Small changes work together to make a big difference to conserving energy at home.

REAL TIME MONITORING

Newfoundland and Labrador Hydro
Real Time Monitoring Pilot Project

Final Report

March 31, 2016

Newfoundland and Labrador Hydro
500 Columbus Drive
St. John's, NL A1K 1J3

Newfoundland Labrador

in partnership with take CHARGE!

newfoundland labrador hydro
a nalcor energy company

1. EXECUTIVE SUMMARY

Over the past several years, residential electricity consumption in the province has been growing. Over the 2003 to 2013 period, for example, residential electricity demand grew by 18% driven largely by new home construction and fuel substitution from fuel oil to electricity. Growth in new housing stock is projected to continue, likely resulting in further growth in residential electricity demand. Given these trends, the Government of Newfoundland and Labrador, through the Office of Climate Change and Energy Efficiency, provided $350,000 for a two year pilot project, starting in 2014-2015, that would seek to determine if households would conserve energy if they either used a real time monitor (RTM) feedback device that provides them with real-time electricity consumption information or if they received energy conservation information on a regular basis.

CCEE designed the pilot in cooperation with the electric utilities and contracted Newfoundland and Labrador Hydro (NLH) to implement the pilot. NLH was chosen to implement the pilot project as it was best positioned from a technical, knowledge, capacity and delivery perspective, with the cooperation of Newfoundland Power, to implement a pilot initiative within the electricity sector given their existing relationships with electricity customers and access to electricity use data. The pilot, which the evaluation consultant characterized as having a robust design, included 750 participants and a control group of 1,382 customers. The 750 participants were delineated as follows:

- 250 households were provided with a real time monitor (RTM) device to provide electricity consumption information in real time;
- 250 households were provided with a RTM, and also received regular public awareness and education materials on energy conservation; and
- 250 households did not receive a RTM device, but did receive public awareness and education materials.

The RTM used for this project was a Blue Line Power Cost Monitor. Final project costs totaled about $319,800.

1.1 Recruitment and Participant Profile

Just over 1,000 households applied to participate in the pilot, however, over 25% of applicants were turned down due to ineligibility. Ineligible households included, for example, those that intended to move within the pilot period.

Of the 750 participating households, administrative data and survey responses indicated that:

- 63% of households were located on the Avalon Peninsula, 32% were located elsewhere on the island of Newfoundland and 5% were located in Labrador;
- 51% of households were headed by an individual between ages 25 and 44, 45% by an individual between ages 45 and 64, and 4% by an individual greater than age 64;
- 44% of houses in the pilot were built in 1995 or later, 24% were built between 1980 and 1994, and 32% were built before 1980;
- 81% of homeowners indicated that energy conservation was important or very important to them, and 17% indicated that energy conservation was somewhat important; and
- 84% used electricity as the primary heating source in their home.

1.2 Key Findings

- Participation in the pilot occurred from January to December, 2015. The results of the pilot were modest. Use of the RTM device, for example, resulted in electricity savings of 1.2% among participants. The estimated RTM impacts in Labrador were negligible.

- The highest rate of savings from the pilot were achieved by RTM participants with multiple heating fuels, that is a situation in which there are two or more sources for space heating in a house. The savings for this group was estimated at 4.0%. The evaluation findings attribute this result to fuel switching for space heating from electricity to other forms of energy.

- Recent results from eight similar studies in other jurisdictions in North America varied from no significant impact to 2.8% savings. The average achieved savings of 1.2% for this pilot is in line with these findings. There is one outlier study published in 2012 regarding the 2005-2006 pilot that deployed Blue Line Power Cost Monitors to 100 participants in NL. This study claimed 18% savings. The evaluation consultant for this project (Navigant Consulting) noted that the reported savings by the evaluation consultant at that time appeared to be extremely high for a behavioural program and that the study may have been handicapped by only having 18 control customers.

- Two participant surveys were deployed, one at the beginning and one at the end of the pilot. Survey respondents indicated that while the pilot was successful at helping them to understand how they use electricity, many did not make a consistent effort to make lifestyle changes that could deliver substantial energy and bill savings. Navigant concluded that possible contributing factors for this are:
    - Low electricity rates: Navigant compared the current island interconnected residential electricity rate of 10.573 cents/kWh with residential rates reported for 177 U.S. utilities and found that after adjusting for exchange rates, NLH's rates are lower than 93% of the U.S. utilities. Lower electricity rates reduce the financial drive to reduce energy use.
    - Customers are not willing to compromise their comfort: For homes heated with electricity, heating accounts for about 70% of electricity use. For electrically heated customers to reduce the level of heating in their homes they must reduce the temperature. For those with alternate heating sources such as a wood stove or propane, participants can reduce their electric use and supplement with another heat source without compromising comfort. The pilot project, however, did not seek to measure change in overall energy use and therefore did not account for fuel switching.
    - A high penetration of electric heat: Navigant found that the group that achieved the highest energy savings were those in the supplemental electric heating group. As noted above, the only way for participants with electric heat to achieve electricity savings from space heating is to reduce their home heating load but this group was not willing to sacrifice comfort.

- Additional survey findings revealed that while respondents reported improved energy literacy over the course of the pilot, this did not necessarily translate to concrete energy conservation actions. For example, 96% of respondents recalled receiving the educational materials and 77%-86% indicated they had found them useful. However, only 16% of respondents reduced their heating use during the pilot period and one-third of respondents reported no behaviour change. Moreover, between the first and second surveys, respondents reported declining interest in the financial benefits associated with lower electricity bills and reported increasing infrequent monitoring of the

real time device. However, nearly 80% of survey respondents indicated that they would recommend participation in the pilot to a friend or family member.

- Respondents also reported that they want more, not less, engagement from the electric utilities. They also reported interest in a smart phone app with “push” notifications.

- Educational materials were included in the pilot because research suggested that energy savings may be achieved if households are regularly reminded of the importance of energy conservation and efficiency. The pilot provided regular monthly informational mail outs to 500 participants in two of the three participation groups. The participation surveys showed, however, that educational materials appear to have no meaningful impact on consumption.

- More than 90% of survey respondents found the RTM ”very easy” or “somewhat easy” easy to use. It was found that over time, participants were less engaged with the device. For example, 85% of respondents indicated that they monitored the RTM daily or multipole times a day at the start of the pilot, but only 52% reported this frequency of use at the end of the pilot.

- Five percent of respondents said their RTM was not working. Of these, about one-half did not report getting the support from the Blueline support line that they needed. Separately, NLH officials recorded 30 participant contacts reporting issues with the RTM. Issues ranged from the meter not showing the proper data readings to faulty equipment that had to be replaced.

2. PROGRAM OVERVIEW

2.1 Background

Over the past several years, residential electricity consumption in the province has been growing. From 2003 to 2013, residential electricity demand grew by 18% driven largely by new home construction and fuel substitution from fuel oil to electricity. Growth in new housing stock is projected to continue over the next several years, likely resulting in further growth in residential electricity demand to 2020. There are several key benefits of reducing energy consumption in the residential sector:

- Reducing peak electricity consumption is important. Peak use occurs during morning and supper hours. Electricity use is lower during off-peak hours when family members are sleeping or at work. If peak demand can be reduced through efficiency and conservation measures, then less costly generation and transmission infrastructure is needed, which will benefit ratepayers.

- By reducing electricity use, householders will be spending less on electricity and have more money freed up to spend elsewhere in the economy. As well as being good for householders, this extra spending, over time, creates activity elsewhere in the economy which can create jobs.

- There are broader societal benefits. For example, investment in existing energy efficiency initiatives, such as those made through the Residential Energy Efficiency Program and takeCHARGE initiatives, allow for homes to be warmer at a lower cost during winter months. For families living in less efficient homes, energy efficiency retrofits will enhance their health and quality of life, as living in cold homes can leave people vulnerable to illness.

2.2 Pilot Project

Budget 2014 included a commitment for the Office of Climate Change and Energy Efficiency (CCEE) to implement a two-year residential energy conservation pilot project with a view to identifying mechanisms to reduce residential electricity demand through energy conservation activities. More specifically, this pilot sought to determine if households would conserve energy if they used a real time monitor (RTM) feedback device that provides them with real-time electricity consumption information and/or if they received energy conservation information and tips on a frequent basis. Education information and tips were included because research suggests that energy savings may be achieved if households are regularly reminded of the importance of energy conservation and efficiency.

CCEE designed the pilot in cooperation with the electric utilities and contracted NLH to implement the pilot. NLH was chosen to implement the pilot project as it was best positioned from a technical, knowledge, capacity and delivery perspective, with the cooperation of Newfoundland Power, to implement a pilot initiative within the electricity sector given their existing relationships with electricity customers and access to electricity use data. The pilot was overseen by a management committee that included officials from CCEE and NLH.

The pilot, which the evaluation consultant characterized as having a robust design, included 750 participants and a control group of about 1,400 customers. The 750 households (about 0.3% of total households in the province) were to be selected, to the extent possible, to be representative of all households in the province:

- 250 households were provided with a RTM device, and also received regular public awareness and education materials on energy conservation;

- 250 households were provided with a RTM device, but did not receive regular public awareness and education materials on energy conservation; and
- 250 households did not receive a RTM device, but did receive public awareness and education materials.

Additionally, a control group of non-participating households were to be selected to better ensure that the project could be evaluated. This control group included 1,382 households.

Funding of $350,000 over two fiscal years was provided, comprising $200,000 in 2014/15 and $150,000 in 2015/16. Newfoundland and Labrador Hydro (NLH) was chosen to implement the pilot initiative within the electricity sector as they are best positioned, in cooperation with Newfoundland Power, to deliver the pilot from a technical, knowledge, capacity and delivery perspective. The pilot was overseen by a management committee that included officials from CCEE and NLH. Detailed budget information is contained in Section 5.

2.3 Participant Recruitment

The recruitment goal was to recruit 750 households from across the province to be, to the extent possible, representative of the household distribution of the province.

Marketing began on September 30, 2014. takeCHARGE used its Facebook, Twitter and website to push recruitment and the posts were shared by NLH and Newfoundland Power. Initial responses were lower than anticipated and a longer timeline was required for the recruitment process than intended. To supplement efforts, a provincial government press release was issued on October 15, 2014 and announcements distributed via its internal Public Service Network. At that time, an online ad was placed on the VOCM website and other stakeholders such as larger municipalities, major employers and the Newfoundland and Labrador Environmental Industry Association were used to distribute materials. To encourage participation, a draw for an iPad took place from the list of applicants. Examples of posters and materials for the recruitment process can be found in Appendix A.

Additionally, selected locations within the province were targeted to minimize travel for installation of the RTMs. These included the St. John's area, Clarenville, Gander, Grand Falls-Windsor, Corner Brook, Stephenville, Rocky Harbour, and Happy Valley Goose Bay. These areas account for about 60% of the province's population.

In total, 1,037 households applied to participate, however, 26% of applicants were deemed ineligible, meaning that 766 eligible households were identified as potential participants. The 750 participants were selected from the 766 eligible households. Ineligible households included, for example, those that did not have two years' worth of electricity billing data prior to the pilot project and those that intended to move within the pilot period (Appendix A includes a list of eligibility requirements).

2.4 Participant Group Allocation and Profile

Challenges with recruitment meant that the sample framework was not fully representative of the province on a regional basis. In particular, there were challenges to recruit participants outside the St. John's region. For example, it was anticipated that 55% of participants would be from the Avalon Peninsula (as noted in Section 3.1, the St. John's area was the only targeted area on the Avalon Peninsula), however, 63% of participants resided in this region (see Table 1). Total participation in Labrador was relatively close to its population share.

Survey data (see Section 4 for further detail) also indicated that participants were generally not representative of all households in the province. For example, 84% of participants used electricity as the primary heating source in their home compared to less than 75% of all households in the province. Other household characteristics, based on information collected during participant survey, included:

- 51% of households were headed by an individual between ages 25 and 44, and 45% by an individual between ages 45 and 64. Only 4% were older than age 64;
- Almost one-half of participants live in relatively newer homes. For example, 44% of houses were built in 1995 or later, and 24% were built between 1980 and 1994; and
- Most participants (81%) indicated that energy conservation was important or very important to them, and 17% indicated that energy conservation was somewhat important.

Table 1: Pilot Project Targets and Participants by Region

	Real Time Monitor (monitor only *and* monitor plus information groups)		Information-only group		Total Participants	
	Target	Actual	Target	Actual	Target (Percent)	Actual (Percent)
Avalon	275	315	138	157	413 (55%)	472 (63%)
Rest of Island	200	160	100	84	300 (40%)	244 (32%)
Labrador	25	25	12	9	37 (5%)	34 (5%)
Total	500	500	250	250	750	750

Participants were then divided into one of the three project groups identified in Section 2.2 based on household heating type. The final numbers by heating type are as follows (Table 2).

Table 2: Pilot Project Participants by Heating Type

	Real Time Monitor (monitor only *and* monitor plus information groups)			Information-only group		
	Electric only	Supplemental electric	No electric	Electric only	Supplemental electric	No electric
Avalon	208	89	18	103	45	9
Rest of Island	91	58	11	47	31	6
Labrador	25	0	0	6	3	0
Total	324	147	29	156	79	15

Applicants were contacted by email to tell them if they were chosen for the pilot and what group they were in. Each treatment group received a separate email. The 16 eligible households that were not selected to be participants received an email thanking them for their interest.

3. ANALYTICAL FINDINGS

Navigant Consulting was contracted by NLH to evaluate the outcomes of the pilot project (details in Section 5). Navigant's key finding (see Appendix B) was that the RTM had a modest but real impact on participant consumption. Use of the RTM resulted in electricity savings of 1.2% (see Table 3). The educational materials did not have any meaningful impact on consumption. Examples of educational material provided are in Appendix C.

Table 3: Principal Impact Findings[1]

	Real Time Monitor (monitor only *and* monitor plus information groups)	Information-only group
Avalon	**1.4%**	**0.0%**
Rest of Island	**0.9%**	**0.0%**
Labrador	**0.0%**	**0.0%**
Total	**1.2%**	**0.0%**

1. Statistical significance is discussed in the Navigant Report

Navigant found that electricity savings were only achieved by participants with multiple heating fuels. Participants with multiple fuels (i.e., supplemental electric) achieved an average of 4.0% energy savings due to the RTM (Table 4). Navigant indicated that the most reasonable explanation for these results is that participants with non-electric heat sources are practicing a form of fuel-switching, that is, they are substituting the use of electric baseboard heaters, for example, with a wood pellet or wood stove. Since the all-electric participants (by definition) have no other heating option, their only option for achieving electricity savings via space-heating controls is to reduce their total home heating load. Conversely, Navigant concluded that achieving such a net reduction in a home heated entirely by electric baseboards, without materially compromising customer comfort, can be a challenge.

Table 4: Impact by Heating Type[1]

	Real Time Monitor (monitor only *and* monitor plus information groups)			Information-only group		
	Electric only	Supplemental electric	No electric	Electric only	Supplemental electric	No electric
Avalon	**0.0%**	**4.6%**	**N/A**	**0.0%**	**0.0%**	**N/A**
Rest of Island	**0.0%**	**3.1%**	**N/A**	**0.0%**	**0.0%**	**N/A**
Labrador	**0.0%**	**N/A**	**N/A**	**0.0%**	**N/A**	**N/A**
Total	**0.0%**	**4.0%**	**N/A**	**0.0%**	**0.0%**	**N/A**

1. Statistical significance is discussed in the Navigant Report

Navigant also found that electricity savings were higher in the winter months (defined at October to March) than in summer months (defined as April to September) (Table 5).

Table 5: Impact by Heating Season[1]

	Real Time Monitor (monitor only *and* monitor plus information groups)		Information-only group	
	Summer Months	Winter Months	Summer Months	Winter Months

Avalon	**0.6%**	**0.8%**	**0.0%**	**0.0%**
Rest of Island	**0.3%**	**0.7%**	**0.0%**	**0.0%**
Labrador	**0.0%**	**0.0%**	**0.0%**	**0.0%**
Total	**0.5%**	**0.7%**	**0.0%**	**0.0%**

1. Statistical significance is discussed in the Navigant Report

Navigant indicated that the reported savings are in line with those reported for similar programs in other jurisdictions.

4. PARTICIPANT SURVEY FINDINGS

Two participant surveys were administered by Navigant (survey is included in Appendix D) to gauge participant perceptions on their involvement and to understand if any behavioural changes have taken place due to participation. The first survey was completed at the start of the pilot project period in January 2015 (81% completion rate) and the second survey was completed after the pilot ended in January 2016 (68% completion rate). Participants who answered the surveys were eligible for a cash prize. Six winners of $250 were given out for both surveys.

Navigant reported that 95% of respondents indicated that the RTM was installed and operating at the time of the initial survey and that 94% of RTMs were operating at the time of the second survey. Among respondents in both surveys that that said their RTM was not working, nine contacted the helpline service and, of these; five did not report getting the support that they needed. Navigant concluded that although this *could* indicate an issue with the helpline personnel or processes, the sample of participants contacting the helpline is too small to make this assertion with any level of certainty. Separately, NLH officials recorded 30 participant contacts reporting issues with their RTM. Issues ranged from the meter not showing the proper data readings to faulty equipment that had to be replaced.

4.1 Participant Expectations

At the start of the pilot project, survey respondents were asked about their financial expectations for the pilot (full details are provided in Appendix B):

- 10% expected to realize no electricity savings as a part of the pilot, and 9% expected to realize savings of up to 5% (recall that actual saving were less than 5%);
- 21% expected to save between 5% and 9% and 34% expected to save 10% or more.
- 26% did not respond or did not provide a savings projection.

Participants were also asked about other anticipated benefits at the start of the pilot (this survey question was open-ended with multiple answers allowed). Selected responses include:

- 33% indicated that that wished to make more informed electricity consumption choices and 12% wanted to become more aware about electricity consumption; and
- 19% indicated that they wished to conserve energy, 18% indicated that they wished to save money, and 8% indicated they wanted to reduce their electricity bill.

In the second survey, participants claim to be satisfied with the program. For example, when asked whether they would recommend the pilot to their friends or family, 78% of respondents said yes.

Navigant concluded that participants with optimistic perceptions regarding savings that they may achieve could lead to participant disillusionment and disengagement, and suggested that NLH may

consider, for any future initiatives, educating participants by presenting them with a set of straightforward, concrete energy savings actions, and a corresponding estimate of potential bill savings.

4.2 Participant Interest throughout Pilot

Navigant concluded that, among participants that had a RTM, there was a decline in participant enthusiasm over the course of the program:

- In the initial survey, 85% of participants checked the RTM at least once per day. The second survey indicated that this rate declined to 52%; and
- In the initial survey, 3% of participants checked the RTM once per week or less than once per week. The second survey indicated that this rate increased to 28%.

However, the surveys found little change in perceived usefulness of the RTM throughout the pilot project. Considering only those participants that responded to both surveys:

- 58% of initial survey respondents found the RTM to be "useful" compared to 52% in the second survey;
- 38% of initial survey respondents found the RTM to be "somewhat useful" compared to 36% in the second survey; and
- 5% of initial survey respondents found the RTM to be "not useful" compared to 13% in the second survey.

4.3 Educational Materials

Navigant reported, for those participants that received educational information, a high recall rate for the materials provided, and indicated that this supports the previous finding in Section 4.1 above that participants wished to better understand their energy consumption.

- 96% recalled receiving electricity saving "tips" and that 85% of respondents found this information to be useful;
- 65% recalled the pilot project "challenges" and 55% recalled pilot project "contests". The challenges and contests were designed to maintain participant enthusiasm throughout the pilot. In this context, 77% found the challenges to be useful and 84% found the contests to be useful; and
- 64% recalled receiving background information on the pilot project and 86% found this information to be useful.

Navigant indicated that, because tips have the most immediately applicable information in the educational materials, the high recall for tips suggests that participants see value in actionable information.

4.4 Change in Participant Behaviours

Participants improved their energy literacy, but this did not necessarily translate to concrete energy conservation actions. Among other findings, the second survey indicated that:

- 33% of respondents did not change their behaviours;
- 19% turned off lights when leaving a room;
- 15% reduced or turned off heat (space heating accounts for about 70% of electricity use in an electricity heated home);
- 10% more consistently unplugged appliances when not in use;
- 6% purchased programmable thermostats; and
- 6% added a supplemental heating source.

Participants were also asked in the second survey what changes could be made to the initiative (this survey question was open-ended with multiple answers allowed). Key findings included:

- Participants focused on deployment strategies. For example, 14% indicated that the program should be made more accessible to everyone and 7% indicated that there should be improved distribution of the monitors;
- Participants spoke about educational materials. For example, 13% wanted more detail in educational materials and 10% wanted additional instructional materials; and
- Participants want more and different forms of communication with participants. For example, 9% wanted more information and 5% wanted more information sent electronically. Navigant suggested that a smart phone app might work well as an electronic form of communication.

5. PROGRAM BUDGET AND IMPLEMENTATION

The provincial government allocated $350,000 for this project covering fiscal years 2014-15 ($200,000) and 2015-16 ($150,000). Total expenditures were $319,771.20, or $30,228.20 below budget. Budget expenditures were as follows (Table 6):

Table 6: Project Budget

Category	Total Project Budget	Projected Expenditures	Actual Expenditures		
			Actual Costs	Difference from Budget	Difference from estimated expenditures
NLH Labour	N/A	$58,750.00	$55,518.39	N/A	($3,231.61)
NLH Marketing	N/A	$13,000.00	$9,617.68	N/A	($3,382,32)
External Consultants	N/A	$267,300.00	$254,635.13	N/A	($12,664.87)
Total	$350,000.00	$339,050.00	$319,771.20	($30,228.20)	($19,278.80)

5.1 External Consultants

NLH implemented the pilot project using both internal resources (e.g., recruitment, purchase of prizes, and distribution of educational materials) and external consultants (i.e., purchase and installation of monitors, development of education materials and project evaluation). Each external consultant contract was awarded pursuant to a Request for Proposals.

Nedco was awarded a contract for $132,500 to supply and install 500 RTMs (see Table 7). The RTM used for this project was a Blue Line Power Cost Monitor. The system is a wireless energy monitoring solution where energy usage data is transmitted in real-time from the electricity meter via the Blue Line optical sensor and sent to a portable In-Home Display. All installs were completed as of January 13, 2015.

M5 was awarded a contract for $26,621.45 the design and development of educational and promotional materials. M5 created the look and feel of the design and created each of the promotional pieces from the content provided by Hydro (examples are provided in Appendix C). The pieces were meant to engage participants and provide them with additional information on energy conservation and efficiency. There were two different groups that the promotional pieces were targeting, including the group that received the meter in addition to information and the information-only group. There were 17 pieces created for each group.

Navigant Consulting was awarded a contract for $108,470 to evaluate the project. This included the development and implementation of two surveys at the start and end of the project as well as a detailed analysis of the outcomes of the project. The Navigant work is summarized in Sections 4 and 5 above and their full report is found in Appendix B.

