CDM Framework Remote First Nations Energy Efficiency Pilot Program Evaluation Memo

September 13, 2023

SUBMITTED TO:
Independent Electricity System Operator

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

NMR Group, Inc.

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Acknowledgements

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Acronyms

Acronym	Definition
CDM	Conservation and Demand Management
CE Tool	Cost-Effectiveness Tool
CF	Correction Factor
DHW	Domestic Hot Water
EM&V	Evaluation Measurement and Verification
EUL	Effective Useful Life
FAST	Field Audit Support Tool
FNCP	First Nations Conservation Program
FTE	Full-time equivalent
HOU	Hours of Use
IESO	Independent Electricity System Operator
IF	Interim Framework
IO	Input-Output
ISR	In-Service Rate
kW	Kilowatt
kWh	Kilowatt-hours
LED	Light-emitting Diode
MAL	Measures and Assumptions List
MW	Megawatt
MWh	Megawatt-hour
NPV	Net Present Value
NTG	Net-to-Gross
PAC	Program Administrator Cost Test
PIA	Prescriptive Input Assumption
PY	Program Year
RR	Realization Rate
StatCan	Statistics Canada
SUPC	Supply and Use Product Classification
SUT	Supply and Use Table
TRM	Technical Reference Manual

Overview

NMR Group, Inc. (NMR), in partnership with subcontractor, Resource Innovations, Inc., (collectively, "the NMR team") and under contract to the Independent Electricity System Operator (IESO), performed an evaluation of the Conservation Demand Management (CDM) Framework's Remote First Nation Energy Efficiency Pilot Program (RFNEEPP) for program years (PYs) 2020 through 2022.

This memo is intended to provide impact evaluation, cost-effectiveness, and jobs impact results to IESO for the CDM Framework PY2020-PY2022 RFNEEPP. In-depth methodologies and results are presented in the appendices, while summaries are provided in the body of the memo.

Program Description

RFNEEPP was a centrally delivered pilot program providing eligible remote First Nation communities, including Wunnumin, Sachigo Lake, Kasabonika, and North Caribou, the opportunity to improve energy efficiency in both residential and community buildings. RFNEEPP helped residents in eligible communities improve the energy efficiency of their homes and manage their energy use more effectively. Energy-efficiency upgrades, education and health and safety upgrades were delivered free of charge to residents. Basic eligible efficiency measures were determined through an in-home energy audit and directly installed by a community representative. The audit results recorded eligibility for extended and weatherization measures that could be installed as part of a second home visit.

Evaluation Objectives

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

- Verify gross energy and demand savings;
- Estimate realization rates (RRs). RFNEEPP has a deemed value of 1 for Net-to-Gross (NTG) since it is a First Nation program;
- Conduct cost-effectiveness analyses;
- Estimate the avoided greenhouse gas (GHG) emissions;
- Perform a limited process evaluation
- Analyze job impacts for the program; and
- Estimate non-energy benefits (NEBs).

SUMMARY OF RESULTS

The impact evaluation results for CDM RFNEEPP are displayed in Table 1. The overall RR for CDM RFNEEPP is 99% for energy savings and 60% for demand savings.

Table 1: RFNEEPP Interim Framework Results

Metric	Units	Evaluated
Participation	Projects	116
Participation	Homes	110
Reported Energy Savings	MWh	95.1
Reported Demand Savings	MW	0.011
Gross Energy RR		0.99
Gross Demand RR		0.60
Gross Verified Energy Savings	MWh	93.9
Gross Verified Demand Savings	MW	0.006
Net-to-Gross (NTG) Ratio	--	1.00
Net Verified Annual Energy Savings (First Year)	MWh	93.9
Net Verified Annual Demand Savings (First Year)	MW	0.006
Net Verified Persisting Energy Savings to PY2026	MWh	93.9
Net Verified Persisting Demand Savings to PY2026	MW	0.006
Program Administrator Cost (PAC) Test Ratio	--	0.02
Levelized Delivery Cost (Energy)	$/kWh	1.82
Levelized Delivery Cost (Demand)	$/kW	$27,266

Section 1 Methodology

This section provides a summary of the impact, cost-effectiveness, jobs impact analysis, and non-energy benefits methodologies in this section. Detailed descriptions of these methodologies are provided in Appendix A.

1.1 Impact Evaluation Methodology

To complete the CDM RFNEEPP impact evaluation, the NMR team performed the following activities:

- Review of program tracking data
- Analysis of in-service rates (ISRs) and hours of use (HOU) using participant survey data
- Engineering desk reviews
- Incorporated results from the PY2019 review of technical reference manuals (TRMs) from other jurisdictions[1]

These are standard practices for comparing evaluated savings with reported savings. IESO Evaluation Measurement and Verification (EM&V) staff agreed with the NMR team to use the entire RFNEEPP population, from both the Interim Framework and 2021 – 2024 Conservation and Demand Management (CDM) Framework, to determine the desk review sample. This was done because program design and delivery were the same between both frameworks. However, only the impact results from the CDM Framework are presented in this memo. A more detailed description of the impact evaluation methodology is provided in Appendix A.1.

1.2 Cost-Effectiveness Evaluation

The NMR team completed the cost-effectiveness analysis in accordance with the IESO requirements as set forth in the IESO *Cost-Effectiveness Guide for Energy Efficiency*[2] and using IESO's *Cost-Effectiveness Tool*. The energy and demand savings results from the impact evaluation were inputs into the IESO *Cost-Effectiveness Tool*, as was administrative cost and incentive information supplied from IESO. A more detailed description of the cost-effectiveness methodology is provided in Appendix A.2.

1.3 Jobs Impact Analysis Methodology

The NMR team quantified the number of full time equivalent (FTE) net job impacts as well as total net job impacts (both direct and indirect jobs) resulting from the investment and activities of each

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[1] See "Secondary Data Review of TRMs" (Section 2.1.2) in the Methodology section of the PY2019 HAP Evaluation.

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

program. We relied on primary and secondary data collection and Statistics Canada[3] (StatCan) Input-Output (IO) modeling to quantify net jobs impacts. IO models are used to analyze the propagation of exogenous economic shocks throughout an economy. The models represent relationships, or flows, of inputs and outputs between industries. When an energy-efficiency program such as RFNEEPP is funded and implemented, it creates a set of "shocks" to the economy, such as demand for specific products and services, and additional household expenditures from energy bill savings. The shocks and their impacts can be measured variables economic output and employment. A more detailed description of the jobs impact analysis methodology is provided in Appendix A.3.

