Per-cycle energy savings of 0.26 kWh (electric hot water) or 0.012 therms (gas hot water) for water heating; 0.05 kWh washer electricity consumption; 1.48 kWh (electric) or 0.05 therms (gas) dryer consumption. Assumed 2 loads of laundry per week per household member.

[9] Note that the estimated savings is significantly higher than the value used in Minnesota's Technical Reference Manual (TRM). This study's estimate is based on the age of the unit, whereas the TRM makes no age assumptions and thus represents a range of ages for existing units. The estimated 800 kWh value is for replacing a 20+ year-old side-by-side refrigerator (with estimated annual usage of 1,400 kWh/year) with a new ENERGY STAR qualified side-by-side refrigerator (with estimated annual usage of 600 kWh/year).

ID	Measure	Applies to	Savings estimates
25	Dehumidifier replacement	Homes with older dehumidifiers that are operated all summer or year-round.	20% savings on estimated typical 500 kWh/yr for summer operation and 1,000 kWh for year-round operation. Use and savings increased by 20% if unit connected directly to a drain.
26	Manage dehumidifier use	Homes with dehumidifiers that are operated all summer or year-round, and noted as having a low humidity setting.	20% savings on annual electricity use (see above), after accounting for replacement savings potential, if applicable.
27	Manage laundry use	Households identified by interviewer as having an opportunity to reduce hot water and dryer energy consumption.	25% savings of estimated laundry energy use (hot water for washer and dryer energy).
28	Interior lighting upgrade	Households identified by interviewer as having an opportunity to replace high-use interior incandescent lighting.	0.8 kWh/ft^2/year savings times floor-weighted fraction of interior lighting that is observed to be incandescent or halogen. Includes gas heating penalty for reduced lighting electricity consumption during the heating season.
29	Exterior lighting upgrade	Households identified by interviewer as having an opportunity to replace high-use exterior incandescent lighting.	270 kWh/year times fraction of exterior lighting observed to be incandescent or halogen.
30	Exterior lighting sensors[10]	Households identified by interview as leaving exterior lights on 24/7.	100 kWh

[10] The 100 kWh estimate is based on an assumption of an average of 1.5 15W CFLs, and is thus likely conservative.

ID	Measure	Applies to	Savings estimates
31	Manage lighting use	Households identified by interview as having an opportunity to reduce use of lighting.	25% reduction in assumed 0.4 kWh/ft^2/year lighting usage. Includes estimated gas heating penalty from reduced lighting electricity consumption during the heating season.
32	Desktop computer power management[11]	Homes with desktop computers that are left on 24/7 or for long periods of time.	400 kWh/yr if left on constantly; 200 kWh/yr if left on for long periods of time.
33	Manage use of electronics	Identified by interviewer as having an opportunity to reduce use of electronics.	25% savings on estimated annual electricity use for electronics (after accounting for computer power management savings above). Annual kWh for electronics estimated from device counts and typical annual use for various devices.
34	Ad hoc opportunities	Other opportunities identified by interviewer	Estimated on an ad hoc basis. Ad hoc opportunities include: • Continuously running pool pump • Continuously-running hot-water circulation pump • In-floor electric heat left plugged in • Use of 40" plasma TV • 1000W halogen outdoor lighting

[11] These estimates are based on Seventhwave's prior CARD research project on residential plug-loads Electricity Savings: Bensch, Ingo, Scott Pigg, Karen Koski, Rana Belshi, 2010, "Opportunities for Home Electronics and Other Plug-In Devices in Minnesota Homes: A technical and behavioral field assessment." This prior study involved monitoring ~40 desktop computers, some of which also had occupancy loggers to tell when someone was using the computer. The savings are for desktop computers (and monitors) only.

Appendix B: Weather Normalization Methodology

We implemented an analysis of the monthly consumption for each home in relation to weather data to perform two important functions: (1) disaggregate weather-sensitive space heating and air conditioning use from other uses; and, (2) adjust heating and cooling consumption to long-term average weather conditions. This appendix provides details about the weather-normalization procedures that we used.

Given a history of monthly electricity or gas consumption for a given home and a database of daily outdoor temperatures for a nearby weather station, we fit one of four models to the data:

1. Model 1 (heating-only): Use per day = $\alpha + \beta_h h_{\tau h} + \varepsilon$
1. Model 2 (cooling-only): Use per day = $\alpha + \beta_c h_{\tau c} + \varepsilon$
2. Model 3 (heating-and-cooling): Use per day = $\alpha + \beta_h h_{\tau h} + \beta_c h_{\tau c} + \varepsilon$
3. Model 4 (no-heating-or-cooling): Use per day = $\alpha + \varepsilon$

where,

$\alpha \equiv$ non-weather sensitive (or base) use per day

$\beta_{h,c} \equiv$ use per heating or cooling degree day

$h_{h,c} \equiv$ average heating or cooling degree days per day from base temperature $\tau_{h,c}$, which in turn is calculated from daily average outdoor temperatures (T_{avg}) as:

$H_h \equiv \max(\tau_h - T_{avg}, 0)$

$H_c \equiv \max(T_{avg} - \tau_c, 0)$

and then averaged over the consumption period

$\tau_{h,c} \equiv$ base temperature for calculating heating or cooling degree days

$\varepsilon \equiv$ random error component

Model 1 (heating only) is appropriate for analyzing gas usage for houses with gas space heat or electrically-heated homes with no air conditioning. Model 2 (cooling only) is appropriate for analyzing electricity usage for houses with air conditioning but no electric space heat. Model 3 is appropriate for analyzing houses with electric space heat and air conditioning. Model 4 is appropriate for gas or electricity consumption where no space-heating or space-cooling equipment is present.

For each of the first three models, the α, β, and τ coefficients are fit individually to each house using a modified least-squares approach that searches across a range of τ values, and chooses the value(s) of τ with the best fit (r^2). An additional Bayesian component effectively restricts τ to be in a range that is typical of most homes, unless the improvement in fit is large.[12] The fourth model (no heating or cooling) is simply fit as the average consumption per day of the period analyzed.

[12] Specifically, we employed a Gaussian loss function centered at 60F with a standard deviation of 8F for $\tau_{h,c}$.

Lacking *a priori* knowledge about the presence or absence of heating and cooling equipment in individual homes, we fit all models to each home, and used goodness-of-fit criteria to select the most appropriate one. When analyzing electricity usage data, models 1, 2 or 3 were dropped from the selection pool if the r^2 statistic was below 0.5 or, in the case of the heating only and heating and cooling models, if a home's heating load was estimated to be less than 15 percent of its overall electricity usage. For gas usage data, the heating only model was dropped for homes where the r^2 statistic was below 0.7. Remaining models were then ranked by r^2 statistic for each home and the model with the highest statistic was selected. If none of the first three models passed the goodness-of-fit criteria for a given home, model 4 (no heating or cooling) was applied to the home.

Once the appropriate model is fit to the data, weather-normalized annual use for each component can be calculated using long-term average heating and/or cooling degree days at the fitted value(s) of τ. The long-term averages that we used were based on the period 1982-2012.

Appendix C: Homeowner Interview Guide

INTEREST IN SAVING ENERGY

You said you pay about ___ to ___ on monthly energy costs. Does that seem like a little, a lot, or somewhere in-between?

What makes you say that?

[if costs seem high]

Do your energy costs ever crowd out other needs or become difficult to pay?

Has your household done anything in particular since you have lived here (or in the past five years) to save on energy?

What have done?

What prompted you to do that?

Where did you get the initial idea?

How did it work out for you?

How closely do you pay attention to the various energy-saving tips that come up in the media and other places from time to time? Do you listen closely, tune out, or listen with one ear open?

Why do you *[whatever interviewee said in response to prior question]*?

Where do you tend to hear those tips the most?

What kinds of tips tend to be the most useful?

Whose tips tend to be the most useful?

UTILITY ENERGY EFFICIENCY PROGRAMS

[Note to Interviewer: Start with the utility for the priority fuel. Then move on to the other utility, if household is an electric and natural gas user. It's okay to be less thorough with the questions on the second utility.]

