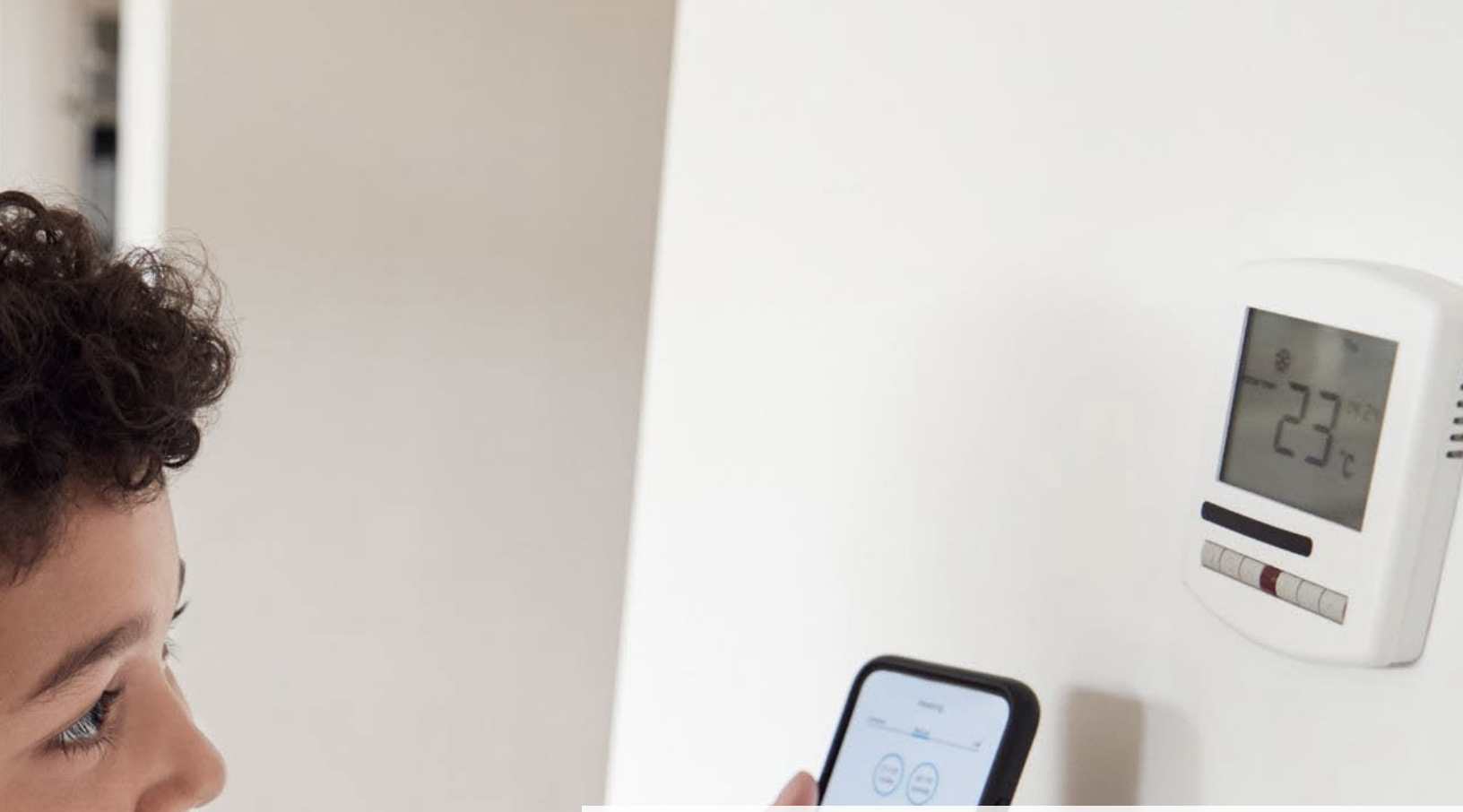

Utilities Kingston/Kingston Hydro Smart Thermostat Program Evaluation Report

FINAL REPORT

September 2, 2022

SUBMITTED TO:
Independent Electricity System Operator

SUBMITTED BY:
NMR Group, Inc. in partnership with Resource Innovations

NMR Group, Inc.

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Acknolwedgements

The NMR team would like to thank the hundreds of treatment customers that supported the NMR team's survey. Their cooperation with the NMR team's efforts has produced high quality data that will serve Ontario conservation efforts for years to come.

The NMR team would also like to thank the LDC program staff who we interviewed. Their insights have been invaluable to our efforts to improve the Conservation Programs.

Finally, the NMR team would like to thank Alice Herrera, Nam Nguyen, and Jimmy Lu at the Independent Electricity System Operator (IESO) for their assistance in coordinating this evaluation effort. With their support and guidance, the NMR team was able to complete their activities as efficiently and successfully as possible.

