Non-Energy Benefits Study: Phase II

Quantified Benefits and Qualitative Insights

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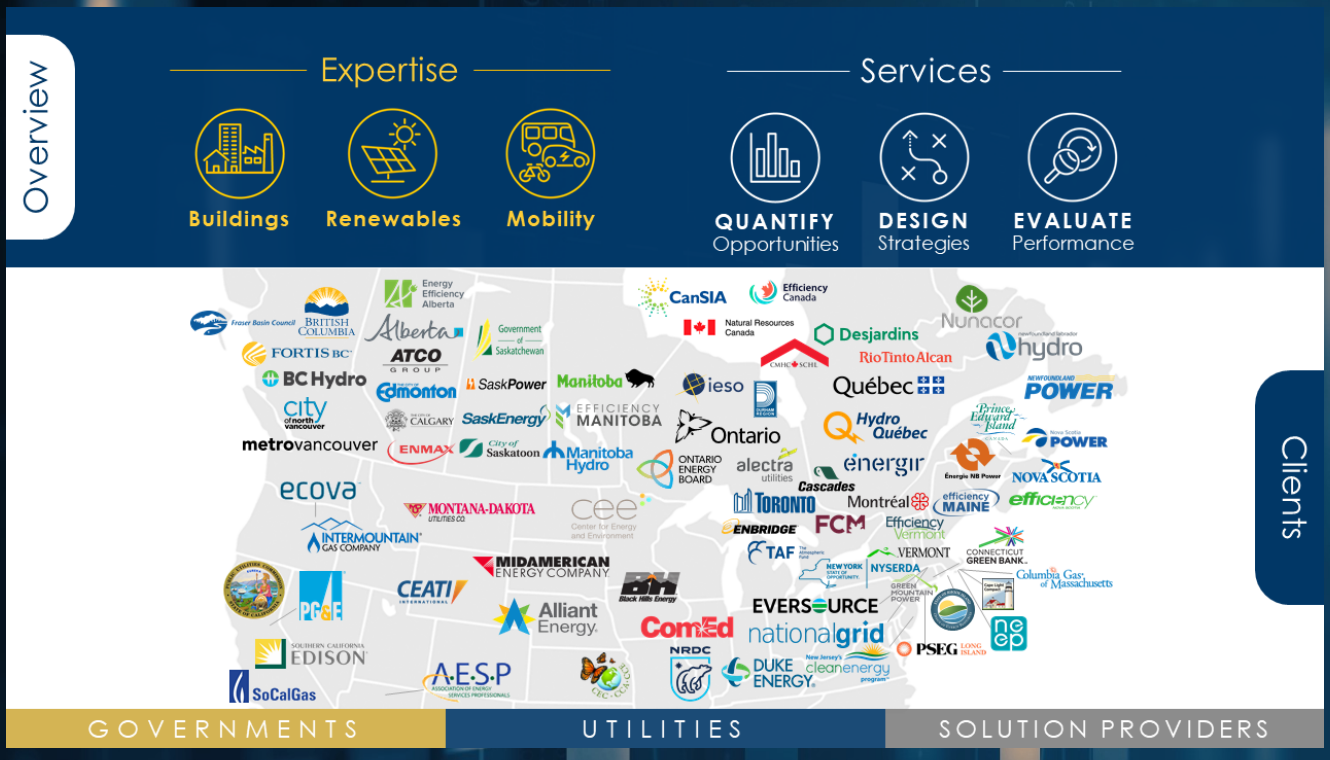

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Executive Summary

In this study, we assessed the Non-Energy Benefits (NEBs) from energy efficiency projects funded by the IESO over the 2017-2019 period. We quantified NEBs in each of the seven sectors served by the IESO programs and we assessed how these values might be included in cost-effectiveness testing. We also gathered qualitative information about NEBs and identified how NEBs can be used to meet IESO program design, marketing, and policy objectives.

The study included four stages:

1. **Screening and review of NEBs** with industry experts to identify the most relevant NEBs for each sector
2. **Participant surveys** that collected quantitative and qualitative data for each sector
3. **NEBs quantification** that combined survey data with IESO program tracking data
4. **Cost-effectiveness guideline review** to understand how NEBs could be captured in IESO's cost-effectiveness tests

The table below outlines all sectors and NEBs included in the study. For each sector, the NEBs are ranked by quantified NEB value. The quantified value is included in brackets.

Table ES1. Ranked NEBs by Sector and (Quantified NEBs Values)

	Residential	Low-income	First Nation (Participant)	Commercial	Institutional	Industrial	Agricultural
Reduced financial stress	4 ($0.03)	1 ($0.09)	2 ($0.090)				
Thermal comfort	1 ($0.11)	2 ($0.08)	1 ($0.092)	2 ($0.05)	2 ($0.25)		2 ($0.003)
Reduced building & equipment O&M[1]	5 ($0.02)			1 ($0.08)	3 ($0.11)	2 ($0.03)	
Improved indoor air quality	3 ($0.05)	3 ($0.02)	4 ($0.06)	3 ($0.007)	1 ($0.27)		3 ($0.002)

[1] O&M stands for Operations & Maintenance

	Residential	Low-income	First Nation (Participant)	Commercial	Institutional	Industrial	Agricultural
Sense of control over energy decisions	2 ($0.06)						
Improved lighting levels			3 ($0.08)				
Reduced spoilage				4 ($0.0002)			4 ($0.001)
Improved business outcomes						1 ($0.04)	1 ($0.09)
Improved product quality						3 ($0.01)	
Total (depends on specific measures)[2]	$0.05 - $0.27	$0.09 - $0.19	$0.09 – $0.32	$0.08 – $0.14	$0.11 - $0.63	$0.08	$0.09 - $0.10

Using NEBs Values

All participant NEBs presented in this study are based on participants' self-reported perception of the value of NEBs they experienced from the energy efficiency measures. Previous studies have found subjective benefits, including the NEBs quantified in this study, to be highly valued by participants. Some jurisdictions choose to use these values primarily for program design, marketing, and customer targeting rather than in cost-effectiveness testing. Other jurisdictions do include subjective or 'soft' NEBs in cost-effectiveness testing. This report highlights many potential uses for the Ontario-specific NEBs values, including marketing, program design and policy support. The report also includes an overview of how these NEBs could be applied in cost-effectiveness testing.

From the study findings, the following key takeaways emerge:

Participants of IESO-funded programs place a great deal of value on NEBs. In many cases, the value of the NEBs within a given sector exceed the value of the participant energy savings. This highlights that there are factors beyond energy savings that may motivate participation in energy efficiency or contribute to positive customer experiences with programs.

NEBs factor into decision-making around program participation across all sectors. More than half of residential respondents and nearly two-thirds of non-residential respondents consider NEBs when deciding to participate in programs. In addition, those who consider NEBs when considering program participation are more likely to pursue additional EE measures in next 5 years.

[2] Some NEBs are specific to certain measures (e.g. improved lighting levels). The total NEB value therefore depends on the measures offered within a given program.

NEB values are likely higher than estimated in this Study. This study did not include all possible participant NEBs from energy efficiency but was limited in scope to NEBs related to specific efficiency measures installed through six IESO CDM programs during 2017-2019. We also elected to use a conservative approach when calculating the NEB values.

The NEBs identified and their valuations vary by sector. Although some NEBs were identified as relevant and valued highly across multiple sectors – notably thermal comfort – there is considerable variation in NEB selection and valuation between sectors. Each sector has a unique combination of NEBs, and even those sectors with a similar NEB mix show differences in their NEBs rankings. For those NEBs that are found across multiple sectors, there is also considerable variation in absolute NEBs values by sector. This supports the sector-specific granularity of this study.

Areas for future research include values by subsector (notably within the agricultural and industrial sectors). Some experts highlighted the potential for there to be differences in the valuation of NEBs in some sub-sectors – in particular those in the agriculture and industrial sectors. Additional targeted research could illuminate the benefits most relevant to subsectors and further shape marketing and communications targeted to those customers.

Applicability to Other Jurisdictions

Because NEBs research has not been completed in all jurisdictions, others may be interested in leveraging this research. While the methodology used in this study is not jurisdiction-dependent and could be replicated in other jurisdictions, the results of the study are specific to Ontario. Given the widely varying NEBs values found in the jurisdictional scan, the Dunsky Team cautions against the simple adoption of these NEB values in other jurisdictions.

Additional considerations regarding the applicability of this work include:

1. The NEBs valuations are dependent on the specific measure mixes installed by surveyed participants as well as the overall program designs. For example, many residential sector survey respondents had installed thermostats, which may have led to an increased valuation of the 'sense of control over energy decisions' NEB. The measures installed in each sector's surveyed population are included in the appendix and the NEBs valuations should be considered in the context of these values.
2. Ontario is a very large province (over 1 million square kilometres – an area larger than France and Spain combined) with a highly diversified economy driven primarily by the services sector as well as key manufacturing industries such as automotive, biotech, pharmaceuticals and communications technologies[3]. Ontario's climate is characterized by cold winter temperatures alongside strong seasonal temperature swings to increasingly warmer summers that are increasing the demand for air conditioning across the province. While the province has generally been a summer-peaking electricity system since 2000, it could be characterized dual peaking system with Ontario having an annual winter peak as recent as 2014[4]. This points to the increased importance and challenge of maintaining

[3] Government of Ontario. (2019). Government of Ontario. Available at this link.
[4] IESO (2014). 2014 Electricity Production, Consumption, Price and Dispatch data. Available at This link.

comfort year-round, and the potential for increased energy intensity compared to other jurisdictions. The NEBs values may have also be impacted by the combination of industries present in Ontario along with the province's home and building characteristics, which are expected to vary from other jurisdictions.

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1. INTRODUCTION

Introduction

Conservation and Demand Management (CDM) programs can offer participants significant value beyond energy savings. Identifying and understanding these non-energy benefits (NEBs) can help CDM program administrators to design and market programs in a manner that best resonates with target participants. Quantifying NEBs (either directly or through generic adders) enables the inclusion of these non-energy impacts streams in program cost-effectiveness testing.

While NEBs are generally recognized amongst CDM professionals to be strong motivators for CDM program participation, NEBs are notoriously difficult to evaluate. Among the very few studies on NEBs quantification completed to date, findings suggest that participant NEBs can exceed the value of energy savings, sometimes considerably.

1.1 – Study Context

In 2015, the IESO adopted a 15% NEB adder alongside the implementation of the Conservation First Framework (CFF). In 2018, the IESO sponsored the NEB Study Phase I ("Phase I Study") which compiled NEB values that had been quantified in other jurisdictions, adapted them to the Ontario context, then compared these values to the adder. The study found that using a global adder of 15% appropriately represents NEBs at the portfolio level but does not provide nuance or granularity of program-level cost-effectiveness. The Phase I study recommended future NEB research in Ontario to collect data from a customer-centric or market perspective and to quantify NEBs in a way that supports IESO cost-effectiveness calculations.

In 2018, the IESO published the findings of the CFF mid-term review. The report considered the use of NEBs when assessing programs and recommended that the IESO ensure that the application of NEBs, in particular societal benefits, is congruent with the IESO's Cost-Effectiveness guidelines.

Building upon both the Phase I Study and the results of the CFF Mid-Term Review, IESO engaged Dunsky Energy Consulting ("Dunsky") in early 2020 to undertake this study, referred to as the Non-Energy Benefits Study Phase II ("Phase II Study").

1.2 – Research Objectives

The Phase II study assesses the NEBs associated with the implementation of energy efficiency projects funded by the IESO over the 2017-2019 period. Specifically, the study objectives were threefold:

- To better understand qualitative aspects of sector-specific NEBs and identify how NEBs can be used to inform program design, marketing, and policy objectives;
- To quantify Ontario-specific NEBs at the sector-level where possible; and
- To ensure the appropriate application of quantified NEBs in cost-effectiveness testing.

1.3 – Study Scope

1.3.1 – NEB Categories

NEBs are generally grouped into three categories based on the benefit recipient: participant, utility, and societal. **The focus of this study was on identifying and quantifying participant NEBs.**

In addition, the study also included three societal NEBs:

- Quantification of illness and mortality costs of avoided air pollution (across all sectors)
- Qualitative research on two societal NEBs within First Nation Communities specifically: (a) education and capacity building; (b) reduced reliance on fossil fuels

Utility NEBs were outside of the scope of this study, although recommendations for future consideration of utility NEBs are included in the Cost-Effectiveness Framework Recommendation section.

Understanding and using NEBs

NEBs can be subjective

While some types of NEBs (e.g. reduced spoilage) may lend themselves to objective quantification, other NEBs (e.g. thermal comfort, reduced financial stress) are inherently subjective. All participant NEBs presented in this study are based on participants self-reported perception of the value of NEBs they experienced from the efficiency measures installed through the CDM programs in 2017-2019.

Previous studies have found subjective benefits, including the NEBs quantified in this study, to be highly valued by participants. Some jurisdictions choose to use these values primarily for program design, marketing, and customer targeting rather than in cost-effectiveness testing [5]. Other jurisdictions do include subjective or 'soft' NEBs in cost-effectiveness testing [6]. This report highlights many potential uses for the Ontario-specific NEBs values stemming from this Phase II study, including marketing, program design and policy support. The report also includes an overview of how these NEBs could be applied in cost-effectiveness testing.

NEBs may not be mutually exclusive

NEBs are often inter-related and may not be mutually exclusive. Some (but not all) previous studies have chosen to address the potential for overlap between NEBs by scaling down the NEBs reported by participants (to equal the total value of energy savings, for example). This study does not scale NEBs to account for potential overlap between different NEBs– it includes the full value of NEBs reported by

[5] NMR Group, Inc. (2011). Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation. Available at **this link**

[6] Lawrence Berkeley National Laboratory. (2020). Applying Non-Energy Impacts from Other Jurisdictions in Cost-Benefit Analyses of Energy Efficiency Programs. Available at **this link.**

surveyed participants. There is a recommendation, however, to cap the total NEBs value when undertaking cost effectiveness testing. This recommendation is discussed in greater detail in Chapter 4.

1.3.2 – Sectors and Programs

The study included seven sectors: Residential; Low-income; First Nation; Commercial; Institutional; Industrial; and Agricultural. A participant dataset including contact information and participant savings was developed based on 2017-2019 energy efficiency projects completed through six of the IESO's Save on Energy programs, as seen in the table below. Descriptions of these programs are included in the Appendix. The participant dataset was not granular enough to enable sampling at the subsector level. All quantified NEB results are provided at the sector level however some qualitative insights are provided for specific sub-sectors.

For the purposes of this study, the First Nation sector is limited to First Nation households in on-reserve communities, which is the eligibility criteria for the IESO's First Nation Conservation Program. We acknowledge that there are also First Nation individuals who live in off-reserve communities and who may have participated in one or more of the IESO's other residential programs, however the IESO does not collect racial or ethnic data from program participants. We also note that while the Home Assistance Program is limited to Low-Income households, the Heating & Cooling Program is not income qualified. As such, it is possible that some participants in the Heating & Cooling Program could be from low-income households.

Table 1. Sector to program mapping

Sector	Heating & Cooling Program[7]	Home Assistance Program	First Nations Conservation Program	Small Business Lighting Program	Retrofit Program	Process Systems & Upgrades Program
Residential	✓					
Low-Income		✓				
First Nation			✓			
Commercial				✓	✓	
Institutional				✓	✓	
Agricultural				✓	✓	
Industrial				✓	✓	✓

[7] The survey team developed the residential sector survey sample and gathered per participant gross savings values from a database of past Heating and Cooling Program participants. When the surveyors verified which measures each survey participant had installed, however, measures from the Instant Discount program were noted by some participants (including lighting). Although the survey sample was developed using the Heating and Cooling program, participants who had also participated in the Instant Discount program considered all measures that they had installed through both programs when quantifying the NEBs that they had experienced. For those participants, the study team augmented the per participant gross savings values from the Heating and Cooling program database to include savings from the measures installed from the Instant Discount program by each participant using the IESO Prescriptive Measures and Assumptions List (April 2020).

2. METHODOLOGY

Methodology

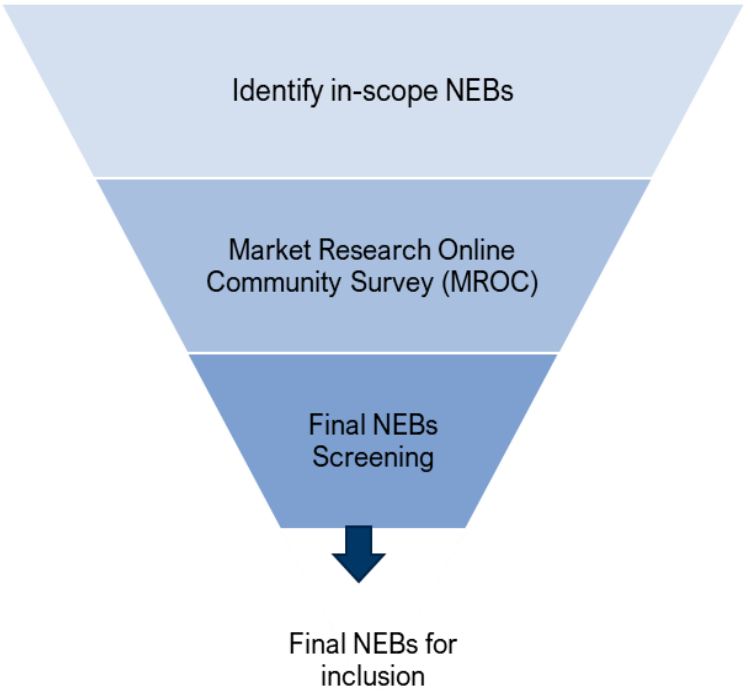
Our approach for conducting the Phase II Study included four main stages, as seen in Figure 1. Below, we outline the methodology used in each of these stages.