Electric Utility

What do you think of your electric utility company?

Do you tend to read materials they send with the bills or other mailings from them?

What kinds of things do they send you?

Do they offer any programs to help customers reduce their electricity usage?

What do they offer?

What do you think of these programs?

Have you ever participated?

In which program?

What prompted you to participate?

What was your experience with it?

[if interested non-participant] What would these programs need to look like before you'd participate in one?

Natural Gas Utility

What do you think of your natural gas utility company?

Do you tend to read materials they send with the bills or other mailings from them?

What kinds of things do they send you?

Do they offer any programs to help customers reduce their natural gas usage?

What do they offer?

What do you think of these programs?

Have you ever participated?

In which program?

What prompted you to participate?

What was your experience with it?

[if interested non-participant] What would these programs need to look like before you'd participate in one?

ENERGY SAVING OPPORTUNITIES

Next, I would like to ask you about a few money- and energy-saving opportunities I encountered in my walk-through. I will point out the top three and would like your sense of which of those you would earnestly consider, might consider, and would be unlikely to do. I'm not trying to promote these things, but only to understand whether any of them seem appealing and why.

[Describe the top three opportunities. Be sure to address any areas the interviewee asked about as well that did not make the list of top three opportunities.]

Do any of these surprise you?

Which, if any, would you consider earnestly? Which, if any, might you consider? Which, if any, would you be unlikely to do?

[Follow up with the questions in the table below, as appropriate.]

Would earnestly consider			
Opportunity-->	describe #1: _____	describe #2: _____	describe #3: _____
What is appealing about this?			
How much do you think you would save by doing this?			
What might hold you back from doing this?			

Might consider			
Opportunity-->	describe #1: _____	describe #2: _____	describe #3: _____
What is appealing about this?			
How much do you think you would save by doing this?			
What might hold you back from doing this?			
What else would you need to make a decision whether to do this?			
Unlikely to do			
Opportunity-->	describe #1: _____	describe #2: _____	describe #3: _____
What makes you disinclined to consider this?			

INFORMATION SOURCES

Let's shift gears for a few minutes before we wrap up.

Where do you tend to go for local information about things going on in your community and area?

Are there any particular local websites you frequent?

Are you active on social media?

DECISION MAKING

Now, I have a few questions to help me understand household decision-making, choices, and interests.

Who would you say is the primary decision-maker when it comes to decisions about appliance purchases?

What about home improvements?

Who would be most likely to open mail from your electric (and natural gas) utility companies?

HOUSEHOLD DRIVERS

Do you (or anyone else in the household) tend to do a lot of do-it-yourself projects on the house?

What kinds of things do you (he/she) like to do?

Do you consider your household to be thrifty?

If you could easily look up how your energy usage compares to your friends or neighbors, would you look it up?

[optional probe for those who say yes: What interests you about that?]

If you could add either some time to your day or a bit of money to your pocketbook, which sounds more appealing?

Next , I am going to read a list of issues. Please indicate whether you are not at all concerned, slightly concerned, somewhat concerned, or very concerned about each issue. How concerned are you about...?

a) the economy

b) the environment

c) energy

d) climate change

DEMOGRAPHICS

Finally, I have just a few demographic questions about your household. How many total people live here most of the year?

What is the highest level of formal education you have completed? *[If not interviewing a decision-maker about either appliance purchases or home improvements, try to ask about the main decision-maker Ask about the interviewee if he/she is a decision maker alone or in conjunction with someone else; otherwise, ask about the main decision-maker.]*

Which of the following broad categories best describes your household's income in 2013? *[Present card with broad categories and record letter response.]*

INTERVIEWER OBSERVATIONS

– What are your main take-aways from this visit?

General

For Electric HU's: what may be causing the high usage?

Response	
□ can't tell	
□ no particular cause(s)	
□ not sure, but might be...	
□ think it is...	

For Gas HU's: what may be causing the high usage?

Response	
□ can't tell	
□ no particular cause(s)	
□ not sure, but might be...	
□ think it is...	

Are there any "no brainer" energy saving opportunities here? (No brainer = substantial in size and clearly beneficial to do. No need to repeat full list from the opportunity checklist.)

Response	
□ can't tell	
□ not really	
□ not sure, maybe...	
□ think it is...	

What is the household's interest in saving energy?

Response	
□ unable to assess	
□ seems uninterested	
□ potentially interested, but with barriers beyond info & $s	
□ potentially interested	

What would a program need to do to engage this household?

Appendix D: Walk-Through Protocol

Field	*Question*	*Answer*
1. Before arrival		
intro_yes	**** 1. BEFORE ARRIVAL*****	Open Open Section
1. Before arrival > Intro questions		
note_intro	Fill out this section in the car prior to go into the home.	
interviewer	Interviewer's name	Joe Joe jeannette Jeannette ben Ben ingo Ingo
hh_id	Enter the household ID number	
change_name	Be sure to change the name at the end of the form when you Save Form and Exit.	
2. Meet and greet		
buildingbasics_yes	**** 2. MEET AND GREET QUESTIONS**** *The following section is related to building age, square footage and time in the household.*	Open Open Section
2. Meet and greet > building_basics		
age	In what decade was the house built? *Choose the closest decade*	decade_1920 1920s or before decade_1930 1930s decade_1940 1940s decade_1950 1950s decade_1960 1960s decade_1970 1970s decade_1980 1980s decade_1990 1990s decade_2000 2000s and beyond
sqft	What's the finished square footage of the house? *Refer to property data information, and confirm with homeowner.*	

Field	*Question*	*Answer*	
time_in_house	How long has the owner lived in the home? *Enter total years in home*		
bills_winter	About how much do you spend on your total energy bill in winter months?		
bills_summer	And in the summer months?		
points_of_interest	Are there any particular parts of the house or particular appliances that you think are particularly big energy users or that you are curious about from an energy standpoint?		
comfort_mg	Do you have any comfort issues in the home? *E.g. drafty in the winter, condensation on windows,*		
additions_mg	Any additions to the original structure?	Yes No	Yes No
detached_bldgs_mg	Are there any detached buildings with electricity? *Do not include garages.*	Yes No	Yes No
meetandgreet_notes	Add any additional notes about this meet and greet conversation		
3. Foundation spaces			
fdn_yes	**** 3. FOUNDATIONS ****	Open	Open Section
3. Foundation spaces > Basement			
bsmt_perc_footprint	Basement: what is the approximate % of footprint area?		
bsmt_finished	Is the basement finished or unfinished?	bsmt_unfinished bsmt_part_finished bsmt_finished	Unfinished Partially finished Finished
bsmt_conditioned	Is the basement conditioned or unconditioned?	Not intentionally Partly intentionally Fully intentionally	bsmt_cond_unintent conditioned bsmt_cond_part conditioned bsmt_cond_full conditioned

Field	*Question*	*Answer*	
bsmt_wall_insul	The walls are…	Uninsulated	Uninsulated
		part_insulated	Partially insulated
		fully_insulated	Fully insulated
		insul_hardtotell	Hard to tell if it's insulated or not
bsmt_floor_insul	The floor above is …	Uninsulated	Uninsulated
		part_insulated	Partially insulated
		fully_insulated	Fully insulated
		Insul_hardtotell	Hard to tell if it's insulated or not
bsmt_note	Provide additional detail on the basement insulation		
3. Foundation spaces > Crawlspaces			
crawl_perc_footprint	Crawlspace: what is the approximate % of footprint area?		
crawl_wall_insul	The walls are…	Uninsulated	Uninsulated
		part_insulated	Partially insulated
		fully_insulated	Fully insulated
		insul_hardtotel	Hard to tell if it's insulated or not
crawl_floor_insul	The floor above is …	Uninsulated	Uninsulated
		part_insulated	Partially insulated
		fully_insulated	Fully insulated
		insul_hardtotel	Hard to tell if it's insulated or not
crawl_note	Provide additional detail on the crawlspace insulatio		
3. Foundation spaces > Slab and			
slab_perc_footprint	Slab foundation: what is the approximate % of footprint area?		