1.4 Non-Energy Benefits Methodology

The NEBs methodology for RFNEEPP followed the same methodology as the *Non-Energy Benefits Study: Phase II*, which assessed the NEBs from energy-efficiency projects funded by the IESO over 2017 – 2019.[4,5] The NEBs were calculated using the relative scaling approach and the willingness to pay approach to determine the value of NEBs that program participants realized by installing program measures. All survey respondents were asked to value all NEBs using both techniques. The data collected from these questions was then used to quantify the NEBs. A more detailed description of the NEBs analysis methodology is provided in Appendix A.4.

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[3] Statistics Canada is the Canadian government agency commissioned with producing statistics to help better understand Canada, its population, resources, economy, society, and culture.

[4] Dunsky. (July 2021). *Non-Energy Benefits: Phase II; Quantified Benefits and Qualitative Insights*. https://www.ieso.ca/-/media/Files/IESO/Document-Library/conservation-reports/Non-Energy-Benefits-Study-Phase-II.ashx

[5] The Phase II study assessed the NEBs from energy-efficiency projects funded by the IESO over 2017-2019. The NEBs were calculated using the relative scaling approach and the willingness to pay approach to determine the value of NEBs that program participants realized by installing program measures. All survey respondents were asked to value all NEBs using both techniques. The data collected from these questions was then used to quantify the NEBs.

Section 2 Impact Evaluation

This section provides the impact evaluation results. Details regarding the impact methodology can be found in Section 1.1 and Appendix A.1. Additional impact-related results, rationale and drivers of realization rates (RR), and general insights from the impact evaluation activities by measure category can be found in Appendix A.

2.1 High-Level Results

The gross verified savings for RFNEEPP have a net-to-gross (NTG) ratio of 1.0 applied to them, meaning gross verified and net verified savings are equal (Table 1). The results presented in this section refer to the gross verified savings and can be considered equivalent to net verified first year savings. It should also be noted that all measure lifetimes and the savings that are associated with those measures persist through 2026. This is a key metric to assess RFNEEPP performance compared to CDM savings targets.

In addition, the results presented in these subsections represent the RFNEEPP impacts for the entire CDM Framework.

2.1.1 Gross Verified Energy Savings Key Results

- RFNEEPP achieved 93.9 MWh of net energy savings persisting to 2026.
- The overall program RR is 99% for energy savings.
- Appliance measures achieved an RR of only 48% for energy savings, while accounting for 3% of the total program savings. Both were the lowest such values among all program measures, largely due to freezers having negative verified savings and an RR of -34% for energy savings.
- Domestic hot water measures had an RR of 86% and accounted for the largest portion of RFNEEPP savings (32%).
- Smart power bars had a realization rate of 512% due to outdated reported savings values being applied to smart power bars.
- The lighting measures category had an RR of 79% and accounted for 24% of total program savings.
- The miscellaneous measure category includes block heater timers and indoor drying racks or clotheslines. It had the second-highest high RR for energy savings (95%) and accounted for the second-most gross verified savings of any category (25%).

2.1.2 Gross Verified Demand Savings Key Results

- RFNEEPP achieved 0.011 MW of net demand savings persisting to 2026.
- The overall program RR is 60% for demand savings.

- Domestic hot water measures had the highest RR (93%) and accounted for the largest portion of CDM RFNEEPP demand savings at 50%.
- Lighting measures had an RR of 85% for demand savings and these represented about 24% of total program demand savings.
- Appliances had a 47% RR and accounted for only 5% of program savings, the lowest of any measure category.
- Smart power bars had no demand savings reported in the tracking data but accounted for 8% of verified demand savings. A measure-level RR could not be calculated for these measures due to no reported demand savings.

2.1.3 Gross Verified and Reported Savings Assessment

The gross verified energy savings for RFNEEPP were comprised primarily by domestic hot water measures, which covered roughly one-third (32%) of total program savings (Figure 1). Miscellaneous (24%), lighting (23%), and power bar measures (18%) were the next largest end-use categories for RFNEEPP. Appliances accounted for only 3% of gross verified savings for RFNEEPP.

Figure 1: Gross Verified Energy Savings by End-Use (kWh/year)

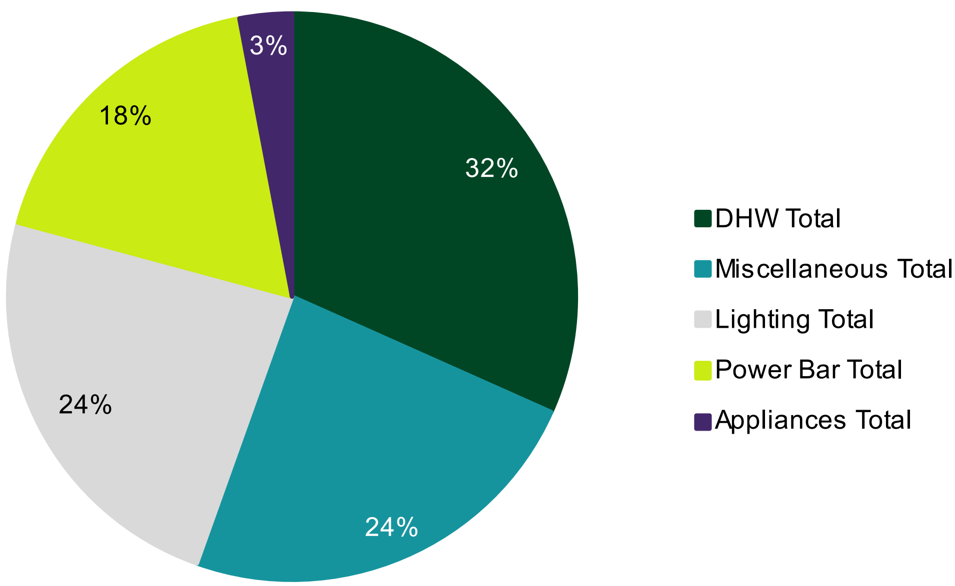
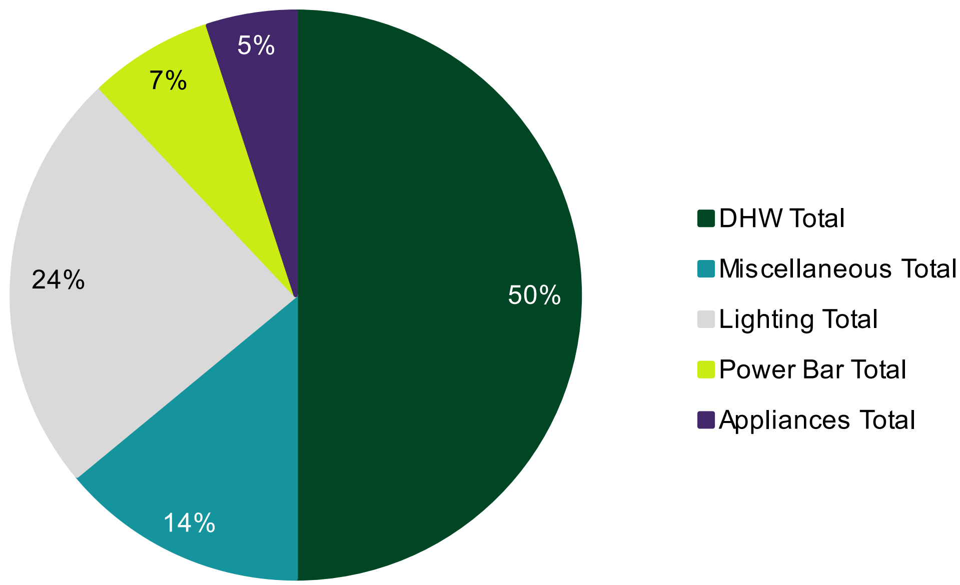