Figure 1. Study Stages

2.1 – Screening & Review of NEBs

Phase I of the project identified potential in-scope NEBs to include in future research. To keep the participant surveys a manageable length, the first stage of the Phase II project – Screening and Review of NEBs – included several steps to prioritize which NEBs to include in the participant surveys. First, the project team refined the in-scope NEB lists identified in the Phase I Study for the industrial and agricultural sectors. The team then reviewed the lists with the IESO to ensure that the NEBs were not already accounted for in IESO cost-effectiveness testing (in which case they were excluded from further study). Next, the study team held an Market Research Online Community (MROC) survey where sector-specific experts reviewed the lists to prioritize which NEBs to include in participant surveys. Following the MROC survey, the project team completed an additional screening process to ensure all NEBs were suitable to include in a participant survey and to finalize the 3-5 NEBs to be quantified for each sector.

Figure 2. NEBs Screening & Review Process



These steps are described in detail in the sub-sections that follow.

2.1.1 – Identify in-scope NEBs

The Phase I Study was used as the basis for scoping which NEBs should be included in this Study, with two notable refinements. The Phase I Study identified NEBs for all sectors in this study, except for the agricultural sector. The Phase I Study also recommended that industrial sectors NEBs should be reviewed in future work due to limited previous NEBs research specific to the that sector. Below we describe the approach we took with each of these sectors to identify additional in-scope NEBs for consideration.

Industrial NEBs

As part of a previous project, the Dunsky team completed research focused on industrial sector barriers to participating in energy efficiency programs and the types of benefits, including NEBs, that can promote industrial participation. From this research, the team developed guidelines for program design strategies on behalf of EfficiencyOne in Nova Scotia[8]. This research included detailed interviews with 20 industrial customers and with 7 program administrators in jurisdictions across North America. The key themes that emerged from this research included the importance of competitiveness, pressure from global trade, and a core focus on productivity.

With these previous research findings in mind, we reviewed the Phase I Study NEBs list and recommended the addition of a NEB for **business competitiveness** for the Industrial Sector.

Agricultural NEBs

As a starting point, the project team drew from the lists of recommended in-scope NEBs for the commercial, institutional, and industrial sectors. The team then met with IESO staff familiar with the agricultural sector to understand which programs agricultural customers participate in, which measures they install, and additional NEBs that may be relevant. As a result of these conversations the project team included additional NEBs, some of which were selected as top-ranked NEBs by the experts as part of the MROC survey (e.g. increased crop, livestock productivity and/or improved health). Overall, the agricultural sector NEBs had a high degree of consensus among the community experts, and few additional NEBs were recommended by experts beyond what was included in the in-scope list and identified through conversation with the IESO.

The in-scope lists for all sectors were reviewed once more with the IESO to ensure that they did not include NEBs already assessed by the IESO. The finalized lists of NEBs were included in the MROC survey, described in the next sub-section.

2.1.2 – Market Research Online Community Survey

The goal of the Market Research Online Community (MROC) Survey was to gather sector-specific NEBs insights from a broad range of sector experts, including those representing industry organizations, advocacy groups, consultants, and more. This information allowed the project team to compile qualitative

[8] Dunsky Energy Consulting. (2019). *Industrial Energy Efficiency: Trends, Barriers, and Strategies*. Available at this link

insights about the NEBs while also narrowing down the 'in-scope' list of NEBs for inclusion in the participant surveys.

The MROC Survey included three days of activities held over two weeks and used a Delphi panel approach. During each day of activities, participants were shown the responses collected during the previous session from other experts, allowing them to reflect on the feedback provided by others and adjust their responses if desired. The goal of this approach was to reach consensus or convergence on the research question. In this case, experts were asked to identify the 'most relevant' NEBs for each sector, with relevance defined as:

- Value from the perspective of an energy efficiency program participant
- Importance from a marketing perspective
- Importance from a policy perspective

Experts were also asked to provide qualitative insight on NEBs identified as most relevant. In addition to providing feedback on the in-scope NEBs lists, experts were also able to suggest novel NEBs that had not been included in the original sector-specific lists. In subsequent sessions, other experts were shown these novel NEBs and could provide their feedback on their relevance.

Following the three days of survey activities, each NEB was classified into one of four categories:

- **Top-ranked NEB:** Those ranked as very relevant for the sector with a high degree of expert convergence
- **Very relevant NEB:** Those ranked as very relevant for the sector with a lesser degree of expert convergence
- **Less relevant NEB:** Those ranked as less relevant for the sector
- **Not relevant NEB:** Those ranked as not very relevant for the sector

2.1.3 – Final NEBs Screening

Following the MROC survey, the project team completed a final screening to develop shortlists of three to five NEBs for each sector that would be used for the participant surveys. To undertake this final screening, we used the following methodology:

1. Start with 'Top-ranked NEBs'
2. Check that all 'Top-ranked NEBs' are quantifiable through participant surveys (eliminate those that are non-quantifiable) (*relevant for novel NEBs suggested by experts in the MROC survey*)

3. Review 'Top-ranked NEBs', applying professional judgement to authenticate the results of the MROC survey (ensuring no redundancy, ensuring experts understood how NEB was defined, etc.)
4. If more NEBs are required (i.e. there are fewer than three NEBs after completing step 3), select additional 'Very relevant NEBs' through the following process:
    a. Check that they are quantifiable (eliminate non-quantifiable)
    b. Check for likelihood of significant variance between jurisdictions (prioritize NEBs more likely to be Ontario specific)
    c. Check for likelihood of significant variance between measures (prioritize those with more variance between measures)
    d. Check for additional considerations
5. If more NEBs are required following Step 4, repeat Step 4 process with the 'Less relevant NEBs'
6. If more NEBs are required following Step 5, repeat Step 4 process with the 'Not relevant NEBs'
7. For all selected NEBs, check for likelihood of significant variance across sub-sectors/segments (consider splitting by segment if significant variance is expected)

Using this screening process, we developed final lists of three to five NEBs for each sector to be included in the participant surveys, shown in the table below.

Table 2. NEBs Included in Participant Surveys, along with MROC relevance rating[9]

	Residential	Low-income	First Nation (Participant)	First Nation (Community)	Commercial	Institutional	Industrial	Agricultural
Reduced financial stress	**Top ranked**	**Top ranked**	**Top ranked**	**Top ranked**				
Improved thermal comfort	**Top ranked**	**Top ranked**	**Very relevant**		**Less/Not Relevant**	**Less/Not Relevant**		**Very relevant**
Reduced building & equipment O&M[10]	**Top ranked**				**Very relevant**	**Top ranked**	**Less/Not Relevant**	
Improved indoor air quality	**Very relevant**	**Top ranked**	**Very relevant**		**Top ranked**	**Less/Not Relevant**		**Very relevant**
Sense of control over energy decisions	**Very relevant**							
Improved lighting levels			**Very relevant**					
Education and capacity building				**Top ranked**				
Reduced reliance on fossil fuels				**Top ranked**				
Reduced spoilage					**Top ranked**			**Less/Not Relevant**
Improved business outcomes							**Top ranked**	**Top ranked**
Improved product quality							**Very relevant**	
Total NEBS in Participant Survey	5	3	4	3	4	3	3	4

[9] Appendix Section A2 - NEB Definitions includes definitions for all NEBs included in the participant survey.
[10] O&M stands for Operations & Maintenance.

2.2 – Participant Survey

Dunsky's market research partner, Ad Hoc Research, conducted telephone and online surveys with past program participants to determine the value of NEBs benefits that they realized by installing program measures. The surveys used two different types of questions to gauge non energy benefits:

- **Relative scaling[11]:** Relative scaling questions ask participants to state the value of an item of interest relative to some base. For this survey, we asked participants to state the value of each NEB relative to the annual electricity bill savings that they estimated *or* (if they could not estimate savings) their annual electricity bill.

- **Willingness-to-pay[12]:** Willingness-to-pay questions ask participants to assign the dollar value they would be willing to pay for the item of interest. In this case, we asked participants what they would be willing to pay for each relevant NEB.

All survey respondents were asked to value all NEBs (for their given sector) using both techniques. The data collected from these questions was used quantify the NEBs – a process described in greater detail in the following section.

The COVID-19 Pandemic

It should be noted that the survey was fielded during June 2020 amidst the COVID-19 pandemic. It is possible that this may have influenced how some survey respondents valued some NEBs. Possible impacts of the pandemic on survey results may include, among others:

- Higher than usual residential NEBs for the residential sector due to stay-at-home orders
- Underrepresentation of some commercial segments (e.g., restaurants) due to closures or other hurdles
- Lower or higher than usual NEBs for the commercial and institutional sectors due to underused office space, increased concerns about air quality due to COVID, etc.

[11] In a review of the application of non-energy benefits in cost-effectiveness tests, Skumatz et al. (2014) found relative scaling questions to be easiest for participants to understand, and to provide consistent responses. Relative scaling questions were recommended as a best practice for quantifying NEBs. This study is available at this link.

[12] In the same study by Skumatz et al. (2014), willingness-to-pay questions were found to benefit from the fact that they provide dollar values, requiring no interpretation to arrive at quantified values. They were found to be somewhat more confusing to participants and to provide more inconsistent or volatile responses than relative scaling questions, however. For this study, willingness-to-pay questions are included to provide another, secondary data point to quantify NEBs alongside the relative scaling questions.

2.3 – NEBs Quantification

2.3.1 – Participant NEBs Quantification

Using the survey responses from above, we took the total sector-level NEB value across all participants and divided it by the total gross savings values across all participants. This calculation was completed for each individual NEB using both Relative Scaling and Willingness to Pay NEB values. For example, for respondents of the residential sector survey we quantified 10 different NEB values (5 NEBs times two questioning techniques per NEB).

In some cases, participants responded either 'don't know' or valued a NEB at zero when asked to value a NEB using one valuation approach but provided a non-zero value when asked using the other valuation approach. These values were not considered to be true zeros – rather, they pointed to participants having difficulty responding to the question. To ensure the responses from these participants were considered, we calculated hybrid values (using the responses provided to the relative scaling question for some participants and the responses provided to the willingness-to-pay question for others). These hybrid values are more representative of the sample as they include all participants that responded to at least one of the two questions with a non-null value. We considered two approaches for determining hybrid values:

- **Hybrid, relative scaling priority** – in which we give priority to the relative-scaling response value given the preference for this approach in previous NEBs research[11]. In this approach, we only consider the willingness-to-pay if the participant did not answer the relative scaling question.

- **Hybrid, minimum approach –** in which we consider the lowest non-null response between the relative scaling and the willingness-to-pay questions.

All values included in the report, as based on the hybrid, minimum approach. While previous NEBs research has demonstrated a preference for relative scaling questions, we acknowledge the inherent challenges with estimating NEBs and that significant variability in NEB values (across different studies/jurisdictions) may hinder their use in cost effectiveness testing and/or their acceptance by stakeholders and decision-makers. As such we recommend using the Hybrid, Minimum Approach, which by design will provide the more conservative estimates of NEB values. In the Study Conclusions Chapter, we reiterate that this approach is likely underestimating the true value of NEBs and as such great care should be taken to avoid any further scaling or discounting of these NEB values. We also include the values calculated using the Hybrid, relative scaling priority approach in the appendix for reference.

It should also be noted that all NEBs quantified in this report reflect the value of the NEB across the surveyed sector population as a whole, not just among those who reported experiencing the particular NEB. Those survey respondents who reported that they had not experienced a given NEB were assumed to have valued the NEB as $0 and were included when calculating the overall value. The measures installed by participants included in the surveyed population are outlined in the Appendix and should be considered when applying NEBs or comparing them to findings from other jurisdictions.

As a final step we calculated the sector-level average value ($/kWh) for each NEB weighted by energy savings across all participants.

Alternative methodology for calculating sector-level average NEBs

Our primary method for calculating sector-level NEBs values ($/kWh) – as described above - was to calculate the sector-level NEB based on a weighted average of energy savings across all participants. This approach does not give equal weighting to all program participants, but rather to the total energy savings achieved in the programs.

An alternative approach was also considered, wherein we calculated the normalized NEB value ($/kWh) for each participant and then simply averaged that value across all participants. This approach gives equal weighting to all program participants, regardless of the volume of energy savings they achieved through program participation.

A comparison of results using both calculation methods is included in the Appendix. Given that the NEBs will be applied to each unit of energy savings in cost-effectiveness testing at the program level (and not to each program participant), our recommendation is to use the first approach (weighted averages based on savings).

If NEBs were to be applied on a participant-by-participant basis, values that were normalized by participant would be more appropriate. Broad application of the NEBs calculated in this study on a per participant basis is not recommended, however. We calculated the values at the sector-level according to the population-wide mix of measures installed. The mix of measures installed by any one participant are expected to vary from the mix of measures installed across the population, and therefore expected to result in different valuation of NEBs.

2.3.2 – Societal NEBs quantification (reduced air pollution)

As part of the review of NEBs, the study team assessed the benefits associated with reduced air pollution, and consequently avoided public health costs.

This assessment was completed in four steps:

1. Review the validity of the approach proposed in the Phase I Study
2. Update this value with the latest available data
3. Provide IESO staff with guidance on how to update this value going forward
4. Provide direction on how this value could be made more precise

Additional detail around these steps and the results of the assessment are provided in the Illness Cost of Air Pollution section.

Additional Societal NEBs

Only one societal NEB - the benefits of reduced air pollution discussed above – was quantified in the Study. This limited assessment of societal NEBs should not be interpreted as an indication that societal NEBs are inherently limited in scope or scale, but rather is a function of the primary focus for the Phase II study being participant NEBs. Other societal NEBs such as macroeconomic benefits (including jobs impacts) could be assessed through future research.

2.4 – Cost-Effectiveness Guideline Review

The IESO currently applies a 15% multiplier to benefits for two of the cost-benefit tests included in the IESO Conservation & Demand Management Energy Efficiency Cost Effectiveness Guide (the IESO CE Guide): the Total Resource Cost Test and the Societal Cost Test. The project team reviewed this practice and assessed practices in other jurisdictions to determine if it could be refined in light of the findings from the Phase II Study. The results of this review are included in the Cost-effectiveness Framework Recommendations section.

2.5 – Summary of data sources and uses

The table below summarizes the key data sources and uses for this study.

Table 3. Data Used in the Study

Data	Description	Uses in Study
Phase I 'In-Scope' NEBs	Based on the results of a jurisdictional scan, the Phase I Study identified a list of potential 'in-scope' NEBs to consider for future quantification research by IESO.	Primary source of NEBs for inclusion in expert MROC survey.
MROC survey Results	During the survey, experts prioritized the NEBs for further study and provided qualitative insights.	Results were used to identify the NEBs to include in the participant survey. Other qualitative sector-specific insights about the NEBs are highlighted throughout this report.
Program participation datasets	The IESO provided program participant datasets spanning the 2017-2019 period.	The datasets were used to develop the survey sample and the source of contact information for past program participants. The datasets also provided per participant program savings values (kWh) which were used to normalize the NEBs.
Participant survey results	Participant surveys were completed for all seven sectors in the study. The surveys asked past program participants to quantify any NEBs they had realized from installing measures through IESO-funded programs and to share qualitative information about their experience.	The per participant quantified NEBs values were combined to calculate sector-wide average values. The qualitative information provided by participants is included throughout the report and provides additional sector-specific context.

Data	Description	Uses in Study
Illness Cost of Air Pollution Data	Several data sources were used to calculate the societal value of air pollution NEB: 1) Public health valuation of air pollution in Ontario[13] 2) Proportion of air pollution attributable to power generation[14] 3) Total electricity generation in ON[15]	This data was combined to calculate the air pollution NEB value.

[13] Health Canada. (2019). Health impacts of air pollution in Canada. Available at **this link.**
[14] Environment and Climate Change Canada. (2018). Canada's Air Pollutant Emissions Inventory. Available at **this link**.
[15] Canada Energy Regulator. (2020). Canada's Energy Future 2020 Data Appendices. Available at **this link**.

3. RESEARCH FINDINGS

3.1 – Summary of findings: participant NEBs

Table 4 below presents the rankings and values of participant NEBs within each sector based on the hybrid minimum $/kWh valuation. Blank cells indicate that the NEB was not prioritized for a given sector during the Screening & Review phase of the study and therefore was excluded from participant surveys for that sector.