Table 7: Project Expenses by NLH and External Consultants

Category	Purpose	Estimated Expenditure	Actual Costs	Difference
NLH	**Recruitment, prizes, labour, mail-outs**	**$71,750.00**	**$65,1366.07**	**($6,032.03)**
Nedco	**RTM purchase and installation**	**$132,500.00**	**$124,077.78**	**($8,422.22)**
M5	**Development of educational materials**	**$26,330.00**	**$26,621.45**	**($291.45)**
Navigant	**Project evaluation**	**$108,470.00**	**$103,935.90**	**($4,534.10)**
Total		**$339,050.00**	**$319,771.20**	**($19,278.80)**

6. CONCLUSIONS AND NEXT STEPS

The findings from this pilot project will set the stage for future programming for the utilities, as well as inform future initiatives that the Government of Newfoundland and Labrador may undertake in the area of energy conservation and energy efficiency. For example, NLH may consider further study on fuel switching options to reduce demand on the provincial electricity grid.

Key findings and conclusions include:

- Recruitment was challenging even though information provided indicated that participants could expect to achieve savings on their electricity bill. Responses to initial advertising was lower than expected and longer timelines were required to identify 750 participants for the pilot project;
- At the start of the pilot project, expected savings that participants felt that they could achieve were optimistic. For example, about three in every five participants felt that their electricity savings would exceed 5% (if those that did not provide a savings projection were excluded, this ratio jumps to over two in every three participants);
- Interest in use of the monitor declined over the pilot period. At the start of the pilot, almost nine in every ten participants used the monitor at least daily. This declined to five in every ten participants by the end of the pilot. Conversely, three in every 100 participants rarely used the monitor at the start of three pilot period. This increased to thirty in every 100 participants by the end;
- Overall electricity savings realized were in line with similar studies in recent years elsewhere in North America, however, electricity savings were concentrated on households with multiple heating sources that could practice fuel substitution, and there were no savings in electric-only households;
- Participants had high recall rates for educational materials and found the information useful, however, the analysis indicated that improved electricity literacy did not result in electricity savings, that homeowners are not willing to reduce their energy consumption if their comfort is compromised, and that one in every three participants indicated they did not adjust their behaviours in any way;
- Participants were satisfied with the program. For example, eight in every ten survey respondents indicated that they would recommend the pilot to their friends or family; and
- The monitor used appears to be appropriate for use in the local climate, given that 94% of respondents to the second survey indicated that their monitor was still working.

APPENDIX A

Sample Recruitment Materials

Want to save energy and save money?

The Office of Climate Change and Energy Efficiency is working in partnership with Newfoundland and Labrador Hydro under the takeCHARGE program on an exciting new initiative to determine whether providing homeowners with real-time information on their electricity consumption encourages them to save energy. Saving energy can help homeowners save money on their electricity bill.

We are looking for 750 households from across the province to participate. Participants will be provided with one or both of the following: a free professionally installed real-time energy monitor, and expert advice and tips on saving energy. It's free to participate and participants will have the chance to win gift cards and energy efficiency kits throughout the pilot.

To check whether you are eligible to participate and get more information, visit http://bit.ly/1w5YSLq. Eligible households can sign up by calling or emailing Emma Nash at NL Hydro at 733-5309 or EmmaNash@nlh.nl.ca.

Recruitment Poster (2 pages)

Be part of an exctiting new pilot project about saving energy

Home Energy Monitoring Pilot Project

The Government of Newfoundland and Labrador will be conducting a year-long pilot project funded by the Office of Climate Change and Energy Efficiency and implemented by Newfoundland and Labrador Hydro under the takeCHARGE program. This project will evaluate the effect that the provision of real-time energy consumption information has on electricity use.

We are currently seeking 750 households in the province to participate in the study. As a participant, each household will fall into one of the three following groups:

i. 250 households will be provided with a real-time electricity demand feedback device and will receive public awareness and education materials on energy conservation
ii. 250 households will be provided with a device but not the public awareness and education materials
iii. 250 households will receive only public awareness and education materials on energy conservation

Sign up for your chance to win an iPad!

Participants will have plenty of chances to win gift cards, energy efficiency kits and much more throughout the pilot.

*Please note that not all respondents may be selected.

Home Energy Monitoring Pilot Project

Eligibility

- Must be the home owner and have an active electricity account for the address for at least the past 24 months.
- Not be planning to be away from your home for more than three consecutive weeks from Nov 2014- Dec 2015.
- Not be planning to move or sell your home before Jan 2016.
- Must take part in two surveys during the course of the pilot project.
- Must agree to read any information sent to you as part of the project.
- Be willing to have your electrical consumption data used as part of the study. The last two years' worth of your electricity consumption data, along with the data collected during the study will be shared with an external agency contracted by Hydro. This will not be released publicly and all information will remain strictly confidential.

Contact Emma Nash if you are interested in participating and have met the above requirements.

emmanash@nlh.nl.ca
OR call toll free 1-888-737-1296 and ask for Emma

Please provide account holder's name, street address, email, phone number and home heating source (i.e. electric, some electric, no electric)

You may be contacted by phone or email in the coming weeks to confirm your eligibility and participation in the study.

Don't forget to tell your friends and family about this opportunity!

Newfoundland Labrador

newfoundland labrador hydro
a nalcor energy company

take CHARGE!

In-home energy reporting. Real time. Wireless

Power Cost Monitor

APPENDIX B

Evaluation Report

REAL TIME MONITOR PILOT PROGRAM

Impact and Process Evaluation

Prepared for:

Newfoundland and Labrador Hydro

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St. John's, Newfoundland A1B 0C9

REAL TIME MONITOR PILOT PROGRAM

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Reference No.: 175906

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EXECUTIVE SUMMARY

The Real-Time Monitoring (RTM) pilot program offered Newfoundland and Labrador Hydro (NLH) and Newfoundland Power (NP) customers the opportunity to receive real-time energy consumption information via an electricity demand feedback device (the "real-time monitor", or RTM), and/or public awareness and education materials on energy conservation ("education"). Participants were recruited via social media and participated in the program for approximately one year, from January of 2015 through to December of the same year.

Seven hundred and fifty participants were recruited and then allocated to one of three groups. One group of 250 received the RTM, a second group of 250 received the RTM and was provided with educational materials over the course of the pilot, and the third group of 250 was provided only with educational materials over the course of the pilot.

The purpose of this study is to evaluate the impact that this program had on participant energy consumption, and the mix of participant attitudes to, opinion of, and self-reported response to the program as a whole (collectively known as the "process" evaluation).

This report covers the impact and process evaluation activities for the January 2015 – December 2015 study period.[1]

Navigant's principal findings for this evaluation are:

[1] The Rest of Island study period is February 2015 – December 2015. This is due to when the RTM devices where installed in this area.

- Participants equipped with the RTM achieved an average of 1.2% electricity savings across the three pilot regions.
- Statistically significant RTM energy savings were achieved exclusively by participants that use multiple space-heating fuels. On average, this group of participants achieved 4% electricity savings.
- No statistically significant electricity savings could be attributed to the educational materials, either in combination with, or without, the RTM.
- When surveyed, participants reported that the program better helped them understand their consumption, but did not consistently report undertaking high-impact conservation actions

In summary: **the RTM pilot substantially increased participants' perceived energy literacy, but motivated only a modest amount of sustained behavioural change in participants.**

The combined results of both impact and process analyses indicate that while participants claim that the pilot helped them to understand how they use power, many have not appeared to make a consistent, conscientious effort to undertake material lifestyle shifts of the kind that could deliver substantial energy (and bill) savings.

Rates in Newfoundland and Labrador are not structured to motivate either conservation (through an inclining block rate), or shifting (through time-of-use, or TOU) and are relatively low compared to many jurisdictions.[2] This aspect of the economic incentive may have affected participant response.

Impact Evaluation

Impacts were estimated using billing data for participants and control customers from three regions: Avalon, Labrador, and Rest of Island (ROI). Control customers were selected through the seasonal matching of individual participants' pre-participation monthly consumption with that of a pool of over 80,000 non-participants.

Navigant's key impact findings include:

[2] A comparison of the Newfoundland rate of 10.573 cents/kWh with the residential rates reported for 177 U.S. utilities by the Edison Electric Institute in its *Typical Bills and Average Rates Report*, Winter 2014 report shows that *without adjusting for exchange rates or inflation*, NLH's rate is lower than 60% of U.S. utilities. When the exchange rate is applied, NLH's rate is lower than that of 93% of the U.S. utilities included in that study.

- **The RTM has a modest but real impact on participant consumption.** Use of the RTM resulted in electricity savings of 1.4% in Avalon and 0.9% in Rest of Island (ROI). The overall average pilot energy saving attributable to the RTM is 1.2%.
- **Savings were only achieved by participants with multiple heating fuels**. Participants with multiple fuels (approximately one third of the sample) achieved an average of 4% energy savings due to the RTM.
- **Savings are in line with those reported for similar programs in other jurisdictions.** Navigant has conducted a short survey of the more recent evaluation literature of similar types of behavioural programs and has found that the average reported impacts to be in line with most of those programs.
- **The educational materials appear to have had no meaningful impact on consumption.** The estimated impact of this treatment is not statistically significant, either alone, or in combination with the RTM.

Navigant's estimate of the percentage impact for each of the two treatments on residential electricity consumption, as a percentage of how much electricity would have been consumed absent the program, is presented for each region in Table 1 below.

Table 1: Principle Impact Findings[3]

	Avalon	Rest of Island	Labrador	*Pilot Average*
RTM	1.4%	0.9%	0.0%	***-1.2%***
Education	0.0%	0.0%	0.0%	***0.0%***

Source: Navigant analysis of NLH and NP billing data

More granular impact estimates may be found in Chapter 3 of this report.[4]

[3] The Avalon and overall average savings are statistically significant. The ROI savings value is not statistically significant, but is sufficiently similar to that of Avalon that Navigant is reasonably confident in reporting that value as the best available estimate of the impact in that region. None of the other savings values is statistically significant and so impacts for the RTM in Labrador, and for the educational materials in all jurisdictions are being reported as zero.

[4] All impacts estimated as part of this evaluation are average across defined groups and sub-groups. Sample size precludes the robust estimation of impacts at the individual participant level.

The impacts presented in Table 1 apply to all participants. Navigant tested whether any incremental savings were delivered when a participant received both the RTM and the educational materials, and found that no statistically significant incremental effect exists. Thus the average savings across all participants that received the RTM (including those that also received the educational materials) is 1.2% for the whole pilot (or 1.4% in Avalon).

Process Evaluation

For the process evaluation of this pilot, Navigant deployed two participant surveys, developed in consultation with NLH and NLH's pilot program partners. The Wave 1 survey was deployed in February 2015 shortly after pilot commencement and was completed by 609 of the 750 pilot participants. The Wave 2 survey was deployed as the pilot ended in December of 2015 and was completed by 414 of the 609 participants that had responded to the Wave 1 survey.

Navigant's key process findings include:

- **Participants improved their energy literacy, but this did not necessarily translate to concrete energy conservation actions.** Although survey responses indicate reasonably strong participant engagement with the informational program outputs, respondents do not seem to have consistently undertaken high-yield conservation actions.

  Improved Energy Literacy:

  - A third of respondents indicated that the biggest benefit of participation was being able to make more informed choices, and a fifth cited the informational features of the monitor. Only 18% indicated that the biggest program benefit was the ability to save money, see Table 2 immediately below the key process findings.
  - Recall of the educational tips provided was very high – 96% of participants recalled receiving these.

  Program Response and Motivation:

  - When provided with an open-ended (unprompted) question regarding behaviour changes, a third of respondents reported no behaviour change at all (see Table 3, immediately below). The most commonly reported behaviour change was "being more aware of energy usage", and only 16% indicated that they had reduced their heating use.
  - Although respondent monitoring of the kWh feature of the RTM was consistent across both survey Waves (a little less than 60% of relevant respondents reported monitoring this feature), monitoring of the "dollars per hour" feature decayed sharply (from 50% to 24%) from Wave 1 to Wave 2. This suggests a decline in interest in the financial

incentive (perhaps because it is relatively low) and thus the likelihood that participants would compromise their comfort for that incentive.

- **Interest in the program appears to have declined over time.** Less than half as many respondents in Wave 2 as in Wave 1 reported checking their monitor multiple times per day. Nearly four times as many respondents in Wave 2 as in Wave 1 reported that they "didn't know" what the most difficult feature to use on the device was, suggesting RTM disuse had reduced feature familiarity.
- **Participants want more, not less engagement.** When asked (in an open-ended question) for suggestions for program improvement, nearly half of survey respondents indicated wanting *more* interaction from the pilot in a way that was more convenient for them, including electronic communications. Given this, it is possible that some kind of smart phone app with "push" notifications (perhaps with user-customized outputs) could reduce the decay in program interest noted above.
- **On the whole participants were pleased with the program.** Nearly 80% of survey respondents indicated that they would recommend participation in the pilot to a friend or family. Between 77% and 86% of respondents indicated that they had found the educational materials useful (depending on the type of material), and over 85% of respondents with an RTM reported that it was at least "somewhat" useful.

Table 2, below provides a summary of how participants responded to being asked on the survey what the greatest benefit of program participation had been. This table is divided into benefits that are purely informational, and benefits that are "actionable", i.e., that imply some sort of direct behavioural improvement that could affect consumption. Multiple responses to this question were permitted.

Table 2: Greatest Benefit(s) of Participation

Type of Benefit	Benefit	Reported by % of Respondents
Informational Benefits	More informed consumption choices	33%
	Information features of monitor	19%
	Became more aware about energy consumption	12%
	Instantaneous feedback	5%
Actionable Benefits	Conserve energy	19%
	Save money	18%
	Reduce electricity bill	8%
	Assist with energy conservation	6%

Table 3, below provides the distribution of responses to the question of how participants changed their behaviour as a result of the program. This distribution of answers is from the second survey, deployed at the end of the pilot. Participants were permitted multiple answers.

Table 3: Reported Behaviour Change due to Program

Behaviour Change	Cited By
I have not changed my behaviour	33%
Turning off lights more often when leaving a room	19%
Turning off or reducing heat	16%
More consistently unplugging appliances when not in use	10%
Purchased programmable thermostat	6%
Added supplemental heating source	6%
Used cold water more often for laundry	5%

Participant Demographics

Participants were recruited exclusively via social media. The distribution of enrolled participants by space-heating fuel and geographic region is summarized in Table 4 below.

Table 4: Distribution of Participants by Region and Heating Type

		Region		
		Avalon	Rest of Island	Labrador
Heating Fuel	**Electric**	41%	18%	4%
	Supplemental Electric	18%	12%	0.4%
	No Electric	4%	2%	0%

Additional information regarding the demographic profile of participants, collected as part of the survey effort include:

- 81% of survey respondents indicated that energy conservation is “extremely” (27%) or “very” (54%) important

- 51% of survey respondents are between 21 and 44 years old, and 45% are between 45 and 64 years old.
- 56% of survey respondents live in houses that are 20 or more years old.

1. INTRODUCTION

The Real-Time Monitoring (RTM) pilot program offered Newfoundland and Labrador Hydro (NLH) and Newfoundland Power (NP) customers the opportunity to receive real-time energy consumption information via an electricity demand feedback device (the "real-time monitor", or RTM), and/or public awareness and education materials on energy conservation ("education"). Participants were recruited via social media and participated in the program for approximately one year, from January of 2015 through to December of the same year.

This report covers the impact and process evaluation activities for the January 2015 – December 2015 study period.[5]

1.1 Objectives of the Evaluation

The purpose of this study is to evaluate the impact this program had on participant energy consumption, and the mix of participant attitudes to, opinion of, and self-reported response to the program as a whole (collectively known as the "process' evaluation).

The objectives of the evaluation included:

- Estimating the study period electric savings by treatment (RTM and/or education) and region. Further, estimate these impacts by:
  - Season (winter/summer)
  - Participant heating equipment type
- Evaluating:
  - Participant satisfaction with the quality and features of the RTM
  - Participant recall and preference for mailed educational materials
  - Participants' self-reported energy conservation actions motivated by the pilot
  - Participants' engagement with the technology and information provided as part of the pilot.

[5] The Rest of Island study period is February 2015 – December 2015. This is due to when the RTM devices where installed in this area.

1.2 Program Overview

The RTM pilot program is offered by NLH to encourage energy conservation behavior of NLH and NP customers. The program is funded by the Office of Climate Change and Energy Efficiency and implemented by NLH under the takeCHARGE program.

Participants were recruited via social media and through a strategy of emailing NLH and Government staff and requesting that they encourage friends and family to participate. Assignment of pilot treatment was conducted by lottery from the pool of applicants. The original intention, developed collaboratively by NLH and Navigant, was to select a stratified random sample of customers from the pool of applicants to participate in the program and use the remainder of the pool of applicants as controls for impact estimation. This would have delivered a randomized control trial (RCT).

Unfortunately there were insufficient program applicants to support this approach and so nearly all applicants were enrolled in the program. Participants were randomly assigned within strata based on historical consumption to one of three treatment groups: those that received only the RTM, those that received the RTM and educational materials (monthly mailings including energy saving tips, incitements to participate in conservation "challenges", etc.), and those that received only the educational materials.

The volume of applicants in the Labrador region was such that this strategy was not strictly followed for that region.

As a condition of enrollment, participants were required to respond to two surveys deployed by NLH, although participants that did not respond to the surveys were not subject to any sanction. As an incentive for participation in those surveys, participants were informed that six randomly selected (two for each region) survey respondents from each survey would receive a cash incentive of $250.

2. EVALUATION APPROACH

This section describes the methods used in estimating electricity savings and evaluating customer feedback from the surveys.

In summary, the impact and process evaluation approaches are described as follows:

1. **Impact Evaluation** – impacts were estimated using customer billing data provided by NLH and NP for participants across three regions, using an econometric technique known as regression with pre-program matching (RPPM). RPPM uses regression analysis to compare the energy use of the participant group to the energy use of a control group carefully selected from a large pool of non-participants based on similarities of pre-program enrollment consumption patterns.
2. **Process Evaluation** – the process evaluation was driven by an analysis of the results of two very similar surveys deployed to RTM Pilot participants, one put in the field shortly after beginning of the pilot (February 2015), and the other fielded at the end of December and beginning of January in 2016.

2.1 Impact Evaluation

This section provides a brief overview of Navigant's approach to estimating the conservation impacts of the RTM pilot. Additional detail regarding the approach (including match-validating graphics and algebraic model specifications) may be found in Appendix A.

2.1.1 Data Used in the Analysis

The estimated impacts presented in this evaluation report are based on participant and matched non-participant billing data. In January 2016, Navigant received data for 720 participants from three regions: Avalon, Rest of Island, and Labrador. Two of these participants lacked sufficient pre-participation consumption data to be included in the analysis and four lacked sufficient post-participation data to be included in the analysis. Control customers were matched by season[6], yielding a final estimation sample of 714 participants and 1,382 control customers. Table 5, below, provides a summary of the population sample for each region. Details regarding the data processing steps used in the analysis can be found in Section A.1 of Appendix A.

Table 5: Number of Customers Received and Used in Analysis

	Avalon	Rest of Island	Labrador	Total
Participant Data Received (Jan 2016)	471	217	32	**720**
Participant Data used in Analysis	466	217	31	**714**
Matched Controls	904	416	62	**1,382**

Source: Navigant analysis of NLH and NP billing data

[6] The use of seasonal matching means that for each participant there may be as many as two matched controls, one for the summer and one for the winter months.

2.1.2 Impact Estimation

The key to the RPPM approach is the pre-processing step in which control customers are selected. The purpose of this step is to ensure that the non-participants included in the control group are as similar as possible to the participants and thus minimize the likelihood of there being any consistent, non-program-related difference in the two groups' consumption patterns.

For example, each participant in the Avalon region's monthly summer consumption prior to enrollment was compared to the monthly summer consumption of over 47,000 non-participants in the same region over the same period. The non-participant with the most similar pattern of summer consumption became that participant's match for the summer months. The same process was repeated for the winter months, all three regions and all participants. This is Navigant's standard empirical approach for estimating energy efficiency program impacts when no randomized control is available, and is well-established in the econometrics and evaluation literature.[7]

More technically, the basic logic of matching is to balance the participant and non-participant samples by matching on the exogenous covariates known to have a high correlation with the outcome variable. Doing so increases the efficiency of the estimate and reduces the potential for model specification bias. Formally, the argument is that if the outcome variable Y is independently distributed conditional on X and D (conditional independence assumption), where X is a set of exogenous variables and D is the program variable, then the analyst can gain some power in the estimate of savings and reduce potential model specification bias by assuring that the distribution of X is the same for treatment and control observations.

Regression analysis is used to control for remaining non-program differences between participants and their matches.[8] In this context, the development of a matched control group is viewed as a useful "pre-processing" step in a regression analysis to assure that the distributions of the covariates (i.e., the explanatory variables on which the output variable depends) for the treatment group are the same as those for the comparison group that provides the baseline measure of the output variable.

[7] See, for instance, Ho, Daniel E., Kosuke Imai, Gary King, and Elizabeth Stuart. 2007. Matching as nonparametric preprocessing for reducing model dependence in parametric causal inference. *Political Analysis* 15(3): 199-236.

Abadie, A. and G.W. Imbens. 2011. "Bias-Corrected Matching Estimators for Average Treatment Effects". *Journal of Business and Economic Statistics* 29(1):1-11.

[8] It deserves emphasis that it is not necessary to match on all possible control variables, as matching involves a tradeoff between model specification bias and efficiency. Control variables not used in matching can be included in the subsequent regression analysis in the usual way.

Typically the exogenous covariates with the highest correlation with a customer's energy use during the evaluation period –and thus, the primary variables for matching –are the customer's energy use in a similar period in the past. Navigant matched on a participant's kWh use seasonally, running separate matching algorithms for the summer and winter months. The winter months are defined as October 2013 through March 2014. Summer months are defined as April 2014 through September 2014.

The regression model is then applied to the study period, January 2015 through December, 2015.[9]

Several regressions were estimated for each region, each one including progressively more treatment variable interactions in order to capture progressively more granular program impacts (e.g., impact by season, etc.)

Details of the regression model can be found in Section A.3.

2.2 Process Evaluation Approach

This section outlines the approach undertaken by Navigant to obtain and analyze participant survey data. It is divided into two sub-sections. The first sub-section describes the survey logistics – when surveys were fielded, how many participants responded, etc. The second sub-section describes the structure of the surveys, the process by which the structure and questions included in the survey were developed, and the rationale of the overall survey design.

2.2.1 Survey Logistics

Two surveys were deployed as part of this evaluation. The first was deployed shortly after the beginning of the pilot (i.e., once all RTM field installs were complete) and the second was deployed toward the end of the pilot. Dates of survey deployment and the number of survey completes by wave are summarized in Table 6, below.

Table 6: Summary of Deployed Surveys

Survey Wave	Date Deployed	Date Completed	# Complete Responses
Wave 1	January 23, 2015	March 2, 2015	609
Wave 2	December 7, 2015	January 16, 2016	414

[9] The Rest of Island study period is February 2015 – December 2015. This is due to when the RTM devices were installed in this area.