Acronyms

Acronym	Definition
CE tool	Cost Effectiveness Tool
EM&V	Evaluated Measurement and Verification
EUL	Effective Useful Life
GHG	Greenhouse Gas
HAP	Home Assistance Program
HVAC	Heating, Ventilation, and Air Conditioning
IDI	In-depth Interview
IESO	Independent Electricity System Operator
IF	Interim Framework
kW	Kilowatt
kWh	Kilowatt-hours
LDC	Local Distribution Company
MAL	Measures and Assumptions List
MW	Megawatt
MWh	Megawatt-hour
NTG	Net-to-Gross
PAC	Program Administrator Cost Test
PY	Program Year
RR	Realization Rate
REUS	Residential End-Use Survey
TRC	Total Resource Cost Test

Executive Summary

NMR Group, Inc. (NMR), in partnership with subcontractor, Resource Innovations, Inc., (collectively, "the NMR team") and under contract to the Independent Electricity System Operator (the IESO), performed an evaluation of the Smart Thermostat Program offered by Utilities Kingston and Kingston Hydro.

Program Description

The Smart Thermostat Program was a locally delivered program that was offered by Utilities Kingston and Kingston Hydro. It provided a $100 bill credit to eligible residential customers who purchased and installed smart thermostats.

Evaluation Objectives

The evaluation sought to address several evaluation objectives, including the following:

- Verify energy and demand savings
- Estimate realization rates (RR)
- Conduct cost-effectiveness (CE) analyses
- Estimate the avoided greenhouse gas (GHG) emissions
- Perform a limited process evaluation

Summary of Results

The impact evaluation results for the Smart Thermostat Program offered by Utilities Kingston and Kingston Hydro are displayed in Table 1. The overall gross RR was 25% for energy savings and 104,589%[1] for demand savings.

Table 1: Smart Thermostat Program Results

Metric	Units	Evaluated
Participation	Thermostats	115
Reported Energy Savings	MWh	96.5
Reported Demand Savings	MW	0.00
Gross Energy RR	-	0.25
Gross Demand RR	-	1,045.89
Gross Verified Energy Savings	MWh	24.2
Gross Verified Demand Savings	MW	0.01
Net-to-Gross (NTG) Ratio	-	1
Net Verified Annual Energy Savings (First Year)	MWh	24.2

[1] The reported peak demand savings was 0.00012 kW per participant. This low reported value in comparison to the relatively large verified peak demand savings, 0.126 kW, led to an inflated realization rate.

Metric	Units	Evaluated
Net Verified Annual Demand Savings (First Year)	MW	0.01
Net Verified Annual Energy Savings (PY2022)	MWh	24.2
Net Verified Annual Demand Savings (PY2022)	MW	0.01
Total Resource Cost (TRC) Test Ratio	-	0.57
Program Administrator Cost (PAC) Test Ratio	-	0.99
Levelized Delivery Cost (Energy)	$/kWh	0.11
Levelized Delivery Cost (Demand)	$/kW	178.90

KEY FINDINGS AND RECOMMENDATIONS

This section summarizes key findings and recommendations for the evaluation. Section 7 presents these key findings and recommendations in greater detail.

Finding 1: Key inputs used in demand and energy savings algorithms can change over time. Technical reference manuals (TRMs) from other jurisdictions are often used as a reference for calculating savings. The TRMs are usually revised yearly with the most up-to-date research. The primary reference used to calculate demand and energy savings for the Smart Thermostat Program was the Illinois TRM from 2019. In the 2022 version, some inputs used to calculate savings were updated, although the changes were not substantial enough to warrant adjustments to the Smart Thermostat Program's algorithm.

> **Recommendation 1.** The NMR team recommends that IESO program staff review referenced TRMs for updates to algorithms or inputs. Since a program's evaluation period can take place over years, a TRM could change substantially during that time. In turn, the equations or inputs used to calculate savings could also change. For example, the peak demand savings definition could be different in each TRM or change over time. Being cognizant of any changes will help produce the most accurate savings estimates.

Finding 2: Ensure referenced deemed savings are appropriate for the program. Underlying deemed savings listed in the Measures and Assumptions List (MAL) are algorithms, input parameters, and assumptions. The Smart Thermostat Program referenced an energy savings value provided in the MAL; however, the value was listed under another program, which assumed all participants have electric heating. This assumption is not appropriate for the Smart Thermostat Program and resulted in producing the inflated gross demand realization rate in Table 1.

> **Recommendation 2.** When referencing savings estimates in the MAL for a program that is not listed in the MAL, ensure that the underlying algorithms, input parameters, and assumptions used to derive the savings listed in the MAL are appropriate for the non-listed program.