Table 4. Summary of Participant NEBs values and ranking by Sector ($ per gross first year kWh)

	Residential	Low-income	First Nation (Participant)	Commercial	Institutional	Industrial	Agricultural
Reduced financial stress	4 ($0.03)	1 ($0.09)	2 ($0.090)				
Thermal comfort	1 ($0.11)	2 ($0.08)	1 ($0.092)	2 ($0.05)	2 ($0.25)		2 ($0.003)
Reduced building & equipment O&M	5 ($0.02)			1 ($0.08)	3 ($0.11)	2 ($0.03)	
Improved indoor air quality	3 ($0.05)	3 ($0.02)	4 ($0.06)	3 ($0.007)	1 ($0.27)		3 ($0.002)
Sense of control over energy decisions	2 ($0.06)						
Improved lighting levels			3 ($0.08)				
Reduced spoilage				4 ($0.0002)			4 ($0.001)
Improved business outcomes						1 ($0.04)	1 ($0.09)
Improved product quality						3 ($0.01)	
Total (depends on specific measures)[16]	$0.05 - $0.27	$0.09 - $0.19	$0.09 – $0.32	$0.08 – $0.14	$0.11 - $0.63	$0.08	$0.09 - $0.10

As can be seen from the table above, some NEBs are valued highly across multiple sectors – notably thermal comfort, which ranked either first or second place for the majority of surveyed sectors. This indicates the broad market appeal of this NEB. There is considerable variation between sectors,

[16] Some NEBs are specific to certain measures (e.g. improved lighting levels). The total NEB value therefore depends on the measures offered within a given program.

however. This variation is in terms of a) NEBs identified as relevant to each sector (and therefore included in the participant survey), and b) NEBs rankings between sectors.

Marketing Insight

Thermal comfort was assigned high value across all sectors, indicating broad appeal of marketing campaigns focused on this NEB. Specific marketing messages will vary by the sector being targeted, but may highlight improved thermal comfort for participants and their families (for the residential, low income, and First Nation sectors) or for customers or employees (for the commercial, institutional, industrial, and agricultural sectors).

Each sector has a unique combination of NEBs, supporting the sector-specific granularity of this study. For example, among non-residential customers, the industrial and agricultural sectors include a different mix of NEBs compared to commercial and institutional – an interesting finding given that individual non-residential sectors have had very limited sector-specific NEBs research in the past. Even those sectors with a similar NEB mix (for example, commercial and institutional) show differences in their NEBs rankings: reduced operations and maintenance ranks first for the commercial sector, whereas it ranks third in the institutional sector. For those NEBs that are found across multiple sectors, there is also considerable variation in absolute NEBs values between sectors.

Potential driving factors behind the results in each sector are explored in greater detail below.

Understanding and interpreting NEB values

The NEB values shown in Table 4 must be considered in light of the NEB identification and assessment methodology set out in the previous chapter. Below we provide additional context for these NEB values based on the study scope and approach.

The values do not reflect all possible participant NEBs that can result from energy efficiency. The NEBs included in this study were limited to those resulting from the installation of specific measures by participants in IESO-funded energy efficiency programs over the 2017-2019 period. Energy performance building certifications, for example, have been shown to provide commercial property owners with notable NEBs such as market value improvements (sales price, rental income, lower vacancy rates) and green attractiveness (e.g. marketing/branding, employee attraction/retention). While the energy efficiency upgrades undertaken through the Save on Energy programs would likely support building certification, it is unlikely that survey participants would attribute the NEBs associated with building certification to the individual measures installed through IESO programs.

The values do not reflect all NEBs stemming from these specific IESO programs studied. To keep the participant surveys to an acceptable length, we limited the survey to 3-5 NEBs per sector. The MROC survey played a critical role in screening and prioritizing the most relevant NEBs for each sector.

The values for each NEB reflect the weighted average across the surveyed sector population as a whole, not just among those who reported experiencing the particular NEB. Those survey respondents who reported that they had not experienced a given NEB were assumed to have valued the NEB as $0 and were included when calculating the overall value. The measures installed by participants included in the surveyed population are outlined in the Appendix and should be considered when applying NEBs or comparing them to findings from other jurisdictions.

3.2 – Residential, Low-income and First Nation Sectors

This section summarizes qualitative insights and valuation results for the residential, low-income, and First Nation sectors.

3.2.1 – Experience with NEBs

The online participant survey included contextual questions focused on decision-making around measure installation, the experience of NEBs, and plans for future energy efficiency measure installation. The phone survey (used for the low-income and First Nation sectors) was a similar format to the online survey but with fewer contextual questions aimed at reducing survey time. As a result, only residential contextual responses were collected and are included below.

The results of these contextual questions for the residential sectors are summarized in the table below.

Table 5 Contextual questions summary – residential sector

Did NEBs contribute to decision to install measures?	Will you implement more measures in next 5 years?	More inclined to pursue additional EE measures because of NEBs experienced?	Equally inclined to pursue additional EE measures because of NEBs experienced?	Less inclined to pursue additional EE measures because of NEBs experienced?	Do not know	Grand Total
Yes	**Subtotal**	**41**	**35**	**7**	**13**	**96**
Yes	Yes	35	17	5	4	61
Yes	No	0	2	0	1	3
Yes	Do not know	6	16	2	8	32
No	**Subtotal**	**8**	**33**	**7**	**8**	**56**
No	Yes	6	12	1	4	23
No	No	0	4	4	0	8
No	Do not know	2	17	2	4	25
Do not know	**Subtotal**	**6**	**8**	**3**	**9**	**26**
Do not know	Yes	4	2	1	2	9
Do not know	No	0	1	2	0	3
Do not know	Do not know	2	5	0	7	14
	Grand Total	**55**	**76**	**17**	**30**	**178**

Key takeaways from this analysis include:

- **NEBs are supporting residential energy efficiency decision making.** More than half of respondents (53%, 96/178) indicated that NEBs were part of their decision-making process to participate in the Save on Energy program and install energy efficiency measures.

- **Participants that factored NEBs into their decision making in the past program are more likely than those who didn't to pursue additional EE measures in the next 5 years** (see Figure 3). 63% (61/96) of participants that factored NEBs into their decision making intend to implement more EE measures in the next five years compared to 41% (23/56) of those that did not consider NEBs and 35% (9/26) who were unsure.

- **Including NEBs in decision making, combined with experience of NEBs in recent project(s), maximise the likelihood of future upgrades** (see Figure 4). Among the participants

that did NOT factor NEBs into their decision making (answered No), only 14% (8/56) indicated that they would be more likely to pursue additional EE measures because of the NEBs experienced. While this number increases to 23% (6/26) of those that were unsure if they had taken NEBs into account, it is still significantly less than the 43% (41/96) of participants that already considered NEBs in decision making indicating that they are now more likely to pursue additional EE measures as a result of their NEBs experience.

- **Participants' experiences with NEBs appear to have a neutral to positive impact on future energy efficiency decisions** (see Figure 4). Among those respondents that did NOT factor NEBs into their original decision making, their experience with NEBs appears to have a neutral impact on their future intentions regarding energy efficiency upgrades. Nearly 60% of these respondents (33/56) indicated that they were equally likely (no change) to undertake upgrades in the future after their experience with NEBs. While 14% (8/56) did indicate that they would be more likely to undertake additional upgrades, this is offset by nearly the same amount (13%, 7/56) indicating that they would be less likely to pursue additional upgrades. In the two other categories of respondents, however, participants' experience with NEBs does appear to have a positive net impact on future upgrade intentions. Among those participants that considered NEBs as part of their original decision making, over 42% were more likely to pursue additional upgrades compared to only 7% that indicated they were less likely going forward. Among the share of respondents that were unsure ("I don't know") whether NEBs were a factor in their original decision making, nearly twice as many respondents indicated that they were more likely (23%) than less likely (12%) to pursue additional energy efficiency upgrades based on their actual experience with NEBs.

Figure 3. Intention to implement more measures in next 5 years, by previous NEBs consideration (residential sector)

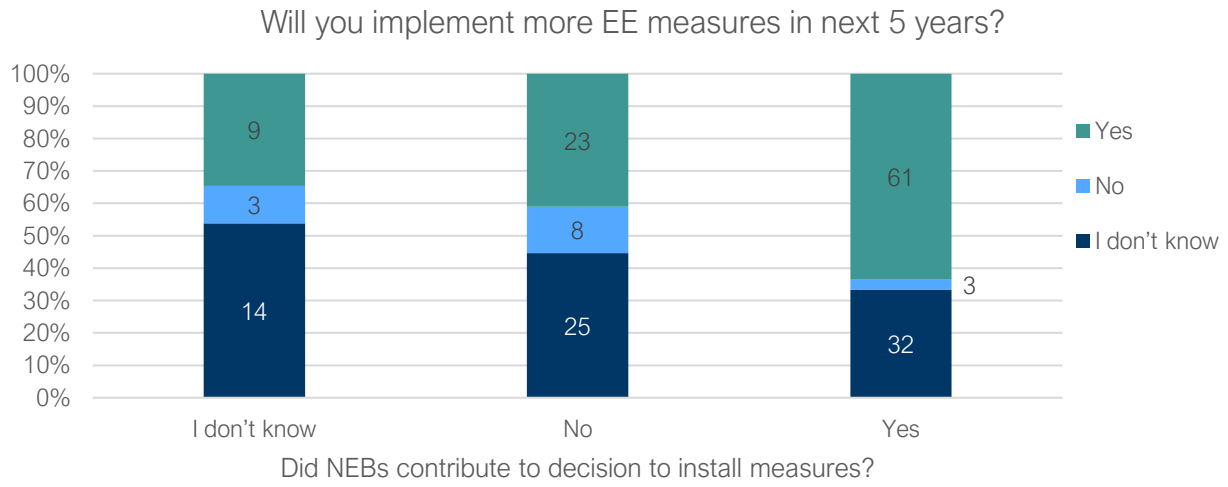
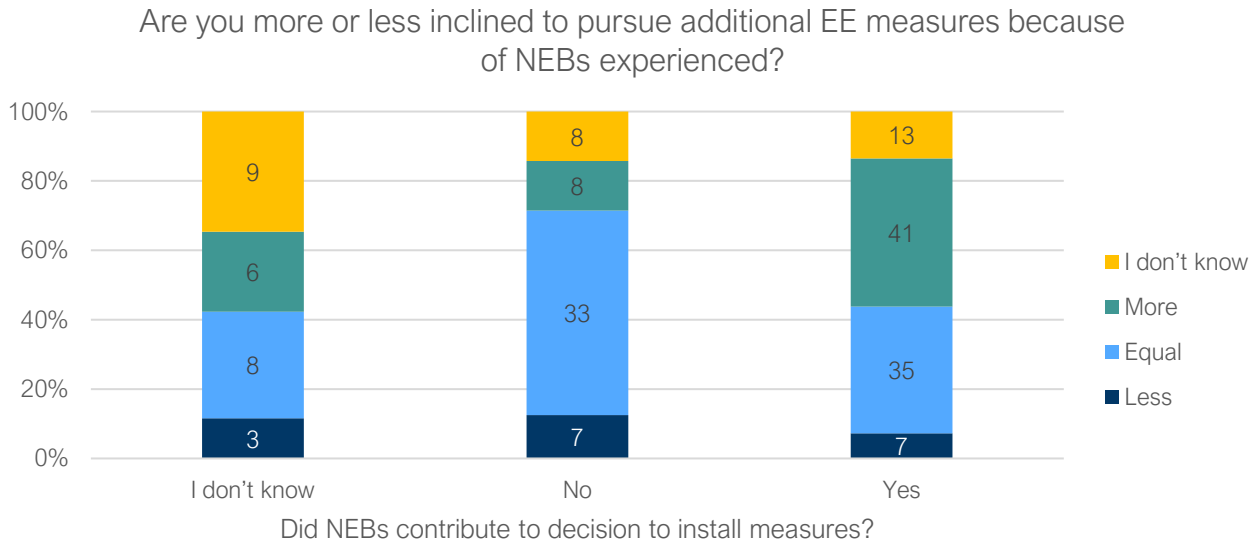


Figure 4. Impact of experience with NEBs on likelihood of future EE activities, by previous NEBs consideration (residential sector)



3.2.2 – Quantified Values

Below, Table 6 includes quantified NEBs values for the residential, low-income, and First Nation sectors. The table includes values on both a $/participant and $/kWh basis. Some NEBs only arise from the installation of specific measure types. In these cases, the applicable measures are indicated alongside the NEB.

Table 6. Quantified Residential, Low-income, and First Nation NEBs

	Applicable Measures	Residential Annual $/Participant	Residential $/kWh	Low-income Annual $/Participant	Low-income $/kWh	First Nation Annual $/Participant	First Nation $/kWh
Reduced financial stress	**All**	$72	$0.03	$131	$0.09	$209	$0.090
Thermal comfort	**HVAC, envelope**	$292	$0.11	$115	$0.08	$214	$0.092
Reduced building & equipment O&M	**All**	$57	$0.02				
Improved indoor air quality	**HVAC, envelope**	$127	$0.05	$36	$0.02	$128	$0.06

	Applicable Measures	Residential Annual $/Participant	Residential $/kWh	Low-income Annual $/Participant	Low-income $/kWh	First Nation Annual $/Participant	First Nation $/kWh
Sense of control over energy decisions	**Control equipment**	$171	$0.06				
Improved lighting levels	**Lighting**					$178	$0.08
Total (depends on specific measures)		$129 - $719	$0.05 - $0.27	$131 - $282	$0.09 - $0.19	$209 - $729	$0.09 – $0.32

Insights from the MROC survey are included alongside the analysis of these quantified values below.

Reduced Financial Stress

Low-Income and First Nation participants assigned higher value to the reduced financial stress NEB than the residential sector. A few experts who participated in the MROC survey noted that NEBs related to reducing financial burden were expected to be valued highly among low-income and First Nation participants, matching the survey results. Experts in the low-income sector noted that reducing bills can help low-income populations to meet other basic needs and ultimately reduce psychological and social challenges.

> "Disconnections are often a step towards homelessness for many, [which has] impacts on the person and the social systems affected, so reducing the financial burden is key."
>
> *- Expert in the low-income sector*

Experts in the MROC survey expected that reduced financial stress would be the most important NEB among residential participants. They also noted that they considered this NEB to be the key driver for most if not all homeowners to participate in programs. These results do not reflect this expectation, with residential respondents assigning less value to reduced financial stress than some of the other NEBs included in the survey – notably thermal comfort, a sense of control over energy decisions, and improved indoor air quality. We cannot definitively conclude, however, that the Expert panel was incorrect in their views on the importance of financial stress as primary motivator. It is possible that the discrepancy is a reflection of the difference between pre-participation motivations and post-participation experience. In some cases, participants may have one set of expectations (motivations) going into the program, but may realize a set of benefits which includes one(s) which had not been anticipated.

Marketing Insight

Reduced financial stress was found to be a critical NEB for the low income and First Nation sectors. Not only was it assigned a high value, it was also experienced by a large portion of those surveyed. 42% of low income respondents reported experiencing this NEB along with 62% of First Nations respondents. Given this context, marketing that makes a direct connection between energy efficiency and bill reductions – especially for deeper saving measures – is expected to be persuasive to many potential participants from these sectors.

For those under financial duress, bills are a monthly reminder of limited financial resources and – for some – bill payment may require financial sacrifices elsewhere. Campaigns may call attention to the fact that less money spent on bills thanks to energy efficiency means more money for life's other priorities.

Thermal Comfort

Thermal comfort was valued highly across all three sectors. Low-income sector experts noted the direct impact of this NEB on health and observed that improved thermal comfort can also provide psychological and social benefits by relieving participants from the constant reminder of inadequate housing. Across all sectors, experts noted that this NEB is especially relevant to Canada given the extreme weather fluctuations that can be seen across seasons, pointing out that participants have an expectation that their home can provide shelter against a range of weather conditions.

Reduced Building & Equipment Operations & Maintenance

Based on feedback gathered during the MROC survey, this NEB was only included in the residential survey. Although valued less than most other NEBs included in the survey, and therefore perhaps less well suited to program marketing, it should be noted that reduced building & equipment O&M does still offer considerable value from the perspective of cost-effectiveness testing.

Improved Indoor Air Quality

MROC survey experts noted that poor indoor air quality can result in a cold, damp environment which can lead to problems (e.g., molds) that contribute to poor physical and mental health. They also noted that indoor air quality may be especially top-of-mind in light of increased focus on COVID-19 and other air-borne diseases.

Air quality was given the highest value by respondents from the First Nation sector. Experts had noted the need for improvements to First Nation housing, pointing to opportunities for programs to focus on deeper savings measures including insulation, air sealing, and heating system upgrades.

> "First Nation communities have an unfortunate history of homes built with poor workmanship not to code that has resulted in rapid deterioration of the housing stock. Including energy efficiency in new construction and renovation moving forward can stop this trend."
>
> *- Expert in the First Nation sector*

Sense of Control over Energy Decisions

Based on feedback gathered during the MROC survey, the sense of control over energy decisions NEB was only included in residential participant surveys. This NEB was described to participants as "better control of energy-using devices (through thermostats, lighting controls, etc.)". The prevalence of thermostats installed by residential participants could explain the importance of this NEB among respondents, as the second highest value NEB in that sector.

Marketing Insight

Two of the top-valued residential sector NEBs focused on improving comfort and air quality. Messages that emphasize that efficiency can keep homes cooler in the summer, warmer in the winter, and with improved air quality throughout the year are expected to be interesting to potential residential participants.