Field	*Question*	*Answer*	
pier_perc_footprint	Pier foundation: what is the approximate % of footprint area?		
foundation_notes	Provide additional detail on the slab or pier foundations		
4. Primary Heating Systems			
htg_open	**** 4. PRIMARY HEATING SYSTEMS ***	Open	Open Section
4. Primary Heating Systems > htg_questions			
htg_sys_fue	What type of fuel does the heating system use?	htg_sys_electric htg_sys_ng htg_sys_prop htg_sys_oil	Electric Natural gas Propane Fuel Oil
htg_sys_type	Type of heating system	gas_furn gas_hyd_boiler gas_steam_boiler baseboard other	Forced-air furnace Hydronic boiler Steam boiler Baseboard Describe below
htg_sys_other	If other, describe "other" type of heating system		
4. Primary Heating System > Primary heating system details			
boiler_type	If boiler, what kind? *Look for a circulation pump (and if yes, hot-water)*	Steam Hotwater	Steam Hot water
Htg_eff	Heaing system efficiency	Condensing Noncondensing	Condensing Non condensing
4. Primary Heating System > Primary heating system photos			
htg_photo_afar	Take a picture of the heating system from afar *Make sure to stand back to get the whole system*		
htg_photo_servicetag	Take a picture of the heating system service tag if it has one *Double check the clarity of photo*		
htg_photo_eguide	Take a picture of the Energy Guide tag, if applicable		

Field	*Question*	*Answer*	
htg_photo_other	Here's room to take another picture if you'd like *Double check the clarity of the photo*		
5.. Water heaters			
dhw_open	**** 5. WATER HEATERS ***** *The following questions are for the water heater.*	Open	Open Section
5.. Water heaters > Water heater			
dhw_type	What kind of water heater is it?	wh_conventional wh_tankless wh_tankless	Conventional storage tank Tankless water heater Indirect fired by a space heater boiler
dhw_vent	What kind of venting does the water heater have? *If it's a tankless, enter power vented*	dhw_atmos dhw_power	Atmospherically vented Power vented
dhw_fuel	What kind of fuel does the water heater use?	naturalgas electric propane	Natural gas Electric Propane
dhw_wrap	Does the water heater have a insulating wrap? *Does not apply for tankless*	Yes No	Yes No
dhw_afar	Take a picture of the water heater from afar *Be sure to capture the venting system*		
dhw_nameplate	Take a picture of the water heater nameplate		
dhw_pic_eguide	Take a picture of the Energy Guide tag, if applicable		
dhw_notes	Add any notes about the domestic hot water heater here.		
6.. Ventilation			
vent_open	**** 5. VENTILATION ***** *The following questions are about the ventilation of the buildings.*	Open	Open Section

Field	*Question*	*Answer*	
6.. Ventilation > vent_questions			
hrv	Is there a Heat Recovery or Energy Recovery unit present?	Yes No	Yes No
cont_exhaust	Is there a continuously running exhaust fan?	Yes No	Yes No
vent_notes	Add any additional notes about the ventilation		
6.. Ventilation > Ventilation images			
hrv_pic_afar	Take a picture of the HRV/ERV from a distance		
hrv_pic_nameplate	Take a picture of the HRV/ERV nameplate		
hrv_control_pic	Take a picture of the HRV/ERV controller *This will likely be near the thermostat*		
cont_exhaust_pic	Take a picture of the exhaust fan if present		
7. Dehumidifiers			
dehumid_open	**** 5. DEHUMIDIFICATION ***** *Open this section if the house has dehumidifiers, either whole house or standalone*	Open	Open Section
7. Dehumidifiers > Dehumidifier questions (1)		(Repeated group)	
dehumid	What kind of dehumidifier? *Look for whole-home dehumidifiers on or near the furnace*	dehum_wholehouse dehum_standalone_drain dehum_standalone_manual	Whole house dehumidifier Standalone dehumidifier - connected to a drain must be emptied manually
dehumid_on	Is the dehumidifier plugged in or actively running? *It doesn't have to be cycling at the moment, but if you can see the settings on, then choose "yes"*	Yes No	Yes No
dehumid_afar	Take a picture of the dehumidifier from a distance		
dehumid_nameplate	Take a picture of the dehumidifier nameplate		

Field	*Question*	*Answer*	
dehumid_settings	Take a picture of the dehumidifier settings *For standalone dehumidifiers*		
dehumid_note	Provide additional details on the dehumidifier here		
8. Laundry			
laundry_open	**** 8. LAUNDRY **** *The following series of questions are laundry appliances*	Open	Open Section
8. Laundry > laundry_questions			
washer_type	What type of washing machine is it?	washer_top	Top loader
		washer_front	Front loader
washer_age	How old is the washing machine?	age5	<5 yrs (2010- present)
		age5_9	5-9 yrs (2005-2009)
		age10-14	10-14 yrs (2000-2004)
		age15-19	15-19 years (1995-1999)
		age20	20+ yrs (1994 or older)
		age_dk	don't know the age
dryer_fuel	What fuel is the dryer?	Naturalgas	Natural gas
		Electric	Electric
		Propoane	Propane
laundry_notes	Add any notes on laundry		
9. Air Conditioners			
clg_open	**** 9. AIR CONDITIONERS **** *The following series of questions are on the cooling systems. You will be able to take note of both the central AC and any room AC that the house has.*	Open	Open Section

Field	*Question*	*Answer*	
9. Air conditioners > Central AC			
clg_sys	Central cooling system type *(select all that apply)*	cc_cac cc_ashp cc_gshp cc_minisplit cc_none	Central AC Air-source heat pump Ground-source heat pump Ductless mini-split No central cooling system
clg_pic_afar	Central systems picture from afar *These pictures should be taken outside*		
clg_pic_nameplate	Central systems picture nameplate *These pictures should be taken outside*		
clg_pic_eguide	Take a picture of the Energy Guide tag, if applicable *There very likely is not a sticker, so don't worry if you can't find it*		
clg_sys_notes	Add any notes for central cooling system here		
9. Air conditioners > roomac_questions			
roomac	Are there any room or sleeve AC units?	Yes No	Yes No
9. Air conditioners > Room or Sleeve AC		(Repeated group)	
roomac_pic_bdrm	Take at least one picture of the room A/C		
roomac_pic_addtl	If needed, take another picture of the room A/C		
roomac_pic_addtl_notes	Provide any notes on the room AC unit pictured here.		

Field	*Question*	*Answer*	
10. Supplementary heating			
supp_htg_open	**** 10. SUPPLEMENTARY HEATING SYSTEMS **** *The following series of questions are related to supplemental space heating. You will be asked to add an image for each type of supplement space heating you choose. You will also have an opportunity to add additional pictures at the end of this section (just keep swiping and you'll see an "add-group" prompt)*	Open	Open Section
10. Supplementary heating > Supplementary heating questions (1)		(Repeated group)	
supp_htg	What kind of supplemental heating system is it? *Choose all that apply*	electric_space electric_bboard wood_stove fireplace_gas firplace_wood supp_htg_other	Electric space heater Electric baseboard Wood / pellet stove Gas fireplace wood-burning fireplace Other
supp_htg_other	If other, describe it here.		
supp_htg_pic_1	Take a picture of the supplemental heating system		
supp_htg_pic_2	If needed, take another picture of the supplemental heating system		
supp_htg_pic_3	If needed, take another picture of the supplemental heating system		
supp_htg_pic_notes	Add any notes for the additional supplemental heating type		
11. Ducts			
ducts_open	**** 11. DUCTS **** *We have just a couple questions on ducts and their location*	Open	Open Section
11. Ducts > ducts_questions			
ducts_ou	Are ducts outside the thermal envelope?	Yes No	Yes No

