Remote Energy Assessments for Residential Homes

A Comparison to Traditional On-site Assessments in Nova Scotia

Acknowledgments

Writing this paper was a collaborative effort between EfficiencyOne, Climative.ai, and the Nova Scotia Department of Municipal Affairs and Housing. It provides a comprehensive evaluation of the use of remote home energy assessments vis-a-vis traditional on-site assessments in the residential sector, with a view to understanding the potential for use in the administration of building retrofit programs, building labelling, and policy planning.

We also extend thanks to Acumen and Homesol for partnering with us on this pilot to deliver the remote assessments. We recognize Peter Rogers and Dave McCall from Acumen, and Peter Bohan and Zenon Pilipowicz from Homesol for providing expert advice, and for conducting the remote assessments. We also appreciate the services, support, and flexibility of IrisCx, whose video platform was used in the research.

This endeavor would not be possible without the contributing authors from EfficiencyOne: Hugh MacDonald and Ryan Kelly, and Winston Morton from Climative.

1 Executive Summary

All pathways to meet 2050 net zero emissions goals in Canada and Nova Scotia must include significant improvements in the energy efficiency of homes. Nova Scotia is a leader in energy efficiency programs[1], providing homeowners and businesses with incentives and rebates to improve building efficiency. These programs contributed 25% of total emissions reductions in the province over the past 10 years. To take advantage of rebates and financing for major home efficiency upgrades[2], Nova Scotia homeowners must complete two home energy assessments using the EnerGuide Rating System (ERS) and HOT2000 (H2K) building modelling software[3] – an initial assessment to estimate the baseline efficiency of the home (pre-assessment), followed by a second assessment (post-assessment) to confirm the energy savings after retrofits are completed. Both pre and post assessments involve the homeowner scheduling a certified Energy Advisor (EA) to come to their home.

While EnerGuide assessments provide a comprehensive and standardized method for assessing the efficiency of homes, it is questionable whether this is the best approach in every circumstance. For example, over 40% of homeowners who have an initial assessment in Nova Scotia do not complete the final assessment, and thereby never claim a rebate[4]. Among those who complete a final assessment, a significant number only upgrade their heating system (e.g., mini split heat pumps), and this trend is increasing. In these situations, an onsite EnerGuide assessment is arguably not the best approach for the following reasons:

- A whole home assessment is not needed to assess heat-only upgrades.
- It is an ineffective use of EA capacity, which creates bottlenecks and increases cycle times for customers waiting for a traditional on-site assessment.
- It costs more to deliver the program on a per home basis.
- It has a negative environmental impact by generating greenhouse gas emissions from travel to homes, and safety implications associated with travel.

Even where a whole home assessment is needed, an onsite EnerGuide assessment may not be the best approach, if for example:

- The home is in a remote area.
- The homeowner prefers not to have an EA on site.
- The scheduled time and duration are inconvenient.
- The wait time for an assessment is too long.

In summary, the customer journey is often encumbered with a EnerGuide assessment that is often inconvenient to the homeowner, takes time, costs money, and is not always required for certain types of

[1] Gaede, J. Haley, B., Abboud, M., Nassar, M., 2021. The 2021 Provincial Energy Efficiency Scorecard. Efficiency Canada, Carleton University, Ottawa, ON.

[2] For example, rebates from the Canada Greener Homes initiative.

[3] HOT2000 is an energy simulation modelling software developed and maintained by Natural Resources Canada to support the EnerGuide Rating System, ENERGY STAR for New Homes, and R-2000 residential energy efficiency initiatives. EnerGuide and HOT2000 are official marks of Natural Resources Canada.

[4] Based on historical statistics from E1's Home Energy Assessment program from 2015-2021.

upgrades, yet is a requirement to access rebates and loans under the Canada Greener Homes (CGH) initiative. With aggressive targets and increased government investment in housing retrofits recently announced by the Government of Canada[5] and the Province of Nova Scotia[6], new approaches should be examined to accelerate the rate at which homeowners undertake energy efficiency upgrades. The solution needs to address barriers encountered by homeowners along their customer journey, as well as industry capacity to meet increased demand. Remote assessments (sometimes referred to as touchless, digital, or virtual assessments) have the potential to help with both.

In a series of research pilots, we examine the merits of remote assessments using data collected in Nova Scotia. Remote assessments were classified into two categories:

Virtual Assessment (Level1): uses publicly available data and electricity consumption data.
Video Assessment (Level2): uses inputs from an EA via a video assessment of the home.

This research builds on other research and studies on the topic of remote assessments, while providing a unique perspective. First, pilot participants received both a remote assessment and an EnerGuide assessment, providing the means to directly compare the results of each level of assessment on a home-by-home basis. Second, the study included a mix of homes that were at the pre-upgrade stage and those that had completed their upgrades (awaiting final assessment after upgrades), providing insight into efficacy for measurement and verification purposes. We also assessed other important factors including customer engagement and satisfaction, assessment cycle times, environmental impacts, and considerations for measurement and verification.

Key findings from the research:

- Level1 and Level2 assessments produced annual energy consumption estimates of within 77% and 84% of EnerGuide assessments, respectively[7].
- Agreement of Level2 upgrade recommendations with EnerGuide assessments ranged from 60% (ceiling insulation) to 80% (foundation and wall insulation, and windows/doors), which were highly impacted by whether individual Energy Advisors (EAs) conducted both assessments, and whether different EAs were used for the same dwelling.
- EnerGuide assessments take 3 times longer to complete than a Level2 assessment[8].
- Enrolment rates for Level2 assessments were significantly higher than those for EnerGuide assessments.
- Customer satisfaction for the video technology was high (9.5 out of 10).
- Participants liked the home energy report, citing that it was easy to understand (80% agreed).
- Feedback from energy advisors was generally positive; opportunities for improvements centered on modelling software features and having more standardized protocols for interactions with the homeowners.

Despite inherent limitations of remote assessments (e.g., lower confidence in current-state building cavity insulation and inability to conduct air tightness tests), our research shows that remote methods provide a

[5] The Canada Greener Homes initiative (2021); Oil to Heap Pump Affordability Grant (2022).
[6] Multi-year agreements were executed between EfficiencyOne and the Province of Nova Scotia for residential efficiency upgrades.
[7] Based on trimmed mean absolute percent error of 23% for Level1 and 16% for Level2.
[8] Includes energy modelling, administration, travel time.

reasonable amount of accuracy as well as providing certain advantages over EnerGuide assessments. As such we put forward the following recommendations and guidelines for use:

1. **Policy and Planning:** Consider the EnerGuide assessment as the "gold standard" with Level1 and Level2 estimates used for building labelling 'lite' options. Level1 assessments provide the means to score an entire stock of residential buildings, on a home-by-home basis, to provide high level estimates of energy intensity and energy savings potential for setting and monitoring efficiency targets and investment planning.
2. **Efficiency Program Service Delivery**: Use remote assessments to triage homes and manage EA capacity. For example, use EnerGuide assessments on homes that meet certain criteria, such as high energy savings potential based on the results of a Level1 and Level2 assessment.
3. **Measurement and Verification.** Use Level2 assessments for verifying simple, single-upgrade projects. In these situations, an EnerGuide assessment is a poor use of energy advisor capacity because a whole home assessment is unnecessary for upgrades that do not affect multiple building systems. In Nova Scotia, it is especially common that homeowners only install mini split heat pumps and no other upgrades, for example. In addition, we provide examples of alternative rebate structures for insulation, which we believe would be easier for homeowners to understand, and for which Level2 assessments could be used for energy savings verification. We recommend further analysis and research into these alternative rebate approaches to understand the potential benefits and risks.

In summary, we believe the evidence is compelling for using Level1 and Level2 assessments in appropriate situations and will result in better outcomes, including:

- Better use of EA capacity.
- Lower costs per assessment, including environmental impact.
- Acceleration of enrollment in retrofit programs.
- Improved customer experience by removing barriers, reducing cycle times, and simplifying eligibility requirements.
- Better insight into entire building stock for building labelling, planning, and prioritizing based energy savings potential.