Upgrades may provide these benefits passively (e.g. through improved insulation) or actively (e.g. through thermostats and other control devices). Given that residential participants placed high value on having control over energy decisions, marketing could show how control devices empower homeowners to proactively managing their home's environment (and by extension the comfort and health of themselves and those that they love).

Improved Lighting Levels

Improved lighting levels was only included in the First Nation sector. Experts noted that this NEB can improve comfort in the home while also impacting health and safety.

3.2.3 – First Nation Community Survey

The First Nation community surveys included in-depth interviews with five participants. All participants had been involved in the administration and/or implementation of energy efficiency activities in First Nation communities. Most were community members, but some were efficiency program implementers who had worked across several communities. The surveys gathered contextual information about the communities' electricity source (off-grid vs. grid connected), heating system fuels, and types of energy efficiency activities completed.

The NEBs included in the First Nation community surveys were:

1. Education and capacity building
2. Reduced financial stress
3. Reduced reliance on fossil fuels

Education and capacity building was selected as the most valuable NEB across all five interviews. This aligns with MROC survey experts who noted that community participation can enhance

the willingness of community members to participate in programs and increase community satisfaction with the experience. One expert emphasized that education and capacity building represent the NEB with the longest-term return on investment potential and recommended that programs equip First Nation communities to develop, design, and implement energy conservation measures without having to rely on expensive outside resources.

Capacity Building in Action

One survey respondent had worked on projects across several communities. For some projects, they were able to hire community helpers to assist the assessment and measure installation crews. They reported that this experience not only offered learning opportunities for community members, but also added local revenue and gave homeowners a sense of comfort when crews were entering their homes.

In other cases, community members were hired as canvassers to sign up program participants and help them through applications, which seen as very was helpful.

This example highlights how including community members in projects not only increases community energy efficiency capacity and knowledge but may also increase community buy-in and participation.

Experts in the MROC survey expressed that sustainability is a core value for many First Nation communities and that energy efficiency programs that are environmentally responsible will consequently be of higher interest. This includes programs that reduce reliance on fossil fuels, which was the second NEB included in the community surveys. Given that most measures installed in the communities did not reduce fossil fuel use associated with heating systems (but instead were primarily focused on lighting and appliance upgrades) and that most of the communities interviewed were grid-connected (and therefore did not reduce diesel used for generation), interviewees noted limited impacts of efficient programs on fossil fuel consumption. This NEB is expected to be more relevant in communities that are not grid connected and who use diesel to generate electricity given the considerable financial and logistical impactions associated with transporting fuel oil to remote First Nation communities.

Finally, interviewees did report some reduction in financial stress among community members who had participated although did not note large decreases in bills. One individual who had worked in other jurisdictions pointed out envelope measures can lead to more noticeable bill savings, pointing to the potential for this NEB to be increasingly important if more emphasis is placed on deeper saving measures in the future.

Marketing Insight

Marketing that draws a direct connection between efficiency program participation and community capacity building is expected to be successful in all types of on-reserve First Nation communities. Messages can focus on benefits to individual community members, such as valuable work experience

conducting energy audits or completing upgrades. They may also highlight benefits to the community overall, such as reduced reliance on external contractors to improve community housing stock efficiency.

3.3 – Non-Residential Sectors

This section summarizes qualitative insights and valuation results for the commercial, institutional, industrial, and agricultural sectors.

3.3.1 – Experience of NEBs

Non-residential participants were surveyed through either online or phone surveys. The online participant survey included contextual questions focused on decision-making around measure installation, the experience of NEBs, and plans for future energy efficiency measure installation. The results are summarized below.

Table 7. Contextual questions summary, non-residential sectors

Did NEBs Contribute to decision to install measures?	Will you implement more measures in next 5 years?	More inclined to pursue additional EE measured because of NEBs experienced	Equally inclined to pursue additional EE measured because of NEBs experienced	Less inclined to pursue additional EE measured because of NEBs experienced	Do not know	Grand Total
Yes	**Subtotal**	**58**	**62**	**6**	**8**	**134**
Yes	Yes	43	36	2	2	83
Yes	No	0	1	3	2	6
Yes	Do not know	15	25	1	4	45
No	**Subtotal**	**16**	**19**	**9**	**9**	**53**
No	Yes	10	15	2	2	29
No	No	0	0	3	0	3
No	Do not know	6	4	4	7	21
Don't know	**Subtotal**	**4**	**8**	**2**	**8**	**22**
Don't know	Yes	3	3	0	1	7
Don't know	No	0	0	0	0	0
Don't know	Do not know	1	5	2	7	15
	Grand Total	**78**	**89**	**17**	**25**	**209**

Key takeaways from this analysis include:

- **NEBs are supporting non-residential energy efficiency decision making.** Nearly two-thirds of respondents (64%) indicated that NEBs were part of their decision-making for participating in the Save on Energy program and installing energy efficiency measures.

- **Participants that factored NEBs into their decision making in the past program are slightly more likely to pursue additional EE measures in the next 5 years** (see Figure 5). 62% (83/134) of participants that factored NEBs into their decision making intend to implement more EE measures in the next five years compared to 55% (29/53) of those that did not consider NEBs and 32% (7/22) who were unsure.

- **Experience with NEBs is most likely to increase the likelihood of future energy efficiency upgrades among populations that were already considering NEBs in their decision making** (see Figure 6). 43% of non-residential participants that factored NEBs into their decision making indicated that they would be more inclined to pursue additional upgrades based on their NEBs experience, compared to only 30% of respondents that did NOT take NEBs into account.

- **Participants' experiences with NEBs have a net positive impact on future energy efficiency decisions.** Table 7 shows that, overall, 37% (78/209) of non-residential respondents indicated that they were more inclined to pursue additional efficiency upgrades based on their NEBs experience, while 8% (17/209) suggested that the experience had left them less inclined for future upgrades. This suggests an overall net positive impact from NEBs on future energy efficiency decisions. If we cross tabulate these results with participants' consideration of NEBs in their initial decision making (see Figure 6), we see that in all cases a greater percentage of participants are more inclined versus less inclined to pursue additional efficiency upgrades based on their experience with NEBs, regardless of whether NEBs were included in original decision making.

Figure 5. Intention to implement more measures in next 5 years, by previous NEBs consideration (non-residential sectors)

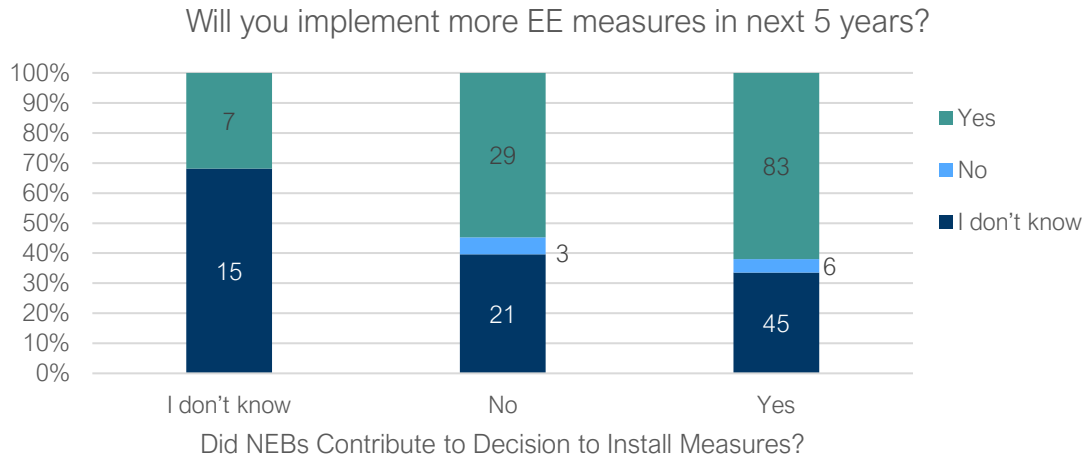
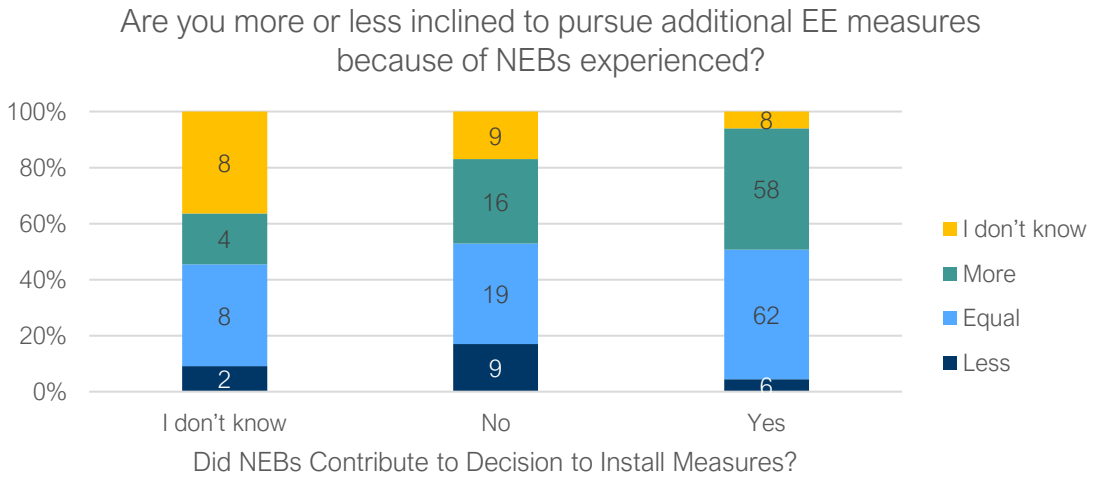


Figure 6. Impact of experience with NEBs on likelihood of future EE activities, by previous NEBs consideration (non-residential sectors)



The findings above are for all non-residential sectors combined, enabling a simple comparison with the residential sector results discussed earlier. While a larger share of the non-residential segment reported considering NEBs in decision-making than in the residential segment (64% vs 53%), the impact of that previous decision making on future efficiency plans appears dampened in the non-residential sector (see Figure 4 vs Figure 6).

Below we present some additional findings at the individual sector level.

Figure 7. Previous consideration of NEBs in decision-making, by non-residential sector

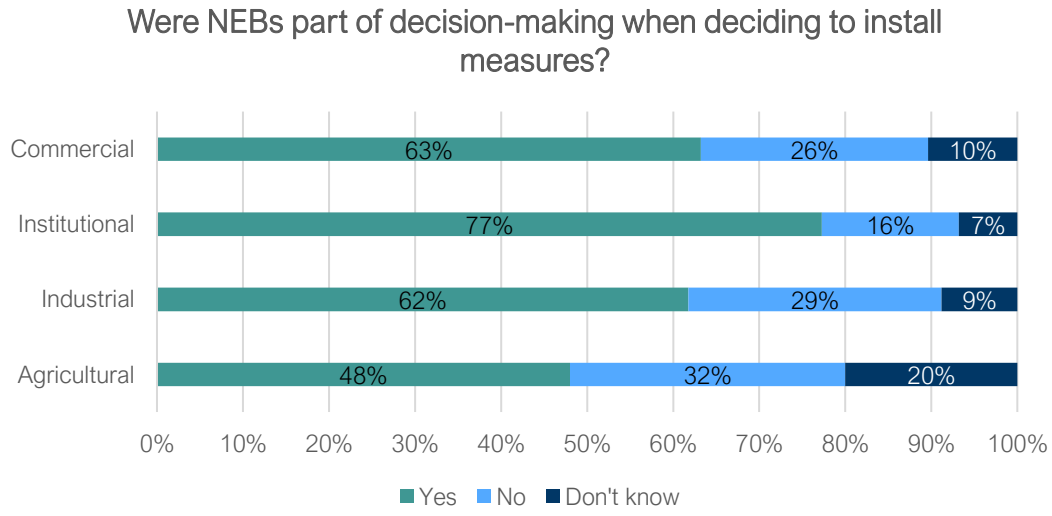


Figure 8. Impact of NEBs experience on future efficiency upgrades, by non-residential sector

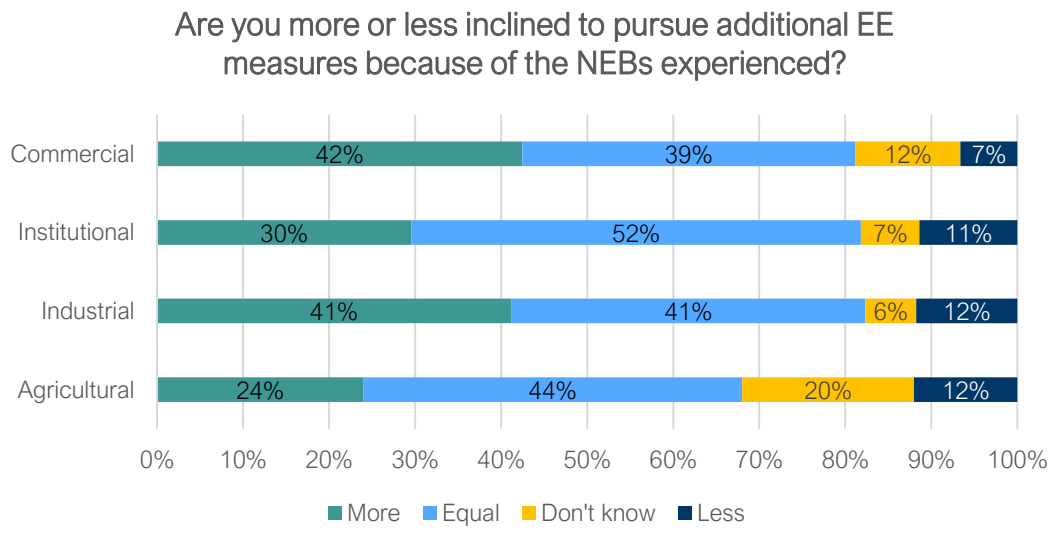
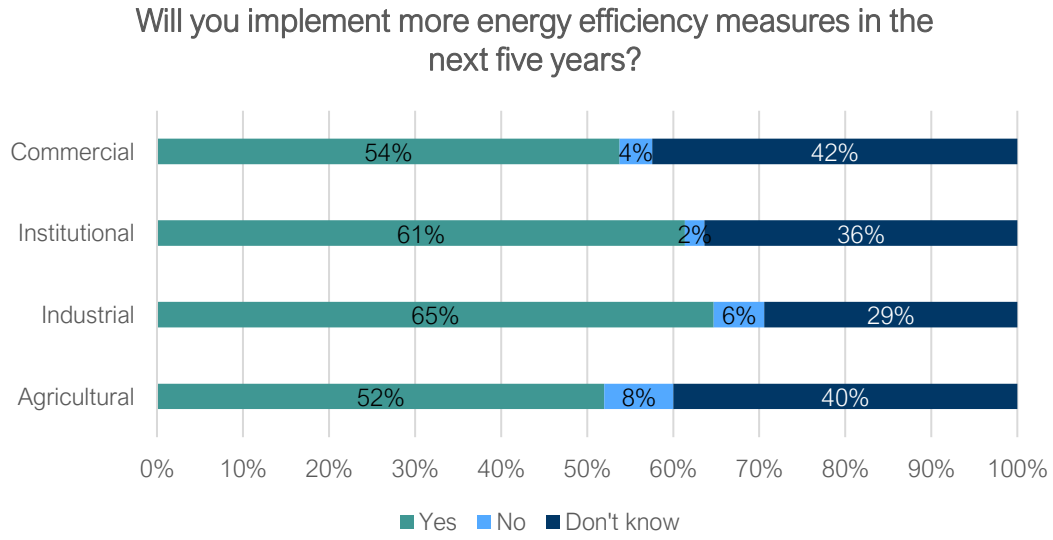


Figure 9. Intention regarding additional efficiency upgrades, by non-residential sector



The majority of commercial, institutional, and industrial surveyed participants reported that they had considered NEBs when deciding to install measures. The remaining portion of the market that responded either 'No' or 'Don't know' indicates further opportunity for marketing the value of NEBs to potential participants.

Of respondents, 68-82% (varying by sector) noted that they were either more or equally inclined to pursue additional measures due to their experience of NEBs. This indicates that the NEBs they experienced were either in-line with their expectations (in the case of 'equally inclined') or exceeded their expectations (in the case of 'more'). The considerable portion the market that did not consider NEBs when installing measures

points to a role for marketing and communications to emphasize NEBs, which may help to capture the portion of the market that is undecided about implementing additional efficiency measures in next five years (29-42%, varying by sector).

3.3.2 – Quantified Values

Below, quantified NEBs values are provided for the commercial, institutional, industrial, and agricultural sectors on a $/kWh basis. Some NEBs only arise from the installation of specific measure types. In these cases, the applicable measures are indicated alongside the NEB.