Field	*Question*	*Answer*	
ducts_loc	If yes, are they in...? *Hint: for attic, look for ceiling registers on the top story (select all that apply)*	Hardtotell Ducts_attic Ducts_garage Ducts_crawl Ducts_other	Hard to tell attic garage crawlspace other, specify below
ducts_notes	Add any notes for the ducts		
12. Thermostats			
tstat_open	**** 11. THERMOSTATS **** *The following questions are about the thermostats and their usage*	Open	Open Section
12. Thermostats > tstat_questions			
tstat_type	What kind of thermostat does the house have?	Tstat_nonprog Tstat_prog Tsta_dial Tstat_none	non programmable Programmable thermostat dial thermostat (no temperature settings) no thermostat
tstat_pic	Take a picture of the thermostat *Make sure it's not overlit and we can see the settings*		
tstat_pic2	Take another picture (optional)		
tstat_pic3	Take another picture (optional)		
tstat_notes	Provide any additional detail on tstats		
13. Kitchen			
kitch_open	**** 13. KITCHEN **** *The following series of questions pertain to the kitchen appliances and faucet temperatures*	Open	Open Section
13. Kitchen > kitch_questions			
range_fuel	What type of fuel does the range use?	Naturalgas Electric Propane	Natural gas Electric Propane
over_fuel	What type of fuel does the oven use?	Naturalgas Electric Propane	Natural gas Electric Propane

Field	*Question*	*Answer*	
refrig_type	What kind of refrigerator?	refrig_tf	Top freezer
		refrig_bf	Bottom freezer
		refrig_sbs	Side by side
refrig_age	How old is the refrigerator?	age5	<5 yrs (2010- present)
		age5_9	5-9 yrs (2005-2009)
		age10-14	10-14 yrs (2000-2004)
		age15-19	15-19 years (1995-1999)
		age20	20+ yrs (1994 or older)
		age_dk	don't know the age
refrig_notes	Provide any additional notes on the fridge or other items in the kitchen		
13. Kitchen > Photos of fridge			
refrig_photo_afa	Take a picture of fridge from afar		
refrig_photo_near	Take a picture of fridge nameplate		
13. Kitchen > Kitchen Lighting			
lght_kitchen	What's the most used kitchen light?	lght_incand	Incandescent
		lght_cfl	CFL
		lght_led	LED
		lght_lf	Linear Fluorescent
		lght_other	Other type of lighting
lght_kitchen_other	If "other," describe it here		
ght_kitchen_pic	Take a picture of the light		
kitchen_notes	Provide any additional details for the kitchen here.		
13. Kitchen > fauc_kitch_group			
Fauc_vol	Kitchen faucet volume		
Fauc_time	Kitchen faucet time		
fauc_temp	Kitchen faucet temperature (OPTIONAL)		
fauc_results	The results of the faucet flow are: [fauc_flow] gpm. There is an opportunity if the gpm is greater than 2		

Field	*Question*	*Answer*	
14. Secondary refrigerators & freezers			
second_fridge_open	**** 14. SECONDARY REFRIGERATORS & FREEZERS **** *The following series of questions focus on secondary refrigerators or freezers, if there are any.*	Open	Open Section
14. Secondary refrigerators & freezers > secondary refrigerator or freezer questions (1)			**(Repeated group)**
second_fridge_typ	Secondary refrigerator or freezer?	second_fridge_tf	Refrigerator, top freezer
		second_fridge_bf	Refrigerator, bottom freezer
		second_fridge_ss	Refrigerator, side by side
		second_fridge_sd	Refrigerator, single door
		second_fridge_compactfridge	Refrigerator, compact
		second_fridge_winecooler	Refrigeratore, wine cooler
		second_fridge_chestfreezer	Freezer, chest
		second_fridge_uprightfreezer	Freezer, upright
second_fridge_age	Age of the secondary refrigerator or freezer?	age5	<5 yrs (2010- present)
		age5_9	5-9 yrs (2005-2009)
		age10-14	10-14 yrs (2000-2004)
		age15-19	15-19 years (1995-1999)
		age20	20+ yrs (1994 or older)
		age_dk	don't know the age
second_fridge_on	Is the refrigerator or freezer plugged in?	Yes	Yes
		No	No
second_fridge_pic	Take a picture of second refrigerator/freezer from distance *Leave door open when taking the picture*		
second_freezer_pic	Take a picture of second refrigerator/freezer nameplate		
second_fridge_note	Add additional notes for the second refrigerator or freezer		

Field	*Question*	*Answer*	
15. Lighting			
lighting_open	**** 15. LIGHTING **** *The following series of questions focus on the lighting in the home. Take note of how many incandescents and CFLs/LEDs you see in the home while you walk through.*	Open	Open Section
15. Lighting > lighting_questions			
lighting_eff_bsmt	Basement: what percentage of interior lighting is efficient?	lght_0 lght_25 lght_50 lght_75 lght_100	0 0.25 0.5 0.75 1.0
lighting_eff_1st	1st Floor: what percentage of interior lighting is efficient?	lght_0 lght_25 lght_50 lght_75 lght_100	0 0.25 0.5 0.75 1.0
lighting_eff_2nd	2nd Floor: what percentage of interior lighting is efficient?	lght_0 lght_25 lght_50 lght_75 lght_100	0 0.25 0.5 0.75 1.0
lighting_eff_ext	Exterior: what percentage of interior lighting is efficient?	lght_0 lght_25 lght_50 lght_75 lght_100	0 0.25 0.5 0.75 1.0
lighting_on	Was there more than one light on in an unoccupied room? *We are looking for lights that are needlessly*	Yes No	Yes No
lighting_torchieres	Are there any halogen torchieres?	Yes No	Yes No
lighting_notes	Provide additional detail on lighting in the house.		
16. Electronics			
electronics_open	**** 16. ELECTRONICS **** *The following series of questions focus on the electronic equipment in the home, like TVs, gaming systems and computers.*	Open	Open Section

Field	Question	Answer	
16. Electronics > TV and peripherals			
tv_intro	Record the number of TVs (by type) below		
tv_small_qty	Small TV (<20") any type		
tv_medium_led_qty	Medium TV (20-32") -- Flat screen		
tv_medium_crt_qty	Medium TV (20-32") – CRT		
tv_large_qty	Large TV (38"+) -- any type *Record as Ad Hoc item (try to determine if*		
vcr_dvd_qty	VCR or DVD player		
dvr_qty	DVR		
settop_boxes_qty	Set-top boxes (cable or satellite) *No DVR, no converters*		
16. Electronics > Computer equipment			
computer_equip_intro	Record the quantity of items below		
desktop_comp_qty	Desktop computers		
monitor_lcd_qty	Monitors, flat screen		
monitor_crt_qty	Monitors, CRT		
desktop_operation	Was any desktop CPU running with no indication that the computer is being used? *Look for LED "on light" on computer itself. Is the monitor off and work station seemed*	Yes No Hardtotell	Yes No Hard to tell
speakers_qty	Powered speaker		
network_equip_qty	Networked equipment *includes modems and routers*		
printer	Printers		
laptop	Laptop computers		
electronics_notes	provide any additional detail on computer equipment here		
16. Electronics > Audio equipment			
audio_intro	Record the quantity of items below		

Field	*Question*	*Answer*	
stereo_qty	Stereo component		
compact_stereo_qty	Compact stereo		
cd_player_qty	CD player		
audio_notes	provide any additional detail on audio equipment here		
17 Showerheads			
shwr_open	**** 17. SHOWERHEADS **** *The following series of questions focus on showerhead measurements and flow. This section is OPTIONAL, depending on input from Scott Pigg on*	Open	Open Section
17. Showerheads > shwr_questions			
shwr_note	Take measurements of showerhead flow for the most used showers *(up to 2 showers)*		
shwr_volume1	Shower bucket volume (first shower)		
shwr_time1	Shower time (first shower)		
shwr_volume2	Shower bucket volume (second shower)		
shwr_time2	Shower time (second shower)		
shwr_results	The results of the showerhead flow are: first shower: [shwr_flow1] gpm and second shower: [shwr_flow2] gpm. There is an opportunity if the gpm is greater than 2.25.		
18. Exterior			
exterior_yes	*** 18. EXTERIOR ***** *The next series of questions are related to exterior features of the home, including garages, additions, and detached buildings.*	Open	Open Section