Figure 2 displays the proportion of gross verified demand savings by end-use category for RFNEEPP. Domestic hot water measures covered half of total demand savings at 3.2 kW for RFNEEPP from PY2022. Showerheads and faucet aerators were the primary demand saving measures installed in the program, accounting for over one-third of gross verified demand savings. Lighting and miscellaneous measures (i.e., indoor drying racks or clotheslines) were the other primary end-use categories that attributed to gross verified demand savings. Lighting measures represented nearly a quarter (24%) of gross verified demand savings, specifically the

7W – 11W LEDs, which accounted for 12% of total savings. The smart power bars and appliance measures only accounted for 8% and 5% of total savings, respectively.

Figure 2: Gross Verified Demand Savings by End-Use (kW/year)



2.1.4 Program Level Savings

Table 1 presents reported, gross verified, and net first year energy and demand savings for the entire CDM Framework RFNEEPP program population covering PY2020 to PY2022, all of which are reported in PY2022. The program realization rate for gross verified energy savings is 97% and gross verified demand savings is 60%. As described above, the NTG ratio is assumed to be 1.0 for the RFNEEPP. Measure level impacts for both energy and demand savings are detailed in Appendix A.

Table 1: RFNEEPP Program Level Reported, Gross Verified, and Net First Year Savings for the CDM Framework

Metric	Units	PY2022
Reported Energy Savings	MWh	95.1
Reported Demand Savings	MW	0.011
Gross Energy RR	MWh	0.99
Gross Demand RR	MW	0.60
Gross Verified Energy Savings	MWh	93.9
Gross Verified Demand Savings	MW	0.006
Net-to-Gross (NTG) Ratio	--	1
Net Verified Annual Energy Savings (First Year)	MWh	93.9
Net Verified Annual Demand Savings (First Year)	MW	0.006
Net Verified Persisting Energy Savings to PY2026	MWh	93.9

Metric	Units	PY2022
Net Verified Persisting Demand Savings to PY2026	MW	0.006

Evaluated CDM RFNEEPP project homes were spread across four First Nations communities:[6]

- Wunnumin (n=63)
- Kasabonika (n=25)
- Sachigo Lake (n=23)
- North Caribou (n=1)

[6] Inconsistent and/or missing program tracking data (e.g., city, postal code) limited efforts to quantify how many unique participants there were in each community. Four projects were affected in total.

Section 3 Cost-Effectiveness Evaluation

This section provides the cost-effectiveness evaluation results. Details regarding the cost-effectiveness methodology can be found in Section 1.2 and Appendix A.2.

The PY2022 CDM RFNEEPP cost-effectiveness results are presented in Table 2. The program did not pass the Program Administrator Cost (PAC) in any year, meaning the program benefits were less than their respective costs. This is consistent with findings for low income programs in other jurisdictions. Additionally, regulations in other jurisdictions commonly do not require low-income programs to meet cost effectiveness.[7]

Table 2: Program Level Cost-Effectiveness Key Metrics

Cost-Effectiveness Test	PY2021	PY2022	Total
PAC			
PAC Costs ($)	$355,017	$1,121,454	$1,476,471
PAC Benefits ($)	$24,131	$8,247	$32,378
PAC Net Benefits ($)	-$330,886	-$1,113,207	-$1,444,093
PAC Net Benefit (Ratio)	0.07	0.01	0.02
Levelized Delivery Cost			
$/kWh	$0.57	$5.86	$1.82
$/kW	$8,541	$89,120	$27,266

The program's PAC and levelized delivery cost (LC) metrics indicate that the program's cost effectiveness dropped significantly from PY2021 to PY2022.

To understand why the ratios changed year to year, one can look at the corresponding costs and benefits that comprise these CE ratios. The PAC costs increased substantially in PY2022, mainly due to the impact of higher admin costs compared to PY2021. The IESO admin costs for PY2022 of $1,086,634 was a 356% increase from the PY2021 IESO admin costs of $305,056. Additionally, net energy and demand savings for PY2021 were much higher than PY2022 with PY2021 accounting for 76% of the total energy savings and 77% of the total demand savings.

At the measure level, the measures with the highest PAC ratio (i.e., were the most cost effective) tended to be measures with low cost and that served lighting, hot water heating, and plug load end uses. These included 11W LED light bulbs, hot water pipe wrap, low water flow devices (bath and kitchen faucet aerators and showerheads), and engine block heater timers.