Finding 3: Local Distribution Company (LDC) program staff reported the Smart Thermostat Program was easy to participate in and administer but fell far short of its participation target. The Smart Thermostat Program reached just over 20% of its participation target, which LDC program staff attributed to the short program duration and customer confusion over which of Kingston's multiple electric and gas LDCs served them. Program staff felt the program was

sufficiently staffed and funded, that it was easy to participate in from the customer perspective, and that it was straightforward to administer from the LDC perspective.

> **Recommendation 3.** If the Smart Thermostat Program were to run again in the future, run it for a longer duration, coordinate with other Kingston LDCs running similar programs, and/or offer a reduced bill credit for electric-only customers.

Section 1 Introduction

The Independent Electricity System Operator (the IESO) retained NMR Group, Inc. (NMR), in partnership with subcontractor, Resource Innovations, Inc. (collectively, "the NMR team"), to conduct an evaluation of its Low Income, First Nations, and Residential Local programs and pilots offered under the Interim Framework (IF). This report includes results, findings, and recommendations for the NMR's team's evaluation of the Smart Thermostat Program offered by Utilities Kingston and Kingston Hydro.

1.1 Program Description

Utilities Kingston and Kingston Hydro provide electric and gas services to a portion of the residents of Kingston, Ontario.[2] These local distribution companies (LDCs) ran an energy-efficiency program incentivizing smart thermostats to eligible residential customers referred to as the Smart Thermostat Program.

1.1.1 Program Design

The program offered a $100 bill credit to eligible residential customers who purchased and installed smart thermostats from October 2019 to December 2020. The $100 rebate was divided equally between Kingston Hydro and Utilities Kingston and applied as a bill credit. Participation was limited to one thermostat per residential account. Customers purchased and installed their smart thermostat of choice and sent proof of payment to Utilities Kingston. Utilities Kingston then applied the bill credit of $100 to that customer's account.[3]

1.1.2 Delivery

Eligible customers submitted an online application with proof of payment to Utilities Kingston and Kingston Hydro after purchasing a smart thermostat meeting the program's technical requirements. Participation was limited to one thermostat per residential account.

1.1.3 Eligibility

To be eligible for the bill credit, customers had to receive both gas and electricity services from Utilities Kingston and Kingston Hydro. The program was available to both homeowners and renters in Utilities Kingston and Kingston Hydro's service territory.

1.2 Evaluation Objectives

The evaluation sought to address several evaluation objectives, including the following:

[2] Utilities Kingston oversees gas services and Kingston Hydro oversees electricity and water services.
[3] Installation costs were not eligible.

- Verify energy and demand savings for the program
- Estimate realization rates (RRs)
- Conduct cost-effectiveness (CE) analyses
- Estimate the avoided greenhouse gas (GHG) emissions from electricity savings using the IESO *Cost Effectiveness Tool*
- Perform a limited process evaluation by addressing key research questions of interest to the program.

Section 2 Methodology

This section presents a summary of the impact evaluation, cost-effectiveness evaluation, and the limited process evaluation methodologies. Detailed descriptions of these methodologies, as applicable, are provided in Appendix A.

2.1 Impact Evaluation Methodology

The reported energy savings referenced the value listed for smart thermostat measures in the IESO Measures and Assumptions List (MAL). The reported peak demand savings applied a "kW per annual kWh" demand factor derived from a load shape in IESO's *Energy Efficiency Cost Effectiveness Tool* (CE tool).

With this reported savings approach in mind, the impact evaluation applied a two-step review method. The first step was a benchmarking exercise, comparing the IESO's algorithms and key inputs with other regional technical reference manuals (TRMs). The second step reviewed and verified the appropriateness of the algorithm and inputs used to derive the reported energy and demand savings.

2.1.1 Benchmarking

The NMR team assessed the accuracy, reasonableness, and recency of the inputs and savings parameters contained in the IESO smart thermostat measure substantiation sheet (which supports the savings listed in the MAL) with a comparison to TRMs from four other jurisdictions. The NMR team selected the following TRMs for comparison based on proximity to the IESO's territory:

- Illinois Statewide Technical Reference Manual (IL TRM)[4]
- New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs (NY TRM)[5]
- Efficiency Vermont Technical Reference Manual (VT TRM)[6]
- Pennsylvania Technical Reference Manual (PA TRM)[7]

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[4] *2022 Illinois Statewide Technical Reference Manual for Energy Efficiency Version 10.0 Volume 3: Residential Measures*, September 24, 2021. https://www.ilsag.info/technical-reference-manual/il-statewide-technical-reference-manual-version-10-0/