Table 8. Quantified Commercial, Institutional, Industrial, and Agricultural NEBs

	Applicable Measures	Commercial ($/kWh)	Institutional ($/kWh)	Industrial ($/kWh)	Agricultural ($/kWh)
Thermal comfort	HVAC, envelope	$0.05	$0.25		$0.003[10]
Reduced building & equipment O&M	All	$0.08	$0.11	$0.03	
Improved indoor air quality	HVAC, envelope	$0.007	$0.27		$0.002[17]
Reduced spoilage	HVAC, refrigeration	$0.0002			$0.001
Improved business outcomes (productivity, competitiveness, investment)	All			$0.03	$0.09
Improved product quality	All			$0.01	
Total (depends on specific measures)		$0.08 – $0.14	$0.11 - $0.63	$0.08	$0.09 - $0.10

Overall Value by Sector

Reviewing the sectors individually, the institutional sector has the highest average NEB value. This was followed by the industrial, then the agricultural sectors, while the commercial sector shows the lowest average NEB value. The top measures installed are similar across sectors – lighting projects are most common, followed by some combination of lighting controls, variable-speed drives, HVAC upgrades, and compressed air measures. The agricultural sector also includes a number of sector-specific measures (for example, low energy livestock waterers and dairy plate coolers).

The high value of NEBs reported by institutional and industrial customers point to the alignment of NEBs with core sector goals. For the institutional sector these goals include patient or inhabitant health and comfort along with efficient use of taxpayer funds. For the industrial sector these goals include

[17] Reflects value for humans (rather than livestock)

competitiveness, productivity, and quality. For both sectors, high average NEB values indicate the value of NEBs in marketing programs to customers.

Reduced Spoilage

Based on feedback gathered during the MROC survey, reduced spoilage was only included in the commercial and agricultural surveys. In both sectors, spoilage is directly linked to revenue of the business. For the commercial sector, experts in the MROC survey pointed out reduced spoilage is also appealing from a wider life-cycle benefits and environmental impact perspective (which is increasingly a motivator for customers in food-related industries). Reduced spoilage has a low value compared to the other non-residential NEBs. Because this NEB is specific to sub-sectors that use or sell perishable goods, it only applies to small subset of participants, resulting in a low valuation when averaged across the entire population.

Indoor Air Quality

Indoor air quality was valued most among institutional and commercial sectors but was also assigned some value by agricultural participants. Experts note that air quality is increasingly relevant during COVID-19, and that improving indoor air quality directly impacts health and safety of employees, tenants and visitors and can provide a competitive advantage in an era when sanitation is a top concern.

Thermal Comfort

Thermal comfort was valued the highest by institutional sector participants and second highest by commercial participants. In both sectors, it is linked to the overall satisfaction, productivity, and health of customers, tenants, patients, and employees.

Marketing Insight

The results of this survey highlight the priority that institutional customers place on the health and comfort of their employees and the people they serve.

Although improved thermal comfort and air quality were not experienced by all institutional respondents (with 26% having reported thermal comfort improvements and 15% air quality improvements)[18], the portion of the population who did experience these NEBs – as a result of having installed relevant measures – assigned them a great deal of value.

Marketing messages that link measure installation with the ability to improve indoor environments – both through thermal comfort and improved indoor air quality – are expected to be persuasive to potential participants. Targeting these messages at institutional audiences where comfort and health are top priorities (e.g. schools and hospitals) is expected to have the greatest impact.

[18] Additional survey results, including the frequency with which each NEB was reported, are included in appendix section A.2, Participant Survey Results.

Reduced Building and Equipment Operations & Maintenance (O&M)

The reduced building and equipment Operations & Maintenance (O&M) NEB was valued highly by commercial, institutional, and industrial sectors. For the industrial sector, experts noted that the appeal of this NEB is mostly in association with improved equipment reliability, pointing out that enhanced up-time and reduced service disruption can lead to higher productivity and competitiveness.

> "Current incentive structures for large industrials incent them to power down during system peaks. Energy efficiency measures, including on-site generation and storage, could reduce the need for them to interrupt their productivity."
>
> *- Expert in the industrial sector*

For institutional participants, experts noted that decreases in maintenance costs allow for more efficient use of public funds. This is appealing given that institutions that depend on public funding often need to compete for public dollars and demonstrate responsible spending. In addition, energy efficiency programs can also help address deferred maintenance backlog which may be a challenge for some institutional facilities.

In the commercial sector, experts pointed out that reduced O&M not only saves on cost – a key concern for commercial customers – but can also free up maintenance staff time to focus on running buildings and improving services.

Marketing Insight

Although the value of efficiency may be intangible to some customers, all will understand the very real benefits that can come from additional staff time, a benefit reported by 86% of commercial survey respondents, 95% of institutional survey respondents, and 57% of industrial respondents[19].

Marketing messages targeted at the commercial, institutional, and industrial sectors can highlight how program participation can reduce time spent on O&M (for example, by reducing the frequency of lightbulbs switch-outs) and free up staff to focus on core business or institutional priorities.

Marketing can highlight the direct link between program participation and additional resource capacity and/or reductions in spending, benefits which can be reported back to shareholders or funding organizations.

[19] Additional survey results, including the frequency with which each NEB was reported, are included in appendix section A.2, Participant Survey Results.

Improved Business Outcomes

The improved business outcomes NEB was included in the industrial and agricultural sector surveys. Both sectors compete globally, resulting in increased business pressure and competitiveness as a key focus of customers.

> "For global firms, [productivity] is the needed metric to maintain investment and production in these firms. It's also how Canadian firms competing globally can have competitive prices and growing sales."
>
> *- Expert in the industrial sector*

The industrial sector valued improved business outcomes above all other NEBs. Experts in the industrial sector noted that profits resulting from increasing productivity/throughput are considered the most relevant to participants (above operational savings, for example). Closely tied to competitiveness, increases in productivity contribute to core strategic industrial business objectives, attracting investors and generating more profit. Increased productivity may also lead to benefits relevant to policy objectives – notably higher wages and economic growth. Experts pointed out that industrial customers will not be interested in participating in an energy efficiency program that does not improve their competitiveness in one way or another, pointing to an opportunity for program marketing to directly make these links for prospective participants.

Experts in the agriculture sector note that agricultural producers in Ontario compete with worldwide producers and consequently improving competitiveness is crucial to business survival. They also note that this NEB has a larger impact on the general economy and food security, which is of particular interest from a policy perspective.

Marketing Insight

Given the competitive environment that industrial and agricultural customers operate within, program benefits should be framed within their ability to improve business outcomes.

Messages can highlight how efficiency will reduce the cost of meeting current and projected environmental regulations in Canada and abroad. They may also connect the dots between setting and achieving corporate sustainability targets and attracting customers and investors, many of whom are increasingly climate-aware.

The most persuasive messages will be tailored to the specific challenges faced by different sub-sectors – from improving health and safety to reducing greenhouse gas emissions – and the ways in which efficiency measures can help to relieve these challenges.

Improved Product Quality

Product quality was only included in the industrial sector surveys. Although some industrial participants valued it to a lesser degree than other industrial NEBs, it was still assigned a substantial benefit. Along with

business competitiveness, product quality represents another metric that can directly impact bottom lines and attract investors.

> "Increased business competitiveness improves the enterprises' bottom line, allows it to export products to other markets, expand operations and provide food security"
>
> *- Expert in the agricultural sector*

Ontario-Specificity

Experts in the MROC survey pointed to several factors that could drive Ontario-specificity of NEBs values. Climate was highlighted as a key difference – notably the relatively cold temperatures (compared to jurisdictions to the south) as well as strong seasonal temperature swings in (compared more moderate climate like the Maritime provinces). This points to increased importance and challenge of maintaining comfort year-round. With respect to agriculture, experts also noted that Ontario agricultural producers must 'house' some operations (e.g. greenhouses, livestock) due to the climate, leading to increased energy intensity of operations.

Subsector Specificity

Although the valuation results were not calculated at the subsector level, experts in the MROC surveys did point out the potential for some sub-sector specificity, which could benefit from increasingly granular analysis in the future. Key NEBs and subsectors of note are listed here:

- **Reduced spoilage** is likely to be a focus of commercial facilities involved in food production, processing, and storage such as food service and grocery stores, but unlikely to be as relevant for other types of commercial buildings.

- **Business competitiveness and productivity** may be more important for trade-exposed, energy-intensive sectors than those with relatively lower energy costs or those that are less exposed to global trade competition. One expert in the MROC survey suggested that some industries like pulp and paper are functioning successfully and do not have much need to invest in other energy efficiency equipment, whereas auto and steel manufacturing companies – for whom reductions in energy costs or making energy costs more predictable are key priorities – could be more interested in participating in energy efficiency programs.

- There is considerable variation in the types of buildings used and energy use profiles within the **agricultural sector,** including greenhouses, livestock operations, and field crop farming, which may result in varying NEBs valuations.

It should be noted that one expert suggested that the size of company and other factors may influence NEB valuations more than specific subsectors.

3.4 – Illness Cost of Air Pollution

As outlined in the methodology section, the calculation and review of the illness cost of air pollution was completed in four steps:

1. **Review the validity of the approach proposed in the Phase 1 Study,**
2. **Update this value with the latest available data,**
3. **Provide IESO staff with guidance on how to update this value going forward, and**
4. **Provide direction on how this value could be made more precise.**

These steps, including relevant outcomes, are included below.

1. Review validity of the approach proposed in the Phase 1 Study

As noted in the Phase I Study (Apr 2018), the health and human life-related costs of air pollution and emissions from electricity production are key societal NEBs.

The project team reviewed the recommended methodology from that report and agree that it is a simple and effective way of allocating the avoided healthcare costs from reduced air pollution. The team recommends updating the public health valuation of air pollution from a 2008 Canadian Medical Association (CMA) report using the Illness Cost of Air Pollution (ICAP) model[20] to a 2019 value by Health Canada using the Air Quality Benefits Assessment Tool (AQBAT) model.[21] For other variables, the team recommends retaining the same sources (all public and regularly updated) but using the latest values available. The methodology and sources are displayed below.

Calculation Methodology

$$A = ((B * C))/D$$

Where:

Variable	Description	Units	Source
A	Air Quality NEB Adder	$/kWh	Calculated
B	Public health valuation of air pollution	2020$	Health Canada, 2019[21]
C	Proportion of air pollution attributable to power generation	%	Canada's Air Pollutant Emissions Inventory (CAPEI), Environment and Climate Change Canada
D	Total electricity generation in ON	TWh	Canada's Energy Future 2020, Canada Energy Regulator (CER)

2. Update this value with the latest available data

The project team updated the value of the adder based on a major update to the public health valuation of air pollution (changing source from CMA to Health Canada) and some minor updates to

[20] Canadian Medical Association, 2008, No Breathing Room, Available at **this link**
[21] Health Canada, 2019, Health impacts of air pollution in Canada. Available at **this link**

other variables (refreshing to latest data available). See below for the updated values and a comparison of those recommended in Phase 1.

Variable	Phase I (DNV 2018) Value	Phase I (DNV 2018) Source	Phase II (Dunsky 2021) Value	Phase II (Dunsky 2021) Source	Comments
Public health valuation of air pollution in Ontario	$4.3B (2006$)	CMA (ICAP)	$56.7B (2020$)	Health Canada (AQBAT)	Significant increase – see below for explanation.
Proportion of air pollution attributable to power generation	0.1%	CAPEI	0.1%	CAPEI	No change in source or value (updated with 2018 values)
Total electricity generation in ON	137 TWh	CER (2015)	144 TWh	CER (2020)	
Air Quality NEB Adder	$0.0000317 /kWh	Calculated	$0.0004002 /kWh	Calculated	The updated value is ~10x higher

The overall NEB adder under the Phase II methodology is significantly higher than the Phase I estimate; this is driven by methodological differences between the ICAP and AQBAT models. The two models have a similar approach based on pollutant concentrations, concentration-response functions (CRFs), reference rates for the different health efforts, the exposed population and the economic valuation of these effects. There are many methodological improvements and updated data sources that makes the Health Canada valuation incrementally more accurate than the previous CMA estimate, including updated population counts, more granular pollutant data and CRFs reflecting the latest research. However, these updates alone would not be expected to cause a divergence on this scale: two key factors drive the order-of-magnitude difference.

- The CMA modelling only considered *acute* exposure deaths, and excluded *chronic* exposure-related deaths, which are around 8 times higher.[22] This was a deliberate choice and is footnoted as such in the CMA report; Health Canada's modelling including both acute and chronic exposure-related deaths, with a consequently higher and more complete valuation.

- ICAP's valuation of each death is around $3M based on a variety of approaches, whereas Health Canada uses a value of around $7M, based on the full socioeconomic costs of the disease (willingness-to-pay). This updated approach is also used by the US EPA and the WHO.

3. Provide IESO staff with guidance on how to update this value going forward

All of the input values are publicly sourced and updated regularly. The accompanying Excel sheet provides a calculator with the ability to update input values as they are published. The project team recommends reviewing the calculation methodology and using the latest data whenever an updated Health Canada report is published; based on the most recent reports (2019 and 2017), this is roughly every two years. This approach would be aligned with the cadence of the IESO's CDM planning (initial planning and mid-point evaluation and adjustments). Health Canada has also indicated that they have analysis underway on the Electricity Generation sector specifically: we recommend reviewing these estimates when published to consider if they align with current values. Though the emissions and electricity generation data are updated more frequently (annually), these are likely to only be small incremental changes and therefore it would be reasonable to only update when updated public health valuations are available. Our recommendation and sources are summarized in the below table.

Variable	Source	Update frequency
Air Quality NEB Adder	Calculated	**Recommendation**: every two years (aligned with mid-point CDM plan update)
Public health valuation of air pollution	**Health Canada 2019**	Varies; roughly every 2 years to date.
Proportion of air pollution attributable to power generation	**Canada's Air Pollutant Emissions Inventory, Environment and Climate Change Canada**	Annually
Total electricity generation in ON	**Canada's Energy Future 2020, Canada Energy Regulator**	Annually
Inflation	Ontario-specific inflation, retrieved from **ON CPI Inflation Calculator (2015-2020)**	Monthly

4. Provide direction on how this value could be made more precise

There are several ways this value could be made more precise, which are discussed below.

- **Break down healthcare costs by pollutant, and allocate those by the proportion emitted by Ontario's power sector.**

The current methodology allocates increase healthcare costs from emissions of fine particulate matter (PM2.5), O_3 and NO_2 using the proportion of PM2.5 emissions attributable to the power generation sector, as PM2.5 is responsible for the majority (67%) of the healthcare costs. To increase precision for this allocation, the healthcare costs per pollutant could be allocated based on the proportion *of each pollutant* attributable to the power generation sector. Canada's air emissions inventory does not currently report O_3 emissions[23], and NO_X is reported rather than NO_2, so we have retained the PM2.5 allocation approach as recommended by DNV-GL.

[23] Though O_3 emissions are not explicitly reported, **Environment and Climate Change Canada** has noted that *"NO_X (such as nitrogen dioxide [NO_2]) and VOCs are the main contributors to the formation of O_3"*

- **Consider the geographical boundaries of specific pollutants as emitted from power sector infrastructure, and the impact on local communities.**

The Phase II methodology allocates the province-wide healthcare costs to the province-wide air pollutant emissions, but the underlying drivers of these factors – population and power generation infrastructure – are not homogeneously distributed across the province. To increase precision, the impact of power generation infrastructure could be directly allocated to the local community through a more detailed analysis of the locations of this infrastructure[24] and the population of that community. Natural gas generation accounts for 69% of the total power generation emissions so would be the first set of infrastructure to consider. The NEB would then only be based on the benefits for the local community surrounding the marginal plant, i.e. the first plant that would reduce their generation when demand is reduced due to efficiency programming.

- **Forecast the impact of changes to energy infrastructure in Ontario, and the consequential changes in air pollution.**

The current methodology uses the latest available data for emissions, healthcare costs and electricity generation. However, the NEB adder is used for future-looking planning and analysis, and Ontario's power generation infrastructure will be undergoing significant change over the coming 20 years. For example, natural gas generation is responsible for 69% of the current PM2.5 emissions from the power generation sector, and is forecasted to grow by 2-4x from 2020 to 2030, and between a decline of 62% to growth of 45% from 2030 to 2040 depending on the scenario[25]. To reflect this forecasted change in power generation infrastructure, the NEB adder could be adjusted for the particular time period under consideration based on the proportion of total generation that will come from fossil sources during that period, compared to the 2020 reference year.

- **Discuss options for sector-specific analysis with Health Canada**

The project team does not recommend IESO staff to install and run the AQBAT model themselves, as it is complex and the key data required for this methodology is available from Health Canada reports without running the model. It would be a substantial time investment (weeks to months) for IESO staff to familiarize themselves with the model and its various input data, and a significant amount of ongoing effort to monitor and integrate the academic research driving the data and methodology updates. There would only be a minimal precision increase from investing this effort.
Instead of having the expertise in-house, the project team recommends engaging with Health Canada to ensure IESO is aware of upcoming relevant analysis – for example, the research Health Canada is undertaking on the healthcare burden associated with the electricity generation sector. By building awareness of the research in this area without becoming researchers themselves, IESO staff can increase precision for the NEB through including the most recent information without significant time investment. Engaging with Health Canada could also result in IESO being able to direct further research efforts from their part to include considerations mentioned above.

[24] See for example **https://www.ieso.ca/localContent/ontarioenergymap/index.html**
[25] Data from **Canada's Energy Future 2020, Canada Energy Regulator**.