Surveys were deployed by Navigant's survey house sub-contractor.

The purpose of conducting two surveys was to be able to compare respondents' views, attitudes and actions over time, in part to evaluate the degree to which program engagement developed over the course of the pilot. For this reason, for the second wave of the survey, only those participants that had responded to the first survey were contacted.

To help motivate participation in the survey, six survey respondents from each survey (two from each of the geographic regions) was randomly selected by Navigant to receive a $250 prize, delivered and administered by NLH.

2.2.2 Survey Structure and Development

Navigant developed the initial survey in collaboration with NLH staff to address the information needs identified by NLH staff and by the Government of Newfoundland and Labrador. The questions included in the survey were designed to provide information about participant attitudes, perceptions and actions in across a range of categories. These categories, and the questions associated with them, were chosen in order to: support the findings of the impact analysis, catalogue the demographic characteristics of the participants, deliver important lessons for future deployments, and help NLH and its stakeholders understand the wider potential of the treatments tested.

A summary of survey categories, and the types of questions answered within each category, is presented in Table 7 below.

Table 7: Survey Design Approach

#	Category	Types of Question
1	Demographics and Energy Efficiency Awareness	• *What are participants' attitudes about conservation?* • *What are some basic demographic features of the participants?*
2	Real Time Monitor Ease of Use	• *Did the RTM work?* • *Was it easy to use?*
3	Real Time Monitor Engagement	• *How much did participants use the RTM?* • *What for?*
4	Educational Materials Engagement	• *What did participants remember receiving?* • *Was it helpful?*
5	Program Satisfaction	• *Was the RTM useful?* • *What did participants get out of the program?*
6	Program Effectiveness	• *Did participants change their behaviour as a result of the program? How?* • *How realistic were participants' expectations for the program??*

3. IMPACT FINDINGS

This chapter presents the findings of Navigant's econometric analysis of the billing data provided by NLH and NP. Navigant's key impact findings include:the RTM had a modest but real impact on participant consumption. Use of the RTM resulted in electricity savings of 1.2% (see Table 3). The educational materials did not have any meaningful impact on consumption. Examples of educational material provided are in Appendix C.

Table 3: Principal Impact Findings[1]

	Real Time Monitor (monitor only *and* monitor plus information groups)	Information-only group
Avalon	**1.4%**	**0.0%**
Rest of Island	**0.9%**	**0.0%**
Labrador	**0.0%**	**0.0%**
Total	**1.2%**	**0.0%**

2. Statistical significance is discussed in the Navigant Report

Navigant found that electricity savings were only achieved by participants with multiple heating fuels. Participants with multiple fuels (i.e., supplemental electric) achieved an average of 4.0% energy savings due to the RTM (Table 4). Navigant indicated that the most reasonable explanation for these results is that participants with non-electric heat sources are practicing a form of fuel-switching, that is, they are substituting the use of electric baseboard heaters, for example, with a wood pellet or wood stove. Since the all-electric participants (by definition) have no other heating option, their only option for achieving electricity savings via space-heating controls is to reduce their total home heating load. Conversely, Navigant concluded that achieving such a net reduction in a home heated entirely by electric baseboards, without materially compromising customer comfort, can be a challenge.

Table 4: Impact by Heating Type[1]

	Real Time Monitor (monitor only *and* monitor plus information groups)			Information-only group		
	Electric only	Supplemental electric	No electric	Electric only	Supplemental electric	No electric
Avalon	**0.0%**	**4.6%**	**N/A**	**0.0%**	**0.0%**	**N/A**
Rest of Island	**0.0%**	**3.1%**	**N/A**	**0.0%**	**0.0%**	**N/A**
Labrador	**0.0%**	**N/A**	**N/A**	**0.0%**	**N/A**	**N/A**
Total	**0.0%**	**4.0%**	**N/A**	**0.0%**	**0.0%**	**N/A**

2. Statistical significance is discussed in the Navigant Report

Navigant also found that electricity savings were higher in the winter months (defined at October to March) than in summer months (defined as April to September) (Table 5).

Table 5: Impact by Heating Season[1]

	Real Time Monitor (monitor only *and* monitor plus information groups)		Information-only group	
	Summer Months	Winter Months	Summer Months	Winter Months
Avalon	**0.6%**	**0.8%**	**0.0%**	**0.0%**
Rest of Island	**0.3%**	**0.7%**	**0.0%**	**0.0%**
Labrador	**0.0%**	**0.0%**	**0.0%**	**0.0%**
Total	**0.5%**	**0.7%**	**0.0%**	**0.0%**

2. Statistical significance is discussed in the Navigant Report

Navigant indicated that the reported savings are in line with those reported for similar programs in other jurisdictions.
The remainder of this chapter is divided into the following four sections:

1. Impact by Treatment and Region
2. Impacts by Treatment, Region, and Season
3. Impacts by Treatment, Region, and Heating Type
4. Impact Comparison with Other Studies

3.1 Impact by Treatment and Region

This section presents Navigant's estimates of the impact of the two treatments[10] deployed as part of this pilot, the RTM and educational information. The impacts presented are the per-participant average impact for the given treatment as a percentage of how much electricity would have been consumed absent the program. These are presented for each region in Table 8 below.

Table 8: Principle Impact Findings

	Avalon	Rest of Island	Labrador	*Pilot Average*
RTM	1.4%	0.9%	0.0%	***-1.2%***
Education	0.0%	0.0%	0.0%	***0.0%***

Source: Navigant analysis of NLH and NP billing data

[10] Although there are only two treatments (RTM, Education), there are three treatment groups: two that receive only one treatment, and one that receives both. As part of its exploratory analysis, Navigant tested for the possibility that the educational materials might (when deployed with the RTM) deliver incremental savings for the group that received both treatments. Finding no statistically significant incremental impact, this interaction term was dropped from the final model.

None of the estimated impacts for the education treatment were statistically significant at any conventional degree of confidence. Given the nature of this treatment, it is Navigant's opinion that in this case the fact that it is impossible to reject the hypothesis that education-driven savings are zero suggests that in fact no energy savings can be ascribed to this treatment.

Estimated RTM impacts for Avalon are statistically significant at the 90% confidence level. Within an upper and lower confidence bound, savings for this region could be as high as 2.6%, or as low as 0.3%.

The estimated RTM impacts in ROI are not statically different than zero at 90% confidence. Despite this, Navigant believes these impacts are still valid and considers that the point estimate (0.9%) should be considered the best available estimate of the RTM impact in that region.

It is Navigant's opinion, supported by the statistically significant impact estimate for Avalon, that the statistical non-significance of the ROI estimated impact is due principally to the smaller sample size available for that region. In other words, the non-significance of this result does not indicate that no impact is present, but simply that the sample size is insufficient to deliver a statistically significant estimated impact. For reference 311 participants in the Avalon region sample were equipped with RTMs. In the ROI region sample only 149 had the RTM. The number of participants in the sample by treatment group and region is summarized in below.

Table 9: Sample Size by Treatment and Region

	Avalon	Rest of Island	Labrador	Total
RTM Only	155	73	10	**238**
Education Only	155	68	9	**232**
RTM and Education	156	76	12	**244**
Total	**466**	**217**	**31**	**714**

Source: Navigant analysis of NLH and NP billing data

The sample size in ROI, while not large enough to produce statistically significant results, is large enough to provide insight into savings (there are 217 participants in the ROI region). While estimated savings are 0.9% for the pilot, they could be as high as 2.9% or as low as -1.0% (implying, counter-intuitively that use of the RTM increases consumption). The wider bounds of the confidence interval (compared to Avalon), are attributable to the fact that these savings estimates are not statistically different from zero at a 90% level of confidence.

Estimated RTM impacts in Labrador were, like those in ROI, statistically non-significant. In this case, however, the estimated impact is reported to be 0% - i.e., the treatment had no effect in Labrador. In the case of ROI, it is possible to make a reasonable case for the practical (if not the statistical) significance of the estimated impact, given its similarity in magnitude to the statistically significant impacts reported for Avalon. In the case of Labrador, however, there are simply too few participants in the sample to make the same case, and so Navigant is reporting no reasonably observable impact.

3.2 Impacts by Treatment, Region, and Season

As described above, and in greater detail in Appendix A, Navigant estimated some additional, ancillary, regressions to deliver more granular impact estimates. This sub-section summarizes the estimated impacts by season, with "summer" defined as the period from April through September and the "winter" defined as the period running from October through March. These results are summarized in Table 10 below. Note that percentage savings are seasonal savings *as a percent of total annual consumption.*

Table 10: Impacts by Treatment, Region, and Heating Type

	Summer		Winter	
	RTM	Education	RTM	Education
Avalon	-0.6%	0%	-0.8%	0%
Rest of Island	-0.3%	0%	-0.7%	0%
Labrador	0%	0%	0%	0%
Pilot Average	**-0.5%**	**0%**	**-0.7%**	**0%**

Source: Navigant analysis of NLH and NP billing data

Navigant has estimated of 0.6% for the Avalon region in the summer, and 0.8% in the winter. These savings are statistically different from zero at the 90% level of confidence.

Savings estimates for the ROI region due to the presence of an RTM device are equal to 0.3% in the summer, and 0.7% in the winter. These results are not statistically different from zero, but are reported as the best available estimates of the impact of the RTM for this region, for the reasons outlined above.

None of the Labrador region results were statistically significant, and, for the reasons outlined previously, are presented as being equal to zero.

All of the impacts due to the educational materials were either statistically or practically non-significant.[11]

3.3 Impacts by Treatment, Region, and Heating Type

As described above, and in greater detail in Appendix A, Navigant estimated some additional, ancillary, regressions to deliver more granular impact estimates. This sub-section summarizes the estimated impacts by heating fuel. Data regarding the type of heating system deployed was provided to Navigant by NLH.

Participants in the pilot were divided into three types of heating sources:

1. All Electric – all space-heating is electric
2. No Electric – no space-heating is electric
3. Supplemental Electric – both electric and non-electric space heating is present

[11] The estimated impact of the educational materials in the summer for Avalon was found to be statistically significant at the 90% (although not the 95%) level of confidence, but with an unexpected sign. That is, the estimated parameter suggested that, in Avalon, during the summer, receipt of the educational materials resulted in an *increase* in consumption. Navigant believes that this is sufficiently improbable (i.e., practically insignificant) and sufficiently isolated from other estimated impacts for education (all non-significant) that it is most reasonable to report that the educational materials had no impact on consumption in this case.

One challenge for estimating this more granular set of impacts is the relative size of each of the participant sub-groups. In many cases there are fewer than 20 participants per sub-group. In these instances Navigant believes it would be imprudent to report *any* results, given the high likelihood of sample bias in such small samples. A summary of the number of participants in each sub-group is presented in Table 11 below.

Table 11: Sample Size by Treatment, Region, and Heating Type

	Electric		No Electric		Supplemental Electric	
	RTM	Education	RTM	Education	RTM	Education
Avalon	204	202	17	18	90	91
Rest of Island	85	87	9	10	55	47
Labrador	22	18	0	0	0	3

Source: Navigant analysis of NLH and NP billing data

The principal finding of this additional analysis was that only those participants classified by NLH as belonging to the "Supplemental Electric" heating group achieved any energy savings, see Table 12 below.

For supplemental electric heating participants in Avalon, Navigant estimated that participants using the RTM achieved a statistically significant average 4.6% reduction in their annual energy use. For supplemental electric heating participants in ROI, the estimated impact of 3.1% was not statistically significant, but is reported below as Navigant's best available estimate of the impact of this sub-group based on the fact that the impact appears in line with the statistically significant one estimated for Avalon.

The estimated impact for all electric participants in Avalon and ROI are not statistically significant, and have point estimates so close to 0 that it is Navigant's opinion that no savings (on average across all participants) were achieved. The estimated impact for all electric participants (not reported in the table below) was a statistically non-significant *increase* in annual electricity consumption of 0.06% (plus or minus approximately 1.25 percentage points). The point estimate of the ROI impact was slightly higher in absolute value, but with even wider confidence bounds.

All of the impacts due to the educational materials were either statistically or practically non-significant.[12]

As noted above, no results are reported when the sub-group in question contained fewer than 20 participants. These are indicated in Table 12, below by "N/R" (not reported).

Table 12: Impacts by Treatment, Region, and Heating Type

	Electric		No Electric		Supplemental Electric	
	RTM	Education	RTM	Education	RTM	Education
Avalon	0%	0%	N/R	N/R	4.6%	0%
Rest of Island	0%	0%	N/R	N/R	3.1%	0%
Labrador	0%	0%	N/R	N/R	N/R	N/R
Pilot Average	**0%**	**0%**	**N/R**	**N/R**	**4%**	**0%**

	Electric		No Electric		Supplemental Electric	
	RTM	Education	RTM	Education	RTM	Education
Avalon	0%	0%	N/R	N/R	4.6%	0%
Rest of Island	0%	0%	N/R	N/R	3.1%	0%
Labrador	0%	0%	N/R	N/R	N/R	N/R
Pilot Average	**0%**	**0%**	**N/R**	**N/R**	**4%**	**0%**

Source: Navigant analysis of NLH and NP billing data

[12] The estimated impact of the educational materials for supplemental electric heating participants in Avalon was found to be statistically significant, but with an unexpected sign. That is, the estimated parameter suggested that, in Avalon, for participants with supplemental electric heat, receipt of the educational materials resulted in an *increase* in consumption. Navigant believes that this is sufficiently improbable (i.e., practically insignificant) and sufficiently isolated from other estimated impacts for education (all non-significant) that it is most reasonable to report that the educational materials had no impact on consumption in this case.

Navigant believes that the most reasonable explanation for results above is that participants with non-electric (in addition to electric) heat sources are practicing a form of fuel-switching, substituting the use of their baseboards for (for example) a pellet or wood stove. Since the all-electric participants (by definition) have no other heating option, their only option for achieving electricity savings via space-heating controls is to reduce their total home heating load.

The results above suggest that participants with only a single (electric) fuel source are either:

- Unwilling to compromise their comfort in order to achieve energy savings and thus are not taking any substantive space-heating-related energy efficiency actions; or,
- That the space-heating energy efficiency actions being taken by these participants are ineffective at delivering any material energy efficiency savings.

As noted in the process evaluation findings, a small but non-trivial number of participants reported reducing how much they heat their house in order to achieve energy savings. NLH may wish to consider conducting some follow-up interviews with all-electric heating participants to learn, in more detail, about the specific space-heating actions undertaken by this group in order to support its other energy efficiency education initiatives.

3.4 Impact Comparison with Other Studies

The previous sections of this chapter on program impacts have summarized the estimated program impacts by the two treatments deployed and by region, as well as seasonally and by customer heating fuel. An important consideration for NLH in evaluating these results, particularly the highest level and most robust ones (i.e., by treatment and region only) is how these compare to other similar types of programs deployed in other jurisdictions.

Navigant has summarized some of the more recent reported results from other studies in Table 13, below. This is not a comprehensive list, but is reasonably representative of the most recent findings in this field. One of these studies is considerably older than the others: Dr. Mountain's study period was in 2005 and 2006. This study is included in the list below, however, since it too was based in Newfoundland and Labrador and also had as its object estimating the impact of a Blue Line PCM on pilot participant energy consumption.

In examining these results, the reader should be aware that in most of these jurisdictions residential rates are both higher than NLH and NP's[13] and may not be a purely fixed rate; residential rate structures may include inclining block and optional TOU rates.

Table 13: Informational Impacts in Other Jurisdictions[14]

Study Author/Organization	Jurisdiction	Date of Publication	Estimated Impact	Sample Size	Notes
National Grid, NSTAR Electric and Western Massachusetts Electric Company	Massachusetts	2008	1.9%	~3,500	Blue Line PCM
Energy Trust of Oregon	Oregon	2009	N/S*	350	Blue Line PCM
Alahmad et al (IEEE Transactions)	Omaha	2012	N/S*	151	Blue Line PCM & Aztech IHD
Mountain, DC	Newfoundland and Labrador	2012	18%	100	Blue Line PCM, 2005 - 2006 study period, 100 participants, 18 controls.
Southern California Edison	California	2013	N/S*	206,565	Web presentment/online portal
Southern California Edison	California	2013	0.92%	177,377	Automated alerts
Southern California Edison	California	2013	0 - 3%	422	In-Home Display - 3% impact for first 30 days, 0% thereafter.
Illume on behalf of Accelerated Innovations	Minnesota	2014	1.8% - 2.8%	14,156	Report commissioned by device vendor.

[13] A comparison of the Newfoundland rate of 10.573 cents/kWh with the residential rates reported for 177 U.S. utilities by the Edison Electric Institute in its *Typical Bills and Average Rates Report*, Winter 2014 report shows that *without adjusting for exchange rates or inflation*, NLH's rate is lower than 60% of U.S. utilities. When the exchange rate is applied, NLH's rate is lower than that of 93% of the U.S. utilities included in that study.

[14] Complete references and hyperlinks to all the studies cited in this table may be found in Appendix B.

Study Author/Organization	Jurisdiction	Date of Publication	Estimated Impact	Sample Size	Notes
Tendril Networks	Arizona	2014	1.2%	508	Impact presented for "Energy Efficiency" cohort.
		Average Impact**	**2.7%**		
		Average Impact (excluding prior Nfld & Labrador Study)	**0.79%**		

N/S: statistically non-significant results

****N/S results assumed to be equivalent to 0%, SCE IHD result treated as 0% since no impact after 30 days.***

The most striking entry in this table is the 18% savings reported for Newfoundland and Labrador in a study published in 2012 about the 2005 – 2006 pilot that deployed Blue Line Power Cost Monitors to 100 participants. The author of this study, Dr. Mountain of McMaster University, is an eminent energy sector economist, and has in the past collaborated with Navigant in its evaluation of the impact of time-of-use (TOU) rates in Ontario. Navigant would note however, that the reported savings appear to be extremely high for a behavioural type of program, and that this study may have been handicapped by only having available 18 control customers.

Further, it is has been suggested by the reviewers of this report that it is possible that in the ten years since the 2005/2006 pilot was conducted, that "natural" energy efficiency (e.g., as a result of improving standards, better education, etc.) has captured many of the conservation opportunities that participants in that previous study took advantage of. That is, participants in this 2015 study may *already* (prior to participation in this pilot) have undertaken some of the changes implemented by the participants in the 2005/2006 study.

The results of all the other studies examined, however, appear to be more or less in line with the overall average impacts reported in section 3.1. Navigant believes that the findings in the other jurisdictions, as summarized in Table 13 lend credence to the accuracy and reasonableness of those reported above for the three regions examined in this study.

4. PROCESS EVALUATION FINDINGS

This chapter of the evaluation presents the findings of Navigant's analysis of the two surveys deployed at the beginning and the ending of the pilot. Recall that the Wave 2 survey (deployed in December 2016) was deployed only to participants that had previously responded to the Wave 1 survey (deployed in January 2015).

Navigant's key process findings include:

- **Participants improved their energy literacy, but this did not necessarily translate to concrete energy conservation actions.** Although survey responses indicate reasonably strong participant engagement with the informational program outputs, respondents do not seem to have consistently undertaken high-yield conservation actions.

  Improved Energy Literacy:

  - A third of respondents indicated that the biggest benefit of participation was being able to make more informed choices, and a fifth cited the informational features of the monitor. Only 18% indicated that the biggest program benefit was the ability to save money, see Table 2 immediately below the key process findings.
  - Recall of the educational tips provided was very high – 96% of participants recalled receiving these.

  Program Response and Motivation:

  - When provided with an open-ended (unprompted) question regarding behaviour changes, a third of respondents reported no behaviour change at all (see Table 3, immediately below). The most commonly reported behaviour change was "being more aware of energy usage", and only 16% indicated that they had reduced their heating use.
  - Although respondent monitoring of the kWh feature of the RTM was consistent across both survey Waves (a little less than 60% of relevant respondents reported monitoring this feature), monitoring of the "dollars per hour" feature decayed sharply (from 50% to 24%) from Wave 1 to Wave 2. This suggests a decline in interest in the financial incentive (perhaps because it is relatively low) and thus the likelihood that participants would compromise their comfort for that incentive.

- **Interest in the program appears to have declined over time.** Less than half as many respondents in Wave 2 as in Wave 1 reported checking their monitor multiple times per day. Nearly four times as many respondents in Wave 2 as in Wave 1 reported that they "didn't know" what the most difficult feature to use on the device was, suggesting RTM disuse had reduced feature familiarity.

- **Participants want more, not less engagement.** When asked (in an open-ended question) for suggestions for program improvement, nearly half of survey respondents indicated wanting *more* interaction from the pilot in a way that was more convenient for them, including electronic communications. Given this, it is possible that some kind of smart phone app with "push" notifications (perhaps with user-customized outputs) could reduce the decay in program interest noted above.

- **On the whole participants were pleased with the program.** Nearly 80% of survey respondents indicated that they would recommend participation in the pilot to a friend or family. Between 77% and 86% of respondents indicated that they had found the educational materials useful (depending on the type of material), and over 85% of respondents with an RTM reported that it was at least "somewhat" useful.

The remainder of this chapter is divided into the following 7 sections:

1. Demographics and Energy Efficiency Awareness**Error! Reference source not found.**
2. Real Time Monitor Ease of Use
3. Real Time Monitor Engagement
4. Educational Materials Engagement
5. Program Satisfaction
6. Program Effectiveness

Each of these sub-sections explores participant responses to specific survey questions, or groups of questions. When responses of both Wave 1 and Wave 2 respondents are compared in a graphic or the text, unless explicitly otherwise noted, the only Wave 1 respondents included are those that also participated in Wave 2.

4.1 Demographics and Energy Efficiency Awareness

The figures below show the demographic breakdowns of survey respondents, including respondent attitudes to energy conservation, type of primary heating equipment, location and age of respondents, and the age of respondents' homes.

Program participants report caring about energy conservation: 81% of respondents said that energy conservation was "very important" or "extremely important."