[5] *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs Version 8*, New York State Joint Utilities, July 31, 2020, https://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/72c23decff52920a85257f1100671bdd/$FILE/NYS%20TRM%20V8.pdf

[6] *Technical Reference User Manual*, Efficiency Vermont, December 31, 2018, https://puc.vermont.gov/document/ev-technical-reference-manual

[7] *Technical Reference Manual Volume 2: Residential Measures*, State of Pennsylvania, February 2021, https://www.puc.pa.gov/pcdocs/1692531.docx

2.1.2 Energy Savings

Both the reported and verified energy savings reference the value listed in the IESO's MAL for smart thermostats. The NMR team further reviewed the measure substantiation sheet supporting the MAL savings, checking for appropriateness of the underlying algorithm, inputs, and assumptions for applicability to the Smart Thermostat Program.

The "measure description" field in the MAL indicates that the smart thermostat measure is specific to electric heating and cooling. While this is appropriate for the IESO's Home Assistance Program (HAP), it is very likely not appropriate for the Smart Thermostat Program since the Smart Thermostat Program requires customers have electric and gas accounts with Kingston Hydro and Utilities Kingston. Therefore, the NMR team calculated two savings estimates: one for participants with electric heat, and one for participants with non-electric heat. A weighted average of these two savings estimates was calculated and used to determine the verified savings per thermostat. The estimated percentage of participants with electric heating was sourced from Ontario's Residential End-Use Survey (REUS).[8]

The smart thermostat measure substantiation sheet does not include a methodology to determine electric savings in situations where natural gas is used for heating. In this case, the NMR team referenced the Illinois TRM to calculate savings.

2.1.3 Demand Savings

Peak demand savings were calculated by multiplying the annual energy savings by a peak demand factor, as shown in Equation 1. The peak demand factor is an output of the load shape in IESO's CE tool. The CE tool contains a library with several HVAC related load shape options to choose from. The NMR team reviewed the option selected by Kingston Hydro for the Smart Thermostat Program for its appropriateness and determined if there was another load shape that was more appropriate for the program.

Equation 1: Peak Demand Savings Algorithm

$$\Delta kW = \Delta kWh * Peak\ Demand\ Factor$$

2.2 COST-EFFECTIVENESS EVALUATION

The NMR team completed the CE analysis in accordance with the IESO requirements as set forth in the IESO *Cost Effectiveness Guide for Energy Efficiency*[9] and using CE tool. The NMR team used the energy and demand savings results from the impact evaluation as inputs into the CE tool. The NMR team also used the administrative cost and incentive information supplied from IESO as inputs. A more detailed description of the cost-effectiveness methodology is provided in Appendix A.

[8] Ontario Residential End-Use Survey (REUS), Cadmus, Oct 2018
[9] *Cost Effectiveness Guide for Energy Efficiency Version 4*, Independent Electricity System Operator, January 20 2021, https://www.ieso.ca/-/media/Files/IESO/Document-Library/EMV/CDM_CE-TestGuide.ashx

2.3 LIMITED PROCESS EVALUATION

Table 2 shows details about the primary data source used to support the limited process evaluation methodology. The process evaluation focused on program design and delivery. The NMR team evaluated program processes through an in-depth interview (IDI) with the LDC program staff from Utilities Kingston and Kingston Hydro. The NMR team developed a customized interview guide that the IESO Evaluated Measurement and Verification (EM&V) staff then reviewed and approved. The NMR team completed the IDI in June 2021 with LDC program staff who were responsible for administering the program. The purpose of this IDI was to learn about the LDC's experiences with program administration and to identify any successes, barriers, and program improvement opportunities should a similar program continue in future years.

Table 2: Limited Process Evaluation Primary Data Sources

Respondent Type	Methodology	Completed	Population	90% CI Error Margin
LDC Program Staff	Phone In-depth Interviews (IDIs)	1	1	0%

Section 3 Impact Evaluation

This section presents the impact evaluation results. Details regarding the impact methodology can be found in Section 2. The following subsections provide detail on each task discussed in the methodology section and concludes with a summary of the program's verified savings.

3.1 BENCHMARKING

To validate the inputs and the algorithm used to calculate savings for the Smart Thermostat Program, the NMR team conducted two review activities. First, the 2019 and 2022 IL TRMs were compared for any updates since IESO's substantiation sheet was based on the 2019 version of the IL TRM, and any major changes to inputs or algorithms needed to be incorporated. Second, the NMR team reviewed TRMs from other nearby jurisdictions to check for major differences in algorithms or inputs.

The formulas used to calculate energy savings, Equation 2, Equation 3, and Equation 4, are shown below.