List of Terms and Acronyms

Term	Definition
BE	Building Envelope
CGH	Canada Greener Homes
DSM	Demand Side Management
E1	EfficiencyOne
EA	Energy Advisor
ENS	Efficiency Nova Scotia
ERS	EnerGuide Rating System
GHG	Greenhouse Gas
GJ	Gigajoule
H2K	HOT2000
HEA	Home Energy Assessment
kWh	Kilowatt hour
NRCan	Natural Resources Canada
SOC	Standard Operating Conditions
RSI	Thermal resistance values applied to insulation levels (Metric System units)
R-Value	Thermal resistance values applied to insulation levels (Imperial System units)

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2 Introduction

Historically, the path for energy efficiency upgrades for NS homeowners starts with a home energy assessment. Completing an assessment using the EngerGuide Rating System (ERS) is a comprehensive, standardized method for assessing each home's efficiency. Remote methods have emerged as an alternative approach in recent years (sometimes referred to as touchless, digital, or virtual assessments). Other jurisdictions have reported using various versions of remote approaches in a variety of settings and uses[9] and the merits of virtual and remote have been well documented[10]. Skepticism about remote methods focuses on the inherent limitations such as the inability to perform air tightness tests (blower door test) and assess current state insulation levels in hard-to-reach areas such as wall cavities. But it is also important to consider other factors, such as the customer journey, putting energy advisor capacity to the best use, accelerating the pace of building renovations to meet carbon reduction goals, environmental considerations (such as emissions from transportation), and costs. The purpose of this paper is to provide a holistic review of remote assessments, and the circumstances under which they should be used, based on the data collected from two research pilots.

We classify assessments into three categories, reflecting the number of inputs and corresponding level of precision in the outputs:

Level1. *Virtual Assessment*

- No input from homeowner or energy advisor.
- Few data points such as home age, size, number of floors, utility data.
- Provides high-level savings and energy use estimates and upgrade recommendations.

Level2. *Video Assessment*

- Inputs from homeowner and video assessment.
- Improved precision of estimates and upgrade recommendations.
- Provides homeowners with an opportunity to discuss upgrade options with an expert.

Level3. *Traditional On-Site Assessment*

- Over 150 inputs (ERS using H2K).
- Highest precision option.
- Explore detailed upgrade options with an expert.
- Identify air sealing opportunities.
- Essential to develop deep retrofit strategy.

3 Problem Statement

The Canadian Government's Greener Homes initiative and the increased funding from the Province of Nova Scotia provides a tremendous opportunity to improve the efficiency of homes in Nova Scotia, thereby making progress toward climate goals, and reducing the energy cost burden for homeowners, particularly

[9] Liza Minor. Why hybrid residential direct-Install programs work during COVID-19 and are here to stay. E-Source. 2021.

[10] Cooper, E., R. Sussman, and B. Rosenberg. 2021. *Remote Home Energy Assessments*. Washington, DC: American Council for an Energy-Efficient Economy. aceee.org/researchreport/b2102.

lower income families. However, the increased demand for efficiency programs creates operational challenges in an environment already experiencing customer confusion and delays caused by restrictive eligibility and rebate requirements and lack of industry capacity. Currently, a traditional on-site home energy assessment is required for homeowners to access the full array of rebates available. Judging by historical results, eligibility and rebate requirements that rely solely on traditional home assessments will put federal and provincial targets at risk. Other approaches are needed to accelerate homes though retrofit programs by addressing barriers encountered by homeowners along their customer journey, as well as industry capacity to meet increased demand.

3.1 Customer Barriers

Primary research conducted by E1 over the years has shown that key barriers to homeowner participation in efficiency retrofit programs can be summarized as follows[11]:

- Costs / value – the up-front cost versus the perceived value.
- Knowledge / uncertainty – the lack of awareness/knowledge, and uncertainty of benefits.
- Inconvenience / burden – time, effort, and inconvenience to complete the work.

Not surprisingly, cost is one of the most often cited barriers by homeowners. However, it is difficult to separate the impact of the cost barrier from the other challenges faced by homeowners. Energy efficiency concepts and solutions can be extremely technical, making it challenging for homeowners to navigate the customer journey. The standard EnerGuide report the homeowner receives after an assessment is lengthy with language that may not be easily digestible for the average person. For example, the report emphasizes gigajoules usage, with no translation into homeowner costs or return on investment for upgrade recommendations. Homeowners are largely left on their own to decipher extremely technical information, to research options, hire contractors, to understand what incentives are available to them, and to manage upgrades. All of this leads to uncertainty in the perceived value of investing in efficiency upgrades.

Increased grants and other incentives from the federal and Nova Scotia provincial government will complement existing funding and alleviate the cost barrier for homeowners. However, increasing incentives without addressing the other fundamental challenges faced by homeowners may limit the impact that incentive increases may otherwise achieve. This includes making it easier for homeowners to get the information they need, presenting it to them in simple and straightforward manner, and reducing process burden. Doing so will empower homeowners with better knowledge, reduce the uncertainty about perceived benefits, and reduce burden – all of which will serve to increase enrolment in efficiency programs and improve the impact of higher incentives.

3.2 Industry Capacity

With the increase in homeowner enrolment in efficiency programs brought about by new funding, increased industry capacity will be needed to meet this demand. Capacity can be increased in two ways: 1) increasing the skilled workforce, and 2) making processes more efficient.

The federal government's commitment to help fund the training of new Energy Advisors (EAs) across the country will help to build the workforce. Improving the efficiency with which customers are moved through the process (or customer journey) can also alleviate capacity pressure. For example, to be eligible for rebates from the Canada Greener Homes initiative, homeowners must complete two home energy

[11] Various research studies including: "Home Energy Assessment Program Research (2013); "Residential Financing and Incentives Research (2014)"; "Efficiency Messaging (2015)".

assessments – an initial assessment to estimate the baseline efficiency of the home, followed by a final assessment to confirm the energy savings after retrofits are completed. Historically, about half of homes who have an initial assessment in Nova Scotia do not complete the second assessment, and thereby never claim a rebate. One reason for this appears to be the lack of opportunities for savings (e.g., newer homes). If there were a way to help homeowners (and EAs) understand the savings potential prior to an on-site assessment, it could help optimize the available EA capacity. While there is value in all home energy assessments, options should be considered for different approaches or different levels of "assessment rigor" for different situations – depending on the attributes of the home.

4 Scope

The scope of this paper, and the accompanying research pilots, is to compare remote assessments to EnerGuide assessments, with a view to understanding:

- Comparability of energy modelling outputs and upgrade recommendations
- Customer experience and engagement.
- Other factors including assessment cycle times, environmental impacts, and considerations for measurement and verification.

Recommendations for appropriate uses for remote assessments is provided, along with a discussion of risks and limitations of each.

5 Background and Approach

This paper draws on the results of two research pilots completed by E1, partnering with Climative, each of which focused on the merits of remote assessments as a viable approach for residential home energy assessments:

1. A two-year study completed in 2021 *(funded in part by a grant from Natural Resources Canada)*, focused on all electrically heated, low-rise residential homes.
2. A one-year study completed in 2022, which expanded on the work of the first pilot, to include all fuel types, and a broader scope of objectives.

Each pilot involved the following components:

- Design of a user-friendly home energy assessment report.
- A secure portal for homeowners to access their Level1 report, and for EAs to generate a Level2 report based on the observations from the remote assessment.
- Remote video assessments for a sample of participants.

Quantitative data obtained from the pilots included Level1 and Level2 energy use estimates and recommendations, and homeowner data collected during the remote assessment. Other data includes:

- Publicly available property data from Property Valuation Services[12].
- Historical E1 program participation data, including H2K data from HEA participants.
- Historical electric energy usage from NS Power billing data.

[12] Open data portal. Property Valuation Services. datazONE | PVSC | DatazONE | (thedatazone.ca)

6 Solution Overview

Climative provided data science expertise and developed the software interface solution for customers and certified EAs. E1 provided the data, building science expertise, marketing and creative design, program design, and partner communications The overall solution consisted of:

- Machine learning models to estimate Level1 and Level2 energy modelling outputs.
- Technical platform (energy modeling software, video software, secure portal).
- Level1 and Level2 customer facing reports.
- Level2 assessment process and protocol.

6.1 Predictive Models

Climative trained machine learning models to predict household energy consumption using thousands of HOT2000 files and publicly available housing data. The models were coded into the software platform to create the outputs for personalized home energy consumption reports. The machine learning models used the following inputs:

Level1 – Home attributes from publicly available data (7 home attributes).

Level2 – Expanded home attributes from user and EA input (15+ attributes).

The models output the following:

- Estimates of weather-normalized energy consumption for the home by category (heat, water, other).
- Retrofit recommendations for the home based on the model estimates (Level1 used models to produce recommendations; Level2 recommendations were made by EAs during the video assessment).
- Predicted energy savings associated with upgrade recommendations.