Figure 1: Importance of Energy Conservation

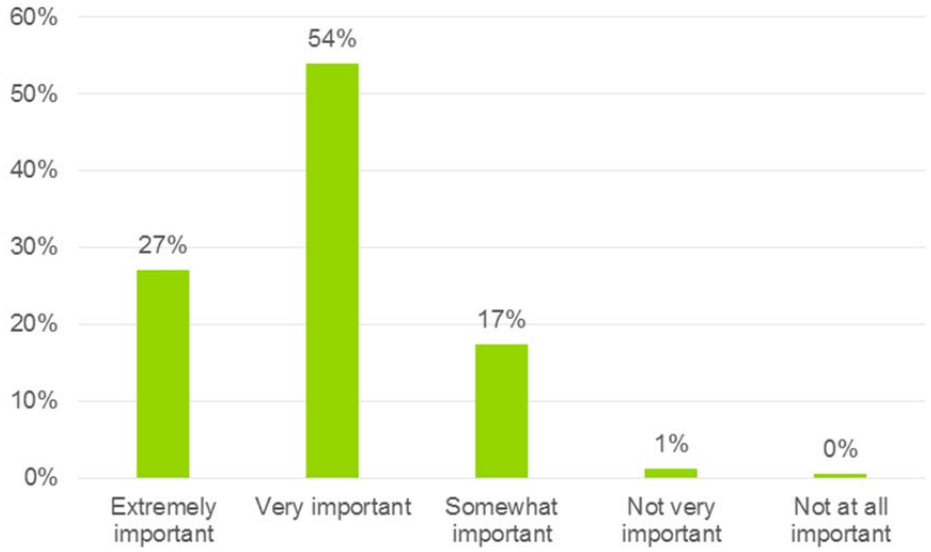


Figure 2: Primary Heating Source of Home

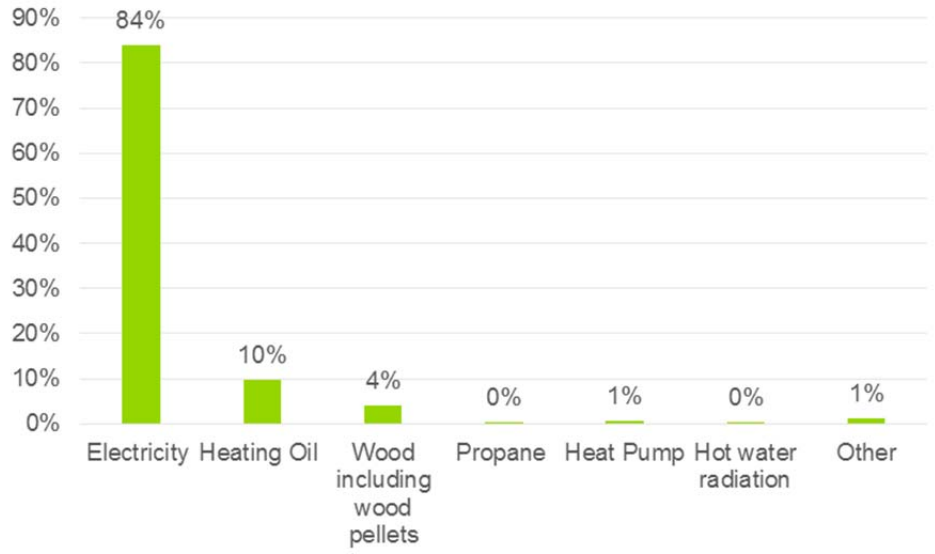


Figure 3: Household Location

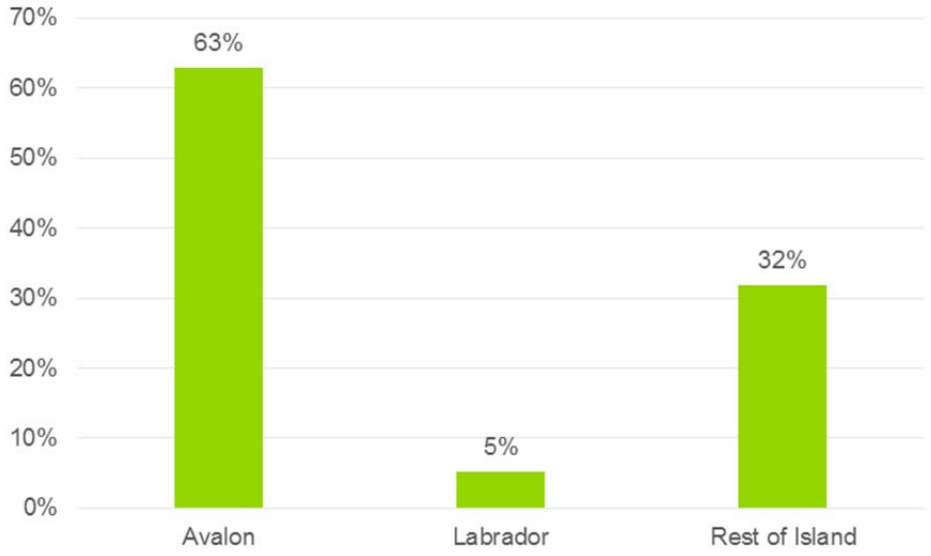


Figure 4: Age of Respondent

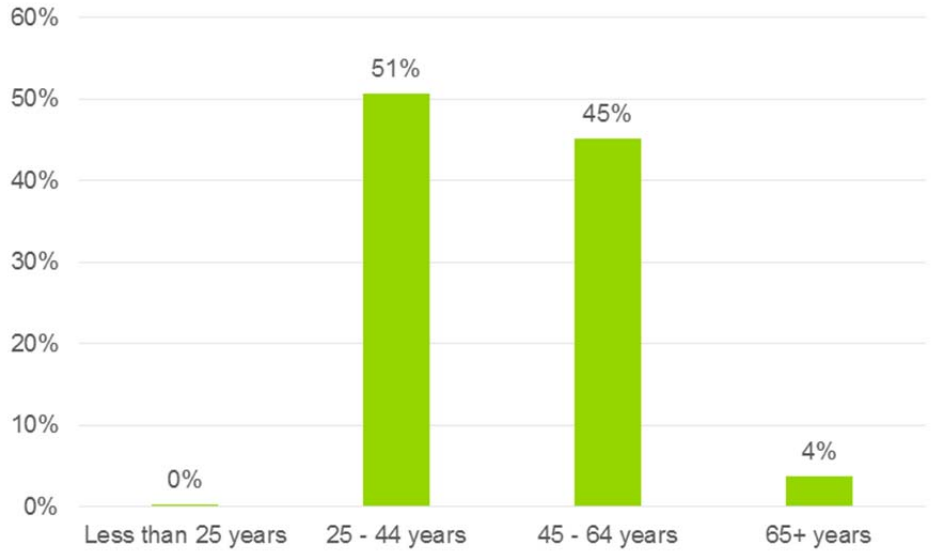
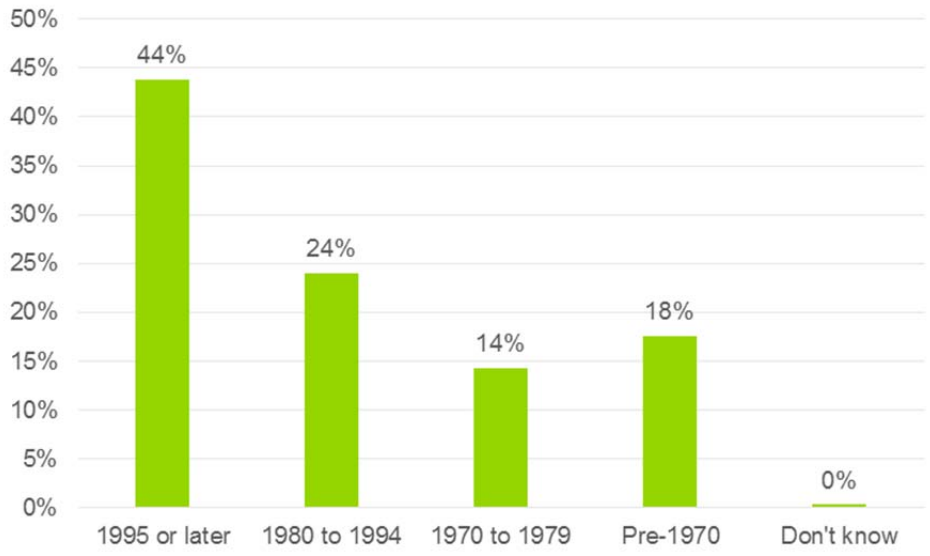


Figure 5: Age of Home

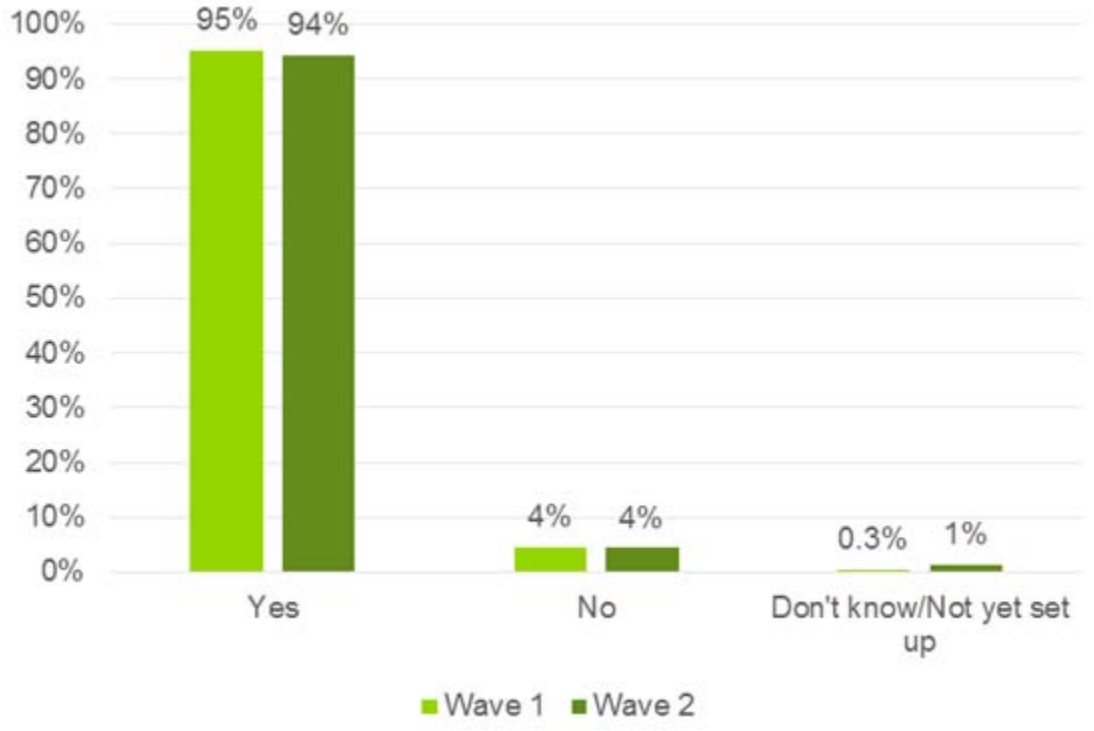


4.2 Real Time Monitor Ease of Use

Nearly all (95%) of devices were functioning at the time of the surveys. One respondent in both Waves indicated that the device had not been set up, and two respondents from Wave 2 indicated that they did not know.

Figure 6 shows the percentage of respondents with functioning devices at the time of survey. This figure includes only respondents surveyed in both Wave 1 and Wave 2.

Figure 6: Real Time Monitor Installed and Operating[15]



The survey asked a follow-up question of the 4% of respondents whose devices were not operating to ascertain whether they had contacted the Blueline helpline and whether they had received the support they required.

Of the 35 respondents across both waves who said their RTM was not operating, just seven respondents from Wave 1 and two respondents from Wave 2 contacted the helpline.

Of the nine that contacted the helpline, five did not report getting the support that they needed. Although this *could* indicate an issue with Blueline's support helpline personnel or processes, the sample of participants contacting the helpline is too small to make this assertion with any conventional level of certainty.

Participants generally found the RTM devices easy to use, with three-quarters of respondents with RTM devices saying the information provided was "very easy" to understand. Overall, more than 90% of

[15] Due to rounding not all values may sum to 100%.

respondents with RTM devices found the information at least "somewhat easy" to understand Figure 7 shows respondents' ratings of the ease of using the RTM.

Figure 7: Ease of Using Real Time Monitor

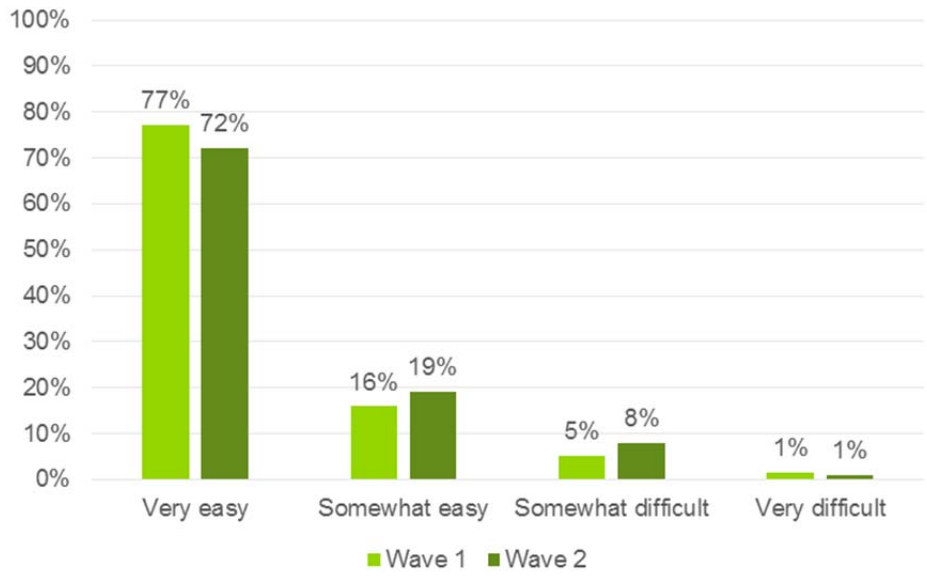


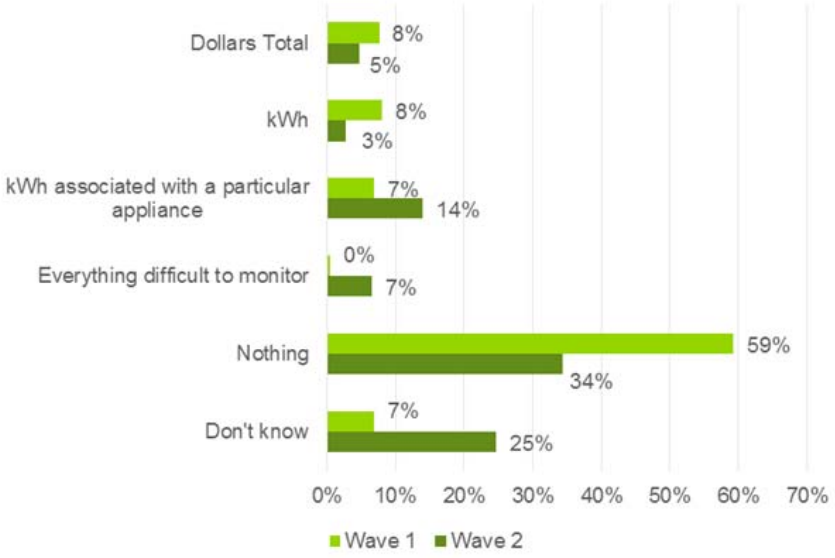
Figure 8 summarizes participant responses to the question of what RTM features were most difficult to monitor. Responses to this question seem to indicate that although participant comfort with the device grew over the course of the pilot, participants were less engaged with the device in the final months of the pilot.

Increasing participant comfort with the device is indicated by the change in the percentage of respondents that said that the "kWh" and "dollars total" features were most difficult to use. In both cases, about half as many Wave 2 respondents as Wave 1 respondents indicated that these features – features that would be expected to be examined most frequently – were difficult to use. Comfort in the device's most commonly used features increased over time.

Conversely, despite comfort with the most common features improving over the course of the pilot, it appears that participants became less engaged with the RTM over time. Contrast the Wave-specific responses identifying "Nothing" as the most difficult feature to monitor versus "Don't Know". The number of respondents saying "Don't Know" nearly quadrupled. These responses indicates that the

RTM was insufficiently top-of-mind for respondents for them to even recall if a particular feature had been difficult to use.

Figure 8: Most Difficult Features to Monitor



4.3 Real Time Monitor Engagement

More than two-thirds of Wave 2 respondents with RTMs used their device to view the electricity use of an appliance at some point during the program. This suggest that participants want to take control of their usage, and are using information from the RTM to try to identify areas where they can make easily-implementable changes with reasonable impacts on their consumption.

Figure 9 shows the appliances that respondents had monitored during the program. Respondents most frequently used the RTM to check the electricity use of their clothes dryer (65%) and stove/oven (58%).

This figure includes responses mentioned by at least 5% of survey respondents.

Figure 9: Appliances Monitored with Real Time Monitor

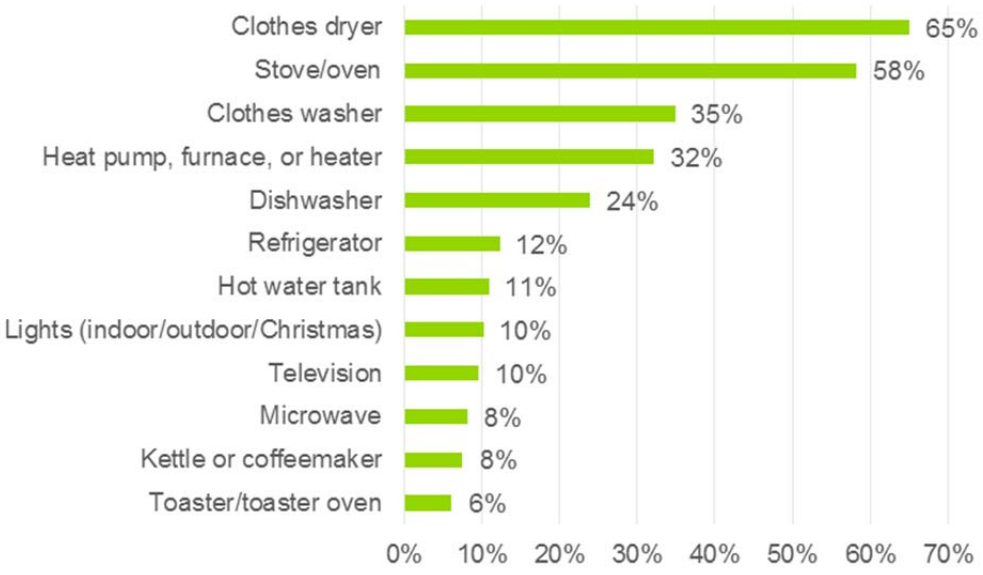


Figure 10 shows the RTM features that participants used. This figure only includes responses mentioned by at least 5% of survey respondents. The survey question associated with the figure below was open-ended.[16]

Participants' engagement with the RTM was generally higher in Wave 1 than in Wave 2, with most features being mentioned more frequently in Wave 1.

The features the usage of which decayed most sharply are those related to electricity costs. The number of respondents indicating that they used the "Dollars per Hour" feature fell by more than half from Wave 1 (when 50% of respondents indicated that it was a feature they used) to 24% for Wave 2. This contrasts sharply with the "kWh" feature. In that case respondent usage slightly increased compared to Wave 1. What caused participants to lose interest in the financial tracking data but not the (comparatively more abstract) energy usage data?

[16] The data provided by the survey house had 17% of Wave 2 respondents mentioning kW and 40% mentioning kWh. Since no Wave 1 responses were coded by the survey house as kWh, Navigant has aggregated these Wave 2 responses into a single category.

One possible hypothesis is that once it became apparent how little the marginal cost of usage is, participants lost interest in the financial metric, but they retained a hobby-like interest in how they use energy. Additional support for this hypothesis may be found in the result reported in Figure 16 that while a third of participants reported that the biggest benefit of the program was "More informed consumption choices" and a fifth reported that the biggest benefit was the information features of the RTM only 18% indicated the biggest benefit was to "save money".

Figure 10: Real Time Monitor Features Used

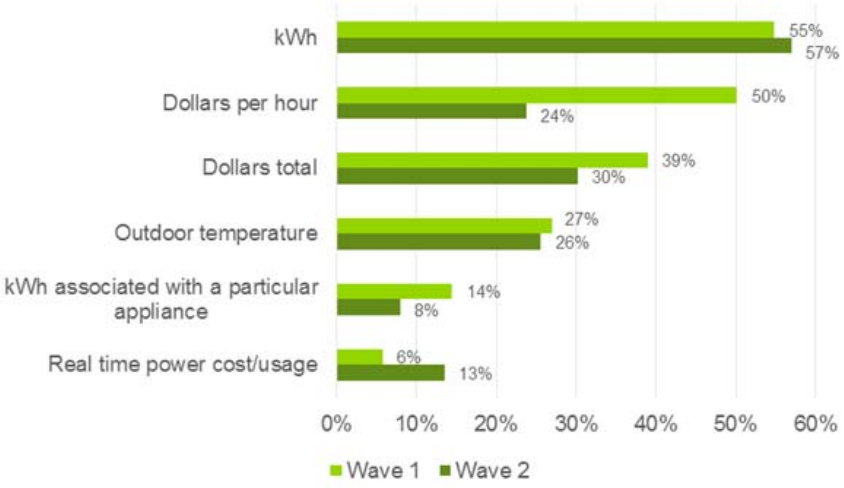
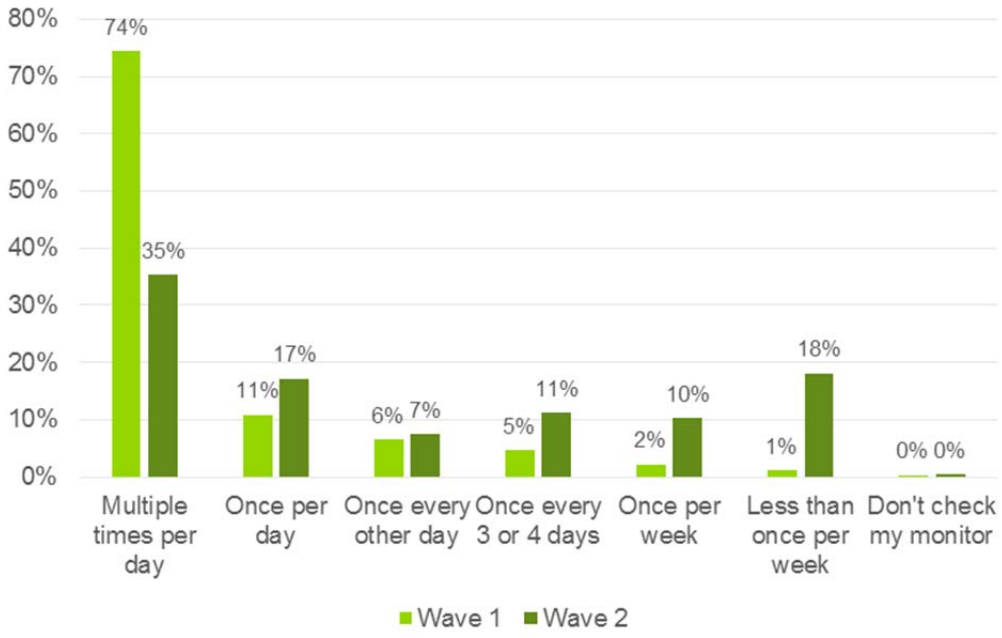


Figure 11 demonstrates waning participant enthusiasm over the course of the program. Fewer than half of the participants that indicated they checked their RTMs multiple times per day as part of Wave 1 indicated that they still did so when interviewed for Wave 2. Likewise, only 1% of Wave 1 respondents indicated that they checked their RTM less than once a week in contrast to nearly 20% of Wave 2 respondents.