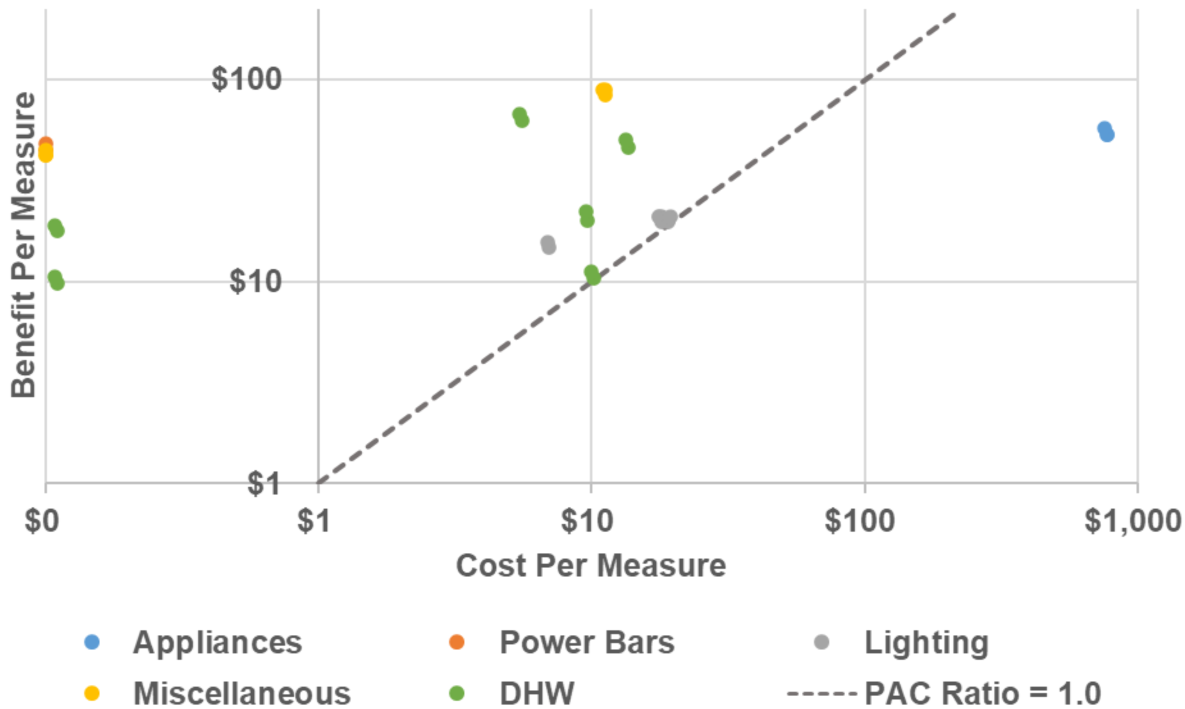
The measures with the lowest PAC ratio (i.e., were the least cost effective) were the various sizes of refrigerator and freezer measures, which also make up the highest cost measures offered in the program. Additionally, there were attic insulation measures that did not generate any energy

[7] *Guidelines for Low-Income Energy Efficiency Programs,* American Council for an Energy-Efficient Economy, https://database.aceee.org/state/guidelines-low-income-programs

or demand savings for the program but carried program costs. Due to a large increase in quantity of the attic insulation measure from PY2021 to PY2022, the negative net benefits attributed to this measure increased from negative $4,563 in PY2021 to negative $15,630 in PY2022.

Figure 3 below more generally presents the relative costs and benefits by end use. We observe that while household appliances (freezers and refrigerators) offer okay benefits, their costs are by far the highest. Clustered around approximately $10 in cost each are some water heating measures, lighting measures, and miscellaneous (block heater timers and outdoor clotheslines) measures. While these measures are low-cost and generally have the best measure-level PAC ratios, they provide relatively smaller benefits per measure. Note, as mentioned earlier in the report, the NMR team verified negative savings for freezer measures.

Figure 3: PAC Benefits vs. Costs by End Use*



*Note: x and y axes use logarithmic scale

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Section 4 Other Energy-Efficiency Benefits

This section provides results related to the program's other energy-efficiency benefits including avoided greenhouse gas emissions (GHG), the jobs impact analysis, and the non-energy benefits analysis.

4.1 Avoided Greenhouse Gas Emissions

This section provides the avoided greenhouse gas (GHG) emission results. The NMR team used the IESO's *Cost Effectiveness Tool* to calculate avoided GHG emissions. The NMR team calculated avoided GHG emissions for the first year and for the lifetime of the measures. Table 3 presents the results of these calculations for each program year and the total for the framework.

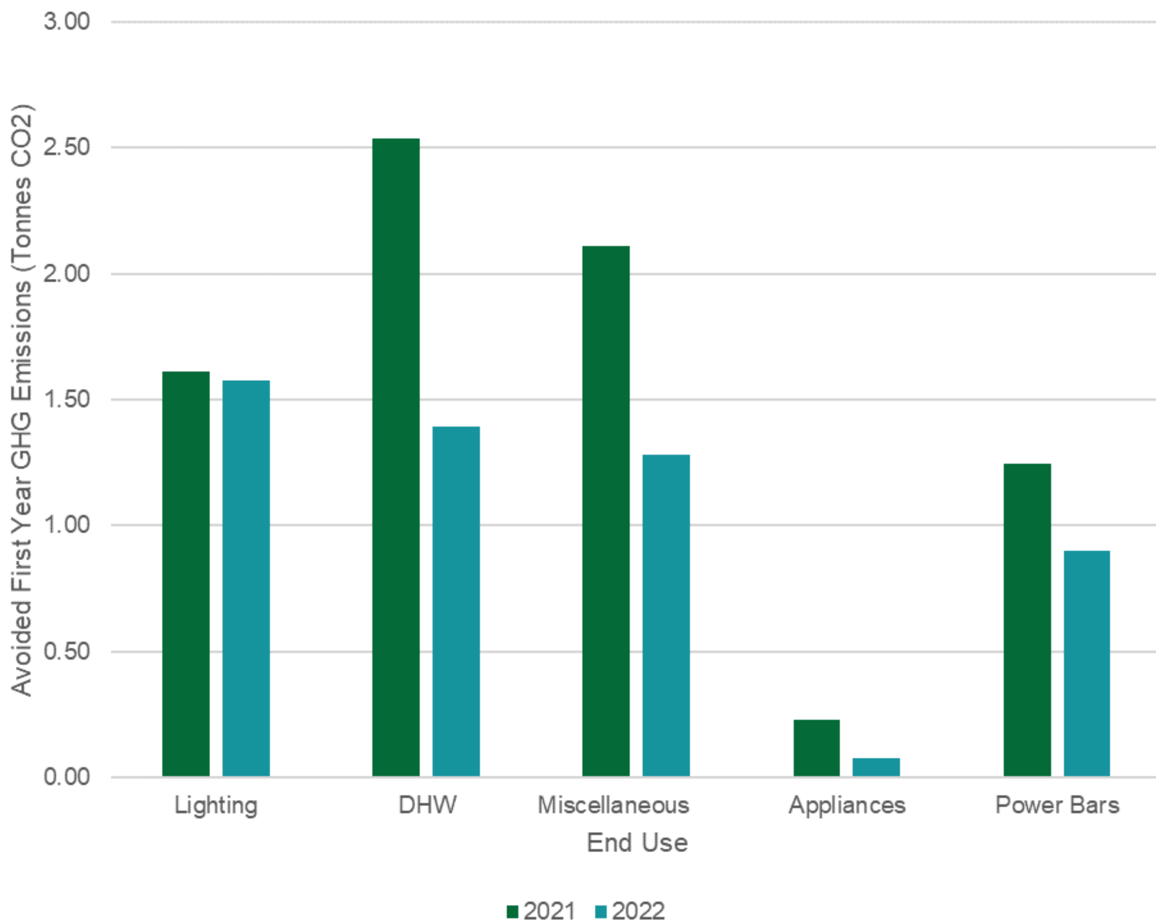
Table 3: Avoided GHG Emissions by Program Year and Total Framework