Equation 2: Total Energy Savings

$$\Delta kWh = \Delta kWh_{heat} + \Delta kWh_{cool}$$

Equation 3: Heating Energy Savings (Electric Heating)

$$\Delta kWh_{heat} = EH_{consumption} \times SF_{electric} \times HF$$

Equation 4: Cooling Energy Savings

$$\Delta kWh_{cool} = \%AC \times FLH \times CAP_{cool} \times \frac{1}{SEER} \times SF_{cool} \times \frac{1}{1000}$$

Table 3 displays a comparison of the inputs to these formulas between the Smart Thermostat Program and the two versions of the IL TRM from 2019 and 2022. The NMR team found minor changes between the 2019 and 2022 IL TRMs, but the differences were not large enough to recommend changes to the Smart Thermostat Program methodology. Specifically, the only changes between the two IL TRMs are the $SF_{electric}$, $SEER$, and SF_{cool} variables.

Table 3: Smart Thermostat TRM Energy Savings Input Comparison

Term	Unit	Smart Thermostat Program	IL TRM 2019	IL TRM 2022
$EH_{consumption}$	kWh/yr	10,782	15,683	15,683
$SF_{electric}$	%	7.4%	7.0%	8.5%
HF	%	100%	100%	100%
$\%ElectricHeat$	%	13.1%	100%	100%
$\%AC$	%	75.5%	100%	100%
FLH	Hr/yr	281.9	629	629
CAP_{cool}	Btuh	33,600	33,600	33,600
$SEER$	Btuh/Whr	14	9.3	12
SF_{cool}	%	8.0%	8.0%	8.4%

Table 4 displays a comparison between the Smart Thermostat Program and TRMs from other jurisdictions for the $SF_{electric}$ and SF_{cool} input variables. These two variables represent the heating or cooling reduction attributable to a smart thermostat, respectively. The variables are specifically highlighted because the other input variables are generally dependent on the jurisdiction's location. Generally, the two values used in the Smart Thermostat Program are in line with those used in other jurisdictions.

Table 4: Smart Thermostat Load Reduction TRM Comparison

Term	Smart Thermostat Program	New York	Vermont	Pennsylvania
$SF_{electric}$	7.4%	8.0%	5.4% or 7.7%	6.4% - 11.5%
SF_{cool}	8.0%	10.0%	8.0%	4.8% - 11.3%

3.2 Energy Savings

3.2.1 Electrically Heated Systems

The algorithms used to derive energy savings in the MAL were provided above in Equation 2, Equation 3, and Equation 4, which were taken from the IESO's smart thermostat measure substantiation sheet. The measure substantiation sheet's inputs were customized for the IESO's HAP. While the HAP requires participants have electric heat for smart thermostat measures, electric heat was not a requirement of the Smart Thermostat Program. Therefore, the NMR team calculated savings for two types of participants: those with electric heat and those without electric heat. The estimated percentage of participants with electric heating was sourced from Ontario's Residential End-Use Survey.[10] For participants with electric heating, all inputs to the energy

[10] Ontario Residential End-Use Survey (REUS), Cadmus, Oct 2018

savings algorithms remained the same as the reported savings calculation. Table 5 defines each algorithm input and presents the value used to determine verified savings.

Table 5: Energy Savings Equation Definitions

Term	Definition	Value	Unit
$EH_{consumption}$	Average annual heating consumption for electrically heated single-family homes in Ontario	10,782	kWh/yr
$SF_{electric}$	Percentage reduction in total household electric heating energy consumption	7.4	%
HF	Household factor, to adjust heating consumption for non-single-family households	100	%
$\%AC$	Percentage of customers with thermostat-controlled air-conditioning	75.5	%
FLH	Estimate of annual household full load cooling hours for air conditioning equipment in Ontario	281.9	Hr/yr
CAP_{cool}	Average rated cooling capacity, assuming 33,600 Btuh for single-family if the capacity is unknown	33,600	Btuh
$SEER$	Seasonal energy efficiency rating of baseline air conditioning unit	14.0	Btu/Whr
SF_{cool}	Percentage reduction in total household cooling energy consumption	8.0	%

Inserting the inputs listed in Table 5 into Equation 2, Equation 3, and Equation 4 yields the following savings per smart thermostat serving an electrically heated system:

ΔkWh_{heat} = 797.9 kWh ΔkWh_{cool} = 40.9 kWh ΔkWh = 838.7 kWh

3.2.2 Non-Electrically Heated Systems

For participants with non-electric heating, Equation 2 and Equation 4 were used again. Though since heating season savings are only derived from reduced ventilation and not from heating, the NMR team referenced Equation 5 and Equation 6 from the Illinois TRM to determine savings from non-electric heated systems. Since the Smart Thermostat program required participants have a gas service account, the NMR team assumed that all non-electric heating systems were gas heated systems.