Figure 11: Frequency of Checking Real Time Monitor

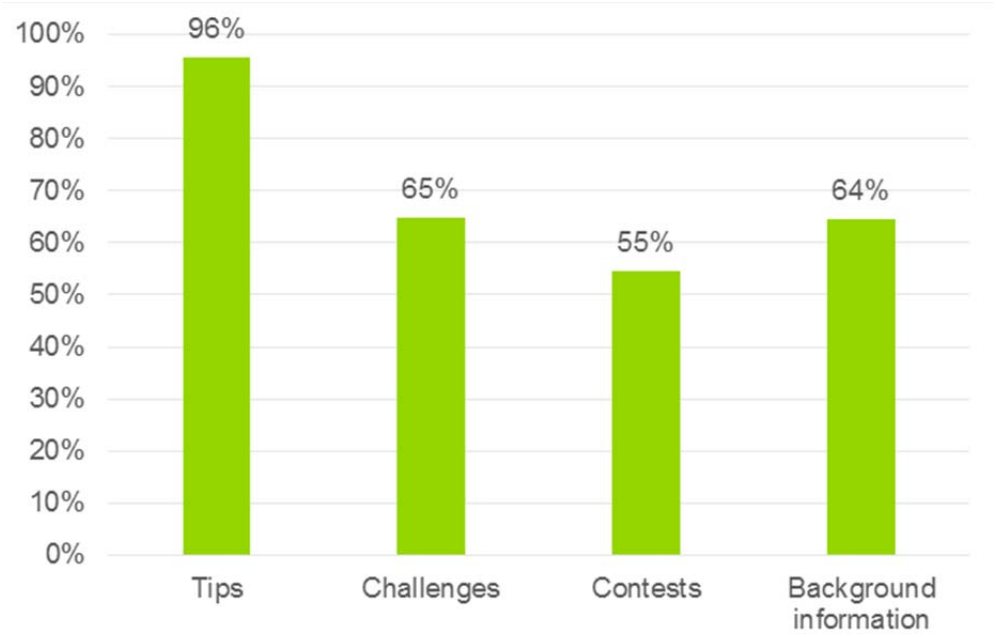


4.4 Educational Materials Engagement

Nearly all (96%) of the respondents that received educational materials recalled the receiving the "Tips". This supports the previous finding in Section 4.3 that participants use the program in order to take control over their energy consumption. Given that the "Tips" have the most immediately applicable information in the educational materials, the high recall of the "Tips" suggests that participants see value in actionable information. The "Challenges", "Contests", and "Background Information" materials had lower recall rates, with "Challenges" and "Background Information" recalled by two-thirds of survey respondents but the "Contests" being recalled only by half.

Figure 12 shows the relative recall rates of the different types of educational materials. This figure includes participants that received only the educational materials, and participants that received the educational materials in conjunction with the real time monitor.

Figure 12: Educational Materials Recalled



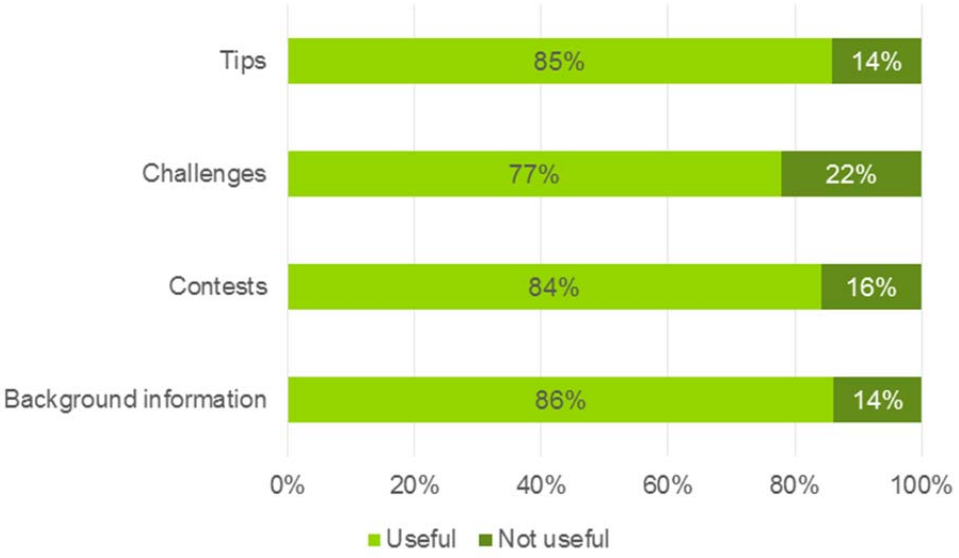
This question was only included in the Wave 2 survey since by the time of the Wave 1 survey was deployed participants receiving the educational materials might only have received one or two sets.

The four categories used to capture the variety of different educational materials provided to participants were developed by NLH in consultation with Navigant. The "background information" category was described to survey respondents as "the background information provided to you about how the people of the province use energy and water in their home, why you should take and action and why what you do matters." The "challenges" category was described to survey respondents as "energy-saving challenges like Earth Hour Lights Off, or the Family Challenge on who can save the most energy."

Participants generally claimed to have found the educational materials provided through the program useful, with over three-quarters of recipients saying they found each material type useful. Of the four types of materials, "Challenges" had the highest percentage of respondents saying they did not find them useful (22%).

Figure 13 shows the percentage of respondents who found the different educational materials useful.

Figure 13: Usefulness of Educational Materials



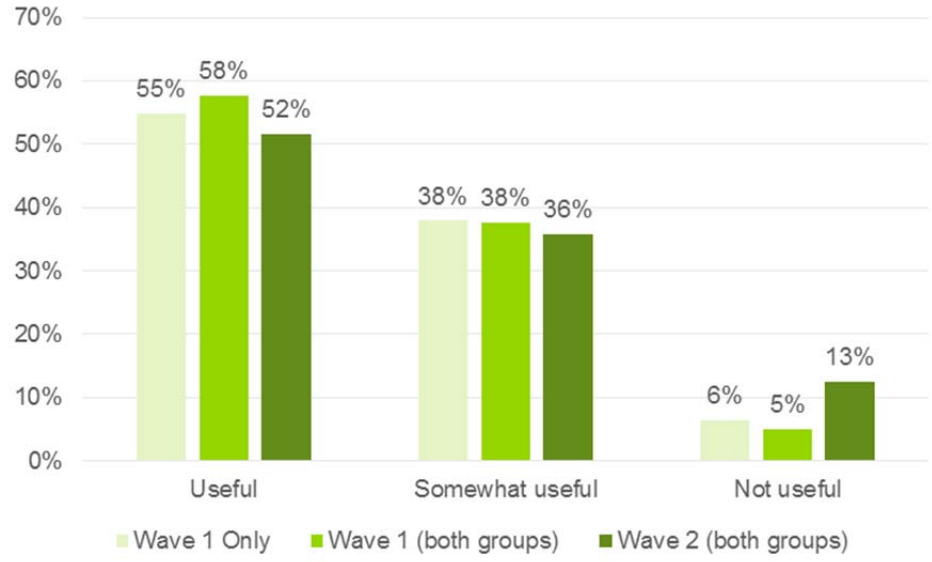
4.5 Program Satisfaction

Overall, participants claim to be satisfied with the program: when asked whether they would recommend the pilot to their friends or family, 78% of respondents said yes.

A majority of respondents reported that the real time monitor device was useful, with a third of respondents from all groups saying it is “somewhat useful”, and more than half of all respondents saying the device is “very” or “extremely” useful. Program dissatisfaction increased slightly over time; the percentage of respondents who found the RTM device to be “not useful” more than doubled from 5% in Wave 1 to 13% in Wave 2.

Figure 14 shows how useful participants reported they found the RTM. The first column shows responses from Wave 1 participants who were not surveyed in Wave 2; the second and third columns show responses from participants who were included in both Wave 1 and Wave 2.

Figure 14: Usefulness of Real Time Monitor by Wave



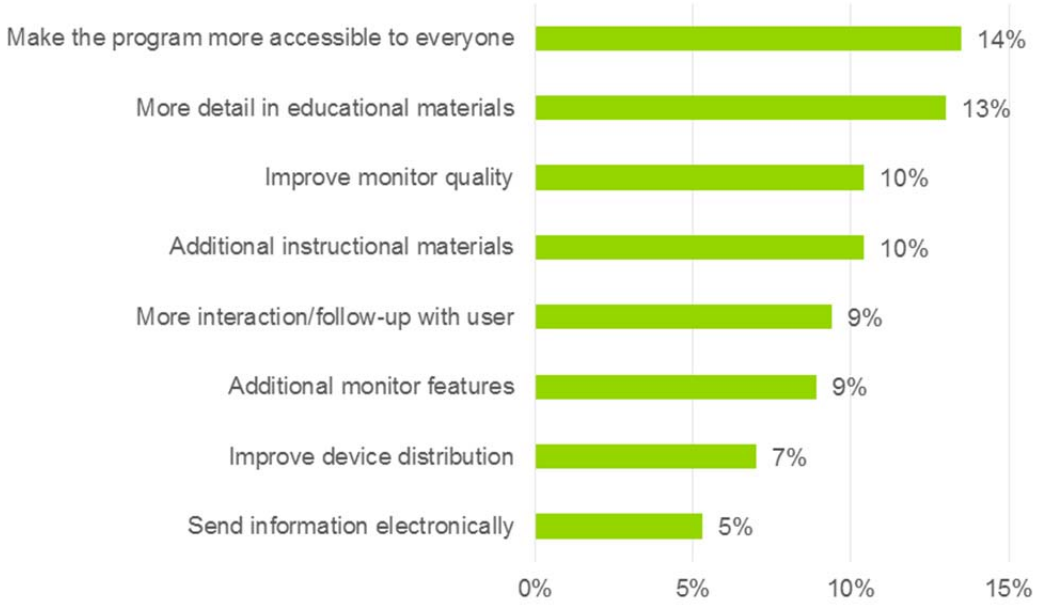
When asked to give open-ended suggestions for ways that NLH could improve the program or RTM, participant responses fall into a pattern indicating that participants would like more information and more engagement from NLH, and across more platforms. The combined percentage of participants that recommended that NLH provide more detail in the educational materials, provide additional instructional materials, interact more frequently with participants, make more (informational) monitor features available to participants and provided information and updates electronically is 46%.

Nearly half of participants want more interaction from the pilot in a way that's more convenient for them. It is possible that some kind of smart phone app with "push" notifications (perhaps with user-customized outputs) could substantially arrest the decay in program interest noted above.

Other suggestions mentioned by less than 5% of respondents included increased relevance of educational materials, incentives or rebates to participate in the program, telephone support for implementing actions described in the educational materials, and offering more monitoring devices for the home.

Figure 15 shows open-ended suggestions mentioned by at least 5% of respondents.

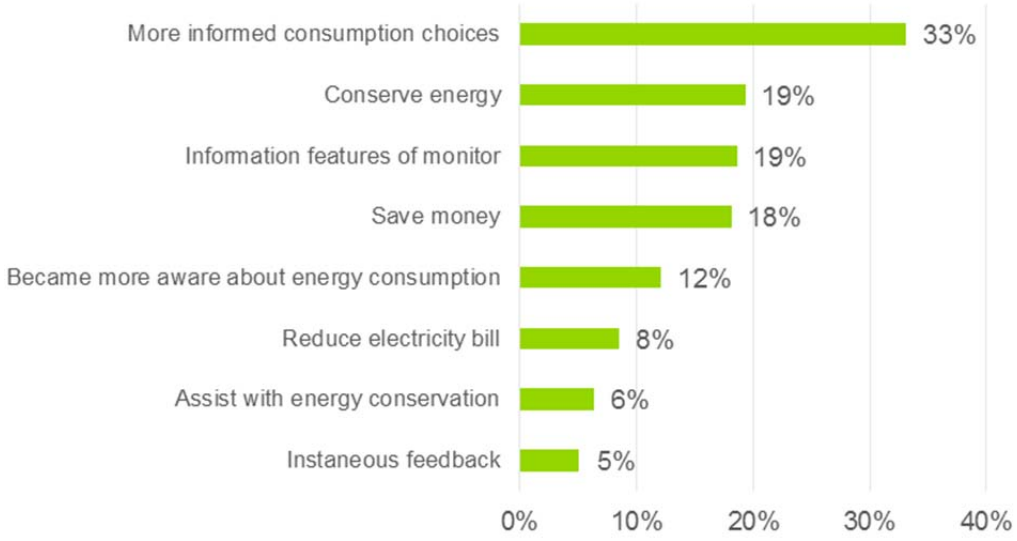
Figure 15: Suggestions to Improve Program or Real Time Monitor



When asked about the biggest benefits of the program during the Wave 1 survey, a third said that it helped them make more informed consumption choices. Additionally, 19% mentioned the information features of the monitor as a major benefit, along with 19% mentioning energy conservation. In contrast to these responses, which indicate relatively intangible benefits (i.e., the satisfaction of understanding one's own consumption), only 18% of respondents reported that the biggest benefit of the program was to save money.

Figure 16 shows open-ended responses mentioned by at least 5% of respondents. Respondents could give multiple answers to this question.

Figure 16: Biggest Benefits of Participation



Although the most common single response category for this question was one that suggests minimal conservation response ("more informed consumption choices"), many participants *did* indicate that they believed the biggest benefit of the program was to help them save money and conserve energy.

How can these self-reported program benefits be reconciled to the empirically estimated impacts, which indicate relatively low levels of savings achieved, on average? The simplest explanation is that participants over-estimated the effectiveness of their actions, or else exaggerated their conservation response to the survey house. Previous studies of the same product have found a similar deviation between self-reported actions and data. From a 2012 IEEE paper: "Although the opinions of the project participants suggested that they took action to reduce their energy consumption as a result of the direct visibility of the real-time data, *the actual power consumption data collected from the devices did not support such assertions.*"[17] (emphasis added).

[17] Alahmad, M., Wheeler, P., Schwer, A., Eiden, J., and A. Brumbaugh, *A Comparative Study of Three Feedback Devices for Residential Real-Time Energy Monitoring*, IEEE Transactions on Industrial Electronics, Vol. 59, No. 4, April 2012

http://projects.absolutepowerandcontrol.com/Why%20Monitor%20Study.pdf

4.6 Program Effectiveness

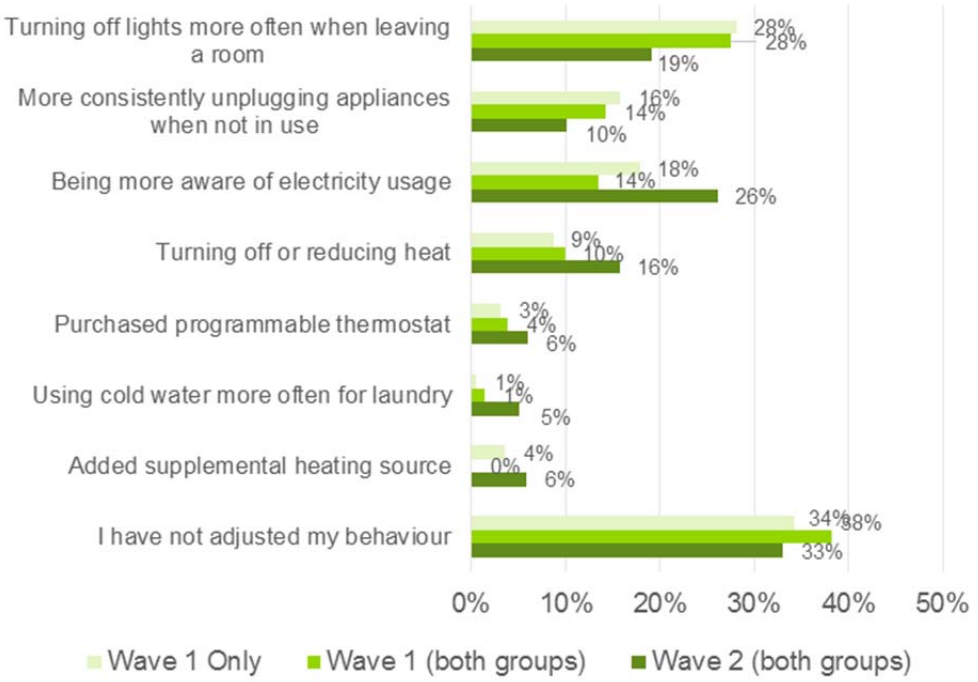
The evidence from the survey results regarding what types of (potentially) energy saving behaviours were adopted over the course of the pilot (as a result of the pilot) appears to be internally inconsistent and must be carefully interpreted.

Figure 17 shows what energy-saving actions participants reported taking as a result of the program. The question associated with this figure is open-ended and allows for multiple responses. This figure includes respondents who were only surveyed in Wave 1, as well as respondents who were surveyed in both Wave 1 and Wave 2.

Several things are striking about the reported findings.

- Approximately a third of participants across both waves report not adjusting their behaviour at all as a result of participating in the pilot.
- More than a quarter of respondents to the Wave 2 survey (at the close of the program) reported that their changed action was “being more aware of electricity usage”. Reporting an improvement in understanding as a changed action suggests that perhaps few concrete actions were undertaken.
- There was a substantial decay in the number of participants reporting that they made an effort to extinguish lights when they left the room from Wave 1 to Wave 2
- The increase in Wave 2 respondents that reported adjusting their heating due to the effects of the program is nearly the same as the number of Wave 2 respondents indicating that they adopted a supplemental (non-electric) heating source as a result of the program.

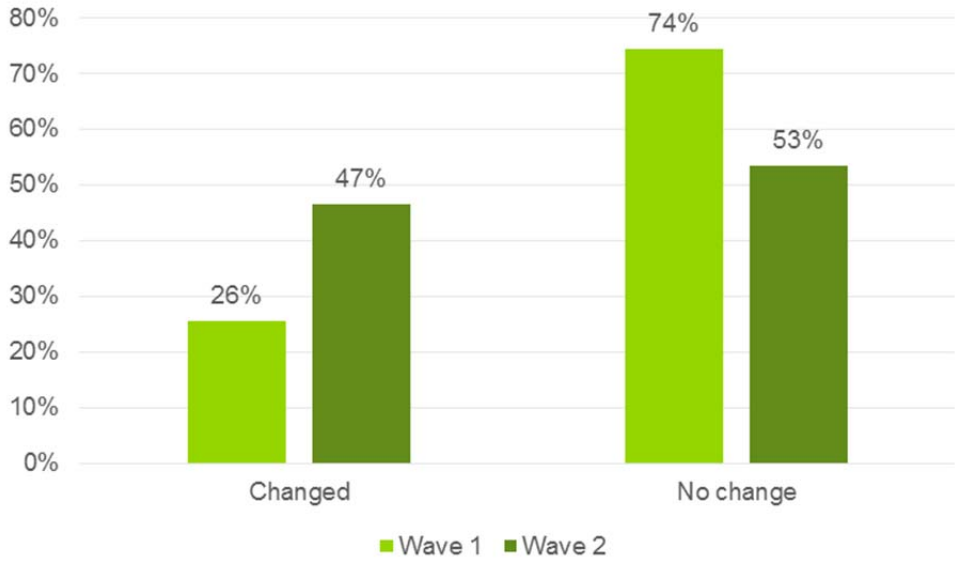
Figure 17: Actions Changed Due to Program



The very small percentage of respondents that claim to have reduced their heating as a result of the program when provided with an open-ended (unprompted) question is particularly striking when compared to another question in the same survey that explicitly questioned participants about their heating settings.

Nearly *half* of the Wave 2 respondents reported changing their heating settings as a result of the pilot (only 16% reported reducing their heating in the open-ended question). Likewise, a quarter of Wave 1 respondents reported changing their heating settings as a result of the pilot in contrast to only 10% reporting a reduction in heating for the open-ended question, see Figure 18, below.

Figure 18: Changes to Heating Settings



The source of this apparent contradiction may be the degree to which respondents made a concerted effort to change their heating behaviour.

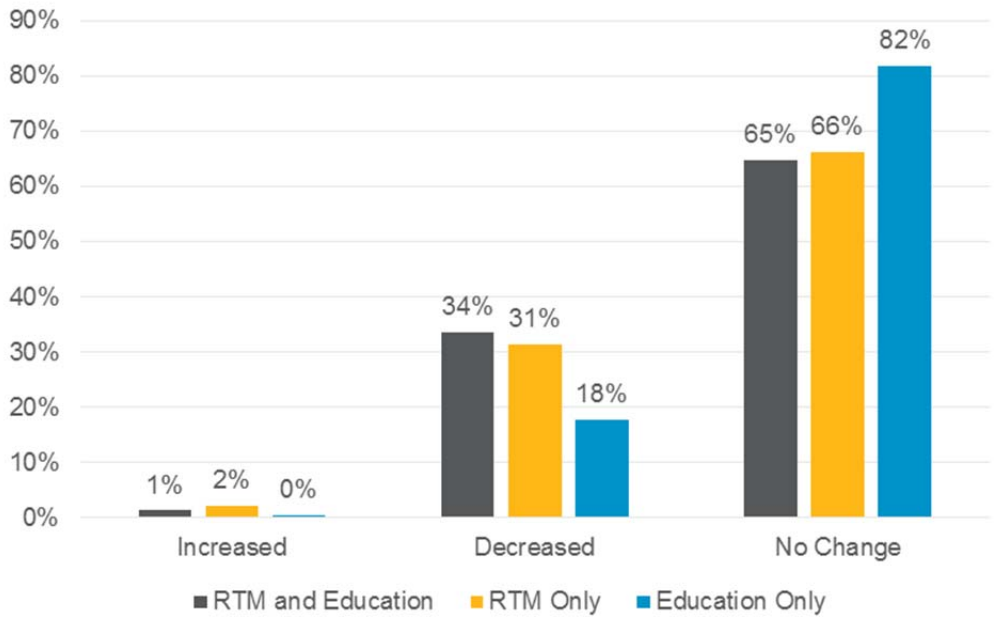
As the responses to more specific temperature adjustment questions below show, the most common heating setting adjustment that respondents report having applied is an overnight temperature setback. Most survey respondents use all-electric (baseboard) heating in their home (see below). This means many different thermostats, few, if any, of which are likely to be programmable.

A respondent that occasionally adjusted one or a few thermostats overnight, might not automatically recall those actions when asked to self-report in the same way that, for example those that consciously (and conscientiously) adjusted *all* of their baseboard thermostats might. When questioned explicitly about heating setting changes, however, the less dedicated respondents might (perhaps due partly to the "halo" effect often observed of survey responses) report their behaviour change.

More than 80% of the "Educational Only" group reported making no change to their heating settings due to the program. There was no notable difference between the group that received the RTM only and the group that received the RTM and educational materials. These findings suggest that receiving only the educational materials is not a strong motivating factor to change behaviour.