6.2 Technical Platform

Building modeling software from Climative was adapted and configured for the technical platform. The platform was customized to fulfill the functional requirements, including:

1. Configuration of the modeling engine to accommodate the customized predictive models.
2. A secure portal where customers access their Level1 and Level2 reports and input details about their home.
3. A dynamic interface to allow inputs from EAs (during remote assessments).

The video software used for the remote assessments was IrisCx[13]. This application is customized for remote service assessments and has specific functionality that made it appealing for remote assessments. One of the core features of the application is the ease with which homeowners can connect with EAs, which is through a link in a text message. Also, the resultant video of the remote assessment is then stored in a secure online location where the homeowner or the EA can access it for future reference.

[13] IrisCx, formerly ICWhatUC.

6.3 Customer Facing Reports

The Virtual Energy Advisor platform (a component Climative's technical platform) creates the customer-facing virtual assessment report. Customers access their report through a secure portal. The portal and report were designed with user experience in mind – keeping it simple and concise, with the core features being:

1. A summary of electrical consumption by end-use category.
2. A comparison of energy use to similar homes.
3. Recommended upgrades, with associated cost savings, rebate amounts, and payback period.

The report is dynamic in the sense that it gets automatically updated when an EAs adds new information about the home (via a remote assessment session with the homeowner). Refer to *Appendix B* for examples of the screens the customer can access in the portal.

6.4 Level2 Assessment Protocols

Level2 assessments emulate a traditional on-site home energy assessment using a specialized video application, whereby a homeowner is guided (safely) through their home by a certified EA. The EA records information about the home into Climative's Virtual Energy Advisor platform, which then updates the Level1 assessment report based on this new information – thereby improving the accuracy of the energy consumption estimates and relevance of recommendations for the home. It also provides the homeowner with an opportunity to discuss recommendations and upgrade options with the EA. Guidelines were developed for EAs to follow during the assessment.

7 Pilot Results

7.1 Comparison of Modelling Outputs

Understandably, the "accuracy" of remote assessments receives significant scrutiny in the industry. In Canada, EnerGuide assessments (using H2K) is the standard framework for residential homes. Consequently, it makes sense that this be the baseline for comparisons. However, it is important to recognize that the EnerGuide approach does not, nor is it intended to, provide accurate estimates of actual energy usage in the home. It is designed to control for variables that influence energy usage such as number of occupants and energy usage behaviour of the occupants. Upgrade recommendations also have an element of subjectivity based on the individual EA.

For the comparison of estimates, we rely on the results from the most recent pilot completed in December 2022. Assessments were completed on 85 Nova Scotia homes, conducted between September and December 2022 (**Table 1**).

Table 1. *2022 pilot sample strata*.

Group	Description	Stage of journey	Assessments performed	Sample Size
1	Public housing units[14]	Pre retrofit (initial assessment)	Level1, Level2, Level3	19
2	General population	Pre retrofit (initial assessment)	Level1, Level2, Level3	36
3	Home Energy Assessment Enrollees awaiting final assessment[15]	Post retrofit (final assessment)	Level2, Level3	30

The sample of homes in Group 2 was intended to be representative of the Nova Scotia low-rise building stock, including a cross section of homes by heat type, age, and size[16]. Certified EAs were contracted to aid in the development of remote assessment protocols, and to conduct the assessments with homeowners. Climative's proprietary building modelling software was used to output key energy usage estimates for homes (calibrated and configured for the purposes of the pilot) and to generate an easy-to-read customer-facing report accessed through a secure portal. Commercial video technology[13] allowed homeowners to interact with an EA using a mobile device.

7.2 Energy Use

Energy use is the estimated total annual energy usage in the home in Gigajoules (GJ) under Standard Operating Conditions (SOC)[17]. It is the equivalent measure used by H2K to control for variables that influence energy usage such as number of occupants and energy usage behaviour of the occupants. Level1 and Level2 assessments deviated from H2K estimates by an average of 23% and 16%, respectively, compared to H2K (Table 2). This is significant because total annual energy use is the measure used for the EnerGuide rating system for residential homes, and these results show that even Level1 assessments provide a reasonable approximation. Overall, Level2 assessments generated results closer to H2K than Level1 as expected. Each approach had consistently higher levels of accuracy on water heat, total energy and other end uses, with the least accurate being space heating. Space heat was sensitive to existing heat pump specifications, which had to be estimated for Level1 assessments, and were incorrectly specified in some Level2 assessments (and some on-site assessments). Estimates were generally consistent across heat type, age, size of home (**Appendix A**). It is interesting that estimates for the public housing units were the closest to H2K estimates compared to the other homes. This could be due to more accurate building attribute data, and the fact that a representative from the Nova Scotia Department of Municipal Affairs and Housing guided the EA during the remote assessments for all the units.

[14] In collaboration with the Nova Scotia Department of Municipal Affairs and Housing.

[15] Most participants in this group were provided by Acumen and Homesol and the statistical properties of the sample cannot be verified. Results are to be viewed as directional only.

[16] Participants were recruited via an email, which were randomly selected but participants were largely accepted on a first come, first serve basis due to practical considerations. However, the distribution of participants demonstrates reasonable approximation to the population of eligible Nova Scotia homes.

[17] EnerGuide Rating System Technical Procedures Version 15.1. November 2015.

Table 2. *Deviation[18] of Level1 and Level2 assessments compared to H2K.*

Level	Total Energy	Space Heat	Water Heat	Other
1 (Virtual)	23%	45%	20%	25%
2 (Video)	16%	29%	10%	19%

7.3 Heat Loss

Estimates of heat loss through various building envelope sections is an important calculation to estimate energy savings potential from insulation and windows and doors upgrades. Level2 assessments were able to predict within about 20% of H2K for walls, foundation, and windows/doors. Ceiling estimates had the largest deviation (30%), which was driven by the public housing results. This was a systematic issue with the public housing ceiling inputs, isolated to one EA.

Table 3. *Accuracy of Level2 Heat Loss Estimates[19].*

		Ceiling	Wall	Foundation	Windows/Doors
Sample Group	1 – Public Units	57%	22%	16%	15%
	2 – Population	29%	16%	23%	22%
	3 – Post-upgrade[20]	14%	14%	26%	21%
Overall		**30%**	**18%**	**21%**	**20%**

7.4 Upgrade Recommendations

Upgrade recommendations are a key part of the EnerGuide assessment report, and for participants in E1's Home Energy Assessment program, rebates are only paid on upgrades recommended by the EA.

Level1 and Level2 recommendations focused on a limited subset of measures compared to those that can be modelled in H2K. Upgrades that are most commonly implemented by homeowners and/or most impactful to the energy use of the home were prioritized. Supported upgrades include:

- Space Heating equipment
- Water heating equipment
- Ceiling insulation
- Wall insulation
- Foundation insulation

Examples of upgrades less frequently implemented by homeowners include drain water heat recovery, exposed floor insulation, and ventilation equipment. In 2022, 0%, .04%, 1.2% of participants in the HEA program implemented upgrades in these categories, respectively. Such measures could be included in future software updates but were out of scope for this pilot.

We examined the level of agreement with EnerGuide recommendations for each upgrade category (**Table 4**). Not surprisingly, Level2 assessments outperformed Level1 in terms of alignment with the EnerGuide assessment. Like the heat loss estimates, ceiling upgrade recommendations were the least accurate overall. This appeared to be a systematic issue with one EA, where the level of agreement with EnerGuide

[18] Trimmed mean absolute percent error (TAAE) compared to h2k.
[19] Heat loss estimates were not produced by Level1 assessments.
[20] Level1 assessments were not used for post-upgrade assessments.

was 39% (versus 73% for the other advisor). As such, this appears to be more of a training issue than a flaw in the methodology.

Table 4. *Alignment of recommendations (% of time recommendations were the same as EnerGuide).*

Level	Heating System Upgrade	Ceiling Upgrade	Wall Upgrade	Foundation Upgrade
1 (Virtual)	50%	56%	70%	74%
2 (Video)	74%	59%	80%	80%

It's important to note that the above results represent a mix of assessments where the Level2 and EnerGuide assessments were completed by different EAs and when they were completed by the same EA. When this effect is isolated, consistency between Level2 and EnerGuide assessments changes dramatically, as summarized in **Table** .

Table 5. *Level2 and Level3 upgrade alignment when EAs are the same and when different*.