Equation 5: Heating Energy Savings (Non-electric Heating)

$$\Delta kWh_{heating} = \Delta Therms \times F_e \times 29.3$$

Equation 6: Gas Heating Energy Savings

$$\Delta Therms = \%FossilHeat \times Gas\_Heating\_Consumption \times Heating\_Reduction \times HF \times Eff\_ISR\_Heat$$

Table 6 defines each algorithm input and presents the value used to determine verified savings used in Equation 5 and Equation 6.

Table 6: Energy Savings Equation Definitions For Gas Heating Systems

Term	Definition	Value	Unit
$\Delta Therms$	Therm savings of natural gas heating system (calculated)	72.4	therms
F_e	Furnace fan energy consumption as a percentage of annual fuel consumption	3.14	%
	Conversion factor	29.3	kWh/therm
%FossilHeat	Percentage of heating savings assumed to be natural gas	100	%
Gas_Heating_Consumption	Estimate of annual household heating consumption for gas heated single-family homes	955	therms
Heating_Reduction	Assumed percentage reduction in total household heating energy consumption due to smart thermostat	8.5	%
HF	Household factor, to adjust heating consumption for non-single-family households	100	%
Eff_ISR_Heat	In-service rate	100	%

Inserting the inputs listed in Table 6 into Equation 5 and Equation 6 yields the following savings per smart thermostat serving a gas heated system:

ΔkWh_{heat} = 74.7 kWh ΔkWh_{cool} = 40.9 kWh ΔkWh = 115.5 kWh

3.2.3 Weighted Average Savings

The Ontario REUS determined that 13.1% of single family heating equipment in eastern Ontario is electrically fueled. Therefore, the NMR team calculated a weighted average consisting of 13.1% electric heating (at 838.7 kWh savings per thermostat) and 86.9% non-electric heating (at 115.5 kWh savings per thermostat) to determine the average savings of 210.3 kWh per thermostat for the full program.

3.3 Demand Savings

The reported savings applied the "Forced_Air_Central_Heating" load shape from the IESO CE tool to the annual energy savings to estimate peak demand savings. This load shape represents electric heating and no cooling. Since the Ontario REUS found that most homes have central cooling in the area where Kingston Hydro's service area is located, the load shape needed to represent cooling. Additionally, since the Smart Thermostat Program required participants to have electric and gas accounts, the NMR team believes that referencing a load shape representing gas

heating is more applicable for this program. For these two reasons, the NMR team considered the "Forced_Air_Central_Heating" load shape not appropriate in this application.

The NMR team instead referenced the peak demand factor from the "Attic Insulation - Gas Fired" load shape to estimate verified peak demand savings. The "Attic Insulation - Gas Fired" load shape represents electric cooling and gas heating. The corresponding weather-sensitive peak demand factor (i.e., kW/kWh) for that load shape is equal to 0.060%. When multiplying this demand factor by the verified energy savings as shown in Equation 1, the resulting peak demand savings per smart thermostat is 0.126 kW.

3.4 RESULTS SUMMARY

Table 7 shows the annual heating and cooling energy savings at both participant and program levels. There were 115 program participants, who yielded a total gross savings equal to 24,183 kWh.

Table 7: Annual Energy Savings

Value	Energy Savings per Participant – Electric Heating (kWh)	Energy Savings per Participant – Non-Electric Heating (kWh)	Weighted Average per Participant (kWh)	Total Program Savings (kWh)
Heating Savings	797.9	74.7	169.4	19,483
Cooling savings	40.9	40.9	40.9	4,699
Total savings	**838.7**	**115.5**	**210.3**	**24,183**

Table 8 shows the demand savings at both participant and program levels. Again, multiplying participant savings by 115 participants, the program yielded a total peak demand savings of 14.4 kW.

Table 8: Demand Savings

Value	Average Impact per Participant (kW)	Aggregate Impact (kW)
Demand impact	0.126	14.4

Section 4 Cost-Effectiveness Evaluation

This section presents the cost-effectiveness evaluation results. Details regarding the cost-effectiveness methodology can be found in Section 2.2 and Appendix A.

Table 9 shows the CE results. The program did not pass the Total Resource Cost (TRC) test nor did it pass the Program Administrator Cost (PAC) test because benefits were less than their respective costs in both tests (i.e., their net benefit ratios were each less than 1.0). The PAC test is meant to understand the relationship between the costs carried and benefits received by the program administrator. The TRC test uses a broader definition of costs and benefits than the PAC test, incorporating those costs carried and benefits received by both the program administrator and customers.