Figure 19 compares the changes that respondents in each of the three treatment groups made as a result of the program. This figure only includes respondents who were surveyed in both Wave 1 and Wave 2.

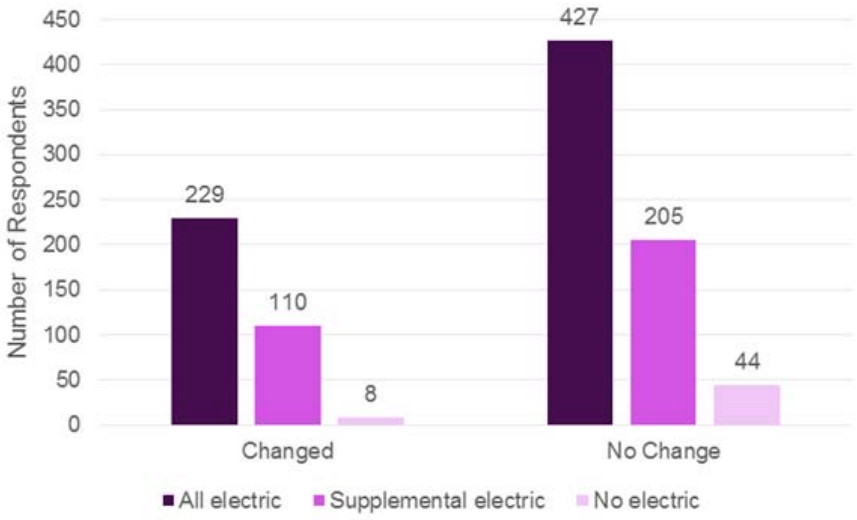
Figure 19: Changes to Heating Settings by Treatment Group



Participants with all-electric heat and supplemental electric heat changed their home heating settings with similar relative frequency, though all-electric customers comprise a much larger portion of the sample frame than partial-electric or non-electric customers. In terms of actual customer behaviour change, more than twice as many all-electric customers reported making changes to their home heating settings as supplemental-electric customers.

Figure 20 shows the number of survey respondents that reported changing their home heating settings, broken out by heat source. This figure includes Wave 1 respondents who were not included in Wave 2 as well as respondents who were surveyed in both waves.

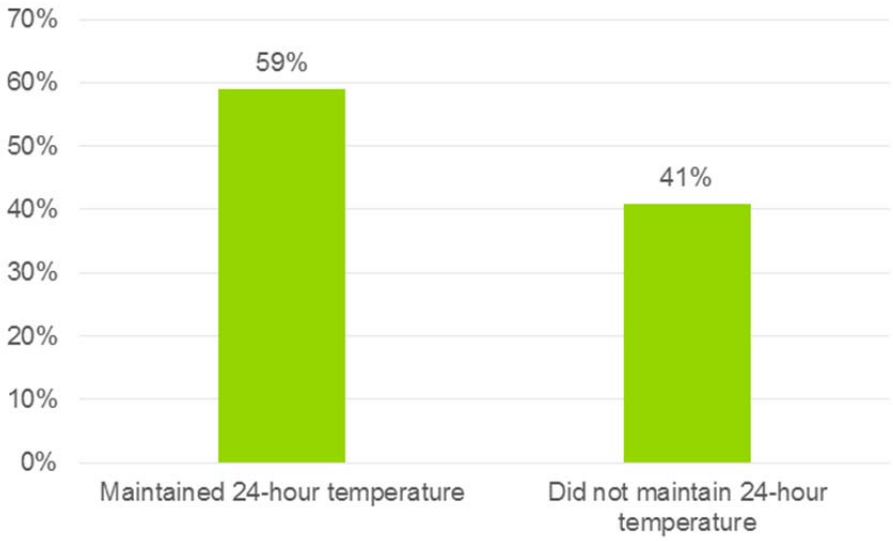
Figure 20: Changes to Heating Settings by Heating Source



At the beginning of the program, more than half (59%) of Wave 1 respondents said that they maintained the same heat settings 24 hours a day prior to participating in the program.

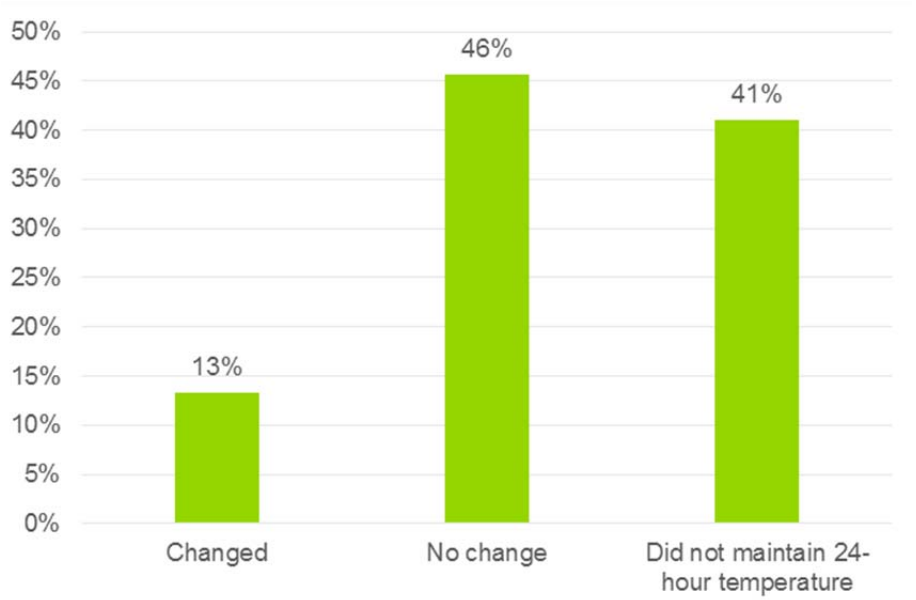
Figure 21 shows the percentage of respondents who maintained a constant home heating setting for 24 hours a day prior to the program.

Figure 21: 24-Hour Heat Setting Prior to Program



When asked in Wave 2 whether they had changed their 24-hour temperature setting due to the program, only 13% had made any changes. Figure 22 shows the percentage of "Yes" respondents in the previous figure that changed their home heating settings as a result of the program.

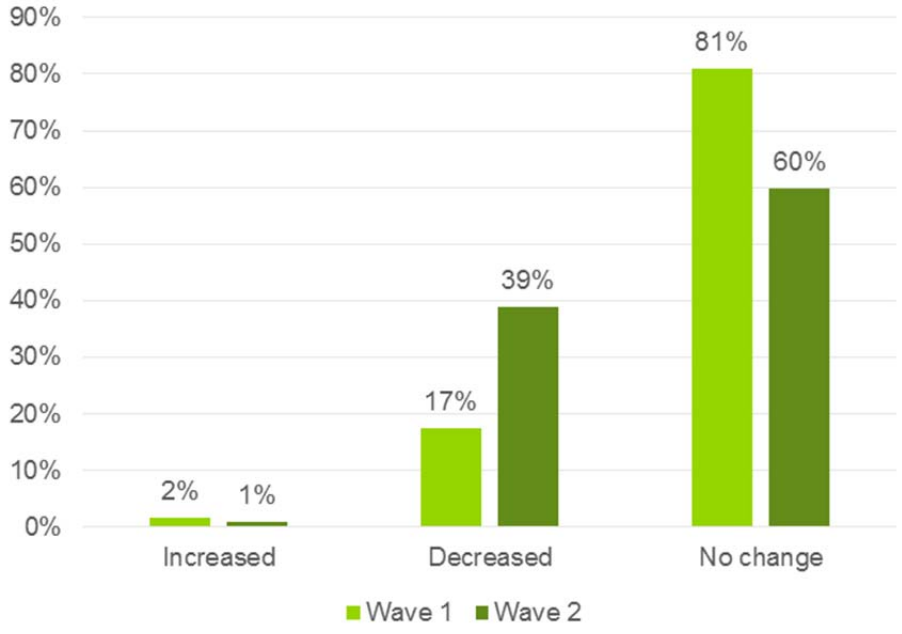
Figure 22: Changes to 24-Hour Heat Setting



More than twice as many respondents reported that they had decreased their temperature in Wave 2 than in Wave 1, and the percentage of respondents that reported making no change dropped from 81% to 60%.

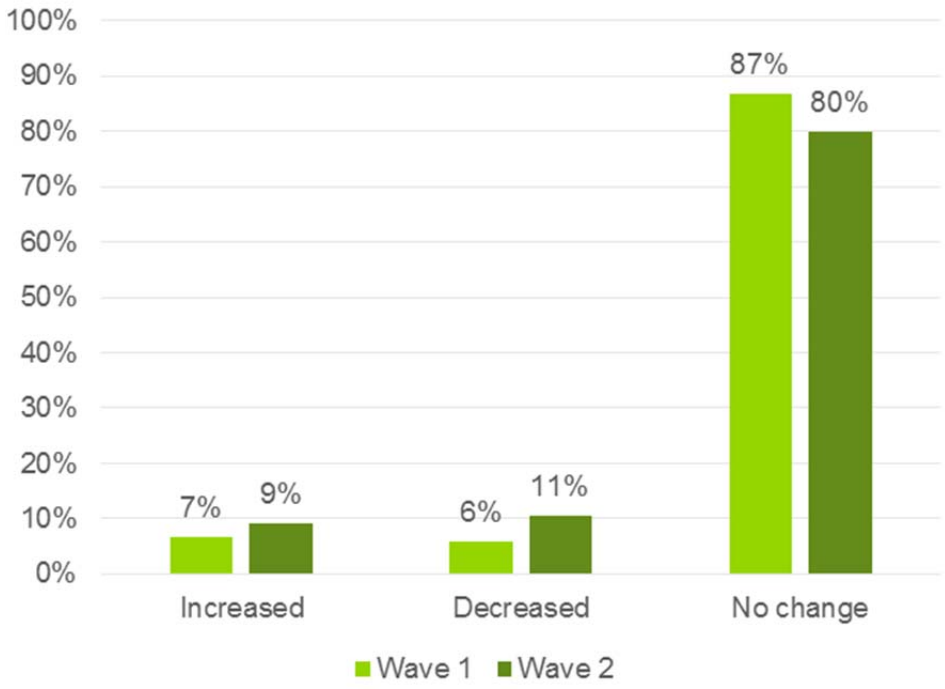
Figure 23 shows respondents' reported changes to their overnight heating settings as a result of the program.

Figure 23: Changes to Overnight Heat Setting



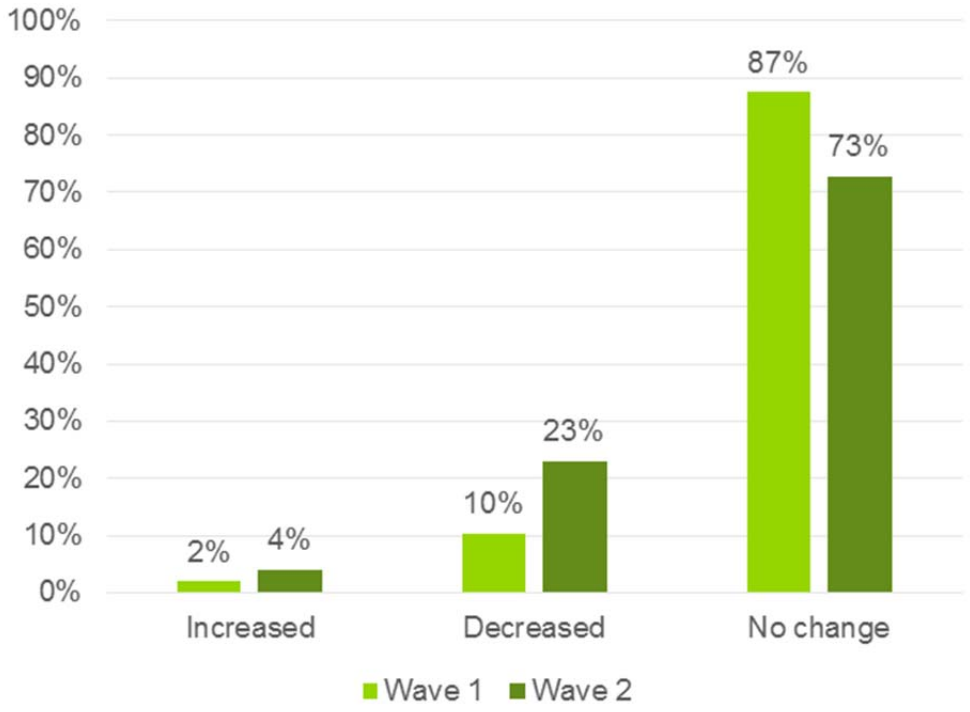
Based on "morning" reported heating setting changes, the program had no net impact on participant heating settings in the morning. Most respondents (87% in Wave 1 and 80% in Wave 2) made no changes to their morning temperature at all, and a similar percentages of respondents reported increasing their morning temperature settings as reported decreasing them. Figure 24 shows morning temperature changes between Wave 1 and Wave 2.

Figure 24: Changes to Morning Heat Setting



The percentage of respondents who that reported decreasing their daytime temperature setting more than doubled from Wave 1 to Wave 2. Figure 25 shows how respondents reported adjusting their daytime temperature settings due to the program.

Figure 25: Changes to Daytime Heat Setting



Responses to a question about their expected annual dollar savings due to the program varied widely, with a quarter of Wave 1 respondents unable to give an estimate. Ongoing participation in the program appears to have increased these participants' certainty in their estimated savings, but no their optimism – the number of survey respondents reporting that they expected achieve no savings at all doubled in Wave 2.

Survey respondents in general, however, appear to have highly optimistic expectations for the financial outcomes of participation, with nearly a third of Wave 2 participants reporting (in response to an open-ended question) that they expected to achieve bill savings of over $200 in the year (see Figure 26). Given the current residential electricity rate for NLH and NP customers of 10.573 cents/kWh[18] this would require these participants to reduce their consumption by a *minimum* of nearly 2,000 kWh per year.[19]

[18] Newfoundland and Labrador Hydro tariff/rate book, http://www.nlhydro.com/wp-content/uploads/2014/04/Complete-Set-of-Rates-effective-July-1-2015-3.pdf
Newfoundland Power tariff/rate book, http://www.newfoundlandpower.com/AboutUs/pdf/ratebook.pdf

[19] For context, the average annual consumption of program participants was approximately 24,000 kWh per year, and the average annual consumption of participants in Avalon without electric heat was approximately 10,000 kWh per year.

While achieving this level or higher of bill savings is not impossible for a participant based on behavioural actions such as those cited by participants in Figure 17 (above), it would require a set of material lifestyle changes, changes that participants, based on the unprompted self-reports in Figure 17 don't necessarily seem to be making.

Participants with highly (perhaps overly) optimistic impressions regarding the bill savings they will achieve could lead to participant disillusionment and disengagement. NLH may consider for any future deployments of a similar program carefully educating participants by presenting them with a set of straightforward, concrete energy savings actions, and a corresponding estimate of potential bill savings.

Figure 26: Dollar Amount Savings Estimate

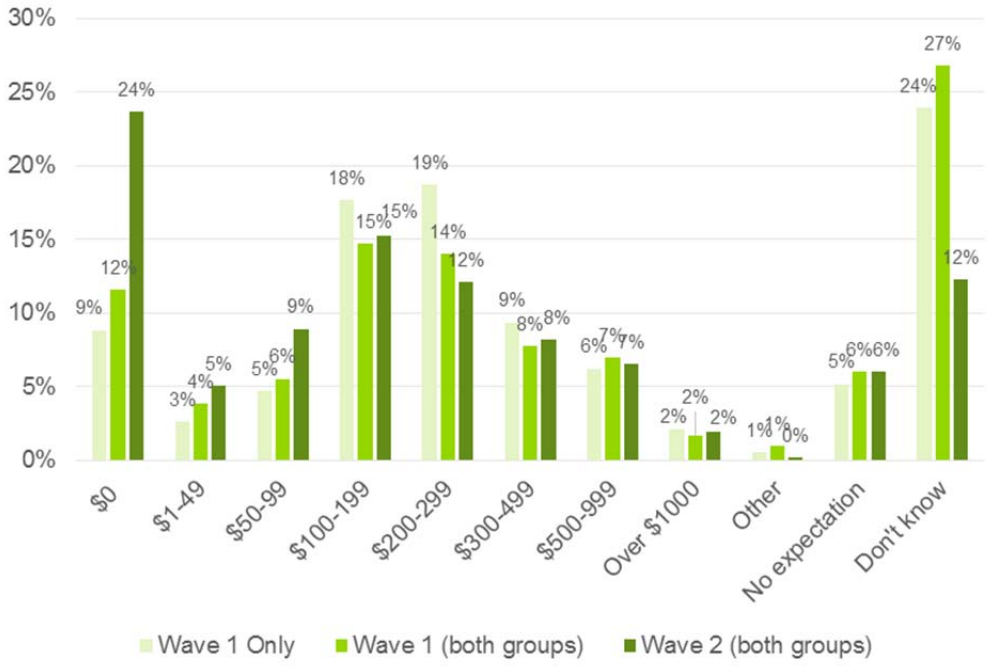
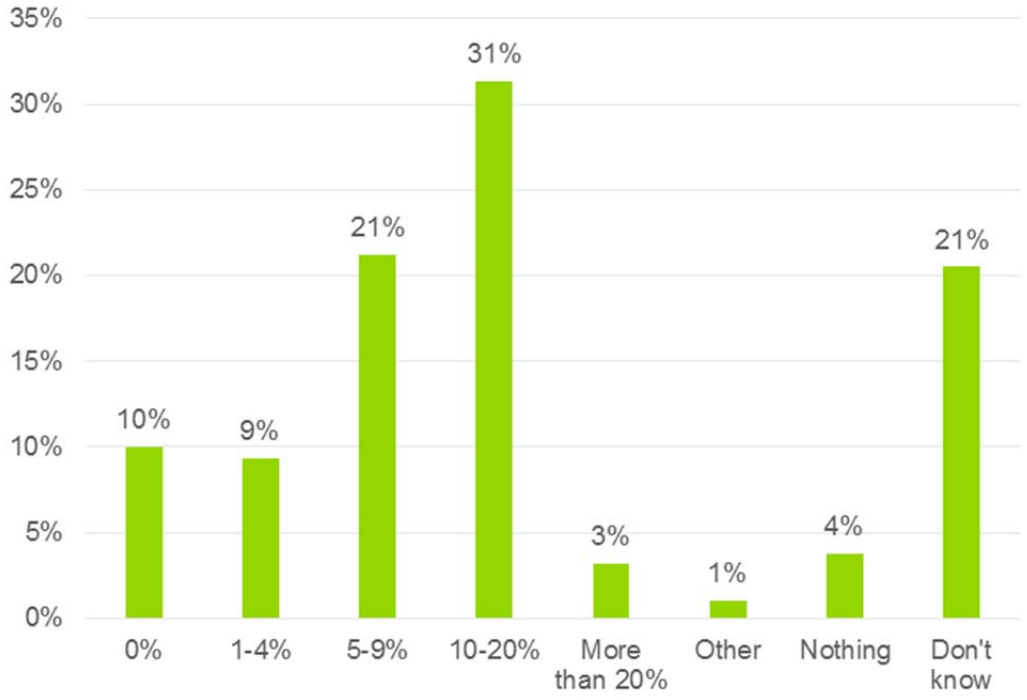


Figure 27 reports participants' perception of the potential energy savings from the program from a slightly different perspective. In Wave 1, one-third of respondents indicated that they expected to reduce their annual electricity bill by 10-20%.

Figure 27: Percentage Savings Estimate



5. CONCLUSION & RECOMMENDATIONS

Navigant's principal findings for this evaluation are:

- Participants equipped with the RTM achieved an average of 1.2% electricity savings across the three pilot regions.
- Statistically significant RTM energy savings were achieved exclusively by participants that use multiple space-heating fuels. On average, this group of participants achieved 4% electricity savings.
- No statistically significant electricity savings could be attributed to the educational materials, either in combination with, or without, the RTM.
- When surveyed, participants reported that the program better helped them understand their consumption, but did not consistently report undertaking high-impact conservation actions

In summary: **the RTM pilot substantially increased participants' perceived energy literacy, but motivated only a modest amount of sustained behavioural change in participants.**

The combined results of both impact and process analyses indicate that while participants claim that the pilot helped them to understand how they use power, many have not appeared to make a consistent, conscientious effort to undertake material lifestyle shifts of the kind that could deliver substantial energy (and bill) savings.

Rates in Newfoundland and Labrador are not structured to motivate either conservation (through an inclining block rate), or shifting (through time-of-use, or TOU) and are relatively low compared to many jurisdictions. This aspect of the economic incentive may have affected participant response. [20]

Navigant's key impact findings include:the RTM had a modest but real impact on participant consumption. Use of the RTM resulted in electricity savings of 1.2% (see Table 3). The educational materials did not have any meaningful impact on consumption. Examples of educational material provided are in Appendix C.

Table 3: Principal Impact Findings[1]

	Real Time Monitor (monitor only ***and*** monitor plus information groups)	Information-only group
Avalon	**1.4%**	**0.0%**
Rest of Island	**0.9%**	**0.0%**
Labrador	**0.0%**	**0.0%**
Total	**1.2%**	**0.0%**

3. Statistical significance is discussed in the Navigant Report

Navigant found that electricity savings were only achieved by participants with multiple heating fuels. Participants with multiple fuels (i.e., supplemental electric) achieved an average of 4.0% energy savings due to the RTM (Table 4). Navigant indicated that the most reasonable explanation for these results is that participants with non-electric heat sources are practicing a form of fuel-switching, that is, they are substituting the use of electric baseboard heaters, for example, with a wood pellet or wood stove. Since the all-electric participants (by definition) have no other heating option, their only option for achieving electricity savings via space-heating controls is to reduce their total home heating load. Conversely, Navigant concluded that achieving such a net reduction in a home heated entirely by electric baseboards, without materially compromising customer comfort, can be a challenge.

Table 4: Impact by Heating Type[1]

	Real Time Monitor	Information-only group

[20] A comparison of the Newfoundland rate of 10.573 cents/kWh with the residential rates reported for 177 U.S. utilities by the Edison Electric Institute in its *Typical Bills and Average Rates Report*, Winter 2014 report shows that *without adjusting for exchange rates or inflation*, NLH's rate is lower than 60% of U.S. utilities. When the exchange rate is applied, NLH's rate is lower than that of 93% of the U.S. utilities included in that study.

	(monitor only *and* monitor plus information groups)					
	Electric only	Supplemental electric	No electric	Electric only	Supplemental electric	No electric
Avalon	**0.0%**	**4.6%**	**N/A**	**0.0%**	**0.0%**	**N/A**
Rest of Island	**0.0%**	**3.1%**	**N/A**	**0.0%**	**0.0%**	**N/A**
Labrador	**0.0%**	**N/A**	**N/A**	**0.0%**	**N/A**	**N/A**
Total	**0.0%**	**4.0%**	**N/A**	**0.0%**	**0.0%**	**N/A**

3. Statistical significance is discussed in the Navigant Report

Navigant also found that electricity savings were higher in the winter months (defined at October to March) than in summer months (defined as April to September) (Table 5).