Field	*Question*	*Answer*	
18. Exterior > House type group			
house_type	Type of house?	hstype_ranch	Ranch (typical one story)
		hstype_splitranch	Split level ranch
		hstype_cape	1 1/2 stories
		hstype_colonial	2 stories
		hstype_other	Other type of housing(describe below)
house_type_other	Describe the "other" kind of house		
siding_brick	Is the siding predominantly brick or stone?	Yes	Yes
		No	No
garage_type	Garage type, if any?	garage_detached	Detached garage
		garage_attached	Attached garage
		garage_none	No garage
garage_livingspace	Is there living space above the attached garage?	Yes	Yes
		No	No
garage_det_power	Is there power to the detached garage?	Yes	Yes
		No	No
garage_det_power_note	If there is electricity in the attached garage, be sure to inspect and take note of electricity users and opportunities *Describe what you find here. If there are no electrical opportunities, write "none"*		
additions	Any additions to the original structure?	Yes	Yes
		No	No
additions_desc	Describe the additions. *Note the type of space added, the foundation type, when added, and how the space is heated and cooled*		
detached_bldgs	Are there any detached buildings with electricity? *Do not include garages. Make sure to look for outbuildings, like sheds or barns*	Yes	Yes
		No	No
detached_bldgs_desc	Inspect the detached building for electricity opportunities. *Describe what you find here. If there are no electrical opportunities, write "none"*		

Field	*Question*	*Answer*	
bldg_general_notes	Is there anything else you'd like to note on the house in general?		
sqft_notes	Check SQ FT and provide any notes about the new square feet calculation, if you need to pay attention to it (per the HH profile)		
18. Exterior > House type group > Exterior photos			
exterior_pic1	Exterior photo 1		
exterior_pic2	Exterior photo 2		
exterior_pic3	Exterior photo 3		
exterior_pic4	Exterior photo 4		
exterior_pic5	Exterior photo 5 *(optional)*		
exterior_pic_note	Provide any additional detail about the exterior pictures here		
19. Insulation			
insul_open	**** 19. INSULATION ***** *The following questions are about both above ground insulation (walls) and attic insulation*	Open	Open Section
19. Insulation > Above grade wall insulation (1)			(Repeated group)
agw_desc	Location description of the wall cavity *e.g. main house or addition*		
agw_insul	What is the level of insulation for the above grade walls?	agw_fully_insul	Appear to be fully insulated
		agw_part_insul	Appear to be partially insulated
		agw_uninsulated	Appear to be uninsulated
		agw_not_assess	Unable to assess
agw_fully_insul	Approximately what % of gross wall area that's insulated *No need to write the % symbol*		

Field	*Question*	*Answer*	
agw_determined	How did you determine the AGW insulation?	agw_visual	Visual inspection of cavity
		agw_evidence	Evidence of retrofitted insulation
		agw_homeowner	Per homeowner
		agw_ircamera	Used the IR camera
		agw_assumed	Assumed, based on home age
agw_pic	If you'd like, take a picture for the wall insulation		
agw_notes	Add any notes here about the wall insulation.		
19. Insulation > Attic space (1)			(Repeated group)
attic_note	The following questions are in regards to the attic insulation		
attic_desc	Location description of the attic space *e.g. main attic or ceiling over addition*		
attic_type	What kind of attic space is this?	attic_open	Open attic
		attic_floored	Floored attic
		attic_enclosed	Enclosed attic
attic_perc	What percentage of total ceiling area? *No need to write the % symbol*		
attic_exist_insul	What type of existing insulation, if any?	insul_fglass	Fiberglass insulation
		insul_batt	Batt insulation
		insul_cellulose	Cellulose insulation
		insul_other	Other type of insulation
attic_exist_insul_depth	What's the depth (in) of existing insulation?		
attic_insul_max_depth	What's the maximum possible depth (in) of insulation? *Enter "99" for open attics*		
attic_insul_pic	If you'd like, take a picture of attic insulation		
attic_insul_notes	Write any additional notes for this attic type here		

Field	*Question*	*Answer*	
20. Windows			
window_open	**** 20. WINDOWS **** *The following series of questions are focused on windows*	Open	Open Section
20. Windows > window_questions			
window_type	What is the dominant window type?	wind_single	Single pane glass
		wind_double	Double pane glass
		wind_singlestorm	Single pane with storm windows
		wind_doublestorm	Double pane with storm windows
		wind_triple	Triple pane windows
window_glass	Are there large areas of glass that might have a big impact on heating or cooling??	Yes	Yes
		No	No
window_glass_image	Take a picture if there is a large area of glass		
window_notes	Describe additional notes on windows		
21. Blower door			
blower_yes	**** 21. BLOWER DOOR ****	Open	Open Section
21. Blower door > Blower door and pressure pan			
bd_prep	Prep for the blower door test *Confirm each prep step*	prep_1	Exterior windows/doors closed
		prep_2	combustion devices disabled
		prep_3	Fireplace damper closed, ashes covered
		prep_4	Air handler, exhaust fans off
		prep_5	interior doors open
		prep_6	basement door open (unless thermally isolated from house
bd_cfm50	Results from the blower door (CFM50)		
bd_ring	Blower door ring *-99 if not used*		
bd_desc	Describe any notable leakage areas		

Field	*Question*	*Answer*	
21. Blower door > Pressure pan test			
pp_loc	Locations *Check all that apply*	pp_attic pp_crawl pp_uncondbsmt pp_floorovergarage pp_exteriorwall pp_other pp_other	Attic Crawlspace Unconditioned basement Floor over garage Exterior wall Other (1) – describe below Other (2) – describe below
pp_loc_other1	Describe "Other (1)" location		
pp_loc_other2	Describe "Other (2)" location		
21. Blower door > PP readings			
pp_supply1	<1 pa Supply		
pp_return1	<1 pa Return		
pp_supply1_3	1-3 pa Supply		
pp_return1_3	1-3 pa Return		
pp_supply3_5	3-5 pa Supply		
pp_return3_5	3-5 pa Return		
pp_supply5_10	5-10 pa Supply		
pp_return5_10	5-10 pa Return		
pp_supply10_20	10-20 pa Supply		
pp_return10_20	10-20 pa Return		
pp_supply20up	>20 pa Supply		
pp_return20up	>20 pa Return		
21. Blower door > Details for all readings of 5+ Pa (1)			
pp_details_pa	Pa reading		
pp_details_loc	Location		

Field	*Question*	*Answer*	
pp_details_issue	Observed issue (e.g. disconnected duct)		
air_leakage_note	The blower door text results of an annual potential therms savings of [air_leakage_rate]. If this rate is greater than 25, then air leakage is an opportunity.		
bd_takedown_list	Blower door take down list	takedown_1	Doors/windows open
		takedown_1	Combustion devices re-enabled
		takedown_1	Fireplace damper open
		takedown_1	Air handler, exhaust fans back on to original setting
22. Ad hoc items			
addtl_open	**** 22. AD HOC ITEMS **** *See something that we haven't mentioned before -- describe it below. You can add as many items as you want.*	Open	Open Section
22. Ad hoc items > Additional Items (1)			(Repeated group)
adhoc_type	What kind of ad hoc item is this?	opportunity	Energy efficiency opportunity
		additional	Additional detail for another section in the form
		interesting	Interesting thing about the house
		random	Totally random thing that I wanted to note
		other	Something else, described below
addtl_desc	Describe the additional items here.		
addtl_pic	Take a picture of the item		
addtl_pic2	If you need it, another place to take a picture		
23. Final Review			
checklist_open	**** 23. FINAL REVIEW****	Open	Open Section