Same versus Different EAs	Heating System Upgrade	Ceiling Upgrade	Wall Upgrade	Foundation Upgrade
Same EA for Level2 and EnerGuide	93%	70%	77%	77%
Different EA for Level2 and EnerGuide	38%	46%	83%	75%

These findings, that differences in EA preferences are a more significant driver in recommendation decision-making than whether a Level2 or EnerGuide assessment is used, is further supported by historical EnerGuide recommendations for homes of similar characteristics where there is a high level of inconsistency in recommendations across individual EAs. There are many subjective factors that could influence recommendations, including the experience and skill of the advisor, customer influences[21] and others. Therefore, caution should be used in interpreting the upgrade consistency statistics too closely. It does speak to an opportunity for a more standardized (or business-rule) approach to recommendations across all levels of assessments – one that is more closely tied to energy modelling estimates and reduces the level of subjectivity of the EA.

These findings suggest that Level2 assessments provide EAs with the tools necessary to provide homeowners with relevant upgrades and the remote nature of the assessment does not materially affect their ability to do so. However, further EA education and training may benefit both Level2 and Level3 assessment processes to ensure EA recommendations are consistent, where appropriate. To be clear, this recommendation is not to discount or compromise individual EA's professional judgement, but to ensure that the community of EAs have a common and complete understanding of best practices regarding what to recommend and when to recommend it to avoid mixed messaging in the market.

[21] Home Energy Assessment 2019 DSM Evaluation, March 10, 2020.

7.5 Customer Engagement

A key objective of the research was to understand if Level1 and Level2 assessments have the potential to improve homeowner engagement and experience by making the customer journey less burdensome and reduce barriers. The first pilot provided the supporting evidence for this aspect of the research.

Table 6 shows results of email campaigns for the first pilot completed in 2021[22] compared to a typical acquisition email campaign for E1's HEA program. The pilot email campaign invited a random sample of homeowners[23] to view their Level1 report on a secure portal. The call to action in the report was to book an HEA (i.e., an EnerGuide assessment).

Email click-through rates[24] were higher for emails that promoted Level1 and Level2 assessments compared to an email campaign promoting traditional EnerGuide assessments. The enrolment rate for an acquisition campaign to recruit participants for a Level2 assessment was 2.6% versus less than 0.5% for traditional assessments[25]. Surveys were conducted with Level1 and Level2 participants, and a focus group with five Level2 participants was conducted. E1 staff participants, Service Organizations, and EAs also provided important feedback throughout the development and implementation phases. Some of the main themes from participant feedback are presented in **Appendix C**.

Table 6. *Comparison of homeowner engagement metrics (Pilot 1, October 2020).*

	Typical HEA Acquisition Campaign (October 2020)	**HEA Acquisition Campaign via Level1 Assessment (September 2020)**	**Level2 Assessment Acquisition campaign (January 2021)**
Emails delivered	22,339	1,143	1,128
Open rate[26]	43%	41%	39%
Click-through rate	5%	**20%**	7%
Enrolment rate for assessment	0.3%	0.4%	**2.6%**

Of note is feedback on the home energy assessment report, which was purpose-built to offer homeowners a simple and engaging report about the efficiency of their home. The report evolved from a simple static, one-page report in the first pilot to a more interactive portal design in the most recent pilot (See **Appendix B** for samples of reports). Feedback from customers was positive, with most survey respondents indicating that the report was easy to understand (**Appendix C**).

[22] Engagement rates for the email campaign to recruit for the 2022 pilot is not comparable because an incentive was offered to participate in the program, which inflates engagement rates (90% open rate; 52% click-through). The pilot completed in 2021 was comparable to a typical HEA acquisition email, inviting email recipients to view their virtual assessment report and sign up for a traditional HEA assessment.

[23] Electrically heated homes.

[24] The percentage of email recipients who opened the email and clicked the link in the message.

[25] Admittedly, the pandemic could have impacted these results.

[26] Percent of emails that were opened by recipients.

Customer satisfaction with the video application and experience was also very high. The video application provided customers with the option to rate their Level2 experience on a scale of 1 to 10 (10 being the best). For those who provided a rating (24 participants out of 85) the average rating was 9.5[27].

Another indicator of engagement is the amount of face time an EA spends with a homeowner. In contrast with a traditional on-site assessment, a Level2 assessment requires the homeowner to be in constant communication with the EA during assessment. Arguably, this means that a homeowner is required to be more engaged during the assessment, as they are in effect an active participant – something that is not required during a traditional on-site assessment. The average time of a Level2 assessment was about 30 minutes.

A unique benefit of a Level2 assessment, also related to engagement, is the potential for customers to have recurring access to the video recording of their assessment. We did not measure this in the pilots, but presumably this would provide an additional tangible benefit to homeowners as they could review their assessment at their convenience, and playback parts of the conversation with the EA.

7.6 Other Factors - Environmental Impacts, Costs and Energy Advisor Capacity

7.6.1 Environmental Impacts

The average return travel distance for EAs in Nova Scotia in 2022 was approximately 20 kilometers (km) per assessment[28], or 2.9 kilograms[29] of carbon dioxide (CO_2) per assessment, for a total of over 45 tonnes of greenhouse gas (GHG) emissions to complete 15,720 assessments in 2022 (**Table 7**). Since 2017, about 27,000 pre-upgrade EnerGuide assessments were performed on homes who participated in Efficiency Nova Scotia's HEA program (a program requirement), resulting in approximately 78 tonnes of CO_2 emissions. Historically, only about half of participants complete a second assessment[30] (suggesting no significant upgrades were made) which equates to roughly 39 tonnes of GHG being emitted without any measurable energy savings reductions from home efficiency upgrades.

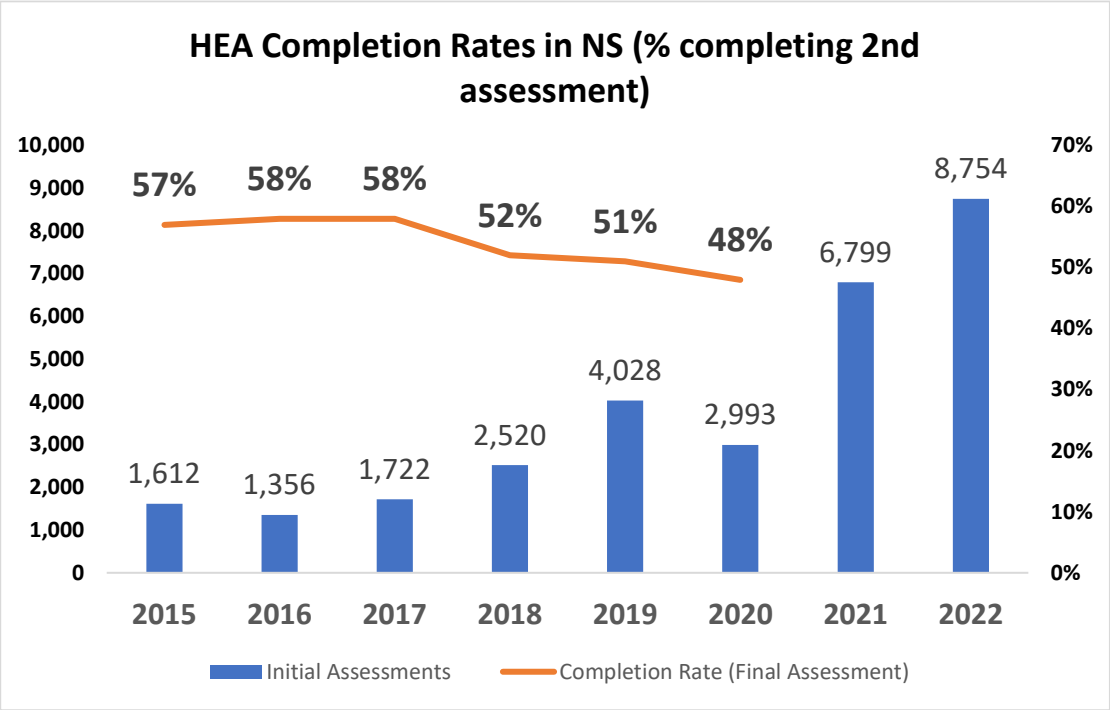
Table 7. *Greenhouse Gas Emissions from EnerGuide Assessments (Nova Scotia, 2022)*.

Assessments[31]	15,720
Average round trip distance (km)[32]	20
Total GHG emissions (kg CO_2)[33]	**45,588**

If current completion rates hold true in 2022, over 20 tonnes of GHG emissions will not be offset by (measurable) energy savings. Furthermore, almost 60% of customers who completed a final assessment in 2022 did not undertake building envelope upgrades (**Chart 2**), meaning the effective percentage of GHG emissions that could be avoided from requiring an EnerGuide assessment is much higher.