Table 5: Impact by Heating Season[1]

	Real Time Monitor (monitor only *and* monitor plus information groups)		Information-only group	
	Summer Months	Winter Months	Summer Months	Winter Months
Avalon	**0.6%**	**0.8%**	**0.0%**	**0.0%**
Rest of Island	**0.3%**	**0.7%**	**0.0%**	**0.0%**
Labrador	**0.0%**	**0.0%**	**0.0%**	**0.0%**
Total	**0.5%**	**0.7%**	**0.0%**	**0.0%**

3. Statistical significance is discussed in the Navigant Report

Navigant indicated that the reported savings are in line with those reported for similar programs in other jurisdictions.
Navigant's key process findings include:

- **Participants improved their energy literacy, but this did not necessarily translate to concrete energy conservation actions.** Although survey responses indicate reasonably strong participant engagement with the informational program outputs, respondents do not seem to have consistently undertaken high-yield conservation actions.

  Improved Energy Literacy:

  - A third of respondents indicated that the biggest benefit of participation was being able to make more informed choices, and a fifth cited the informational features of the monitor. Only 18% indicated that the biggest program benefit was the ability to save money, see Table 2 immediately below the key process findings.
  - Recall of the educational tips provided was very high – 96% of participants recalled receiving these.

  Program Response and Motivation:

  - When provided with an open-ended (unprompted) question regarding behaviour changes, a third of respondents reported no behaviour change at all (see Table 3, immediately below). The most commonly reported behaviour change was "being more

aware of energy usage", and only 16% indicated that they had reduced their heating use.

  - Although respondent monitoring of the kWh feature of the RTM was consistent across both survey Waves (a little less than 60% of relevant respondents reported monitoring this feature), monitoring of the "dollars per hour" feature decayed sharply (from 50% to 24%) from Wave 1 to Wave 2. This suggests a decline in interest in the financial incentive (perhaps because it is relatively low) and thus the likelihood that participants would compromise their comfort for that incentive.

- **Interest in the program appears to have declined over time.** Less than half as many respondents in Wave 2 as in Wave 1 reported checking their monitor multiple times per day. Nearly four times as many respondents in Wave 2 as in Wave 1 reported that they "didn't know" what the most difficult feature to use on the device was, suggesting RTM disuse had reduced feature familiarity.
- **Participants want more, not less engagement.** When asked (in an open-ended question) for suggestions for program improvement, nearly half of survey respondents indicated wanting *more* interaction from the pilot in a way that was more convenient for them, including electronic communications. Given this, it is possible that some kind of smart phone app with "push" notifications (perhaps with user-customized outputs) could reduce the decay in program interest noted above.
- **On the whole participants were pleased with the program.** Nearly 80% of survey respondents indicated that they would recommend participation in the pilot to a friend or family. Between 77% and 86% of respondents indicated that they had found the educational materials useful (depending on the type of material), and over 85% of respondents with an RTM reported that it was at least "somewhat" useful.

APPENDIX A. IMPACT ANALYSIS TECHNICAL APPENDIX

This Appendix is divided into three sections:

1. Data Cleaning
2. Control Group Validation
3. Regression Models and Results

A.1 Data Cleaning

In January 2016 Navigant received billing data and installation dates for 720 participants, and approximately 80,000 non-participants from three regions: Avalon, Rest of Island, and Labrador. Navigant matched each of these participants to a control customer drawn from the non-participant pool by season (two seasons were used, as described in more detail below in Section A.2).

To create a cleaned sample of bills for the impact analysis, Navigant removed the following data from the raw set, prior to estimation:

- Observations with fewer than 20 or more than 40 days in the billing cycle.
- Outlier observations, defined as observations of average daily consumption more than one order of magnitude larger than the median average daily consumption of all treatment and control customers in the same region.
- Customers with fewer than 2 months of billing data (per season) in the matching period.
- Observations in the evaluation period that fell in a month for which there was no corresponding pre-enrollment period observation.

This resulted in a cleaned sample for the impact analysis containing 714 participants and 1,382 unique comparison customers.

A.2 Control Group Validation

All matching was based on Euclidean distance (sum of squared differences) for the variables used for matching, as described in section 2.1. Matching was done with replacement (a given non-participant could act as a control customer for multiple participants).

The pool of non-participant households available for matching consisted of over 80,000 residential customers (across three regions) whose billing data were provided by NLH and NP.

Each participant was matched to a nonparticipant based on usage in a 6 month season. The winter months are defined as October 2013 through March 2014. Summer months are defined as April 2014 through September 2014. For each program participant who had at least 2 months of monthly billing data available (for each season) prior to enrollment, average daily energy consumption in each month in the pre-enrollment period was compared to that of all customers in the available pool over the same months. Matching was done in the period before the installation of the RTM monitor for all participants. Customers with fewer than 2 months for matching during the matching period were removed from the analysis.

To verify the robustness of the matches, average daily usage (kWh) per month for both participants and controls over the matching seasons, are compared. Figure 28, Figure 29, and Figure 30 illustrate these results. As can be seen from these figures, the quality of the matched comparison group is high, with participant and non-participant usage closely tracking each other for each region.

Figure 28: Participant and Control Group Validation - Avalon

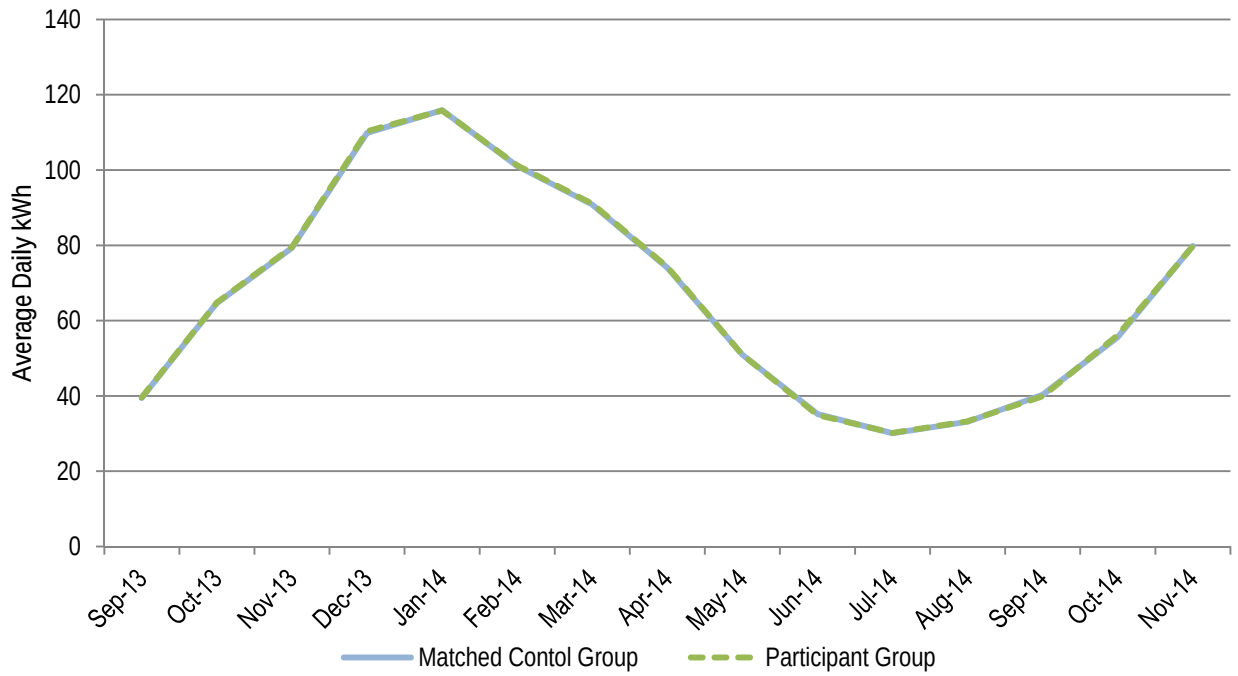


Figure 29: Participant and Control Group Validation - ROI

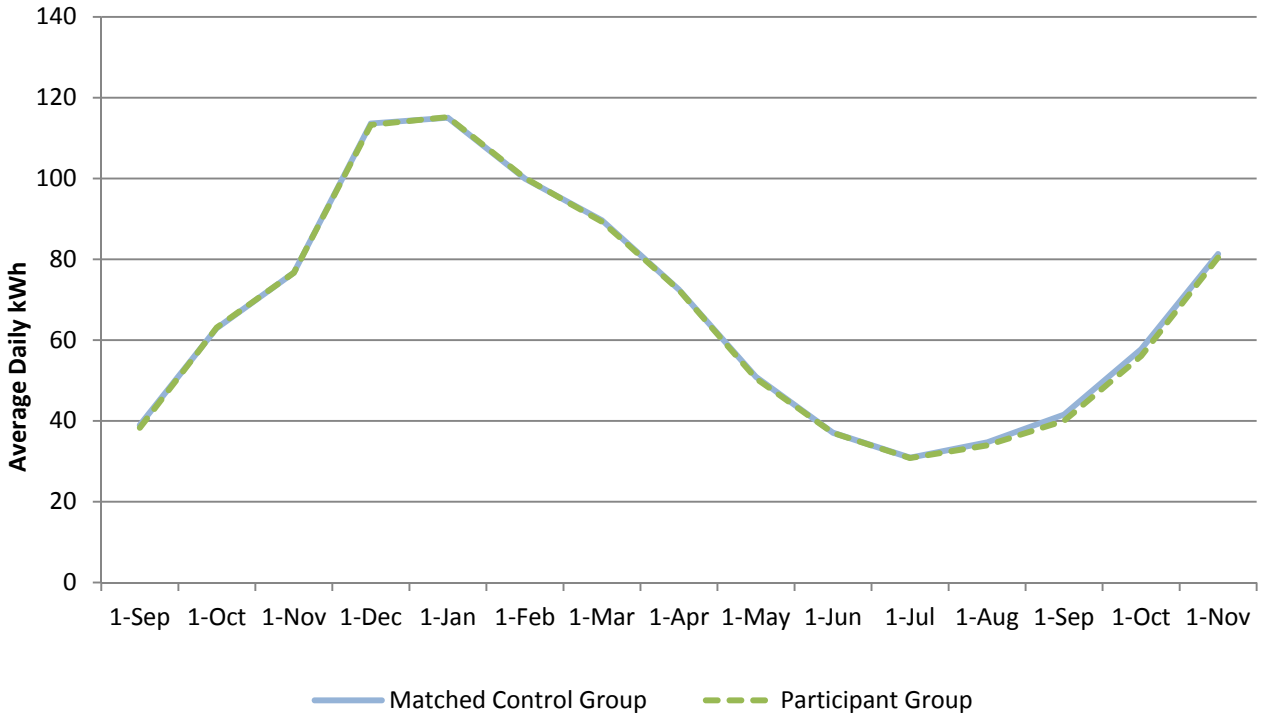
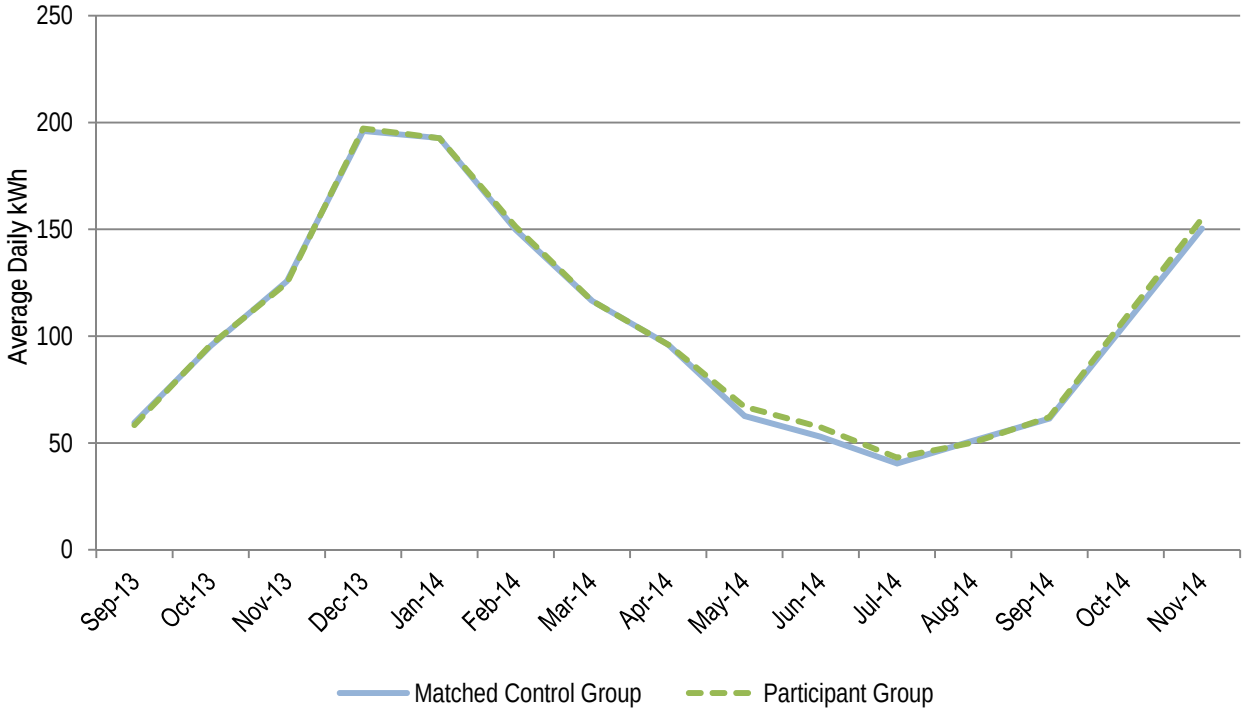


Figure 30: Participant and Control Group Validation - Labrador



A.3 Regression Models and Results

Data on energy use by participants and their matched controls were used in a regression analysis to estimate program impacts. Three regression models were estimated for this analysis, performed for each region (a total of nine models were estimated). Prior to the models estimated below, as part of Navigant's exploratory analysis, regressions were estimated that included an interaction between the two treatments – i.e., allowing for the possibility that the combined effect of the educational materials and the RTM is different from the sum of the two effects. The initial exploratory analysis showed that this interaction was not statistically significant and so, to simplify the analysis, it was dropped from the final specifications provided below.

The dependent variable for the regression models defined as average daily kWh ($ADU_{k,t}$) use for a billing period ending in month *M*, where *M* pertains to the evaluation period January 2015 to December 2015. Control variables are defined below.

Model 1 regression outputs are presented in Table 14, Table 15, and Table 16 below. Regression outputs for Models 2 and 3 are available on request.

Model 1: Impacts by Delivery Type

$$ADU_{k,t} = \beta_1 Device_k + \beta_2 Information_k + \boldsymbol{\gamma} Yrmo_t + \boldsymbol{\delta} Pre\_kWh_{k,t} + u_t$$

- $Device_k$ = An indicator variable equal to 1 if participant *k* received a device, 0 otherwise
- $Information_k$ = An indicator variable equal to 1 if participant *k* received information, 0 otherwise
- $Yrmo_t$ =The fixed effect for year/month M (M=October, November, etc.)
- $Pre\_kWh_{k,t}$ = The average daily kWh use by household *k* in the month of the matching period corresponding to month t. For instance, the value of $PREkWh_{kt}$ for February 2015 is February 2014

Model 2: Impacts by Season

$$ADU_{k,t} = \beta_1 Device_k{:}\, Summer_t + \beta_2 Information_k{:}\, Summer_t + \beta_3 Device_k{:}\, Winter_t + \beta_4 Information_k{:}\, Winter_t + \boldsymbol{\gamma} Yrmo_t + \boldsymbol{\delta} Pre\_kWh_{k,t} + u_t$$

- $Device_k$ = An indicator variable equal to 1 if participant *k* received a device, 0 otherwise

- $Winter_t$ =An indicator variable equal to 1 if Month *M* is in the winter, 0 otherwise
- $Summer_t$ = An indicator variable equal to 1 if Month *M* is in the summer, 0 otherwise
- $Information_k$ = An indicator variable equal to 1 if participant *k* received information, 0 otherwise
- $Yrmo_t$ =The fixed effect for year/month M (M=October, November, etc.)
- $Pre\_kWh_{k,t}$ = The average daily kWh use by household *k* in the month of the matching period corresponding to month *t*. For instance, the value of $PREkWh_{kt}$ for February 2015 is February 2014

Model 3: Impacts by Primary Fuel Type

$$ADU_{k,t} = \beta_1 Device_k{:}\, Electric_k + \beta_2 Device_k{:}\, NoElec_k + \beta_3 Device_k{:}\, Both_k + \beta_4 Information_k{:}\, Electric_k + \beta_5 Information_k{:}\, NoElec_k + \beta_6 Information_k{:}\, Both_k + \boldsymbol{\gamma} Yrmo_t + \boldsymbol{\delta} Pre\_kWh_{k,t} + u_t$$

- $Device_k$ = An indicator variable equal to 1 if participant *k* received a device, 0 otherwise
- $Information_k$ = An indicator variable equal to 1 if participant *k* received information, 0 otherwise
- $Electric_k$ =An indicator variable equal to 1 if customer k's primary heating source is electric only, 0 otherwise
- $NoElec_k$ = An indicator variable equal to 1 if customer k's primary heating source is non-electric, 0 otherwise
- $Both_k$ An indicator variable equal to 1 if customer k's primary heating source is a mix of electric and non-electric sources, 0 otherwise
- $Yrmo_t$ =The fixed effect for year/month M (M=October, November, etc.)
- $Pre\_kWh_{k,t}$ = The average daily kWh use by household *k* in the month of the matching period corresponding to month *t*. For instance, the value of $PREkWh_{kt}$ for February 2015 is February 2014

Parameter estimates, standard errors, R-squared, and t-statistics for Model 1 are presented in Table 14, Table 15, and Table 16 below. In the tables, the use of ":" indicates an interaction between two variables.

Table 14: Model 1 Regression Outputs - Avalon

	Coefficient	Std. Error	T-stat	P-Value	R-Squared
$Device_k$	-0.948	0.459	-2.063	0.039	0.971
$Information_k$	0.729	0.458	1.592	0.111	0.971
$Yrmo_{201501}$	13.439	3.419	3.931	0.000	0.971

$Yrmo_{201502}$	6.933	1.338	5.180	0.000	0.971
$Yrmo_{201503}$	9.045	1.807	5.004	0.000	0.971
$Yrmo_{201504}$	14.094	1.945	7.248	0.000	0.971
$Yrmo_{201505}$	10.758	1.823	5.900	0.000	0.971
$Yrmo_{201506}$	5.445	0.941	5.786	0.000	0.971
$Yrmo_{201507}$	6.836	1.348	5.070	0.000	0.971
$Yrmo_{201508}$	3.022	3.057	0.989	0.323	0.971
$Yrmo_{201509}$	7.367	1.704	4.322	0.000	0.971
$Yrmo_{2015010}$	9.312	0.910	10.238	0.000	0.971
$Yrmo_{2015011}$	5.921	1.148	5.160	0.000	0.971
$Yrmo_{2015012}$	11.425	1.581	7.225	0.000	0.971
$Yrmo_{201501}: Pre\_kWh_{k,201401}$	0.864	0.031	27.970	0.000	0.971
$Yrmo_{201502}: Pre\_kWh_{k,201402}$	0.815	0.013	65.171	0.000	0.971
$Yrmo_{201503}: Pre\_kWh_{k,201403}$	0.937	0.019	48.203	0.000	0.971
$Yrmo_{201504}: Pre\_kWh_{k,201404}$	0.820	0.023	36.330	0.000	0.971
$Yrmo_{201505}: Pre\_kWh_{k,201405}$	0.821	0.027	29.967	0.000	0.971
$Yrmo_{201506}: Pre\_kWh_{k,201406}$	0.828	0.020	41.817	0.000	0.971
$Yrmo_{201507}: Pre\_kWh_{k,201407}$	0.888	0.040	22.149	0.000	0.971
$Yrmo_{201508}: Pre\_kWh_{k,201408}$	1.056	0.108	9.788	0.000	0.971
$Yrmo_{201509}: Pre\_kWh_{k,201409}$	0.751	0.054	13.881	0.000	0.971
$Yrmo_{2015010}: Pre\_kWh_{k,201410}$	0.809	0.025	32.394	0.000	0.971
$Yrmo_{2015011}: Pre\_kWh_{k,201411}$	0.885	0.019	47.478	0.000	0.971
$Yrmo_{2015012}: Pre\_kWh_{k,201412}$	0.907	0.021	42.478	0.000	0.971

Table 15: Model 1 Regression Outputs - ROI

	Coefficient	Std. Error	T-stat	P-Value	R-Squared
$Device_k$	-0.591	0.755	-0.782	0.434	0.965
$Information_k$	-0.519	0.792	-0.655	0.513	0.965
$Yrmo_{201502}$	10.981	2.413	4.551	0.000	0.965
$Yrmo_{201503}$	5.471	2.099	2.607	0.009	0.965
$Yrmo_{201504}$	8.044	2.123	3.789	0.000	0.965
$Yrmo_{201505}$	14.190	3.486	4.071	0.000	0.965
$Yrmo_{201506}$	10.750	1.421	7.563	0.000	0.965
$Yrmo_{201507}$	4.258	1.587	2.683	0.007	0.965
$Yrmo_{201508}$	7.819	1.742	4.488	0.000	0.965
$Yrmo_{201509}$	5.486	2.357	2.327	0.020	0.965
$Yrmo_{2015010}$	10.237	1.558	6.572	0.000	0.965
$Yrmo_{2015011}$	8.733	2.020	4.323	0.000	0.965
$Yrmo_{2015012}$	14.799	2.763	5.356	0.000	0.965
$Yrmo_{201502}: Pre\_kWh_{k,201402}$	0.795	0.022	36.195	0.000	0.965
$Yrmo_{201503}: Pre\_kWh_{k,201403}$	0.995	0.022	44.610	0.000	0.965
$Yrmo_{201504}: Pre\_kWh_{k,201404}$	0.909	0.025	36.996	0.000	0.965
$Yrmo_{201505}: Pre\_kWh_{k,201405}$	0.805	0.053	15.333	0.000	0.965
$Yrmo_{201506}: Pre\_kWh_{k,201406}$	0.746	0.028	26.304	0.000	0.965
$Yrmo_{201507}: Pre\_kWh_{k,201407}$	0.909	0.045	20.233	0.000	0.965
$Yrmo_{201508}: Pre\_kWh_{k,201408}$	0.846	0.061	13.918	0.000	0.965
$Yrmo_{201509}: Pre\_kWh_{k,201409}$	0.795	0.072	11.107	0.000	0.965
$Yrmo_{2015010}: Pre\_kWh_{k,201410}$	0.781	0.043	18.118	0.000	0.965
$Yrmo_{2015011}: Pre\_kWh_{k,201411}$	0.843	0.033	25.681	0.000	0.965

$Yrmo_{2015012}$: $Pre\_kWh_{k,201412}$	0.855	0.037	23.290	0.000	0.965

Table 16: Model 1 Regression Outputs - Labrador

	Coefficient	Std. Error	T-stat	P-Value	R-Squared
$Device_k$	4.491	6.392	0.703	0.483	0.910
$Information_k$	-8.514	6.218	-1.369	0.171	0.910
$Yrmo_{201501}$	40.434	17.083	2.367	0.018	0.910
$Yrmo_{201502}$	50.544	14.936	3.384	0.001	0.910
$Yrmo_{201503}$	58.776	17.752	3.311	0.001	0.910
$Yrmo_{201504}$	69.966	30.374	2.303	0.022	0.910
$Yrmo_{201505}$	61.879	10.028	6.171	0.000	0.910
$Yrmo_{201506}$	27.675	4.927	5.617	0.000	0.910
$Yrmo_{201507}$	26.168	6.001	4.360	0.000	0.910
$Yrmo_{201508}$	14.902	5.941	2.508	0.012	0.910
$Yrmo_{201509}$	7.830	3.103	2.523	0.012	0.910
$Yrmo_{2015010}$	30.482	7.959	3.830	0.000	0.910
$Yrmo_{2015011}$	62.796	13.589	4.621	0.000	0.910
$Yrmo_{2015012}$	43.259	21.524	2.010	0.045	0.910
$Yrmo_{201501}$: $Pre\_kWh_{k,201401}$	0.745	0.090	8.286	0.000	0.910
$Yrmo_{201502}$: $Pre\_kWh_{k,201402}$	0.687	0.073	9.399	0.000	0.910
$Yrmo_{201503}$: $Pre\_kWh_{k,201403}$	0.744	0.114	6.540	0.000	0.910
$Yrmo_{201504}$: $Pre\_kWh_{k,201404}$	0.559	0.211	2.648	0.008	0.910
$Yrmo_{201505}$: $Pre\_kWh_{k,201405}$	0.287	0.107	2.672	0.008	0.910
$Yrmo_{201506}$: $Pre\_kWh_{k,201406}$	0.630	0.063	10.063	0.000	0.910
$Yrmo_{201507}$: $Pre\_kWh_{k,201407}$	0.540	0.044	12.203	0.000	0.910

$Yrmo_{201508}$: $Pre\_kWh_{k,201408}$	0.970	0.039	25.052	0.000	0.910
$Yrmo_{201509}$: $Pre\_kWh_{k,201409}$	0.900	0.059	15.352	0.000	0.910
$Yrmo_{2015010}$: $Pre\_kWh_{k,201410}$	0.581	0.138	4.213	0.000	0.910
$Yrmo_{2015011}$: $Pre\_kWh_{k,201411}$	0.383	0.141	2.722	0.007	0.910
$Yrmo_{2015012}$: $Pre\_kWh_{k,201412}$	0.659	0.158	4.160	0.000	0.910

APPENDIX B. OTHER STUDIES COMPLETE REFERENCES

This appendix provides the complete references for the studies cited in Table 13 in section 3.4, above.