Field	*Question*	*Answer*	
23. Final Review > checklist_questions			
fdn_confirm	Did you mean to skip questions on the BASEMENT AND CRAWLSPACES? *If not, go back and add information. If yes, just confirm below*	confirm	Confirm
htg_confirm	Did you mean to skip questions on the HEATING SYSTEM? *If not, go back and add information. If yes, just confirm below*	confirm	Confirm
dhw_confirm	Did you mean to skip questions on the WATER HEATER? *If not, go back and add information. If yes, just confirm below*	confirm	Confirm
clg_confirm	Did you mean to skip questions on the COOLING SYSTEM? *If not, go back and add information. If yes, just confirm below*	confirm	Confirm
ducts_confirm	Did you mean to skip questions on the DUCTS? *If not, go back and add information. If yes, just confirm below*	confirm	Confirm
insul_confirm	Did you mean to skip questions on INSULATION? *If not, go back and add information. If yes, just confirm below*	confirm	Confirm
tstat_confirm	Did you mean to skip questions on the THERMOSTAT? *If not, go back and add information. If yes, just confirm below*	confirm	Confirm
vent_confirm	Did you mean to skip questions on the VENTILATION *If not, go back and add information. If yes, just confirm below*	confirm	Confirm
window_confirm	Did you mean to skip questions on the WINDOWS? *If not, go back and add information. If yes, just confirm below*	confirm	Confirm

Field	*Question*	*Answer*	
kitch_confirm	Did you mean to skip questions on the KITCHEN? *If not, go back and add information. If yes, just confirm below*	confirm	Confirm
lighting_confirm	Did you mean to skip questions on the LIGHTING? *If not, go back and add information. If yes, just confirm below*	confirm	Confirm
electronics_confirm	Did you mean to skip questions on the ELECTRONICS? *If not, go back and add information. If yes, just confirm below*	confirm	Confirm
laundry_confirm	Did you mean to skip questions on LAUNDRY? *If not, go back and add information. If yes, just confirm below*	confirm	Confirm
exterior_confirm	Did you mean to skip the EXTERIOR questions? *If not, go back and add information. If yes, just confirm below*	confirm	Confirm
blower_confirm	Did you mean to skip the BLOWER DOOR? *If not, go back and add information. If yes, just confirm below*	confirm	Confirm
youdidit	You completed the walk-through. Good job!	confirm	Confirm
24. Interview-pt1			
owner_oper_yes	**** 24. OWNERS OPERATIONS QUESTIONS **** *The following section includes questions related to the operation of equipment and settings of equipment of the household*	Open	Open Section
24. Interview-pt1 > owner_tech_age_questions			

Field	*Question*	*Answer*	
htg_age	Age of the heating system	age5	<5 yrs (2010- present)
		age5_9	5-9 yrs (2005-2009)
		age10-14	10-14 yrs (2000-2004)
		age15-19	15-19 years (1995-1999)
		age20	20+ yrs (1994 or older)
		age_dk	don't know the age
clg_age	Central cooling system age	age5	<5 yrs (2010- present)
		age5_9	5-9 yrs (2005-2009)
		age10-14	10-14 yrs (2000-2004)
		age15-19	15-19 years (1995-1999)
		age20	20+ yrs (1994 or older)
		age_dk	don't know the age
hrv_age	Age of the HRV system	age5	<5 yrs (2010- present)
		age5_9	5-9 yrs (2005-2009)
		age10-14	10-14 yrs (2000-2004)
		age15-19	15-19 years (1995-1999)
		age20	20+ yrs (1994 or older)
		age_dk	don't know the age
lighting_24hr	Are there any lights you leave on for 12 or 24 hours?	Yes	Yes
		No	No
lighting_24hr_desc	If yes, describe the lighting that's on for 12 or 24 hours		
lighting_waste	How commonly do you have lights on in rooms that aren't used? Does that happen	Never	Never or rarely
		Week	Every week or two
		Days	Every few days
		Alltime	All the time
computer_operations	Optional if notice lots of TVs/gaming systems: Do you run any of your TVs, gaming systems, or other major electronic devices more than 4 hours per day on average? *Do any of these devices run a lot (4+ hours/day) in the background or when not being actively used?*		

Field	*Question*	*Answer*	
24. Interview-pt1 > Winter tstat usage			
temp_home_winter	At what temperature do you keep home when home and awake (winter)		
temp_sleep_winter	When asleep? (winter)		
temp_away_winter	When away? (winter)		
tstat_manual_winter	Do you change it manually or have the tstat change it automatically?	temp_auto	Temperature is set automatically
		temp_manual	Temperature is set manually
		temp_depends	Depends on situation
tstat_winter_desc	Provide additional detail here		
24. Interview-pt1 > Summer tstat usage			
temp_home_summer	At what temperature do you keep home when home and awake (summer)		
temp_sleep_summer	When asleep? (summer)		
temp_away_summer	When away? (summer)		
tstat_manual_summer	Do you change it manually or have the tstat change it automatically?	temp_auto	Temperature is set automatically
		temp_manual	Temperature is set manually
		temp_depends	Depends on situation
24. Interview-pt1 > Owner HVAC operational questions			
owner_furnace_auto	Do you ever set your furnace fan to 'On' so that it runs continuously, regardless of whether the heating or cooling system is operating? *Looking for only long-periods of time when it's on.*	Yes	Yes
		No	No
		Not sure	Not sure
owner_furnace_auto_desc	If yes, describe when and for what reason		
owner_dehumid_oper	How much do you run the dehumidifier?	dehum_partsumme	Part of the summer
		dehum_allsummer	All summer
		dehum_yrround	Year-round
		dehum_other	Other
owner_dehumid_oper_desc	Describe if "other" way of operating the dehumidifier.		

Field	*Question*	*Answer*	
owner_hrv_oper	How much do you run the Heat Recovery Ventilator?		
owner_supphtg_oper	How often do you run your supplemental heating? *When? Where? Under what circumstances? (e.g. under the desk while working vs. heating half the house during cold nights). Provide notes for all kinds of supplemental heating*		
owner_hotwater_ope	Do you use a lot of hot water for anything in particular -- like long or very frequent showers or baths or a lot of loads of laundry on the "hot" setting?"		
owner_other_desc	Ask the owner about anything else you saw that may be a high energy consumer (if applicable) *Ask about operation and usage patterns*		
25. Interview - pt2			
owner_int_yes	**** 25. INTERVIEW QUESTIONS **** *The following section includes questions related to the operation of equipment and settings of equipment of the household*	Open	Open Section
25. Interview - pt2 > interview_questions			
interview1	Does energy bills seem like a little, a lot, or somewhere in-between? *What makes you say that? Other needs crowded out? Difficult to pay?*		
Interview2	Has your household done anything in particular since you have lived here (or in the past five years) to save on energy? *What have done? What prompted to do that? Initial idea? How did it work out?*		
Interview3	How closely do you pay attention to the various energy-saving tips that come up in the media and other places from time to time? *Where do you hear? What tips most useful? Whose tips?*		

Field	*Question*	*Answer*
Interview4	What do you think of electric company?	
Interview5	Do you read materials the electric company sends with the bills?	
Interview6	What kinds of things does the electric company send you?	
Interview7	Does the electric company offer any programs to help customers reduce usage? *What do they offer? What do you think of programs? Ever participated?*	
Interview8	What do you think of natural gas company?	
Interview9	Do you read materials gas company send with the bills?	
Interview10	What kinds of things do gas company send you?	
Interview11	Does gas company offer any programs	
25. Interview - pt2 > Energy savings opps interview		
ee_opps_desc	Describe top three opps	
ee_opps_surprise	Do any of these surprise you?	
ee_opps_consider	Which would you consider earnestly, might consider, unlikely to do?	
ee_opps_earnest1	Earnestly consider #1	
ee_opps_earnest_appeal1	#1a: What is appealing about this?	
ee_opps_earnest_saving1	#1a: How much do you think you'd save?	
ee_opps_earnest_holdback1	#1a: What might hold you back?	
ee_opps_earnest2	Earnestly consider #2	
ee_opps_earnest_appeal2	#2a: What is appealing about this?	
ee_opps_earnest_saving2	#2a: How much do you think you'd save?	
ee_opps_earnest_holdback2	#2a: What might hold you back?	
ee_opps_earnest3	Earnestly consider #3	
ee_opps_earnest_appeal3	#3a: What is appealing about this?	