4. NEB APPLICATIONS

4.1 – Cost-effectiveness testing

Including NEBs in cost-effectiveness testing is a best practice for CDM programs[26]. The exclusion of NEBs results in a lack of symmetry between the costs and benefits of a test, where all costs are included but not all benefits associated with those costs are accounted for. This can result in an understatement of the value of CDM, which may lead to fewer opportunities being pursued by program administrators as a result of CDM programs or measures not passing cost-effectiveness tests.

The IESO currently applies a multiplier to benefits for two of the cost-benefit tests included in the IESO Conservation & Demand Management Energy Efficiency Cost Effectiveness Guide (the IESO CE Guide): the Total Resource Cost Test (TRC) and the Societal Cost Test (SCT)[27]. This methodology can be refined by: 1) Considering NEBs at the utility, participant, and societal level, rather than aggregating these values; 2) including NEBs in additional tests (see the following section for considerations); and 3) replacing the multiplier used with the Ontario-specific NEBs quantified for this project.

This memo provides guidance on which NEBs categories should be included in each cost-effectiveness test and outlines which NEBs category each of the NEBs included in the study falls under. Additional considerations for applying NEBs values at different levels of cost-effectiveness testing (program vs. portfolio) are also provided.

4.1.1 – Including NEBs in Cost-Effectiveness Tests

Using multiple tests when assessing programs can provide varying perspectives on program cost-effectiveness. The test, or tests, used by the IESO to assess programs may change over time as the policy environment or organizational objectives shift. Given this potential for this change, this section provides an overview of how NEBs can be applied to tests expected to be used by the IESO now and into the future.

Below, Table 9 summarizes the tests currently used by the IESO that account for the value of NEBs through the use of a multiplier. The multiplier used by the IESO can be considered to encompass benefits from two NEBs categories: participant and societal.

Table 9. Current Consideration of NEBs in IESO Cost-Effectiveness Tests

	Total Resource Cost Test	Societal Cost Test	Program Administrator Cost Test	Ratepayer Impact Measure Test	Participant Cost Test
NEBs considered through use of general multiplier	Yes	Yes	No	No	No

[26] Northeast Energy Efficiency Partnerships. (2017). *Non-Energy Impacts Approaches and Values: an Examination of the Northeast, Mid-Atlantic, and Beyond*. Available at **this link**.
[27] See Section 5 of the IESO CE Guide, *Calculation of Cost-Effectiveness Tests*.

A more nuanced approach to accounting for NEBs would start by first splitting NEBs into categories (utility, participant, and societal), then considering each category individually for inclusion in tests. A general principle for determining which NEB categories should be included in a cost-effectiveness test is to consider whether the costs for each category are accounted for in the test. For example, the Total Resource Cost test considers the costs incurred by utilities as well the costs incurred by participants. It follows that all benefits realized by both groups should also be included, to the extent possible, so that the costs and benefits are symmetrical.

Cross jurisdictional studies on NEBs best practices have noted that many program administrators do not include NEBs in all tests where they could (likely as a result of limited jurisdiction-specific values) and noted that all traditional tests described in the California Standard Practice Manual allow for the inclusion of at least one category of benefits[28,29]. Table 10 below provides of summary of the findings of these studies, indicating where the IESO could expand the use of NEBs in cost-effectiveness tests and noting which NEB categories are recommended for inclusion in each test.

Table 10. Recommended Inclusion of NEBs in Cost-Effectiveness Tests

	Total Resource Cost Test	Societal Cost Test	Program Administrator Cost Test	Ratepayer Impact Measure Test	Participant Cost Test
Utility Benefits	Yes	Yes	Yes	Yes	No
Participant/Customer Benefits	Yes	Yes	No	No	Yes
Societal Benefits	No	Yes	No	No	No

While the IESO has not historically included NEBs in the Participant Cost Test, this approach is now possible given the participant level NEBs that have been quantified through this study. It should be noted that the IESO CE Guide states that the PCT is typically used to assist with program design or planning (for example, to develop incentive levels), rather than for approval screening. Including participant non-energy benefits in the PCT may suggest that program incentive levels could be lowered, which may not align with other program design considerations. As such, the use of NEBs in the PCT should be approached with caution.

4.1.2 – The Application of NEBs at the Program and Portfolio Levels

The NEBs quantified in the study are sector specific, and therefore can be applied at the program or portfolio level. As noted in the previous section, each cost-effectiveness test assesses cost-effectiveness

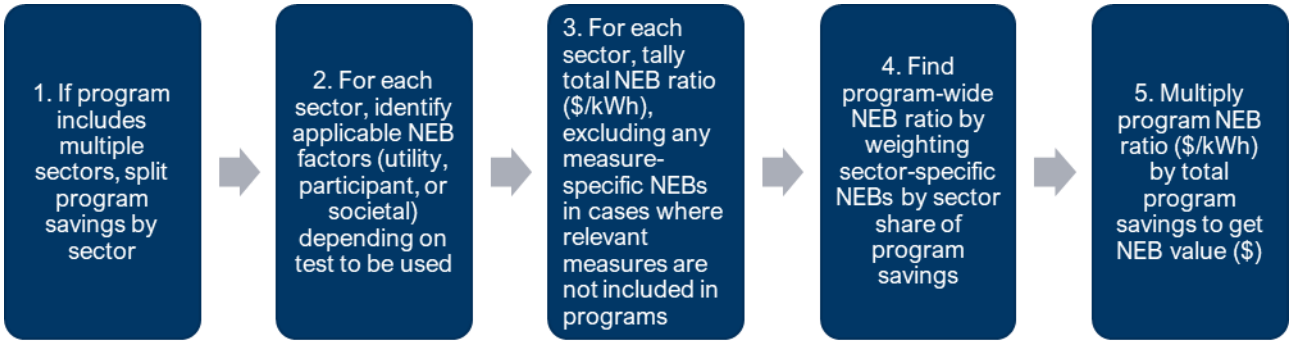
[28] American Council for an Energy Efficient Economy. (2018). *Cost-Effectiveness Tests: Overview of State Approaches to Account for Health and Environmental Benefits of Energy Efficiency*. Accessed online: https://www.aceee.org/sites/default/files/he-ce-tests-121318.pdf

[29] Lazar, J., Colburn, K. (2013). *Recognizing the Full Value of Energy Efficiency.* https://www.raponline.org/knowledge-center/recognizing-the-full-value-of-energy-efficiency/

from a different perspective, and therefore should only include the NEB categories (i.e., utility, participant, or societal) relevant to that perspective. For cost-effectiveness at the program level, the measures included in a program must also be considered when tallying the total NEB value: only NEBs associated with measures offered by a program (indicated by the measure-specificity notes associated with each NEB) should be included as a benefit in cost-effectiveness testing.

The diagram below summarizes the process of calculating NEBs at the program level. This is followed by guidance on the inclusion of NEBs at the portfolio level.

Program Cost-Effectiveness Process



Step 1: If program includes multiple sectors, split program savings by sector.

	Program-Wide Savings
Business Lighting Program	40,400,000 kWh

	Sector-Specific Program Savings	Portion of Program Savings in Each Sector
Commercial	24,240,000 kWh	60%
Institutional	12,120,000 kWh	30%
Agricultural	4,040,000 kWh	10%

Step 2: For each sector, identify applicable NEB factors (utility, participant, or societal) depending on test to be used. In this case, the TRC test will be used and therefore utility and participant NEBs should be included. Because utility NEBs were not quantified, only participant NEBs will be considered. If utility NEBs are quantified in the future, they could be included.

	Total Resource Cost Test	Societal Cost Test	Program Administrator Cost Test	Ratepayer Impact Measure Test	Participant Cost Test	Levelized Delivery Cost Metric
Utility Benefits	Yes	Yes	Yes	Yes	No	Yes
Participant/Customer Benefits	Yes	Yes	No	No	Yes	No
Societal Benefits	No	Yes	No	No	No	No

Step 3: For each sector included in program, tally total NEB ratio ($/kWh), excluding any measure-specific NEBs in cases where relevant measures are not included in program. In this case we are assessing a lighting-focused program, so NEBs specific to non-lighting NEBs (HVAC, refrigeration, and envelope) are excluded.

	Applicable Measures	Commercial ($/kWh)	Institutional ($/kWh)	Agricultural ($/kWh)
Thermal comfort	HVAC, envelope	$0.05	$0.25	$0.003[17]
Reduced building & equipment O&M	All	$0.08	$0.11	
Improved indoor air quality	HVAC, envelope	$0.007	$0.27	$0.002[30]
Reduced spoilage	HVAC, refrigeration	$0.0002		$0.001
Improved business outcomes (productivity, competitiveness, investment)	All			$0.09
Total		**$0.08**	**$0.11**	**$0.09**

Rows formatted in light grey text are not relevant to the program in this example, and therefore not included in the total row.

[30] Reflects value for humans (rather than livestock)

Step 4: Find program-wide NEB ratio by weighting sector-specific NEBs by sector share of program savings

	Sector $/kWh	% of Program Savings
Commercial	$0.08	60%
Institutional	$0.11	30%
Agricultural	$0.09	10%

Program $/kWh
$0.09

Step 5: Multiply program NEB ratio ($/kWh) by total program savings to get NEB value ($)

	kWh		Program $/kWh		NEB Value ($)
Small Business Lighting Program	40,400,000	x	$0.09	=	$3,636,000

Portfolio cost-effectiveness can be calculated by aggregating all program-level results along with any additional costs that cannot be attributed to any single program (e.g. overhead). Non-energy benefits calculated at the program level will therefore be included when all program level costs and benefits are aggregated to assess portfolio cost-effectiveness.

Maximum NEB values to be considered in cost-effectiveness testing

To ensure that program activities funded by electricity ratepayers are driven by primarily energy system benefits rather than NEBs, the NEB value included in cost-effectiveness calculations should not be greater than the total avoided costs. If the total NEB values is greater than the total avoided costs, we recommend that only including a portion of the NEBs value – specifically an amount equivalent in value to the total program energy benefits – be included in the cost-effectiveness calculation.

For additional clarity, we are NOT recommending that NEB values be scaled down or reduced. Rather we are recommended that that entire NEB value be calculated and acknowledged, and that in certain circumstances only a portion of that value be brought forward into the cost-effectiveness tests.

4.1.3 – Comparison to Other Jurisdictions

Below, the inclusion of NEBs in cost-effectiveness tests in four other jurisdictions are described.

Table 11. Inclusion of NEBs in Cost-Effectiveness Tests in Other Jurisdictions

	Inclusion of Participant NEBs	Inclusion of Utility NEBs	Inclusion of Societal NEBs	Primary Test	Primary Assessment Level	Secondary Test	Approach Used to Estimate NEB
British Columbia[31]	Yes	Yes	Yes	TRC	Program	UCT, MTRC[32]	Adder
California[33]	Yes (Low-income Only)	Yes	No	TRC	Portfolio	UCT	Quantified
Massachusetts [33]	Yes	Yes	Yes	TRC	Program	None	Quantified
New Hampshire[33]	Yes	Yes	Yes	TRC	Program	None	Adder

As can be seen from the table above, the inclusion of NEBs in cost-effectiveness tests varies from jurisdiction from jurisdiction – from the NEBs types included (participant, utility, and/or societal), the tests used, the level of assessment (program vs. portfolio), and the approach used to estimate the NEB (adder vs. quantified). Rather than following an established practice taken from other jurisdictions, the inclusion of NEBs in cost-effectiveness testing by the IESO should be tailored to the objectives and context of IESO funded programs and may change over time.

Utility Non-Energy Benefits

Participant NEBs are not included in the Program Administrator Cost (PAC) test which is another common cost-effectiveness test used by various jurisdictions. Reviewing Table 10 above, the PAC only includes utility NEBs, which were not in-scope for this study.

[31] BC Hydro. (2018). Demand Side Management Milestone Evaluation Summary Report F2018. Available at **this link**

[32] Here, 'Modified TRC' is shortened to MTRC. This refers to a TRC test that has been modified from the standard TRC test (as described in the California Standard Practice Manual, available at **this link**). For BC Hydro, the MTRC uses a zero-emission energy alternative for the avoided cost of natural gas and includes NEBs in the TRC calculation. Additional details on the BC Hydro MTRC test can be found at **this link**.

[33] National Energy Screening Project. (2020). Database of Screening Practices (Interactive Dashboard). Available at **this link**

The National Energy Screening Project has developed a US-wide Database of Screening Practices[34] which summarizes cost-effectiveness practices across the country. The database includes a summary of non-energy utility system benefits commonly accounted for by program administrators. These benefits represent a starting point for the utility NEBs that could be considered by the IESO if utility benefits are of interest moving forward.

Building on the previous sub-section Table 12 below summarizes the inclusion of utility NEBs for those jurisdictions that do consider quantified utility values in their cost-effectiveness testing: California and Massachusetts.

Table 12. Inclusion of Utility NEBs in California and Massachusetts Cost-Effectiveness Testing

	Avoided costs of Complying with RPS	Avoided Environmental Costs	Avoided Credit and Collection Costs	Reduced Risk	Increased Reliability	Market Transformation	Increased Resilience
California[34]	Yes	Yes	No	No	No	No	No
Massachusetts[34]	Yes	Yes	Yes	Yes	Yes	No	No

4.2 – The Application of NEBs to Demand Savings Values

The IESO expressed interest in NEBs values in $/kW given an increasing focus on demand savings moving forward. The project team notes that expressing NEBs in $/kW terms represents a couple of challenges:

1. **Natural flow of non-energy benefits:** all the important NEBs are experienced by customers throughout the year, not at specific moments that are coincident with system peak. Thermal comfort, for example, is experienced throughout the heating and cooling seasons. Reduced operation and maintenance are experienced when the O&M would have occurred with the pre-retrofit equipment, which is usually not coincident with system peak either. It is much more intuitive to use $/kWh values (or $/customer, etc.). A measure still provides major non-energy benefits during off-peak periods.

2. **Risk of double-counting and confusion:** there is no obvious or logical way to split NEBs between the energy and the capacity impacts, and most if not all of NEBs should be attributed in our opinion to the energy portion. Because of this, $/kW values, should they be used, would not be additive to $/kWh values. Only $/kW *or* $/kWh should be used to avoid the risk of double-counting benefits.

[34] National Energy Screening Project. (2020). Database of Screening Practices (Interactive Dashboard). Available at **this link**

With this context in mind, the team gathered net annual kWh and peak kW savings from past program evaluations and developed kWh/kW ratios that can be applied to the NEB $/kWh valuations[35]. These ratios are outlined in Table 13 below.

Table 13. kWh/kW Ratios for Application of NEBs to Demand Savings

Sector	kWh/kW Ratio[36]
Residential	12,703
Low-income	4,659
First Nation	5,050
Commercial	10,062
Institutional	10,062
Industrial	9,940
Agricultural	10,062

[35] Savings values are from the 2019 residential, business, and industrial evaluations for all programs with the exception of the Instant Discount program, which was discontinued in 2019. Savings for the Instant Discount program are from the 2018 evaluation. The kWh and kW values used are included in Appendix Section 5.4.
[36] For sectors with savings from multiple programs (all except low-income and First Nation), an average of the kWh/kW ratio weighted by program savings was calculated across all relevant programs.

5. CONCLUSIONS

Conclusions

5.1 – Key Findings

Based on the results presented in this report, the following key takeaways emerge:

Participants of IESO-funded programs place a great deal of value on NEBs. In many cases, the value of the NEBs within a given sector exceed the value of the participant energy savings. This highlights that there are factors beyond energy savings that may motivate participation in energy efficiency or contribute to positive customer experiences with programs.

NEBs factor into decision-making around program participation across all sectors. More than half of residential respondents and nearly two-thirds of non-residential respondents consider NEBs when deciding to participate in programs. In addition, those who consider NEBs when considering program participation are more likely to pursue additional EE measures in next 5 years.

NEB values are likely higher than estimated in this Study. This study did not include all possible participant NEBs from energy efficiency but was limited in scope to NEBs related to specific efficiency measures installed through six IESO CDM programs during 2017-2019. We also elected to use a conservative approach (minimum non-null value) when calculating the NEB values from two different types of questions. Additionally, only one societal NEB was quantified in this study. Given these factors we strongly recommend that NEB values should not be further discounted or scaled.

The importance of different NEBs varies by sector. Although some NEBs are valued highly across multiple sectors (e.g. thermal comfort), most NEBs are valued differently across different sectors. This points to the value of sector-specific marketing to prospective participants of IESO-funded programs.

The NEBs identified and their valuations vary by sector. Although some NEBs were identified as relevant and valued highly across multiple sectors – notably thermal comfort – there is considerable variation in NEB selection and valuation between sectors. Each sector has a unique combination of NEBs, and even those sectors with a similar NEB mix show differences in their NEBs rankings. For those NEBs that are found across multiple sectors, there is also considerable variation in absolute NEBs values by sector. This supports the sector-specific granularity of this study.

Areas for future research include values by subsector (notably within the agricultural and industrial sectors). Some experts highlighted the potential for there to be differences in the valuation of NEBs in some sub-sectors – in particular those in the agriculture and industrial sectors. Additional targeted research could illuminate the benefits most relevant to subsectors and further shape marketing and communications targeted to those customers.