Table 9: Program Level Cost-Effectiveness Key Metrics

Cost-Effectiveness Test	Value
TRC	
TRC Costs ($)	43,344
TRC Benefits ($)	24,503
TRC Net Benefits ($)	-18,841
TRC Net Benefit (Ratio)	0.57
PAC	
PAC Costs ($)	21,494
PAC Benefits ($)	21,307
PAC Net Benefits ($)	-187
PAC Net Benefit (Ratio)	0.99
Levelized Unit Energy Cost	
$/kWh	0.11
$/kW	178.90

The program's achieved PAC ratio came close to being cost effective, at 0.99. To understand what would help make the program cost effective, the NMR team looked at primary drivers of this program's PAC ratio. One of those drivers is program participation. The program's business case targeted 500 participants while only achieving 115 participants. Entering a quantity of 250 participants in each of 2019 and 2020 in the CE tool, for a total of 500, the PAC ratio spikes to 2.25, making the program look very cost effective if the targeted participation was achieved. Of course, with such an increase in participation, the program would incur additional administrative costs which is not reflected in this exercise, so the 2.25 PAC ratio can be considered an upper bound for the targeted level of participation.

Following this same approach of holding administrative costs the same, only one additional participant is needed to push the PAC ratio over the 1.0 (cost effective) threshold.

Section 5 Limited Process Evaluation

This section presents the limited process evaluation results. Details regarding the limited process methodology can be found in Section 2.3.

5.1 LDC Program Staff Perspectives

The following subsections highlight the feedback received from the LDC program staff about the design and delivery of the program.

5.1.1 High-Level Results

High-level results from the LDC staff IDI include the following:

- LDC program staff delivered the program themselves without support from a program delivery vendor. They marketed it selectively to Utilities Kingston/Kingston Hydro customers via bill inserts, messaging in e-billing, e-mails, and social media. Staff reported having sufficient funding and staffing to run the program.
- The Smart Thermostat Program reached just over 20% of its participation target. LDC program staff attributed this to the short program duration and customer confusion over which of Kingston's multiple electric and gas LDCs served them.
- Program staff stated that the program's greatest strengths were how easy it was to participate from the customer perspective (e.g., minimal paperwork requirements) and how straightforward it was to administer from the LDC perspective (e.g., straightforward review and approval process).
- If LDC program staff were to run the Smart Thermostat Program in the future, they would consider running it for a longer duration, coordinating with other Kingston LDCs running similar programs, and additionally offering a reduced bill credit for electric-only customers.

5.1.2 Program Design and Delivery

Program staff indicated that the goal of the Smart Thermostat Program was to encourage customers to replace analog and older programmable thermostats with smart thermostats. The program did not utilize a delivery vendor. Program staff managed everything, from developing a business case and securing funding, marketing the program, developing an online customer application portal, reviewing applications, and issuing bill credits to customers.

Program staff used bill inserts, messaging in e-billing, e-mails, and social media to market the program. In addition, there were handouts and slides on TVs featuring the program in Utilities Kingston and Kingston Hydro's reception areas. Program staff did not inform local commercial retail stores about the program because Kingston is served by three electricity providers, and staff did not want to promote the program to customers who were not eligible to participate.

Program staff reported having sufficient resources (i.e., funding and staffing) to run the Smart Thermostat Program. They noted that the program was relatively easy to administer. They vetted

each applicant individually but noted that time commitment was not substantial given the program size. They estimated that it took up to ten minutes to process each application. They tracked the following program data in an Excel workbook: thermostat type, serial number, date purchased, location purchased, and date credit applied, and customer details. They then coordinated with the billing department to issue bill credits for eligible customers.

5.1.3 Customer Participation

Program staff indicated that the Smart Thermostat Program had 117 successful applicants while it was in effect from October 2019 to December 2020. The program reached just over 20% of its target of 500 participants. Program staff attributed low participation to the short program duration, explaining that it took time to raise customer awareness and persuade customers to participate. Based off anecdotal customer feedback, program staff said that the customers who participated in the program appreciated the opportunity to receive the bill credit for their thermostat upgrade.

5.1.4 Barriers and Opportunities

Program staff reported that the greatest barrier to program participation was related to the fact that Kingston is served by three electric LDCs, and customers often do not know which LDC serves them. This, in turn, created customer confusion about program eligibility as customers needed to receive both gas and electric service from Utilities Kingston and Kingston Hydro to be eligible for the program. Program staff said they had to reject applications from residents who received only electric service from Kingston Hydro, or neither electric nor gas service from Utilities Kingston and Kingston Hydro.

Program staff stated that the program's greatest strengths were how easy it was to participate from the customer perspective and how straightforward it was to administer from the LDC perspective. The paperwork requirements for the customer were relatively minimal (e.g., uploading invoices and applications through an online form that the LDC designed for the program). As noted in the above section, the administrative burden on the program staff was also relatively minimal (e.g., reviewing invoices, applications, and verifying accounts; communicating with customers; coordinating with billing team regarding participant bill credits).