[27] Data extracted from the IrisCx platform.
[28] Estimates are based on financial records of total travel costs paid to EAs which were based on historical averages for trip distances. As such, no data was available to test the distribution or variability in distances travelled.
[29] CO2 Converter - OpenCO2.net.
[30] Based on Home Energy Assessment program tracking data derived from Natural resource Canada assessment files.
[31] ENS tracking data based on H2K file transfers from Natural Resources Canada in 2022.
[32] Based on ENS travel expenses paid to contracted EAs.
[33] Total is subject to rounding error.

Chart 1. *HEA Final Assessment Completion Rates*[34].



7.6.2 Energy Advisor Capacity

In E1's experience, the average time to complete an EnerGuide assessment, including the assessment, modelling, administration, and travel time is about 7 hours[35], compared with a Level2 assessment which is conservatively estimated at about 2 hours[36]. On a cost basis, Level2 assessments are less than half the cost per assessment[37]. Simply put, three Level2 assessments can be completed for every EnerGuide assessment, for less than half the price per assessment.

Given that a significant number of EnerGuide assessments are either deployed to homes that don't undertake upgrades (**Chart 1**), or don't upgrade the building envelope (**Chart 2**), it represents an ineffective use of EA capacity, which is already strained in Nova Scotia. The impact of the Canada Greener Homes initiative on volumes (**Chart 1**) and upgrade patterns will further exacerbate capacity challenges. Not surprisingly, there has been a shift toward heat pump installations over insulation with the added rebates for heat pumps from new federal and provincial programs (**Chart 3**). Historically, the number of homes doing heat-pump-only upgrades is significant (**Table 8**), and if these percentages remain at or above current rates going forward, it means there will be an increasing number of EAs spending time doing the final assessment on homes for which a final assessment adds very little value for the homeowner, and building labelling can be achieved with Level1 or Level2 assessments.

[34] Based on an 18-month window from time of first assessment. Consequently, not enough time elapsed for calculating completion rates in 2021 and 2022 (at the time of writing).
[35] Feedback from contracted Energy Advisors.
[36] Data tracked in IrisCx video platform, combined with feedback from Energy Advisors.
[37] Costs are not directly related to assessment time dues to additional software license costs for remote assessments. Software costs per assessment decrease as volumes increase.

Chart 2. *Distribution of HEA Participants in Nova Scotia with No Building Envelope Upgrades.*

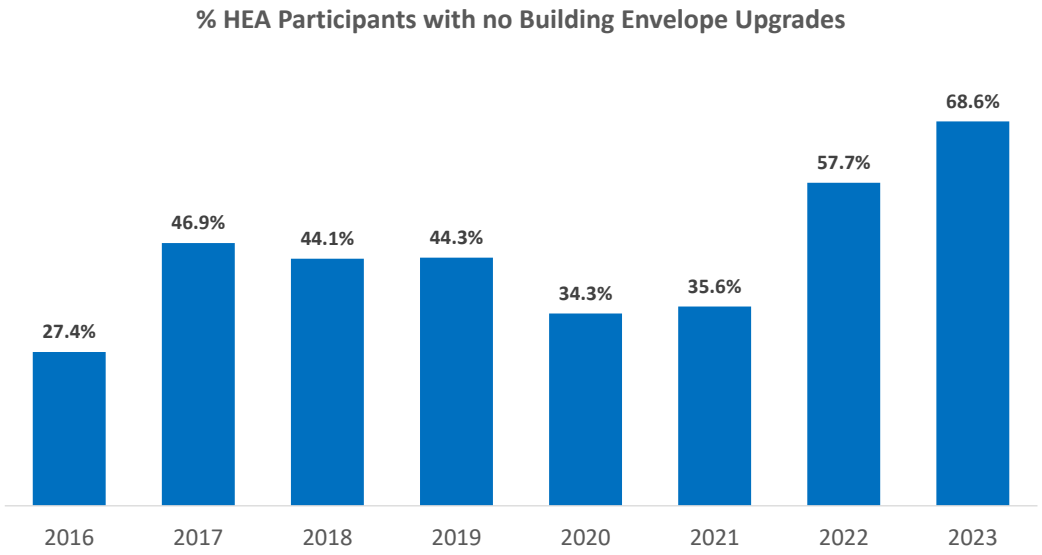


Chart 3. *HEA Upgrade Patterns*.

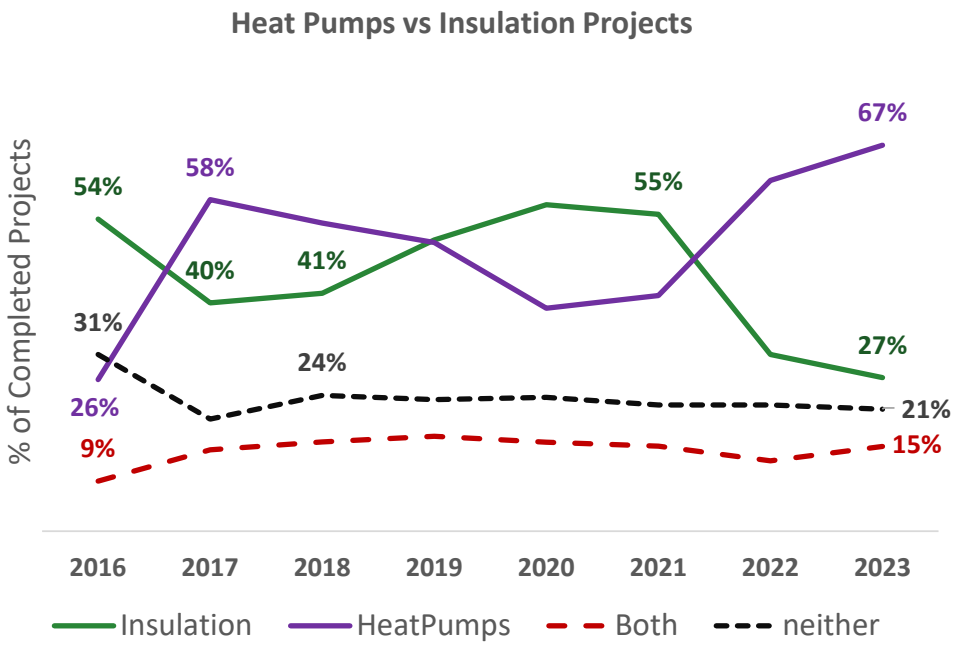


Table 8. *Distribution of HEA homes installing heat-pump-only (2017 – 2019).*

		Size of Home (square feet)			
		<1,000	**1,000-1,499**	**1,500-1,999**	**2000+**
Year Built	**<1960**	6%	12%	12%	10%
	1960-1980	7%	10%	19%	19%
	1981-1990	50%	38%	31%	29%
	1991-2000	42%	42%	32%	37%
	>2001	72%	62%	62%	55%

This, combined with the fact that roughly half of all initial EnerGuide assessments performed on Nova Scotia homes in the HEA program result in no follow-up assessment is important for two reasons. First, it reduces renovation throughput by creating a bottleneck at the energy assessment stage Second, there is a cost to the low carbon economy by burning fossil fuel, as well as increasing the overall cost per unit of energy savings for the program and using budget that could otherwise be put toward incentives.