Including the participant NEBs quantified in this study in cost-effectiveness testing will increase the value of the Total Resource Cost test but will not change the results of the Program Administrator Cost Test, although utility NEBs could be quantified in future research

efforts. The Total Resource Cost (TRC) test should include both utility and participant NEBs. The participant NEBs quantified in this study are expected to be exceed the 15% NEBs adder currently used in the TRC test (the degree to which will vary by program and sector(s) being assessed). The Program Administrator Cost (PAC) test should include utility NEBs. Because utility NEBs were not quantified as part of this study, there will be no changes to the PAC benefits. Given the increasing focus on the PAC test moving forward, future research could quantify utility NEBs, starting with those most commonly seen in other jurisdictions (as outlined in the Cost-Effectiveness Framework Recommendations section).

5.2 – Applicability to other jurisdictions

Because NEBs research has not been completed in all jurisdictions, others may be interested in leveraging this research. While the methodology used in this study is not jurisdiction-dependent and could be replicated in other jurisdictions, the *results* of the study are specific to Ontario. Given the widely-varying NEBs values found in the jurisdictional scan completed in the Phase I study and supplemented with additional research in Phase II, the Dunsky Team cautions against the simple adoption of these NEB values in other jurisdictions.

Additional considerations regarding the applicability of this work include:

1. The NEBs valuations are dependent on the specific measure mixes installed by surveyed participants as well as the overall program designs**.** For example, many residential sector survey respondents had installed thermostats, which may have led to an increased valuation of the 'sense of control over energy decisions' NEB. The measures installed in each sector's surveyed population are included in the appendix and the NEBs valuations should be considered in the context of these values.

2. Ontario is a very large province (over 1 million square kilometres – an area larger than France and Spain combined) with a highly diversified economy driven primarily by the services sector as well as key manufacturing industries such as automotive, biotech, pharmaceuticals and communications technologies[37]. Ontario's climate is characterized by cold winter temperatures alongside strong seasonal temperature swings to increasingly warmer summers that are increasing the demand for air conditioning across the province. While the province has generally been a summer-peaking electricity system since 2000, it could be characterized dual peaking system with Ontario having an annual winter peak as recent as 2014[38]. This points to the increased importance and challenge of maintaining comfort year-round, and the potential for increased energy intensity compared to other jurisdictions. The NEBs values may have also be impacted by the combination of industries present in Ontario along with the province's home and building characteristics, which are expected to vary from other jurisdictions.

[37] Government of Ontario. (2019). Government of Ontario. Available at this link.
[38] IESO (2014). 2014 Electricity Production, Consumption, Price and Dispatch data. Available at This link.

5.3 – Study Limitations

We would like to acknowledge the following study limitations, which are highlighted throughout the report but gathered here for ease of reference. These limitations should be noted by the reader when interpreting the study results.

- All participant NEBs presented in this study are based on participants' self-reported perception of the value of NEBs they experienced from energy efficiency measures.
- NEBs are often inter-related and may not be mutually exclusive. Some previous studies have chosen to address the potential for overlap between NEBs by scaling down the NEBs reported by participants. This study does not account for potential overlap between different NEBs – it includes the full value of NEBs reported by surveyed participants.
- The participant surveys used to quantify NEBs took place in 2020, while measure installations took place between 2017 and 2019. For some participants, a considerable period of time elapsed between installation and survey.
- The NEBs selected and their associated values are based on the program design and measures offered at the time of measure installation (between 2017 and 2019). Future changes to program design, including measures offered, may alter NEBs valuations.
- The participant survey was fielded during the COVID pandemic. It is possible that the pandemic impacted the surveyed participant responses.
- Only one societal NEB – the benefits of reduced air pollution – was quantified in this Study. This limited assessment of societal NEBs should not be interpreted as an indication that societal NEBs are inherently limited in scope or scale, but rather is a function of the primary focus for the Phase II study being participant NEBs.
- The NEBs values quantified in this study do not reflect all possible participant NEBs that can result from energy efficiency. The NEBs included in this study were limited to those resulting from the installation of specific measures by participants in IESO-funded energy efficiency programs over the 2017-2019.
- The NEBs value quantified in this study do not reflect all NEBS stemming from these specific IESO programs studied. To keep the participant surveys to an acceptable length, we limited the survey to 3-5 NEBs per sector. The MROC survey played a critical role in screening and prioritizing the most relevant NEBs for each sector.

6. APPENDIX

Appendix

A.1 – Program Descriptions

A participant dataset was developed based on 2017-2019 energy efficiency projects completed through six of the IESO's Save on Energy programs, as seen in the table below.

Sector	Heating & Cooling Program[39]	Home Assistance Program	First Nations Conservation Program	Small Business Lighting Program	Retrofit Program	Process Systems & Upgrades Program
Residential	✓					
Low-income		✓				
First Nation			✓			
Commercial				✓	✓	
Institutional				✓	✓	
Agricultural				✓	✓	
Industrial				✓	✓	✓

A description of each program, as they stood within the 2017-2019 timeframe, is included below.

Heating & Cooling Program: This program provided incentives for energy-efficient HVAC equipment for residential customers who purchase and install qualifying new or replacement equipment through a participating contractor.

Instant Discount Program: This program offered residential customers discounts on energy efficient products at the point of sale by integrating discounts into retailers' electronic inventory-tracking and purchasing systems.

First Nation Conservation Program: This program was offered to on-reserve First Nation customers. Although, delivery strategies were tailored specifically to individual First Nation communities, the program was based on the province-wide Home Assistance Program, offering the same measures through a similar program design. A program representative (implementation delivery contractor) directly installed eligible efficiency measures as determined through an in-home energy assessment.

[39] The survey team developed the residential sector survey sample and gathered per participant gross savings values from a database of past Heating and Cooling Program participants. When the surveyors verified which measures each survey participant had installed, however, measures from the Instant Discount program were noted by some participants (including lighting). Although the survey sample was developed using the Heating and Cooling program, participants who had also participated in the Instant Discount program considered all measures that they had installed through both programs when quantifying the NEBs that they had experienced. For those participants, the study team augmented the per participant gross savings values from the Heating and Cooling program database to include savings from the measures installed from the Instant Discount program by each participant.

Small Business Lighting Program: This program offered up to $2,000 in free, directly installed energy-efficient lighting upgrades for eligible businesses. To participate, businesses must have 50 or fewer employees on site at any point in time and cannot have previously participated in the program.

Retrofit Program: The Retrofit Program provided incentives to non-residential customers (industrial, commercial, institutional and multi-family residential sectors) for the purchase and operation of energy efficient equipment. Incentives were available through two streams: the prescriptive track offered incentives on a per unit basis, while custom track incentives were on a per-kWh or per-kW basis.

Process Systems & Upgrades Program: This program was targeted to participants who wish to implement large scale projects, expected to achieve 300 MWh of electricity savings per year, that require engineering design to optimize overall processes and systems. The program included an engineering feasibility studies and project incentives for a variety of energy efficiency projects.

A.2 – NEB Definitions

The NEBs included in this study were defined as follows:

NEB	Definition
Reduced financial stress	Reduced stress related to making bill payments or reduced worries about shut-offs due to bill non-payment.
Thermal comfort	Improvement in ability for building to maintain a comfortable temperature.
Reduced building & equipment Operations and Maintenance (O&M)	Reduced labour or other costs associated with reduced operations and maintenance to maintain building systems.
Improved indoor air quality	Reduction in air pollutants in indoor environment.
Sense of control over energy decisions	Perceived improvement in control over energy use of building and equipment.
Improved lighting levels	Spaces that are more appropriately lit.
Reduced spoilage	Reduced spoilage of perishable products due to improved refrigeration or ventilation.
Improved business outcomes	Increased competitiveness due to productivity gains, reduced costs, increased attractiveness to investors, or other factors.
Improved product quality	Increase in percentage of production passing quality standards.

A.3 – Participant Survey Results

Sampling Plan per Sector

Sector	Online or Phone	Number of participants with contact available in lists	Number of participants in initial sample
Low-income	Phone	19,852	300 valid numbers
First Nation (participants)	Phone	3,228	300 valid numbers
First Nation (community survey)	Phone	TBD	TBD
Residential	Online	2,788	2,788
Commercial	Online	11,466	5,000
Institutional	Online/Phone	3,098	3,098
Industrial	Online/Phone	1,824	1,824
Agricultural	Online/Phone	933	933

For the residential, institutional, industrial and agricultural sectors, the entire population was included in the survey sample. Due to phone surveys typically having higher response rates than for online surveys, the Low-income and First Nation sectors have smaller samples than the other sectors. For those two sectors, the initial sample included 300 valid numbers, which means that any invalid phone number reached prompted the inclusion of one more participant in the sample.

A.3.1 – Residential Sector Survey Results

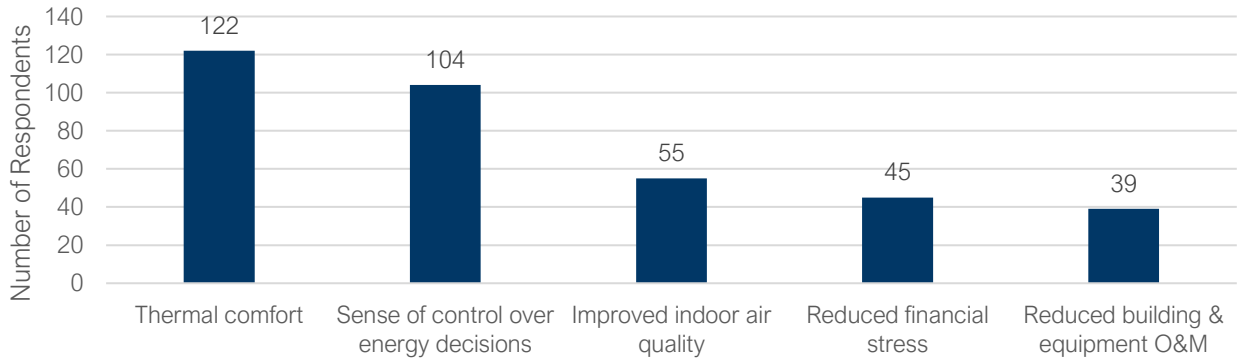
The residential sector survey included five NEBs, listed here:

- Thermal comfort
- Sense of control over energy decisions
- Improved indoor air quality
- Reduced financial stress
- Reduced building & equipment O&M

The residential sector survey included **176 participants** from the Heating and Cooling and Instant Discount programs who had installed the measures included in the table below. On average, each survey participant installed 3.8 measures.

Measure	Number of Units Installed by Survey Participants
Furnace with electronically commutated motor	113
Central air conditioner	90
Thermostat	89
Lighting	129
Weatherstripping	57
Power bar	45
Lighting controls	36
Hot water pipe wrap	31
Ceiling fan	29
Clothesline umbrella stand/clothesline kit	25
Ductless heat pump (cold climate and standard)	14
Ducted air source heat pump (cold climate and standard)	14
Heavy duty outdoor plug timers	13
Electric water heater blanket	6
Baseboard programmable thermostat	20
Circulator pump with electronically commutated motor	1

The frequency each NEB was reported by residential respondents is below.



A.3.2 – Low-income Sector Survey Results

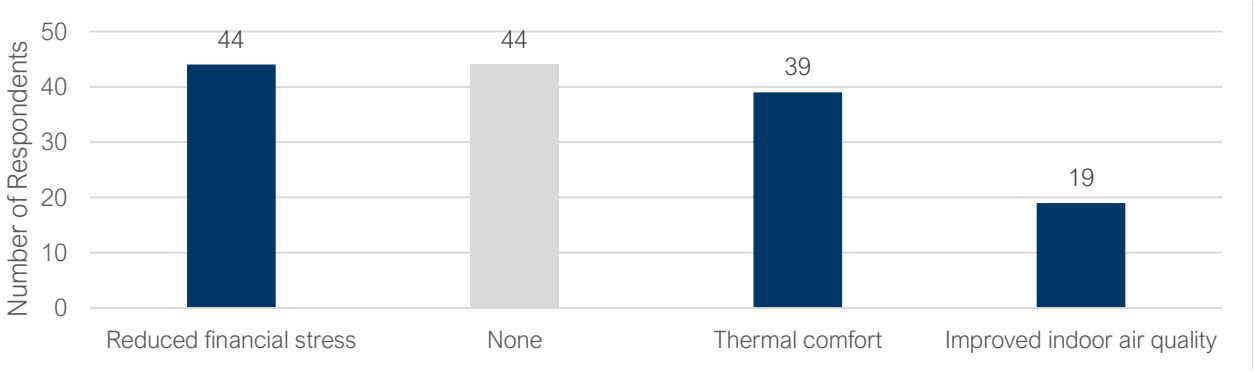
The low-income sector survey included three NEBs, listed here:

- Reduced financial stress
- Thermal comfort
- Improved indoor air quality

The low-income sector survey included **105 participants** from the Home Assistance program who had installed the measures included in the table below. On average, each survey participant installed 5.88 unique measures.

Measure	Number of Units Installed by Survey Participants
Lighting	92
Power bar	71
Clothes drying rack	70
Efficient showerhead	47
Refrigerator replacement	40
Attic insulation	34
Smart thermostat (for electrically-heated homes)	34
Wall insulation	29
Freezer replacement	27
Hot water pipe wrap	25
Comprehensive draft proofing	23
Basement insulation	22
Dehumidifier replacement	22
Hot water tank insulation	16
Efficient aerator	14
Block heater timer	11
Window air conditioner replacement	9

The frequency each NEB was reported by low-income respondents is below.



A.3.3 – First Nation Sector Survey Results

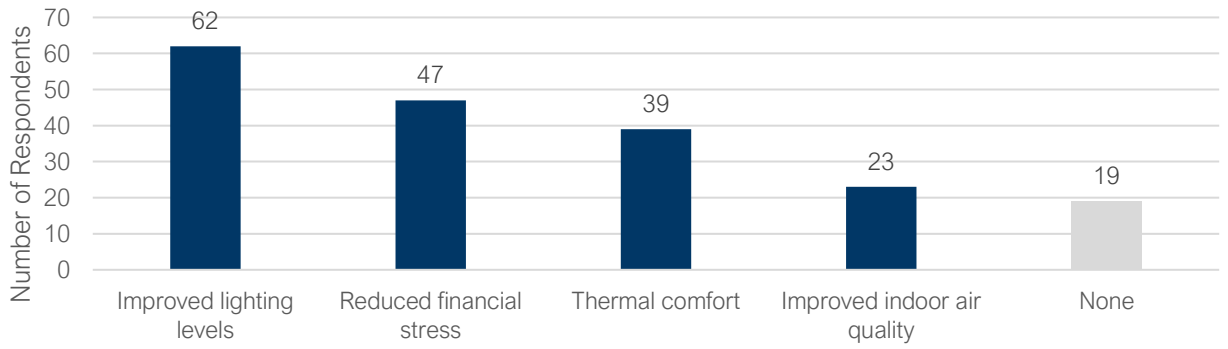
The First Nation sector survey included four NEBs, listed here:

- Reduced financial stress
- Improved lighting levels
- Thermal comfort
- Improved indoor air quality

The First Nation sector survey included **100 participants** from the First Nations Conservation program who had installed the measures included in the table below. On average, each survey participant installed 5.05 different measures.

Measure	Number of Units Installed by Survey Participants
Lighting	86
Power bar	71
Efficient showerhead	44
Freezer replacement	36
Refrigerator replacement	35
Block heater timer	30
Efficient aerator	22
Thermostat	22
Hot water tank insulation	21
Attic insulation	19
Hot water pipe wrap	18
Comprehensive draft proofing	18
Window air conditioner replacement	17
Dehumidifier replacement	13
Wall insulation	12
Basement insulation	12

The frequency each NEB was reported by First Nation respondents is below.



A.3.4 – Commercial Sector Survey Results

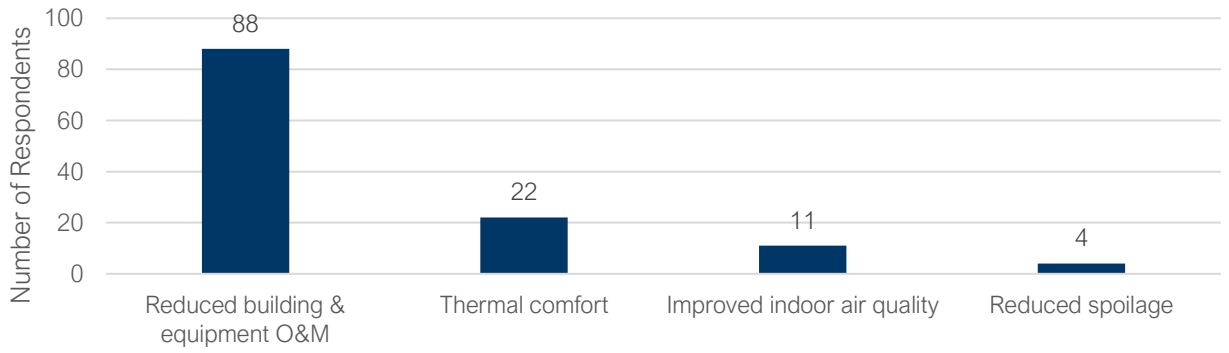
The commercial sector survey included four NEBs, listed here:

- Reduced spoilage
- Improved indoor air quality
- Thermal comfort
- Reduced building & equipment O&M

The commercial sector survey included **102 participants** from the Save on Energy Retrofit and Save on Energy Small Business Lighting programs who had installed the measures included in the table below. On average, each survey participant installed 2.53 different measures.