Field	*Question*	*Answer*
ee_opps_earnest_saving3	#3a: How much do you think you'd save?	
ee_opps_earnest_holdback3	#3a: What might hold you back?	
ee_opps_might1	Might consider #1	
ee_opps_might_appeal1	#1: What is appealing about this?	
ee_opps_might_saving1	#1b: How much do you think you'd save?	
ee_opps_might_holdback1	#1b: What might hold you back?	
ee_opps_might_decision1	#1b: What else would you need to have to make decision?	
ee_opps_might2	Might consider #2	
ee_opps_might_appeal2	#2: What is appealing about this?	
ee_opps_might_saving2	#2b: How much do you think you'd save?	
ee_opps_might_holdback2	#2b: What might hold you back?	
ee_opps_might_decision2	#2b: What else would you need to have to make decision?	
ee_opps_might3	Might consider #3	
ee_opps_might_appeal3	#3: What is appealing about this?	
ee_opps_might_saving3	#3b: How much do you think you'd save?	
ee_opps_might_holdback3	#3b: What might hold you back?	
ee_opps_might_decision3	#3b: What else would you need to have to make decision?	
ee_opps_unlikely1	Unlikely to do #1	
ee_opps_unlikely_why1	#1c: What makes you disinclined to consider this?	
ee_opss_unlikely2	Unlikely to do #2	
ee_opps_unlikely_why2	#2c: What makes you disinclined to consider this?	
ee_opss_unlikely3	Unlikely to do #3	
ee_opps_unlikely_why3	#3c: What makes you disinclined to consider this?	

Field	*Question*	*Answer*	
25. Interview - pt2 > Information and decision			
local_info	Where do you go for local info? *Particular websites? Active on social media?*		
primary_decision_appliance	Who is primary decision maker for appliance purchases?		
primary_decision_home	Who is primary decision maker for home improvements?		
primary_mailopener	Who is most likely to open mail from utility companies?		
diy	Household tend to do a lot of DIY projects?		
diy_desc	What kind of DIY projects		
hh_thrifty	Consider household to be thrifty?		
energy_compare	Would you look up comparison energy use? *What interests you about that?*		
time_v_money	Would you rather have time or money?		
altruism	Household altruism		
concern_economy	How concerned are you about the economy ? *Not at all concerned, slightly concerned, somewhat concerned, very concerned*	not_concern slight_concern somewhat_concern very_concern	Not at all concerned Slightly concerned somewhat concerned Very concerned
concern_environ	How concerned are you about environment? *Not at all concerned, slightly concerned, somewhat concerned, very concerned*	not_concern slight_concern somewhat_concern very_concern	Not at all concerned Slightly concerned somewhat concerned Very concerned
concern_energy	How concerned are you about energy ? *Not at all concerned, slightly concerned, somewhat concerned, very concerned*	not_concern slight_concern somewhat_concern very_concern	Not at all concerned Slightly concerned somewhat concerned Very concerned

Field	*Question*	*Answer*	
concern_climate	How concerned are you about climate? *Not at all concerned, slightly concerned, somewhat concerned, very concerned*	not_concern slight_concern somewhat_concern very_concern	Not at all concerned Slightly concerned somewhat concerned Very concerned
25. Interview - pt2 > Demographics			
hh_size	Number of people live here most of year?		
hh_educ	Highest level of education		
hh_income	Select the broad category that describes hh income		
26. . Opportunities			
ee_opps_open	**** 26. OPPORTUNITIES **** *The following series of questions will help us quickly understand the EE opportunities available in the home. Fill out the section immediately post visits along with the interview*	Open	Open Section
26. Opportunities > ee_opps_questions			
26. Opportunities > ee_opps_questions > hvac_opps			
generated_table_list_label_526	HVAC opportunities *(YES=technical opp exists; NO=no technical opportunity; NA=not applicable; DK= Don't know)*		
reserved_name_for_field_list_labels_527		opps_yes opps_no opps_na opps_dk	YES NO NA DK
hvac_opp_htgsystem	High efficiency heating syste	opps_yes opps_no opps_na opps_dk	YES NO NA DK
hvac_opp_fuelswitch	Heating system fuel switch	opps_yes opps_no opps_na opps_dk	YES NO NA DK

Field	*Question*	*Answer*	
hvac_opp_tstatsettings	Thermostat settings	opps_yes	YES
		opps_no	NO
		opps_na	NA
		opps_dk	DK
hvac_opp_furnacefan	Furnace Fan operation	opps_yes	YES
		opps_no	NO
		opps_na	NA
		opps_dk	DK
hvac_opp_electricheater	Electric space heater (or other supp heat use) reduction	opps_yes	YES
		opps_no	NO
		opps_na	NA
		opps_dk	DK
hvac_opp_manageac	Manage AC use	opps_yes	YES
		opps_no	NO
		opps_na	NA
		opps_dk	DK
hvac_opp_cac	Central AC replacement	opps_yes	YES
		opps_no	NO
		opps_na	NA
		opps_dk	DK
hvac_opp_rac	Room AC replacement	opps_yes	YES
		opps_no	NO
		opps_na	NA
		opps_dk	DK
hvac_opp_duct	Duct sealing	opps_yes	YES
		opps_no	NO
		opps_na	NA
		opps_dk	DK
hvac_opp_ventsystem	Manage ventilation system	opps_yes	YES
		opps_no	NO
		opps_na	NA
		opps_dk	DK
hvac_opps_notes	HVAC opps notes		

Field	*Question*	*Answer*	
26. Opportunities > ee_opps_questions > shell_opps			
generated_table_list_label_539	Shell measures *(YES= technical opp exists; NO= no technical opportunity; NA = not applicable; DK= Don't know)*		
reserved_name_for_field_list_labels_540		opps_yes	YES
		opps_no	NO
		opps_na	NA
		opps_dk	DK
shell_opp_wallinsul	Wall insulation	opps_yes	YES
		opps_no	NO
		opps_na	NA
		opps_dk	DK
shell_opp_ceilinsul	Ceiling insulation	opps_yes	YES
		opps_no	NO
		opps_na	NA
		opps_dk	DK
shell_opp_insulother	Other insulation	opps_yes	YES
		opps_no	NO
		opps_na	NA
		opps_dk	DK
shell_opp_airleakage	Air leakage reduction	opps_yes	YES
		opps_no	NO
		opps_na	NA
		opps_dk	DK
shell_opp_windowreplace	Window replacement	opps_yes	YES
		opps_no	NO
		opps_na	NA
		opps_dk	DK
shell_opp_notes	Notes on Shell opportunities		
26. Opportunities > ee_opps_questions > dhw_opps			
generated_table_list_label_547	DHW measures *(YES= technical opp exists; NO= no technical opportunity; NA = not applicable; DK= Don't know)*		

Field	*Question*	*Answer*	
reserved_name_for_field_list_labels_548		opps_yes	YES
		opps_no	NO
		opps_na	NA
		opps_dk	DK
dhw_opp_fuelswitch	Water heater fuel switch	opps_yes	YES
		opps_no	NO
		opps_na	NA
		opps_dk	DK
dhw_opp_upgrade	Water heater eff upgrade	opps_yes	YES
		opps_no	NO
		opps_na	NA
		opps_dk	DK
dhw_opp_shwrhead	showerhead replacements	opps_yes	YES
		opps_no	NO
		opps_na	NA
		opps_dk	DK
dhw_opp_aerator	Aerators	opps_yes	YES
		opps_no	NO
		opps_na	NA
		opps_dk	DK
dhw_opp_temp	Temp reduction	opps_yes	YES
		opps_no	NO
		opps_na	NA
		opps_dk	DK
dhw_opp_dhwwrap	Water heater wrap	opps_yes	YES
		opps_no	NO
		opps_na	NA
		opps_dk	DK
dhw_opp_habit	Water-use habits	opps_yes	YES
		opps_no	NO
		opps_na	NA
		opps_dk	DK
dhw_opp_notes	Notes on DHW opportunities		