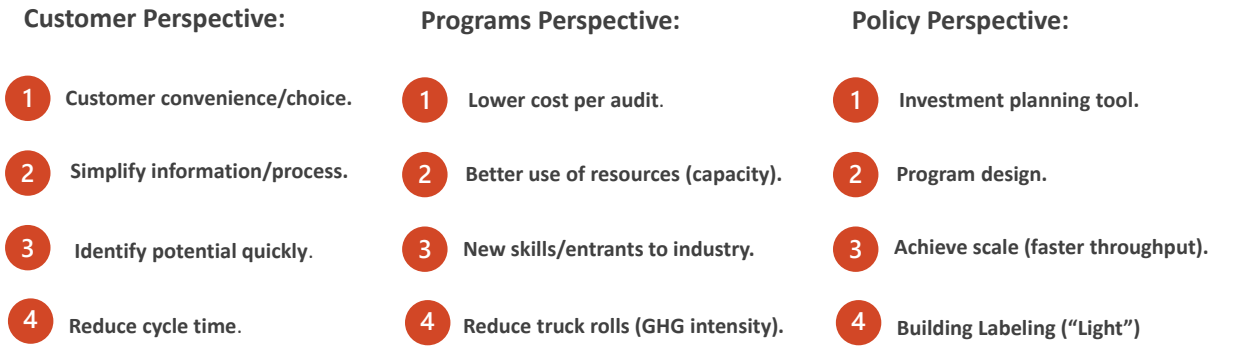
7.7 Measurement and Verification

In Nova Scotia, measurement and verification (M&V) for heat-only upgrades (e.g., mini split heat pump installations) is not consistent across programs, the result of different eligibility restrictions based on funding source, and different rebate levels. Efficiency Nova Scotia's Green Heat program does not require whole-building simulation via an EnerGuide assessment for claiming savings. However, customers that install heat-only upgrades in the HEA program do require an EnerGuide assessment and whole-building simulation to be eligible for additional rebates. In the Green heat program, savings for electrically heated homes are estimated using a billing analysis and estimates for other homes are based on engineering calculations (i.e., assumptions about the size and efficiency of existing equipment and upgrade equipment). Level2 assessments offer the potential to standardize the approach across programs and provide more accuracy than engineering calculations or billing analyses for individual households because neither of these options account for household-level building envelope characteristics. Furthermore, E1 believes that Level2 assessments could be used as a simplified alternative to H2K for whole home savings. Currently in Nova Scotia, H2K estimates need to be adjusted, or "calibrated", based on actual energy usage in electrically heated homes because energy use estimates output by H2K are not based on actual energy use (i.e., the usage estimates are based on SOC). Level2 assessments can easily output estimates of actual usage if sufficient data is available to train the models to do so. This would preclude the need for savings adjustments at the end of the year.

7.8 Other Uses and benefits

Level1 and Level2 assessments have other benefits from a customer, program administration, and policy perspective (Figure 1).

Figure 1. *Benefits of Level1 and Level2 assessments*.



Remote assessments also provide an opportunity to explore alternative rebate structures by overcoming the barrier of hard-to-validate, "hidden" upgrades such as wall cavity insulation. For example, the rebate structure for wall insulation under the Canada Greener Homes initiative requires a precise accounting of each wall in the building, the respective R-values, and which ones have been upgraded and to what level (**Table 9**). This approach is not intuitive and leaves homeowners wondering what their rebate will be, which is unknown until they receive their cheque.

Table 9. *HEA Rebate Guide for Wall Insulation in Nova Scotia*[38].

Rebate Amounts			
% of upgraded wall area insulated	**From RSI 1.32 (R-7.5) and up to RSI 2.11 (R-12)**	**Greater than RSI 2.11 (R-12) and up to RSI 3.52 (R-20)**	**Greater than RSI 3.52 (R-20)**
20%	$660	$760	$1,000
100%	$3,300	$3,800	$5,000

Options for rebate structures that would better accommodate a remote assessment (and are potentially simpler and easier to understand) include:

a) Rebates proportional to the amount of insulation added, validated based on receipts or invoices (**Table 10**).

b) Rebates which are strictly performance-based (e.g., $0.30/kWh of savings). Like the above example, receipts and invoices can be used to determine the amount of wall area upgraded, and to what level, which can be used to generate savings estimates in the Level 2 model.

[38] Derived from Efficiency Nova Scotia HEA Rebate Guide.

Table 10. *Example Rebate Structure for Insulation Upgrades.*

Upgrade	R-value added	Rebate ($/100 ft²)
Ceiling Insulation (Below Attics)	20-40	$30
	40+	$60
Ceiling Insulation (Flat Roofs or Cathedral Ceilings)	12+	$60
Above Ground Exterior Wall Insulation	5-10	$70
	10+	$90
Foundation Wall Insulation	10-20	$40
	20+	$80

8 Conclusions and Recommendations

Accelerating the efficiency of the existing building stock is essential to achieve aggressive GHG reduction targets set by all levels of government. Traditional methods, using on-site energy assessments with the EnerGuide and HOT2000 approach, provide the most detailed and precise means for assessing each home's efficiency. This is excellent for producing a building label; however, this level of detail is not necessary to support rebate programs and encourage retrofit activity. Indeed, only about 1.5 % of eligible homes per year are being assessed using this approach. Different approaches are needed to engage homeowners, reduce cycle times, and get more homes undertaking efficiency upgrades.

This research into the use of remote methods to assess the efficiency of low-rise residential homes has demonstrated that such approaches show promise to help achieve efficiency assessments at scale. Remote assessments were able to accurately reproduce the results of traditional energy consumption models with up to 84% using few home attributes.

Level2 assessments, provide EAs with the tools necessary to provide homeowners with relevant upgrades and the remote nature of the assessment does not materially affect their ability to do so. However, further EA education and training may benefit both Level2 and EnerGuide assessment processes to ensure EA recommendations are consistent. To be clear, this recommendation is not to discount or compromise individual EA's professional judgement, but to ensure that the community of EAs have a common and complete understanding of best practices regarding what to recommend and when to recommend it.

There have been tens of thousands of EnerGuide assessments in Nova Scotia, but less than 200 Level2 assessments. E1 recommends that Level2 assessments be scaled to collect more data to understand the calibration factor that results when comparing Level2 assessments to EnerGuide assessments, and how those calibration factors compare.

Here are the key findings:

- Level1 and Level2 assessments produced annual energy consumption estimates of within 77% and 84% of EnerGuide assessments, respectively.
- Agreement of Level2 upgrade recommendations with EnerGuide assessments ranged from 60% (ceiling insulation) to 80% (foundation and wall insulation, and windows/doors).
- EnerGuide assessments take 3 times longer to complete than a Level2 assessment[39].

[39] Includes energy modelling, administration, travel time.

- Enrolment rates for Level2 assessments are significantly higher than those for EnerGuide assessments.
- Customer satisfaction for the video technology was high (9.5 out of 10).
- Participants liked the simple energy report, citing that it was easy to understand (80% agreed).
- Feedback from EAs was generally positive; opportunities for improvements centered on modelling software features and having more standardized protocols for interactions with the homeowners.

Limitations of virtual and remote methods are well known, and typically revolve around accuracy of energy use estimates, and the level of precision that the modelling platform provides compared to H2K, particularly around current-state insulation levels in walls and ceilings, as well as the inability to conduct air flow tests.

Despite these limitations, our research shows that remote methods provide a reasonable amount of accuracy as well as providing certain advantages over EnerGuide assessments. As such, we put forward the following recommendations and guidelines for use:

1. **Policy and Planning:** Consider the EnerGuide rating as the "gold standard" with Level1 and Level2 estimates used for building labelling 'lite' options. Level1 assessments provide the means to score an entire stock of residential buildings, on a home-by-home basis, to provide high level estimates of energy intensity and energy savings potential for setting and monitoring efficiency targets and investment planning.
2. **Efficiency Program Service Delivery**: Use remote assessments to triage homes and manage EA capacity. For example, use EnerGuide assessments on homes that meet certain criteria, such as high energy savings potential based on the results of a Level1 and Level2 assessment.
4. **Use Level2 assessments for measurement and verification.** Use Level2 assessments for verifying simple, single-upgrade projects. In these situations, an EnerGuide assessment is a poor use of energy advisor capacity because a whole home assessment is unnecessary for upgrades that do not affect multiple building systems. In Nova Scotia, it is especially common that homeowners only install mini split heat pumps and no other upgrades, for example. In addition, we provide examples of alternative rebate structures for insulation, which we believe would be easier for homeowners to understand, and for which Level2 assessments could be used for energy savings verification. We recommend further analysis and research into these alternative rebate approaches to understand the potential benefits and risks.

In summary, we believe the evidence is compelling for using Level1 and Level2 assessments in appropriate situations and will result in better outcomes, including:

- better use of energy advisor capacity.
- lower costs per assessment, including environmental impact.
- acceleration of enrollment in retrofit programs.
- improved customer experience by removing barriers, reducing cycle times, and simplifying eligibility requirements.
- better insight into entire building stock for building labelling, planning, and prioritizing based energy savings potential.

9 Appendix A: Detailed Level1 and Level2 Results

Four modelling scenarios were examined to compare energy use estimates. **Scenario 3 was deemed the most appropriate for Level2 comparison to H2K because it corrected for obvious EA input errors** (which were the result of various factors that could be corrected with better training on the modelling platform and clearer protocols). These included errors in heated floor area, year built, footprint, and number of storeys. Any discrepancies between H2K and EA's input in building insulation RSI, water heater attributes, and furnace attributes were not changed.

Scenario Descriptions:

Scenario 1: **Level1** - Generated using publicly available data.

Scenario 2: **Level2** Machine Learning Approach - uncorrected inputs.