Avoided (Tons CO_2 equivalent)	PY2021	PY2022	Total
First Year	7.74	5.22	12.96
Lifetime	156.33	51.35	207.68

Corresponding to energy and demand savings performance, each end-use produced higher first year GHG emissions reductions in PY2021 compared to PY2022.

Overall, PY2021 achieved 7.74 tons CO2 equivalent in first year GHG reductions compared to 5.22 in PY2022, a 32% reduction year over year. Most of this reduced impact in PY2022 came from the DHW and miscellaneous end-uses, which accounted for 46% and 33% of the overall decrease in first year GHG reduction achieved in PY2022. The appliances end-use saw the largest year over year percentage decrease of any end-use experiencing a 67% decrease, but this category only accounted for 3% and 1% of the PY2021 and PY2022 GHG reduction respectively. No end-use saw an increase in avoided GHG emissions in PY2022, but the lighting end-use saw the smallest decrease, only 2% less than PY2021., the lighting end-saw its percentage contribution to the total program year savings increase from 21% in PY2021 to 30% in PY2022due to the overall decrease in avoided GHG emissions in PY2022 compared to PY2021 while the lighting end-use avoided GHG emissions remained relatively flat across the two program years.

Figure 4: Comparison of Avoided GHG Emissions by End Use and Program Year



4.2 Jobs Impact Analysis

This section provides the jobs impact analysis results. Details regarding the jobs impact analysis methodology can be found in Section 1.3 and Appendix A.3. Additional jobs impact results can be found in Appendix C.

4.2.1 Input Values

The model was used to estimate the impacts of two economic shocks – one representing the demand for energy-efficient products and services from RFNEEPP, and the other from the increased household expenditures due to bill savings (and net of program funding). Table 4 shows the input values for the demand shock representing the products and services related to RFNEEPP. Each measure installed as part of RFNEEPP was categorized according to the StatCan IO Supply and Use Product Classifications (SUPCs).

Table 4: Summary of Input Values for Demand Shock

Category Description	Non-Labor ($ Thousands)	Labor ($ Thousands)	Total Demand Shock ($ Thousands)
Major appliances	20	2	22
Other miscellaneous manufactured products	21	0	21
Electric light bulbs and tubes	6	0	6
Small electric appliances	1	2	3
Other professional, scientific, and technical services	-	-	33
Office administrative services	-	-	1,392
Total			**1,476**

Table 5 shows the calculations and input value for the household expenditure shock.[8] This shock represents the net additional amount that households would inject back into the economy through spending. Additional background and details about the shock inputs can be found in Appendix A.3.

[8] The model is actually run with a normalized value of $1 million in extra household expenditures and the job results can be scaled by the actual demand shock.

Table 5: Summary of Input Values for Household Expenditure Shock

Description	Demand Shock *($ Thousands)*
Net Present Value (NPV) of energy bill savings	146
Residential portion of program funding	(517)
Net bill savings to residential sector	**(371)**
Percent spent on consumption (vs. saved)	54%
Total Shock	**(201)**

4.2.2 Model Results

Impacts from the StatCan I-O model are generated separately for each shock and added together to calculate overall program job impacts. In the case of RFNEEPP, two different sets of job impacts are combined into the overall job impacts. Table 6 shows the total estimated job impacts by type – combining the impacts from the demand and household reinvestment shocks. The majority (10 out of the 11 estimated total jobs) were in Ontario. All the direct and indirect jobs created were created in Ontario. A slightly smaller share of the induced jobs was in Ontario, with 2 out of 3 induced total jobs within the province. The FTE estimates are slightly less, with a total of 8 FTEs (of all types) created in Ontario and 9 FTEs added throughout Canada. Calculating relative program performance as a function of jobs created per $1M of program budget is helpful in comparing different program years. RFNEEPP was estimated to create 7.4 total jobs per $1M of investment in 2022.

Table 6: Total Job Impacts by Type

Job Impact Type	FTE *(in person-years)* - Ontario	FTE *(in person-years)* - Total	Total Jobs *(in person-years)* - Ontario	Total Jobs *(in person-years)* - Total	Total Jobs per $1M Investment *(in person-years)*
Direct	4	4	5	5	3.5
Indirect	2	2	3	3	2.0
Induced	2	2	2	3	2.0
Total	**8**	**9**	**10**	**11**	**7.4**

A more detailed write up of the model impacts, including a breakout of impacts by industry, can be found in Appendix C.

4.3 Non-Energy Benefits Analysis

This section provides the NEBs estimation results. Details regarding the NEBs methodology can be found in Section 1.4 and Appendix A.4.

Please note that the PY2022 NEB results are presented in this section for informational purposes only. The team used the Phase II study NEBs values within the PY2022 Cost Effectiveness calculator rather than the PY2022 NEBs study values per IESO guidance. This will allow the IESO to collect additional NEBs data in future evaluation years.

1.1.1 Key Findings

Key findings from the NEBs analysis include the following:

- Using the **hybrid, minimum approach**, the PY2022 NEBs values were $0.21/kWh for reduced financial stress, $0.09/kWh for thermal comfort, $0.12/kWh for improved indoor air quality, and $0.10/kWh for improved lighting levels.

1.1.2 Quantified NEBs Values

The PY2022 RFNEEPP participant survey included six participants who had experienced at least one NEB from the measures installed through the program. The RFNEEPP participant survey asked about participant experiences with four NEBs:

- **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.
- **Improved indoor air quality:** Reduction in air pollutants in indoor environment.
- **Improved lighting levels:** Improved indoor or outdoor lighting.

Two PY2022 participants experienced NEBs from reduced financial stress, three experienced NEBs from improved thermal comfort, two experienced NEBs from improved indoor air quality, and four experienced NEBs from improved lighting levels (Figure 5).