Program staff shared several ideas for increasing participation in any future iterations of the Smart Thermostat Program. These include running the program for a longer duration, coordinating with other Kingston LDCs running similar programs, and offering half of the program's bill credit amount to customers who received only electric service from Kingston Hydro. In addition, program staff acknowledged the value of performing evaluation activities when it is feasible, such as soliciting participants' feedback and comparing their pre- and post-participation bills to assess participants' energy savings.

Section 6 Other Energy Efficiency Benefits

This section presents results related to the program's other energy-efficiency benefits including avoided GHG emissions.

6.1 Avoided Greenhouse Gas Emissions

The NMR team used the IESO's CE tool to calculate avoided GHG emissions. The NMR team calculated avoided GHG emissions for the first year and for the lifetime of the measures. Table 10 presents the results of these calculations.

Table 10: Avoided Greenhouse Gas Emissions

First Year GHG Avoided (Tons CO_2 equivalent)	Lifetime GHG Avoided (Tons CO_2 equivalent)
2.40	41.8

Section 7 Key Findings and Recommendations

The following section presents detailed key findings and recommendations for the evaluation.

Finding 1: Key inputs used in demand and energy savings algorithms can change over time. TRMs from other jurisdictions are often used as a reference for calculating savings, and are usually revised yearly with the most up-to-date research. The primary reference used to calculate demand and energy savings for the Smart Thermostat Program was the Illinois TRM from 2019. In the 2022 version, some inputs used to calculate savings were updated. Specifically, the percentage reduction in heating and cooling load associated with the installation of a new smart thermostat. These changes were not substantial enough to warrant adjustments to the Smart Thermostat Program's algorithm.

> **Recommendation 1.** The NMR team recommends that IESO program staff review referenced TRMs for updates to algorithms or inputs. Since a program's evaluation period can take place over years, a TRM could change substantially during that time. In turn, the equations or inputs used to calculate savings could also change. For example, the peak demand savings definition could be different in each TRM or change over time. Being cognizant of any changes will help produce the most accurate savings estimates.

Finding 2: Ensure referenced deemed savings are appropriate for the program. Underlying deemed savings listed in the Measures and Assumptions List (MAL) are algorithms, input parameters, and assumptions. The Smart Thermostat Program referenced an energy savings value provided in the MAL; however, the value was listed under another program, which assumed all participants have electric heating. This assumption is not appropriate for the Smart Thermostat Program and resulted in producing the inflated gross demand realization rate in Table 1.

> **Recommendation 2.** When referencing savings estimates in the MAL for a program that is not listed in the MAL, ensure that the underlying algorithms, input parameters, and assumptions used to derive the savings listed in the MAL are appropriate for the non-listed program.

Finding 3: LDC program staff reported the Smart Thermostat Program was easy to participate in and administer but fell far short of its participation target. The Smart Thermostat Program reached just over 20% of its participation target, which LDC program staff attributed to the short program duration and customer confusion over which of Kingston's multiple electric and gas LDCs served them. Program staff felt that the program was sufficiently staffed and funded, that it was easy to participate in from the customer perspective, and that it was straightforward to administer from the LDC perspective

> **Recommendation 3.** If the Smart Thermostat Program were to run again in the future, run it for a longer duration, coordinate with other Kingston LDCs running similar programs, and/or offer a reduced bill credit for electric-only customers.

Appendix A Cost-Effectiveness Methodology

This appendix presents additional details about the cost-effectiveness methodology. A summary of the methodology was provided in Section 2.2

The NMR team completed the CE analysis using IESO's CE tool in accordance with the IESO *Cost Effectiveness Guide for Energy Efficiency.*[11] The NMR team populated the tool with the following key information from the evaluation:

- First year energy and demand savings in kWh and kW, respectively
- Effective Useful Life (EUL)
- End use load profile
- Incremental equipment and installation cost.
- Net to gross ratios for energy savings and demand savings. These were both set equal to one for this program.

Additionally, the IESO provided program administrative costs for use in the CE calculation.

The IESO *Cost Effectiveness Tool* provides many outputs and varying levels of granularity. The key outputs the NMR team selected to be directly presented in this report are as follows:

- TRC test costs, benefits, and ratio
- PAC test costs, benefits, and ratio
- Levelized unit cost by kWh and kW

[11] *Cost Effectiveness Guide for Energy Efficiency Version 4*, Independent Electricity System Operator, January 20, 2021, https://www.ieso.ca/-/media/Files/IESO/Document-Library/EMV/CDM_CE-TestGuide.ashx