Measure	Number of Units Installed by Survey Participants
Lighting	100
Lighting Controls	31
Variable-speed drive	27
HVAC upgrades	26
Chiller replacement	10
Metering equipment	7
Pumps	7
System optimization	7
Envelope improvements	6
Building automation systems	6
Cleaning cooler/freezer condenser units	6
Control equipment	5
Walk-in cooler and freezer lighting	5
HVAC measures	5
Operations (e.g. scheduling)	4
Energy management system	3
Strip curtains for walk-in coolers and freezers	3
Electronically commutated motor upgrades (condenser and evaporator)	3
Retro-commissioning	2
Display case lighting	1

The frequency each NEB was reported by commercial respondents is below.



A.3.5 – Institutional Sector Survey Results

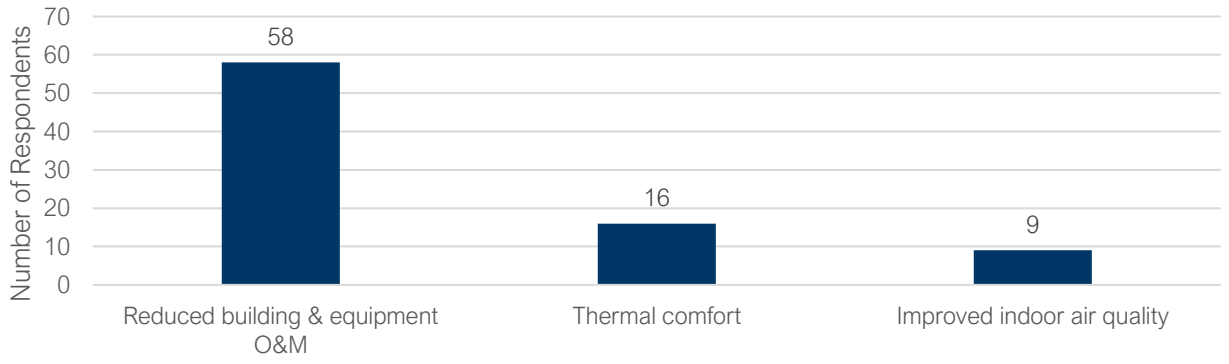
The institutional sector survey included three NEBs, listed here:

- Reduced building & equipment O&M
- Thermal comfort
- Improved indoor air quality

The institutional sector survey included **61 participants** from the Save on Energy Retrofit and Save on Energy Small Business Lighting programs who had installed the measures included in the table below. On average, each survey participant installed 3.24 different measures.

Measure	Number of Units Installed by Survey Participants
Lighting	63
Lighting controls	39
Variable-speed drive	20
HVAC redesign	18
Building automation systems	14
Control equipment	13
Envelope improvements	7
Energy management system	7
Metering equipment	7
Refrigeration system optimization (system components, free cooling)	6
Chiller replacement	5
Commissioning and retro-commissioning	5
Compressed air system optimization	2
Wastewater treatment (blowers, centrifuges, UV)	1

The frequency each NEB was reported by institutional respondents is below.



A.3.6 – Industrial Sector Survey Results

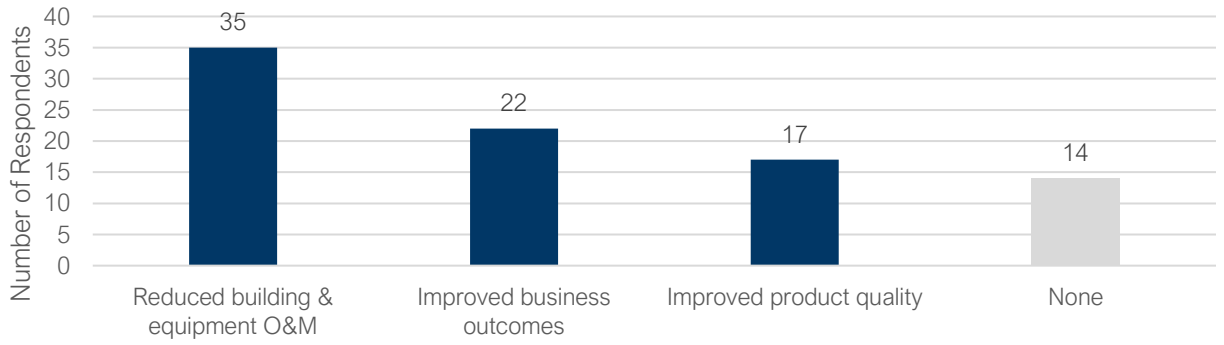
The industrial sector survey included three NEBs, listed here:

- Improved business outcomes
- Reduced building & equipment O&M
- Improved product quality

The industrial sector survey included **61 participants** from the Process and Systems Upgrade, Retrofit, and Small Business Lighting programs who installed the measures included in the table below. On average, each survey participant installed 3.87 different measures.

Measure	Number of Units Installed by Survey Participants
Lighting	60
Lighting control	36
Compressed air systems (leak management, pressure reduction, compressor sequencing/allocation, upgraded distribution net)	18
Variable frequency drives	16
Compressed air	15
Lighting controls	13
HVAC redesign	9
Variable-speed drives	9
Waste heat recovery	8
Process upgrades	8
Energy management system	6
Pumps	6
HVAC measures	6
Cogeneration	5
Blower controls	5
Chillers	5
Control equipment	5
Operations (e.g. scheduling)	4
Chiller replacement	3
System optimization	3
Pumping system optimization	2
Wastewater treatment (blowers, centrifuges, UV)	2
Refrigeration system optimization (system components, free cooling)	2
Building automation system	2
Metering equipment	2
Hydraulic air compressor	1
Ventilation on-demand (schedule based, auxiliary fan shut down, full RFID implementation)	1
Retro-commissioning	1

The frequency each NEB was reported by industrial respondents is below.



A.3.7 – Agricultural Sector Survey Results

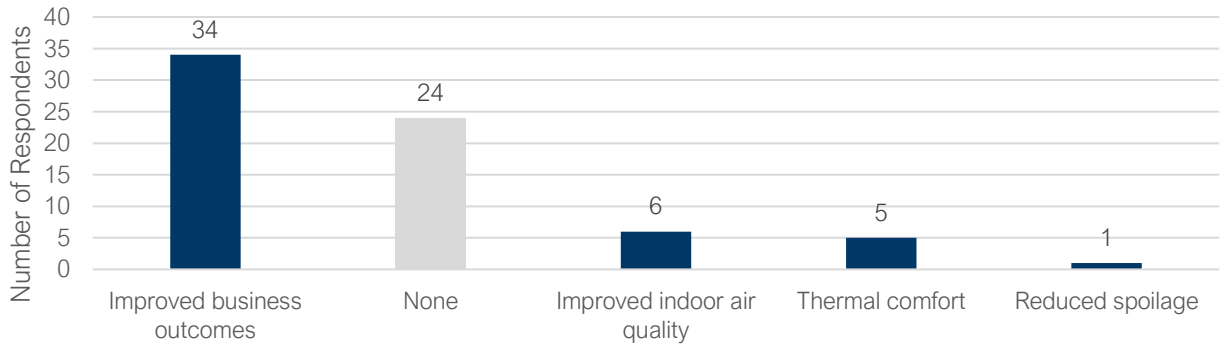
The agricultural sector survey included four NEBs, listed here:

- Improved business outcomes
- Improved indoor air quality
- Thermal comfort
- Reduced spoilage

The agricultural sector survey included **62 participants** from the Save on Energy Retrofit and Small Business Lighting programs who had installed the measures included in the table below. On average, each survey participant installed 1.49 different measures.

Measure	Number of Units Installed by Survey Participants
Lighting	61
Lighting control	10
Low energy livestock waterers	8
Variable-speed drives	2
Dairy plate cooler	2
High volume low speed fan	2
Chiller replacement	1
Envelope improvements	1
High temperature cut out thermostat	1
Dual and natural exhaust ventilation	1
Milk scroll compressor	1

The frequency each NEB was reported by agricultural respondents is below.



A.4 – Comparison of calculation methodologies for average NEB values

The tables below show the average NEB values for each NEB within each sector, based on two different calculation approaches:

- **Average (per participant):** A $/kWh value was calculated for each individual participant, then all values were averaged.
- **Average (overall):** Refers to an overall average value where total NEB benefits ($'s) were summed across all participants and then divided by the total energy savings (kWh) across all participants.

Agriculture

Test	NEB	Average (per participant)	Average (Overall)	Difference
NEB 1 Hybrid (min approach) ($/kWh)	Improved business outcomes	$0.03	$0.09	-66%
NEB 2 Hybrid (min approach) ($/kWh)	Improved indoor air quality	$0.01	$0.002	202%
NEB 3 Hybrid (min approach) ($/kWh)	Thermal comfort	$0.01	$0.003	223%
NEB 4 Hybrid (min approach) ($/kWh)	Reduced spoilage	$0.002	$0.001	238%
NEB 1 Hybrid (RS-priority) ($/kWh)	Improved business outcomes	$0.04	$0.09	-54%
NEB 2 Hybrid (RS-priority) ($/kWh)	Improved indoor air quality	$0.023	$0.012	84%
NEB 3 Hybrid (RS-priority) ($/kWh)	Thermal comfort	$0.022	$0.013	78%
NEB 4 Hybrid (RS-priority) ($/kWh)	Reduced spoilage	$0.002	$0.001	238%

Residential

Test	NEB	Average (per participant)	Average (Overall)	Difference
NEB 1 Hybrid (min approach) ($/kWh)	Reduced financial stress	$0.03	$0.03	18%
NEB 2 Hybrid (min approach) ($/kWh)	Thermal comfort	$0.14	$0.11	34%
NEB 3 Hybrid (min approach) ($/kWh)	Reduced building & equipment O&M	$0.03	$0.02	46%
NEB 4 Hybrid (min approach) ($/kWh)	Improved indoor air quality	$0.05	$0.05	10%
NEB 5 Hybrid (min approach) ($/kWh)	Sense of control over energy decisions	$0.08	$0.06	30%

Test	NEB	Average (per participant)	Average (Overall)	Difference
NEB 1 Hybrid (RS-priority) ($/kWh)	Reduced financial stress	$0.06	$0.11	-39%
NEB 2 Hybrid (RS-priority) ($/kWh)	Thermal comfort	$0.21	$0.16	33%
NEB 3 Hybrid (RS-priority) ($/kWh)	Reduced building & equipment O&M	$0.06	$0.05	27%
NEB 4 Hybrid (RS-priority) ($/kWh)	Improved indoor air quality	$0.12	$0.10	20%
NEB 5 Hybrid (RS-priority) ($/kWh)	Sense of control over energy decisions	$0.18	$0.11	74%

Commercial

Test	NEB	Average (per participant)	Average (Overall)	Difference
NEB 1 Hybrid (min approach) ($/kWh)	Reduced spoilage	$0.01	$0.0002	3313%
NEB 2 Hybrid (min approach) ($/kWh)	Improved indoor air quality	$0.09	$0.007	1278%
NEB 3 Hybrid (min approach) ($/kWh)	Thermal comfort	$0.63	$0.05	1226%
NEB 4 Hybrid (min approach) ($/kWh)	Reduced building & equipment O&M	$0.12	$0.08	50%
NEB 1 Hybrid (RS-priority) ($/kWh)	Reduced spoilage	$0.01	$0.0003	3378%
NEB 2 Hybrid (RS-priority) ($/kWh)	Improved indoor air quality	$0.10	$0.02	375%
NEB 3 Hybrid (RS-priority) ($/kWh)	Thermal comfort	$0.65	$0.09	632%
NEB 4 Hybrid (RS-priority) ($/kWh)	Reduced building & equipment O&M	$0.72	$0.17	330%

Institutional

Test	NEB	Average (per participant)	Average (Overall)	Difference
NEB 1 Hybrid (min approach) ($/kWh)	Reduced building & equipment O&M	$0.21	$0.11	87%
NEB 2 Hybrid (min approach) ($/kWh)	Improved indoor air quality	$0.32	$0.27	16%
NEB 3 Hybrid (min approach) ($/kWh)	Thermal Comfort	$0.17	$0.25	-34%
NEB 1 Hybrid (RS-priority) ($/kWh)	Reduced building & equipment O&M	$0.66	$0.70	-5%
NEB 2 Hybrid (RS-priority) ($/kWh)	Improved indoor air quality	$0.33	$0.28	18%

Test	NEB	Average (per participant)	Average (Overall)	Difference
NEB 3 Hybrid (RS-priority) ($/kWh)	Thermal Comfort	$0.19	$0.26	-25%

Industrial

Test	NEB	Average (per participant)	Average (Overall)	Difference
NEB 1 Hybrid (min approach) ($/kWh)	Improved business outcomes	$1.50	$0.04	3660%
NEB 2 Hybrid (min approach) ($/kWh)	Reduced building & equipment O&M	$0.77	$0.03	2701%
NEB 3 Hybrid (min approach) ($/kWh)	Improved product quality	$0.12	$0.01	1158%
NEB 1 Hybrid (RS-priority) ($/kWh)	Improved business outcomes	$2.33	$0.08	2758%
NEB 2 Hybrid (RS-priority) ($/kWh)	Reduced building & equipment O&M	$2.18	$0.10	2029%
NEB 3 Hybrid (RS-priority) ($/kWh)	Improved product quality	$1.16	$0.06	1910%

First Nation

Test	NEB	Average (per participant)	Average (Overall)	Difference
NEB 1 Hybrid (min approach) ($/kWh)	Reduced financial stress	$0.13	$0.090	48%
NEB 2 Hybrid (min approach) ($/kWh)	Improved lighting levels	$0.24	$0.08	216%
NEB 3 Hybrid (min approach) ($/kWh)	Thermal comfort	$0.22	$0.092	142%
NEB 4 Hybrid (min approach) ($/kWh)	Improved indoor air quality	$0.14	$0.06	150%
NEB 1 Hybrid (RS-priority) ($/kWh)	Reduced financial stress	$0.15	$0.11	34%
NEB 2 Hybrid (RS-priority) ($/kWh)	Improved lighting levels	$0.35	$0.14	158%
NEB 3 Hybrid (RS-priority) ($/kWh)	Thermal comfort	$0.31	$0.12	161%
NEB 4 Hybrid (RS-priority) ($/kWh)	Improved indoor air quality	$0.22	$0.06	277%

Low-income

Test	NEB	Average (per participant)	Average (Overall)	Difference
NEB 1 Hybrid (min approach) ($/kWh)	Reduced Financial Stress	$0.14	$0.09	58%
NEB 2 Hybrid (min approach) ($/kWh)	Thermal Comfort	$0.14	$0.08	84%

Test	NEB	Average (per participant)	Average (Overall)	Difference
NEB 3 Hybrid (min approach) ($/kWh)	Improved Air Quality	$0.04	$0.02	67%
NEB 1 Hybrid (RS-priority) ($/kWh)	Reduced Financial Stress	$0.18	$0.09	98%
NEB 2 Hybrid (RS-priority) ($/kWh)	Thermal Comfort	$0.17	$0.09	86%
NEB 3 Hybrid (RS-priority) ($/kWh)	Improved Air Quality	$0.04	$0.02	76%

A.5 – Values Used to Calculate kWh/kW Ratio

Savings values are from the 2019 residential, business, and industrial evaluations for all programs with the exception of the Instant Discount program, which was discontinued in 2019. Savings for the Instant Discount program are from the 2018 evaluation. For sectors with savings from multiple programs (all except low-income and First Nation), an average of the kWh/kW ratio weighted by program savings was calculated across all relevant programs.

Sector to Program Mapping

Sector	Program
Residential	Instant Discount
	Heating and Cooling
Low Income	Home Assistance Program
First Nation	First Nations Conservation Program
Commercial	Small Business Lighting Program
	Retrofit Full Cost Recovery Program
	Retrofit Pay for Performance
Institutional	Small Business Lighting Program
	Retrofit Full Cost Recovery Program
	Retrofit Pay for Performance
Industrial	Small Business Lighting Program
	Retrofit Full Cost Recovery Program
	Retrofit Pay for Performance
	Process & Systems Upgrades Program
Agricultural	Small Business Lighting Program
	Retrofit Full Cost Recovery Program
	Retrofit Pay for Performance

Annual Savings and Calculated kWh/kW Ratio by Program

	Net Annual		
Program	kWh	kW	kWh/kW Ratio
Instant Discount	415,000,000	31,800	13,050
Heating and Cooling	14,652,200	5,120	2,862
Home Assistance Program	8,139,900	1747	4,659
First Nations Conservation Program	2,070,600	410	5,050
Small Business Lighting Program	19,500,000	4,000	4,875
Retrofit Full Cost Recovery Program	188,800,000	16,400	11,512
Retrofit Pay for Performance	55,700,000	8,000	6,963
Process & Systems Upgrades Program	5,521,000	1,340	4,120