Figure 5: Participant Observation of NEBs, Phase II & PY2022

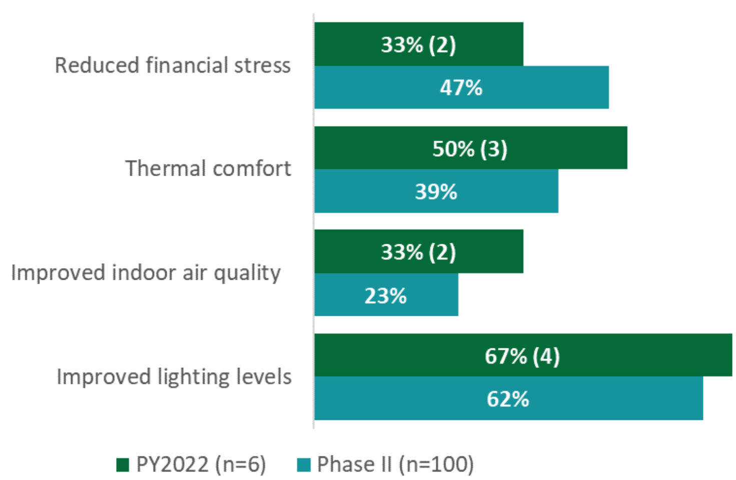


Table 7 shows quantified NEBs values for Phase II and PY2022 based on the hybrid, minimum ($/kWh) valuation, the approach recommended by the Phase II study.[9] In PY2022, reduced financial stress was valued highest by RFNEEPP respondents ($0.21/kWh), followed by improved indoor air quality ($0.12/kWh), improved lighting levels (($0.10/kWh), and thermal comfort ($0.09/kWh).

Two surveyed RFNEEPP auditors reported that participants experienced NEBs from improved lighting levels and improved indoor air quality. One surveyed RFNEEPP contractor reported no non-energy benefits.

Table 7: Quantified NEBs ($/kWh), PY2022 & Phase II

NEB	PY2022	Phase II
Reduced financial stress	$0.21	$0.09
Thermal comfort	$0.09	$0.09
Improved indoor air quality	$0.12	$0.06
Improved lighting levels	$0.10	$0.08

One RFNEEPP participant who’s heating system was not connected to the grid (and had no reported energy savings) but had received weatherization measures experienced NEBs from improved thermal comfort. This participant estimated their electricity savings from these program-installed upgrades for a full year to be $100 and reported that this benefit was approximately equal in value to the amount of their electricity savings. They reported they would be prepared to pay $100 per year if they had to pay for this benefit. This participant’s NEBs responses were not factored into the reported NEBs results since their heating system was not connected to the grid.

The Phase II study found that program participants placed a great deal of value on NEBs. In many cases, the value of the NEBs exceeded the value of the participant energy savings. This was also the case in PY2022, with most respondents reporting NEBs having an equal or higher value on a yearly basis than the amount of their electricity bill or savings. Furthermore, when asked if they had to pay for a certain benefit, independently from the energy savings, seven of the eight (88%) participant estimates were of an equal or higher value per year than the amount of their electricity bill or 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.

[9] Dunsky. (July 2021). *Non-Energy Benefits: Phase II; Quantified Benefits and Qualitative Insights*. https://www.ieso.ca/-/media/Files/IESO/Document-Library/conservation-reports/Non-Energy-Benefits-Study-Phase-II.ashx

Section 5 Key Findings and Recommendations

This section provides the evaluation key findings and recommendations.

Finding 1: Tracking of health and safety barriers in project files and tracking data was inconsistent and overly broad. Tracking data only flagged projects that received funding to address health, safety, and comfort – i.e., no record of specific health and safety concerns. Engineering desk reviews turned up projects with health and safety barriers (e.g., mold, exposed electrical wiring) without a corresponding line item in tracking data, and projects with a flag for health issues in tracking data but no corresponding record in project files. Tracking health and safety barriers is key to understanding the potential for increasing the uptake of high-savings measures like weatherization. Previous evaluations[10] have recommended an emphasis on weatherization upgrades due to high per-unit savings and co-benefits of increased occupant comfort.

> **Recommendation 1a.** Improve the quality and comprehensiveness of health, safety, and comfort data collected on-site and contained in the program tracking data. This could include adding required fields to program tracking data for any projects where auditors and contractors identify a health and safety barrier (e.g., what barrier(s) did they observe, what measures were they unable to install as a result).

> **Recommendation 1b.** Develop a participant journey map for homes with observed health and safety barriers. Equip auditors and contractors with the time and resources to provide guidance on how participants can remediate any observed health and safety barriers. This could include referrals to contractors that could conduct the necessary remediation and program incentives specifically tied to these steps. In addition, these journey maps can extend into follow-up plans for participants to receive certain energy-efficiency measures that weren't installed due to health and safety concerns, after remediation has occurred.

Finding 2: Auditors and contractors observed whether participants' homes contained heat recovery ventilation (HRV) but rarely recommended maintenance or upgrades. Auditors and contractors documented the presence of HRV systems in 40% of desk-reviewed projects (n=77). However, only slightly more than one-fourth (29%) of desk-reviewed projects had an operational HRV, and there was no documentation of why non-operational systems were not in use. Engineering desk reviews did not find any evidence that auditors and contractors consulted participants on the overlapping impacts of upgrading building insulation and ventilation systems[11]. Data on HRV were not passed through to the program tracking database.

> **Recommendation 2a.** In participant homes that receive air sealing, add specific incentives for HRV or energy recovery ventilator (ERV) installation and/or upgrade to promote deeper air sealing savings. Program support for HRV/ERV should include

[10] See Finding 1 in the 2021-2024 CDM Framework: PY2021 Energy Affordability Program Evaluation Report; see also Recommendation 2a in the Interim Framework: First Nations Conservation Program Evaluation Report.

[11] ASHRAE Standard 62.1 and 62.2 dictate a certain level of ventilation needed per person in a given space for acceptable indoor air quality.

balancing, maintenance, and educational materials. While an HRV/ERV represents an additional electric load, the deeper savings from tightening the home, lowering the overall heating and/or cooling load of the home, and potential non-energy benefits in occupant comfort and indoor air quality may outweigh the increased electrical load from any added mechanical ventilation.

Recommendation 2b. Create variables in program tracking data that document whether participant homes have an HRV/ERV, and whether it is operational. As part of recommending building envelope upgrades, require that auditors and contractors assess whether ventilation systems are appropriately sized following those upgrades, per industry best practice.