Field	*Question*	*Answer*	
26. Opportunities > ee_opps_questions > appl_opps			
generated_table_list_label_557	Appliance measures *(YES= technical opp exists; NO= no technical opportunity; NA = not applicable; DK= Don't know)*		
reserved_name_for_field_list_labels_558		opps_yes	YES
		opps_no	NO
		opps_na	NA
		opps_dk	DK
appl_opp_fridgereplace	Fridge/freezer replace	opps_yes	YES
		opps_no	NO
		opps_na	NA
		opps_dk	DK
appl_opp_fridgeremove	Fridge/freezer removal	opps_yes	YES
		opps_no	NO
		opps_na	NA
		opps_dk	DK
appl_opp_washerreplace	Washer replacement	opps_yes	YES
		opps_no	NO
		opps_na	NA
		opps_dk	DK
appl_opp_dryerfuel	Dryer fuel switch	opps_yes	YES
		opps_no	NO
		opps_na	NA
		opps_dk	DK
appl_opp_laundryhabit	Laundry habits	opps_yes	YES
		opps_no	NO
		opps_na	NA
		opps_dk	DK
appl_opp_dehumreplace	Dehumidifier replacement	opps_yes	YES
		opps_no	NO
		opps_na	NA
		opps_dk	DK

Field	*Question*	*Answer*	
appl_opp_dehumuse	Manage dehumidifier use	opps_yes	YES
		opps_no	NO
		opps_na	NA
		opps_dk	DK
appl_opp_notes	Notes on appliance opportunities		
26. Opportunities > ee_opps_questions > light_opps			
generated_table_list_label_567	Lighting measures *(YES= technical opp exists; NO= no technical opportunity; NA = not applicable; DK= Don't know)*		
reserved_name_for_field_list_labels_568		opps_yes	YES
		opps_no	NO
		opps_na	NA
		opps_dk	DK
light_opp_extupgrade	Exterior lighting efficiency upgrade	opps_yes	YES
		opps_no	NO
		opps_na	NA
		opps_dk	DK
light_opp_extsensor	Exterior lighting photocell/timer	opps_yes	YES
		opps_no	NO
		opps_na	NA
		opps_dk	DK
ight_opp_intupgrade	Hi efficiency interior lighting	opps_yes	YES
		opps_no	NO
		opps_na	NA
		opps_dk	DK
light_opp_usage	Manage lighting use	opps_yes	YES
		opps_no	NO
		opps_na	NA
		opps_dk	DK
light_opp_notes	Notes on lighting opportunities		

Field	*Question*	*Answer*	
26. Opportunities > ee_opps_questions > elec_opps			
generated_table_list_label_574	Electronics measures *(YES= technical opp exists; NO= no technical opportunity; NA = not applicable; DK= Don't know)*		
reserved_name_for_field_list_labels_57		opps_yes	YES
		opps_no	NO
		opps_na	NA
		opps_dk	DK
elec_opp_desktopmgmt	Desktop computer mgmt	opps_yes	YES
		opps_no	NO
		opps_na	NA
		opps_dk	DK
elec_opp_usage	Use habits	opps_yes	YES
		opps_no	NO
		opps_na	NA
		opps_dk	DK
elec_opp_notes	Notes on electronics opportunities		
26. Opportunities > ee_opps_questions > inter_opps			
generated_table_list_label_579	Discussed Opportunites *Write the number of opportunity you discussed during interview*		
hvac_opp_htgsystem_interview	High efficiency heating system		
hvac_opp_fuelswitch_interview	Heating system fuel switch		
hvac_opp_tstatsettings_interview	Thermostat settings		
hvac_opp_furnacefan_interview	Furnace Fan operation		
hvac_opp_electricheater_interview	Electric space heater (or other supp heat use) reduction		
hvac_opp_manageac_interview	Manage AC use		
hvac_opp_cac_interview	Central AC replacement		
hvac_opp_rac_interview	Room AC replacement		
hvac_opp_duct_interview	Duct sealing		

Field	*Question*	*Answer*
hvac_opp_ventsystem_interview	Manage ventilation system	
shell_opp_wallinsul_interview	Wall insulation	
shell_opp_ceilinsul_interview	Ceiling insulation	
shell_opp_insulother_interview	Other insulation	
shell_opp_airleakage_interview	Air leakage reduction	
shell_opp_windowreplace_interview	Window replacement	
dhw_opp_fuelswitch_interview	Water heater fuel switch	
dhw_opp_upgrade_interview	Water heater eff upgrade	
dhw_opp_shwrhead_interview	showerhead replacements	
dhw_opp_aerator_interview	Aerators	
dhw_opp_temp_interview	Temp reduction	
dhw_opp_dhwwrap_interview	Water heater wrap	
dhw_opp_habit_interview	Water-use habits	
appl_opp_fridgereplace_interview	Fridge/freezer replace	
appl_opp_fridgeremove_interview	Fridge/freezer removal	
appl_opp_washerreplace_interview	Washer replacement	
appl_opp_dryerfuel_interview	Dryer fuel switch	
appl_opp_laundryhabit_interview	Laundry habits	
appl_opp_dehumreplace_interview	Dehumidifier replacement	
appl_opp_dehumuse_interview	Manage dehumidifier use	
light_opp_extupgrade_interview	Exterior lighting efficiency upgrade	
light_opp_extsensor_interview	Exterior lighting photocell/timer	
light_opp_intupgrade_interview	Hi efficiency interior lighting	
light_opp_usage_interview	Manage lighting use	
elec_opp_desktopmgmt_interview	Desktop computer mgmt	
elec_opp_unplug_interview	Unplug opportunities	
elec_opp_usage_interview	Use habits	

Field	*Question*	*Answer*	
27. . Interviewer observations			
int_obs_open	**** INTERVIEWER OBSERVATIONS **** *What are your main takeaways from this visit?*	Open	Open Section
27. Interviewer observations > int_obs_questions			
int_obs_general	Provide a general summary of what you saw in the home and dynamics of the household?		
electric_hu_cause	For electric HU's, what may be causing the high usage?	cause_canttell cause_noparticularcause cause_notsurebutmightb cause_thinkitis	Can't tell No particular cause(s) Not sure but might be… Think it is…
electric_hu_cause_desc	Provide more detail about your answer above		
gas_hu_cause	For gas HU's, what may be causing the high usage?	cause_canttell cause_noparticularcause cause_notsurebutmightb cause_thinkitis	Can't tell No particular cause(s) Not sure but might be… Think it is…
gas_hu_cause_desc	Provide more detail about your answer above		
no_brainer_opps	Are there any no-brainer energy savings opportunities?	ause_canttell cause_noparticularcause cause_notsurebutmightb cause_thinkitis	Can't tell No particular cause(s) Not sure but might be… Think it is…
no_brainer_desc	Provide more detail about your answer above		
hh_interest	What's the household interest in saving energy?	interest_unableassess interest_uninterested interest_interested_barriers interest_interested	Unable to Assess Seems uninterested Potentially interested, but with barriers beyond info & $ Potentially interested

Field	*Question*	*Answer*
hh_interest_desc	Describe the household interest in more detail.	
program_engage	What would a program need to do to engage this household?	
**** Final photos ***		

Appendix E: Pilot Postcards

Duluth Postcard Mailer

Duluth postcard front

Minnesota Power can help!

minnesota power
AN ALLETE COMPANY

power of one
a conservation program

Duluth postcard back with *treatment* group message

Your home uses more energy than the average home in Duluth. Act now to learn how you can save energy and enhance your home's comfort.

Here's how to get started

Understand how you use energy.
Go to www.mnpower.com/portal and login to complete or update the Your Home Energy Report (YHER) survey. If you are a new user, you'll need an email address and your Minnesota Power account number to register.
Enter event code **SAVE353**.

Act on recommendations.
Our ideas will help you save energy, save money and increase the comfort of your home.

Questions?
Call us at **218-355-2843** or email us at **powerofone@mnpower.com**

Duluth postcard back with *control* group message

Rochester Postcard

Rochester postcard front

Rochester postcard back with *treatment* group message

Rochester postcard back with *control* group message