Scenario 3: **Level2** Machine Learning Approach - corrected inputs.

Scenario 4: **Level2** using H2K inputs.

Table 11. *Energy Use by Model Scenario – Deviation from H2K*[18].

	End Use				**Heat Loss**			
	Total Energy	*Space Heating*	*Water Heating*	*Others*	*Ceiling*	*Wall*	*Foundation*	*Window/Door*
Scenario 1	23%	45%	20%	25%	N/A (Level1 heat loss was not computed)			
Scenario 2	16%	37%	10%	18%	28%	27%	25%	21%
Scenario 3	16%	29%	10%	19%	30%	18%	21%	20%
Scenario 4	9%	23%	2%	N/A	7%	12%	19%	19%

Table 12. *Energy Use (Deviation from H2K).*

Home Attributes		**Total Energy**		**Space Heat**		**Water Heat**	
		Level1	*Level2*	*Level1*	*Level2*	*Level1*	*Level2*
Sample Group	1 – Public Units	20%	11%	36%	15%	16%	8%
	2 – Population	21%	17%	42%	28%	17%	12%
	3 – post-upgrade[20]	*N/A*	15%	*N/A*	33%	*N/A*	9%
Heat Type	Electric	24%	19%	50%	36%	11%	10%
	Nonelectric	19%	13%	35%	26%	25%	10%
Year Built	Before 1940	30%	21%	46%	38%	15%	11%
	1941 - 1990	20%	15%	41%	29%	20%	9%
	1991 – 2022	18%	15%	41%	26%	20%	11%
Size of Home (ft^2)	<1,500	15%	15%	29%	20%	26%	8%
	1,500 – 1,999	26%	16%	44%	31%	7%	13%
	2,000 – 2,500	30%	14%	43%	32%	17%	10%
	>2,500	18%	17%	39%	28%	16%	10%
Overall		**23%**	**16%**	**45%**	**29%**	**20%**	**10%**

Table 13. *Level2 Heat Loss (Deviation from H2K).*

		Ceiling	Wall	Foundation	Windows/Doors
Sample Group	1 – Public Units	57%	22%	16%	15%
	2 – Population	29%	16%	23%	22%
	3 – post-upgrade	14%	14%	26%	21%
Heat Type	Electric	19%	17%	20%	20%
	Nonelectric	31%	17%	23%	20%
Year Built	Before 1940	21%	18%	20%	25%
	1941 - 1990	36%	22%	19%	18%
	1991 – 2022	23%	11%	24%	23%
Size of Home (ft^2)	<1,500	46%	26%	20%	18%
	1,500 – 1,999	33%	7%	13%	19%
	2,000 – 2,500	27%	9%	49%	19%
	>2,500	16%	22%	18%	24%
Overall		**30%**	**18%**	**21%**	**20%**

Table 14. *Agreement of Recommendations with H2K.*

		Heating System Upgrade		Ceiling Upgrade		Wall Upgrade		Foundation Upgrade	
		Level 1	*Level 2*	*Level 1*	*Level 2*	*Level 1*	*Level 2*	*Level 1*	*Level 2*
Sample Group	1 – Public Units	28%	50%	56%	50%	72%	72%	89%	72%
	2 – Population	61%	86%	56%	64%	69%	83%	67%	83%
	3 – post-upgrade	*N/A (Group 3 was the post upgrade sample)*							
Heat Type	Electric	60%	95%	40%	65%	80%	85%	90%	85%
	Nonelectric	44%	62%	65%	56%	65%	76%	65%	76%
Year Built	Before 1940	50%	83%	33%	50%	33%	67%	50%	67%
	1941 - 1990	32%	64%	64%	56%	64%	72%	76%	76%
	1991 – 2022	70%	83%	52%	65%	87%	91%	78%	87%
Size of Home (ft^2)	<1,500	43%	64%	57%	57%	71%	79%	86%	86%
	1,500 – 1,999	13%	25%	50%	25%	63%	88%	88%	38%
	2,000 – 2,500	42%	100%	67%	67%	67%	67%	42%	75%
	>2,500	75%	85%	50%	70%	75%	85%	80%	95%
Overall		**50%**	**74%**	**56%**	**59%**	**70%**	**80%**	**74%**	**80%**

10 Appendix B: Customer Report Design

Figure 2. *Home Assessment Report (Pilot 1)*

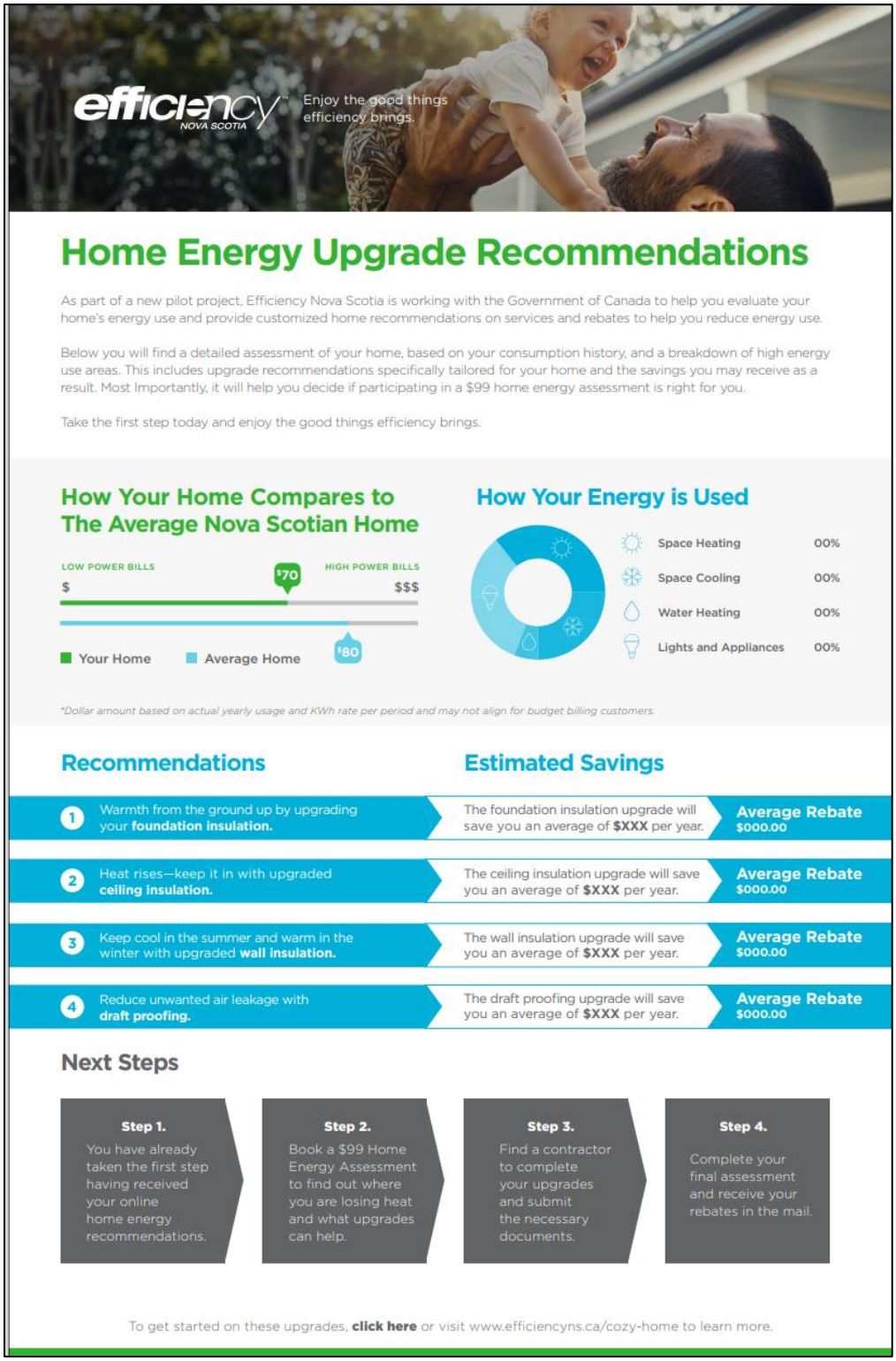
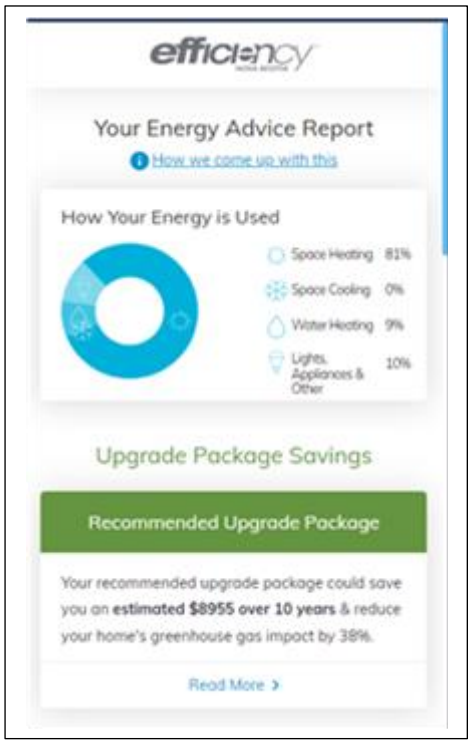
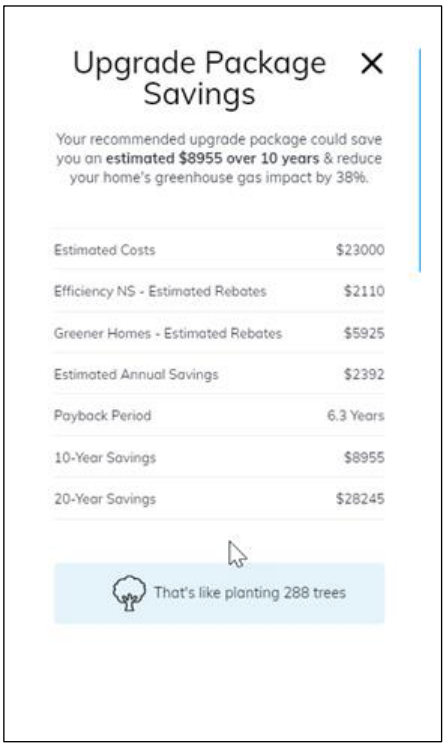
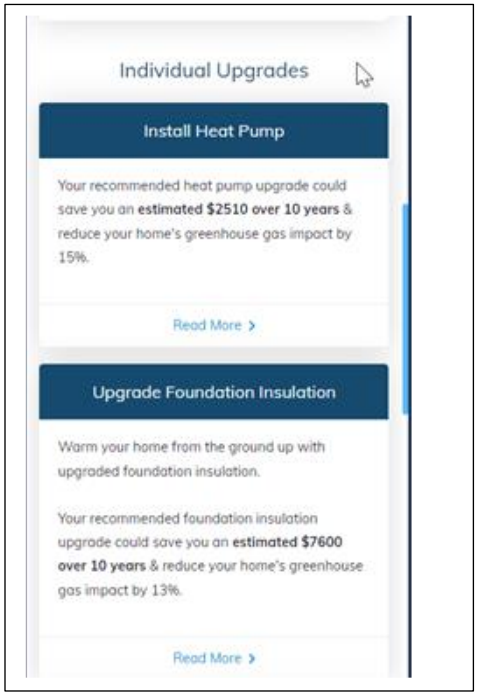
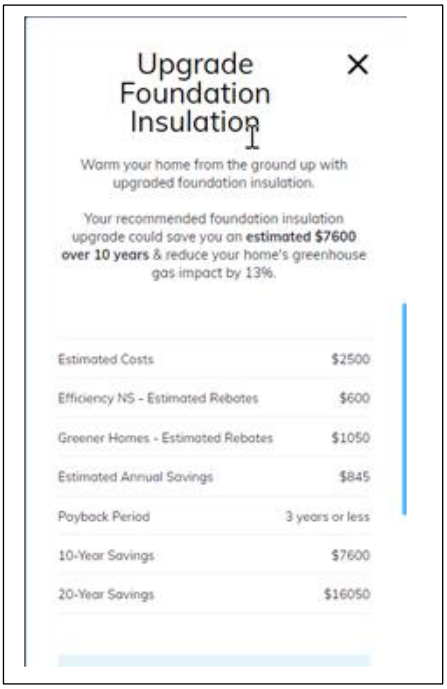