Finding 3: RFNEEPP program tracking data lists completed projects under multiple identifiers for the same home and contains inconsistent contact information for verifying unique participants. In addition, tracking data does not typically include key characteristics that are collected during audits such as building type or mechanical equipment for heating/cooling. Data quality issues such as multiple unique identifiers, inconsistent contact information, and incomplete building/equipment characteristics can adversely affect program planning and evaluation. A single, unique identifier that traces all project work back to one home improves the timeliness of sample development and subsequent data requests to program vendors. Identifiers can also be generated for homes where project work was attempted but not completed, to facilitate follow-up visits and track incomplete audits. These unique identifiers are critical for impact evaluations that encompass multiple program years. Data capturing key building and/or equipment characteristics can be used to better estimate savings impacts, to identify additional energy saving opportunities at existing participant homes, and to provide insights into future program offerings. However, all RFNEEPP participant records were missing data on building type information and had no fields to record mechanical equipment details.

Recommendation 3a. Work with program staff and program delivery vendors to consistently incorporate details collected on-site into the tracking data (e.g., building type, mechanical equipment for heating/cooling, heating fuel, efficiency, capacity, and HRV data (see ***Finding 2***). This could include revising the IESO's Field Audit Support (Fast) Tool program or development of a new uniform electronic data collection form for auditors to upload these data directly into the tracking data.

Recommendation 3b. Consolidate the multiple, overlapping sets of application identifiers currently used in tracking data such that each home has a unique identifier.

Recommendation 3c. Quantify the number of attempted but incomplete RFNEEPP audits, in addition to tracking program participants. These data can help program staff and program delivery vendors determine where program participation has the greatest growth potential and more quickly identify where there are potential participation barriers.

Recommendation 3d. Develop protocols to verify that Measure Lists the IESO provides to delivery agents split out reported savings for measures whose substantiation sheets have different reported savings depending on building type, heating and/or cooling systems, heating fuel, etc. IESO Measure Lists should also flag which demand factor is used to calculate savings. Ensure the MAL also documents these different reported savings.

Finding 4: Desk review results suggest that the average consumption of replaced refrigerators aligns more closely with the federal minimum consumption (UEC_{base}) than assumed existing consumption (UEC_{exist}). IESO deemed UEC_{exist} values are reasonable compared with equivalent deemed values in the Illinois Technical Reference Manual (TRM) but overestimate actual existing refrigerator consumption as observed in PY2022 and PY2021 desk reviews.[12] No other TRMs in the cross-jurisdictional scan explicitly listed UEC_{exist} values. No TRMs require blended savings based on existing equipment and federal minimum baselines, as is currently the case in IESO substantiation sheets. Instead, reviewed TRMs list separate savings assumptions depending on whether the refrigeration equipment has a time of sale or early replacement baseline.[13] Separate MAL entries for time of sale and early replacement scenarios would reflect the reality that the IESO is in some cases replacing refrigeration equipment past its effective useful life (EUL). As a result, separate MAL entries could improve the accuracy of claimed savings from refrigeration upgrades.

Recommendation 4a. Create separate MAL entries for time of sale vs. early replacement refrigerators, as well as different refrigerator configurations (e.g. top-freezer, bottom-freezer, side-by-side). Alternatively, conduct an appliance baseline study to update the current assumption in substantiation sheets that the remaining useful life (RUL) of an early replacement refrigerator/freezer is one-third of its effective useful life.

Recommendation 4b. Conduct an appliance baseline study to update unit energy consumption values in all appliance substantiation sheets.

Recommendation 4c. Make delivery vendors aware of any future changes to appliance baseline assumptions. Verify that vendors are installing refrigeration equipment that consumes less energy than the assumed unit energy consumption of existing (UEC_{exist}) and minimally compliant (UEC_{base}) refrigerators / freezers.

Finding 5: The energy consumption thresholds for refrigerators and freezers listed in Audit & Retrofit Protocols do not align with the equipment age used to determine eligibility for replacement (i.e., manufactured in 2011 or earlier) as listed in auditors' data collection forms. A cross-jurisdictional scan of technical reference manuals (TRMs) determined that for refrigerators and chest freezers, the Audit & Retrofit protocol thresholds for energy consumption

[12] PY2022 includes EAP and RFNEEPP desk reviews, whereas PY2021 only includes EAP desk reviews. Desk reviews are not sufficient for recommending updates to UEC_{exist} because they do not reflect the energy consumption for refrigerators associated with the non-participant population. A representative baseline for appliance energy consumption requires a sample frame containing households with and without prior experience in energy-efficiency programs such as EAP.

[13] "Time of sale" refers to cases where the replaced equipment is past its effective useful life (EUL), so the baseline equipment meets the minimum regulatory requirements for energy consumption (UEC_{base}). "Early replacement" refers to cases where the existing equipment is not past its EUL. In these instances, the baseline equipment is the existing refrigerator for the assumed remaining useful life (UEC_{exist}), then the "time of sale" baseline (UEC_{base}) until the end of its effective useful life (EUL). Refer to entry 5.1.6 in the 2022 Illinois TRM for additional details. Some jurisdictions may adjust their baseline and/or EUL assumptions based on the region, income levels, etc. of the populations they serve.

(925 & 615 kWh, respective) imply that only models older than 2001 would be eligible for replacement. However, data collection forms list 2012 as the threshold for auditors and contractors to use when determining eligibility.

Recommendation 5a. Lower the audit protocol thresholds for refrigerators and chest freezers to the NY TRM LMI baseline consumption for a refrigerator manufactured in the latest year IESO has determined is still eligible for replacement (2011) per the data collection forms included in project files.

Recommendation 5b. Specify separate minimum refrigerator and freezer consumption thresholds in Audit & Retrofit Protocols based on appliance configuration (e.g., upright vs. chest freezers).

Appendix A Detailed Methodology

This appendix presents the methodology applied for various components of the RFNEEPP evaluation: impact, cost-effectiveness, avoided GHG emissions, jobs impacts, and non-energy benefits (NEBs).

A.1 Impact Methodology

This appendix provides additional details about the impact evaluation methodology. A summary of the methodology was provided in Section 1.1. As noted there, IESO Evaluation Measurement and Verification (EM&V) staff agreed with the NMR team to use the entire RFNEEPP population, from both the Interim Framework and 2021 – 2024 Conservation and Demand Management (CDM) Framework, to determine the desk review sample. This was done because program design and delivery were the same between both frameworks. However, only the impact results from the CDM Framework are presented in this memo.