Alahmad, M., Wheeler, P., Schwer, A., Eiden, J., and A. Brumbaugh, *A Comparative Study of Three Feedback Devices for Residential Real-Time Energy Monitoring*, IEEE Transactions on Industrial Electronics, Vol. 59, No. 4, April 2012

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http://socserv.mcmaster.ca/qsep/p/qsep449.pdf

Opinion Dynamics on behalf of National Grid, NSTAR Electric, and Western Massachusetts Electric Company, *Final Report for: PowerCost Monitor Pilot Program Evaluation*, 2008

http://library.cee1.org/sites/default/files/library/8807/CEE_Eval_PowerCostMonitorPilotProgramEvaluation_10Dec2008.pdf

Sipe, B., and S. Castor of Energy Trust of Oregon, *The Net Impact of Home Energy Feedback Devices*, presented at the 2009 Energy Program Evaluation Conference, Portland, 2009

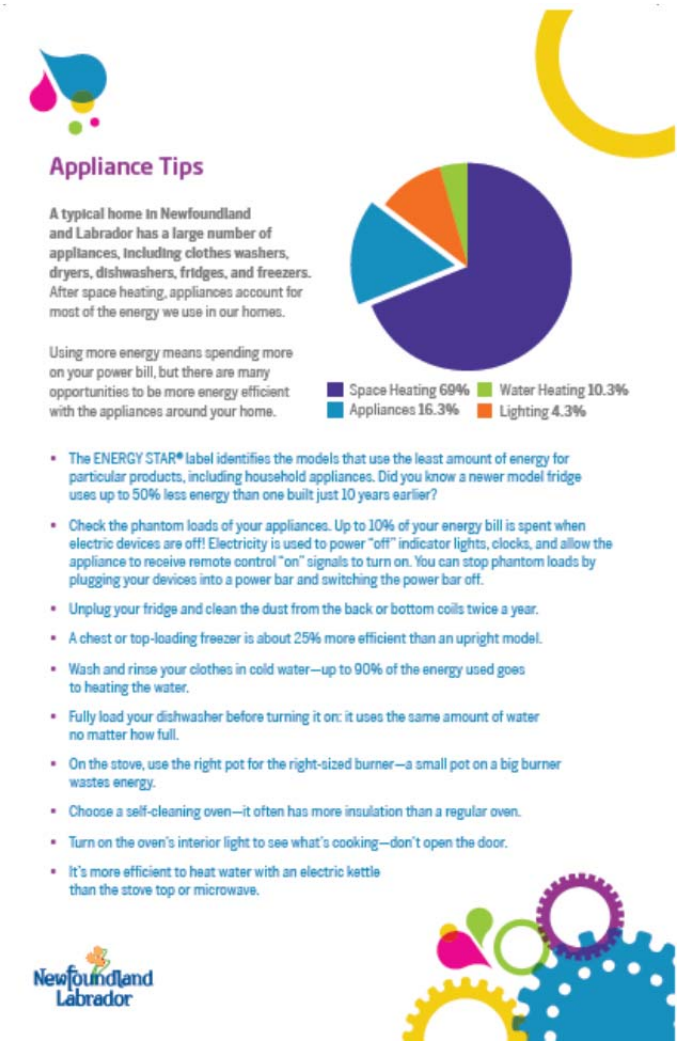
http://energytrust.org/library/reports/Home_Energy_Monitors.pdf

Tendril et al on behalf of Tucson Electric Power, *TEP Power Partners Project Final Report*, 2014

http://www.osti.gov/scitech/servlets/purl/1123882

3. APPENDIX C

Sample Educational Materials



Here's your opportunity to learn even more ways to conserve energy at home. These tips work together to make your home more efficient and comfortable, and they save you money too!

HOME ENERGY MONITORING PILOT PROJECT

Newfoundland Labrador

in partnership with takeCHARGE! | hydro

Visit the Turn Back the Tide Interactive House

The Government of Newfoundland and Labrador has a website called Turn Back the Tide. It is a one-stop-shop to help you understand the impacts of climate change and learn how to be more energy efficient. Becoming more energy efficient is about using less energy to do the things we need. But what are the benefits? Quite simply, there are many and they can be realized by everyone.

Visit the site's interactive house, http://www.turnbackthetide.ca/interactive-house.html. Take a look through the house and discover easy ways to save energy, cut waste, and reduce greenhouse gas emissions.

Send us three things you learned and be **ENTERED TO WIN** a takeCHARGE prize pack valued at $100. Entries can be emailed to takechargehydro@nlh.nl.ca

Newfoundland Labrador

4. APPENDIX D

Participant Survey

Newfoundland and Labrador Hydro

Home Energy Monitoring Pilot Program: Initial Survey

Part 1: Introduction and Screener

1.1 Good evening. My name is _____ and I'm calling from IPSOS Reid on behalf of Newfoundland and Labrador Hydro. May I please speak with <insert name>?

a. Yes (continue to 1.2)
b. Yes, I will get them (continue to 1.2)
c. No, not available (arrange callback, thank you and terminate)
d. No, refused (thank you and terminate)

Read: **"According to our records, you recently agreed to participate in the Home Energy Monitoring Pilot Program from the Government of Newfoundland and Labrador run under Newfoundland and Labrador Hydro's takeCHARGE initiative. As a participant, you received an email from Newfoundland and Labrador Hydro informing you of the pilot program."**

1.2 Can I please speak with the person most familiar with the pilot program?

a. Yes (continue to 1.3, repeat introduction)
b. No (arrange callback)
c. Refused (thank you and terminate)

1.3 You also agreed to take part in two short surveys, one at the beginning of the program and a second following program completion. By participating in this survey, you will be automatically entered into a draw to win one of six $250 cash prizes.

Is now a good time to conduct this first short survey? The survey will take less than 10 minutes to complete.

a. Yes (continue to 2.1)
b. No (arrange callback)
c. Refused (thank you and terminate)

Part 2: Program-specific Questions

11.

2.1 Did you receive a real time monitor?

a. Yes (continue to 2A.1)
b. No (continue to 2.2)

Part 2A: Participants with RTM

2A.1 Is your real time monitor operating?

a. Yes (continue to 2A.4)
b. No (continue to 2A.2)
c. Not yet set up (continue to 2A.2)
d. Don't know/Not sure/Can't remember (continue to 2A.2)
e. Refused (continue to 2A.2)

RTM not operating

2A.2 Have you contacted the Blueline helpline?

a. Yes (continue to 2A.3)
b. No (continue to 2.2)
c. Don't know/Not sure/Can't remember (continue to 2.2)
d. Refused (continue to 2.2)

2A.3 Did you get the support you needed from the Blueline helpline?

a. Yes (continue to 2.2)
b. No (Please Explain) _____ (continue to 2.2)
c. Don't know/Not sure/Can't remember (continue to 2.2)
d. Refused (continue to 2.2)

RTM operating

2A.4 How easy is it to understand the information displayed by your real time monitor?

a. Very difficult (continue to **Error! Reference source not found.**)
b. Somewhat difficult (continue to **Error! Reference source not found.**)
c. Somewhat easy (continue to **Error! Reference source not found.**)
d. Very easy (continue to **Error! Reference source not found.**)
e. Don't know/Not sure/Can't remember (continue to **Error! Reference source not found.**)
f. Refused (continue to **Error! Reference source not found.**)

2A.5 What features on your device do you monitor? [DO NOT PROMPT - ALLOW MULTIPLE RESPONSES]

a. $Dollars per hour (continue to 2A.6)
b. Outdoor temperature (continue to 2A.6)
c. $Dollars total (continue to 2A.6)
d. kWHrs (continue to 2A.6)
e. kWHrs associated with a particular appliance (continue 2A.6)
f. 24 hour max/min (continue to 2A.6)
g. Spinning disk (continue to 2A.6)
h. Signal Strength (continue to 2A.6)
i. Other (specify): _____ (continue to 2A.6)
j. Don't know/Not sure/Can't remember (continue to 2A.6)
k. Refused (continue to 2A.6)

2A.6 Which features on your device are the most difficult to monitor? [DO NOT PROMPT - ALLOW MULTIPLE RESPONSES]

a. $Dollars per hour (continue to 2A.7)
b. Outdoor temperature (continue to 2A.7)
c. $Dollars total (continue to 2A.7)
d. kWHrs (continue to 2A.7)
e. kWHrs associated with a particular appliance (continue 2A.7)
f. 24 hour max/min (continue to 2A.7)
g. Spinning disk(continue to 2A.7)
h. Signal Strength(continue to 2A.7)
i. Other (specify):_____ (continue to 2A.7)
j. Don't know/Not sure/Can't remember (continue to 2A.7)
k. Refused (continue to 2A.7)

2A.7 How often do you check your real time monitor?

a. Multiple times per day (continue to 2A.8)
b. Once per day (continue to 2A.8)

c. Once every other day (continue to 2A.8)
d. Once every 3 or 4 days (continue to 2A.8)
e. Once per week (continue to 2A.8)
f. Less than once per week (continue to 2A.8)
g. Don't know/Not sure/Can't remember (continue to 2A.8)
h. Refused (continue to 2A.8)
i. Don't check my monitor (continue to 2A.8)

2A.8 Overall, how useful is your real time monitor?

a. Not at all useful (continue to 2.2)
b. Not very useful (continue to 2.2)
c. Somewhat useful (continue to 2.2)
d. Very useful (continue to 2.2)
e. Extremely useful (continue to 2.2)
f. Don't know/Not sure/Can't remember (continue to 2.2)
g. Refused (continue to 2.2)

Part 2 Cont.… All Participants

2.2 Prior to your participation in the pilot program, did you maintain the same home heating settings 24 hours a day?

a. Yes (continue to 2.3)
b. No (continue to 2.4)
c. Don't know/Not sure/Can't remember (continue to 2.3)
d. Refused (continue to 2.3)

2.3 On average, what temperature did you maintain? _____ degrees Celsius (continue to 2.9)

2.4 Prior to your participation in the pilot program, did you modify your home's temperature overnight?

a. Yes (continue to 2.5)
b. No (continue to 2.7)
c. Don't know/Not sure/Can't remember (continue to 2.6)
d. Refused (continue to 2.6)

2.5 On average, what temperature did you maintain your home overnight and for how many hours?

a. _____ degrees Celsius
   For _____ hours (continue to 2.6)

b. Don't know/Not sure/Can't remember (continue to 2.6)
c. Refused (continue to 2.6)

2.6 On average, what did you change your temperature to in the morning?

a. _____ degrees Celsius (continue to 2.7)
b. Don't know/Not sure/Can't remember (continue to 2.7)
c. Refused (continue to 2.7)

2.7 Prior to your participation in the pilot program, did you modify your home's temperature at any other time during the day?

a. Yes (continue to 2.8)
b. No (continue to 2.9)
c. Don't know/Not sure/Can't remember (continue to 2.9)
d. Refused (continue to 2.9)

2.8 On average, what temperature did you maintain your home at other times during the day and for how many hours?

a. _____ degrees Celsius
   For _____ hours (continue to 2.9)

b. Don't know/Not sure/Can't remember (continue to 2.9)
c. Refused (continue to 2.9)

2.9 Have you changed your home heating settings as a result of your participation in the pilot program?

a. Yes (continue to 2.10)
b. No (continue to 2.13)
c. Don't know/Not sure/Can't remember (continue to 2.13)
d. Refused (continue to 2.13)

2.10 Now we would like to understand specifically how you have changed your home heating settings as a result of participating in the pilot program.

As a result of your participation in the pilot program, on average, how did you change your home's temperature overnight and for how many hours?

a. Increased [_____] / Decreased [_____] (mark response with "X")
   By _____ degrees Celsius

   For _____ hours (continue to 2.11)

b. Other (specify) _____ (continue to 2.11)
c. I did not change my home's temperature overnight (continue to 2.11)
d. Don't know/Not sure/Can't remember (continue to 2.11)
e. Refused (continue to 2.11)

2.11 As a result of your participation in the pilot program, on average, how did you change your home's morning temperature?

a. Increased [_____] / Decreased [_____] (mark response with "X")
   By _____ degrees Celsius (continue to 2.12)

b. Other (specify) _____ (continue to 2.12)
c. I did not change my home's temperature in the morning (continue to 2.12)
d. Don't know/Not sure/Can't remember (continue to 2.12)
e. Refused (continue to 2.12)

2.12 As a result of the program, on average, how did you change your home's temperature at other times during the day?

a. Increased [_____] / Decreased [_____] (mark response with "X")
   By _____ degrees Celsius

   For _____ hours (continue to 2.13)

b. Other (specify) _____ (continue to 2.13)
c. I did not change my home's temperature at any other time (continue to 2.13)
d. Don't know/Not sure/Can't remember (continue to 2.13)
e. Refused (continue to 2.13)

2.13 What other actions did you undertake to reduce your electricity consumption prior to your participation in the pilot program, for example turning off the lights when you leave a room? [DO NOT PROMPT - ALLOW MULTIPLE RESPONSES]

a. Turning off lights when leaving a room (continue to 2.14)
b. Unplugging appliances when not in use (continue to 2.14)
c. Using cold water for laundry (continue to 2.14)
d. Reducing hot water consumption (continue to 2.14)
e. Using LEDs/Compact fluorescent lights (continue to 2.14)
f. Purchased programmable thermostat (continue to 2.14)
g. Upgraded windows and/or doors (continue to 2.14)

h. Installed new insulation (continue to 2.14)
i. Added/replaced caulking/weatherstripping (continue to 2.14)
j. Using LED Christmas lights (continue to 2.14)
k. Purchasing energy star appliances (continue to 2.14)
l. Having a blow test/energy audit done (continue to 2.14)
m. Added a supplemental heating source, such as a propane fireplace of wood pellet stove (continue to 2.14)
n. Other (specify) _____ (continue to 2.14)
o. I did not practice any energy conservation behaviours (continue to 2.14)
p. Don't know/Not sure/Can't remember (continue to 2.14)
q. Refused (continue to 2.14)

2.14 How have you adjusted your actions as a result of participating in the pilot program? [DO NOT PROMPT - ALLOW MULTIPLE RESPONSES]

a. Turning off lights more often when leaving a room (continue to 2.15)
b. More consistently unplugging appliances when not in use (continue to 2.15)
c. Using cold water more often for laundry (continue to 2.15)
d. Further reducing hot water consumption (continue to 2.15)
e. Using more LEDs/Compact fluorescent lights (continue to 2.15)
f. Purchased programmable thermostat (continue to 2.15)
r. Upgraded windows and/or doors (continue to 2.15)
s. Installed new insulation (continue to 2.15)
g. Added/replaced caulking/weatherstripping (continue to 2.15)
h. Using more LED Christmas lights (continue to 2.15)
i. Purchasing more/only energy star appliances (continue to 2.15)
j. Having a blow test/energy audit done (continue to 2.15)
k. Added a supplemental heating source, such as a propane fireplace of wood pellet stove (continue to 2.15)
l. Other (specify) _____ (continue to 2.15)
m. I have not adjusted my behaviour (continue to 2.15)
n. Don't know/Not sure/Can't remember (continue to 2.15)
o. Refused (continue to 2.15)

2.15 What are the major benefits to you as a result of participating in the pilot program? [DO NOT PROMPT - ALLOW MULTIPLE RESPONSES AND RECORD ORDER OF RESPONSES]

a. Save money (continue to 2.16)
b. Conserve energy/electricity (continue to 2.16)
a. More informed consumption choices [ORDER:_____] (continue to 2.16)
b. Reduce electricity bill [ORDER:_____] (continue to 2.16)
c. Reduce fuel oil heating bill [ORDER:_____] (continue to 2.16)
d. Instantaneous feedback [ORDER:_____] (continue to 2.16)

e. Assist with energy/electrical conservation [ORDER:_____] (continue to 2.16)
f. Assist with environmental conservation [ORDER:_____] (continue to 2.16)
g. Information features of monitor [ORDER:_____] (continue to 2.16)
h. Other (specify) _____ [ORDER:_____] (continue to 2.16)
i. Don't know/Not sure/Can't remember (continue to 2.16)
j. Refused (continue to 2.16)

2.16 Through participation in the pilot program, how much do you expect to save per year on your electricity bill? [DO NOT PROMPT]

a. $ _____ per year (continue to 3.1)
b. _____ % per year (continue to 3.1)
c. Other (specify) _____ (continue to 3.1)
d. Don't know/Not sure/Can't remember (continue to 3.1)
e. Refused (continue to 3.1)

Part 3: Energy Efficiency Personality

3.1 How important would you say electricity conservation is to you?

a. Not at all important (continue to 3.2)
b. Not very important (continue to 3.2)
c. Somewhat important (continue to 3.2)
d. Very important (continue to 3.2)
e. Extremely important (continue to 3.2)
f. Don't know/Not sure/Can't remember (continue to 3.2)
g. Refused (continue to 3.2)

3.2 I will read five factors that influence the purchase an electricity-consuming product, for example, a new fridge. Please rank the importance of each factor with 1 being most important and 5 being least important. [RANDOMIZE ORDER]

a. Product cost [RANK:____] (continue to 4.1)
b. Product with the latest technology [RANK:____] (continue to 4.1)
c. Product brand name [RANK:____] (continue to 4.1)
d. Product energy efficiency (E.g. Energy Star rating) [RANK:____] (continue to 4.1)
e. Product design/aesthetics [RANK:____] (continue to 4.1)
f. Don't know/Not sure/Can't remember (continue to 4.1)
g. Refused (continue to 4.1)

Part 4: Demographics

4.1 Which of the following best describes the type of home you live in? [READ LIST]

a. Single family, detached (i.e., freestanding house (continue to 4.2)
b. Single family attached such as town house or row house (continue to 4.2)
c. Two apartment house or duplex (continue to 4.2)
d. Multi-family building (low-rise) (continue to 4.2)
e. Multi-family building (high-rise) (continue to 4.2)
f. Other (specify)_____ (continue to 4.2)
g. Don't know/Not sure/Can't remember (continue to 4.2)
h. Refused (continue to 4.2)

4.2 What is the approximate floorspace of your home including basement and attached garage if you have one? Record answer_____ (continue to 4.3)

4.3 Approximately what year was your home built?

a. 1995 or later (continue to 4.4)
b. 1980 to 1994 (continue to 4.4)
c. 1970 to 1979 (continue to 4.4)
d. Pre-1970 (continue to 4.4)
e. Don't know/Not sure/Can't remember (continue to 4.4)
f. Refused (continue to 4.4)

4.4 What is the primary heating source of your home?

a. Electricity (continue to 4.5)
b. Home heating oil (continue to 4.5)
c. Wood including wood pellets (continue to 4.5)
d. Propane (continue to 4.5)
e. heat pump (continue to 4.5)
f. Other (SPECIFY) _____ (continue to 4.5)
g. Refused (continue to 4.5)

4.5 Including yourself and any children, how many people live in your home at least six months of the year?

a. (Record Number) _____ (continue to 4.6)
b. Refused (continue to 4.6)

4.6 Has this number increased or decreased in the past two years?

a. Increased by more than one person (continue to 4.7)
b. Increased by one person (continue to 4.7)
c. Stayed the same (continue to 4.7)
d. Decreased by one person (continue to 4.7)
e. Decreased by more than one person (continue to 4.7)
f. Other (specify) _____ (continue to 4.7)
g. Refused (continue to 4.7)

4.7 What age range do you fall within?

a. Less than 25 years (continue to 4.8)
b. 26 – 44 years (continue to 4.8)
c. 45 – 64 year (continue to 4.8)
d. 65+ years (continue to 4.8)
e. Refused (continue to 4.8)

4.8 What is the approximate range of your annual household income, before taxes?

a. Under $25,000
b. $25,000 – $49,999
c. $50,000 – $74,999
d. $75,000 – $149,999
e. Over $150,000
f. Refused

RECORD NAME OF RESPONDENT

THANK RESPONDENT AND TERMINATE SURVEY