Figure 3. *Home Assessment Report / Portal (Pilot 2).*



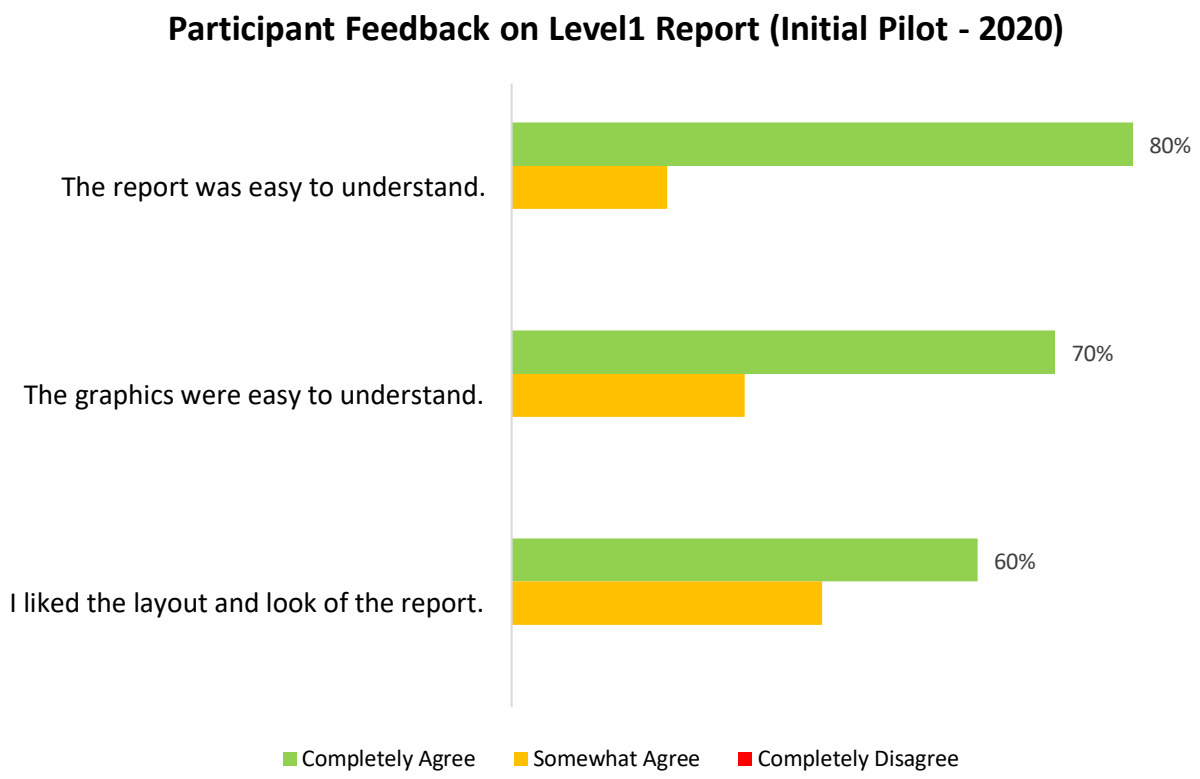






11 Appendix C: Customer and Partner Feedback

Figure 4. *Participant Feedback on Report Design*[40].



Homeowner Feedback Themes:

- Most homeowners stated that virtual assessment reports are generally easy to understand.
- Most homeowners said they were at least somewhat likely to contact E1 to learn more about their virtual assessment reports.
- Most homeowners stated they were at least somewhat likely to use a remote assessment service if offered.
- Customers appreciated that remote assessment appointments were concise, as they did not have to arrange for half of a day off from work. Those that knew their homes well were able to further reduce appointment times.
- Though the video call was convenient, several customers expressed they did not receive proper instructions prior to the call regarding areas they would need to access and extra equipment they might require.
- Following the video assessment, some customers were unclear of where to start or what steps to take next.
- Several homeowners indicated they had expected the video assessment to be more thorough.

[40] Survey of 200 participants. August 2020.

EA Feedback Themes:

- EA noted significant time savings for remote assessments compared to EnerGuide assessments. Video calls were found to take up to 30 minutes. The total engagement and file processing took no more than 1 hour and 30 minutes compared to four or more hours for EnerGuide (depending on travel requirements).
- EAs were able to complete much of their remote assessment record keeping and energy modelling during the video call, contributing to time savings.
- Minimal video call connectivity issues were experienced, even when customers were in more rural areas and ventured outside of their homes to help EAs collect information.
- EAs and customers found the video application to be very intuitive and user friendly.
- The energy modelling application and procedures are built on elements that are familiar to EAs, lessening the learning curve for new users.