A.1.1 Impact Sampling

The NMR team sampled RFNEEPP participants at the project level for desk reviews (Table 8). Initially, the projects were examined to determine what measures and combination of measures were most common across projects to ensure that strata could be created without excluding any measure categories. Projects were then binned based on the level of deemed gross savings for the entire project. These bins were the high-savers (projects whose summed measure savings were in the top 20% of savings), medium-savers (projects whose summed measure savings were in-between the 33rd and 80th percentile of savings) and low-savers (projects whose summed measure savings were in the lowest 33% of savings).

The NMR team used the projects in the top 20% of savings as the sample frame for desk reviews. Initial allocations yielded a sample size that met the desired confidence levels for all measures of interest except refrigerators and freezers. Given this deficiency and the low incidence of these measures in the program population, the NMR team modified the allocation to include a census review of projects with either a refrigerator or freezer. These steps resulted in a final sample size of 77 projects. This approach balanced competing needs, that the desk review sample included the most program savings possible while covering as many low-incidence measures as possible.

Table 8: Desk Review Sample Summary

n	77
Avg. # of Measures per Project	8.9
Avg. kWh Deemed Savings per Project	1,387

A.1.2 Program Tracking Database Review

The NMR team analyzed the participant database and conducted a cross-cutting assessment to identify the evaluation priorities and to develop a sampling plan. The NMR team assigned priorities based on the following metrics:

- Measures that accounted for the largest share of savings
- Measures that have the most uncertainty around their estimated savings
- The amount of evaluation work done for each measure in previous evaluations

The NMR team also conducted a comprehensive review of the RFNEEPP tracking database to identify key measures, savings discrepancies, and other issues that impact the accuracy of reported savings. The review checked for consistency between measure-level reported savings and the Measures and Assumptions List (MAL) values. In addition, the NMR team verified the accuracy of reported savings calculations based on the IESO substantiation sheet algorithms for prescriptive measures that were updated as a part of the PY2019 impact evaluation activities. The NMR team also leveraged the database to calculate gross and verified net savings for the entire population. Equation 1 shows the program tracking data correction factor calculation, which aligned reported savings with the updated PY2019 evaluation substantiation sheet savings values. Note that if there were no errors or inconsistencies in the reported savings calculations, the correction factor would equal one.

Equation 1: Program Tracking Data Correction Factor

$$\begin{aligned} &Tracking\ Data\ Correction\ Factor\ (CF) \\ &\quad = Deemed\ savings\ value\ (PY2019\ Updated\ Substantiation\ Sheet\ Savings) \\ &\quad \div Reported\ Saving \end{aligned}$$

As part of the program tracking database review, the NMR team also reviewed the appliance energy consumption thresholds used in substantiation sheet algorithms and the IESO Audit and Retrofit Protocols to determine measure eligibility and calculate program savings for refrigerators and freezers. This review consisted of three tasks:

- A jurisdictional scan to compare baseline energy consumption data, using updated versions of the TRMs that informed PY2019 substantiation sheet savings updates

- Analysis of on-site metering of refrigeration energy consumption by RFNEEPP technicians

- A review of the split between existing appliance consumption and federal minimum energy consumption in substantiation sheet algorithms

The results of the appliance energy consumption threshold review are discussed in B.4.

A.1.3 In Service Rate (ISR) and Hours of Use (HOU) Analysis

The NMR team surveyed RFNEEPP participants to verify the number of measures installed and in use on their premises. No measures achieved the desired sampling error (10%) at a 90% confidence level based on the PY2022 participant survey alone, so the NMR team incorporated the PY2021 FNCP participant survey ISR results.[14]

[14] Aerators, showerheads, indoor drying racks or clotheslines, and tank/pipe insulation did not have an ISR due to low sample sizes.

The NMR team also surveyed participants to determine HOU for measures more directly impacted by occupant usage. However, no measures achieved the desired sampling error (10%) at a 90% confidence level to justify an adjustment, even when incorporating PY2021 FNCP participant survey HOU results.

The results for the ISR and HOU aspects of the participant surveys are discussed in Section 2 and Appendix A.

A.1.4 Engineering Desk Reviews

The engineering desk reviews consisted of a review of the 77 sampled projects that the NMR team selected as part of the program tracking database review and sampling process. The program delivery vendor provided the NMR team with documentation for the sampled projects. The NMR team conducted a thorough review of the detailed project documents, which consisted of application forms, invoices, appliance shipment confirmations, energy models, photos, and auditor data collection forms.

A.1.5 Prescriptive Measures

The NMR team assessed prescriptive measure quantities and measure descriptions based on the documentation provided for the sampled projects. The NMR team conducted additional research to determine the actual nominal energy usage for appliance measures based on existing and new equipment model numbers (when available) to reflect savings estimates more accurately from these measures. The NMR team used the program tracking data review, the PY2019 review of other TRM's, and the desk review to calculate measure-specific RRs, which the NMR team then applied to the population. The NMR team generated measure specific ISR values from participant survey results and then applied them to gross savings calculations. Equation 2 shows the gross verified savings calculation for prescriptive measures. Note that if there were no corrections as a result of the program tracking data review, nor adjustments made during the PY2019 substantiation sheet savings review (Equation 1), the RR would only reflect any discrepancies found during the desk review (i.e., quantity discrepancies or installed measure inconsistencies).

The inputs for the equation are described below:

- **Gross verified savings:** The evaluated savings after all evaluation activities, excluding net-to-gross adjustments, are conducted.
- **Reported unit savings:** The savings associated with installing one unit of a particular measure (e.g. one light bulb or 3' of pipe insulation) according to the IESO's substantiation sheets and MAL.
- **Desk review RR:** This is the ratio of reported to verified savings for a particular measure based on review of project files. For example, some measures have discrepancies in quantity or type between data sources or may exist in program tracking data but not in project file documentation.

- **Adjusted TRM CF:** A factor applied to ensure that reported savings align with deemed savings values defined in substantiation sheets (see Equation 1).
- **ISR:** For each measure, the percentage of units distributed to participants that are still in use. This factor accounts for measures distributed to participants that are not used. For example, gross verified savings for freezers include a factor of 98% because one participant reported that the freezer they received was no longer in use.
- **HOU adjustment:** For each measure where hours of use appear in its substantiation sheet algorithm, this factor represents the ratio of self-reported HOU (via the participant survey) to deemed hours of use (as defined in substantiation sheets).
- **Measure quantity:** The number of measures that a participant received. For example, a participant who received 20 lightbulbs would have the per-unit savings value multiplied by 20.

Equation 2: Gross Verified Savings – Prescriptive Measures

$$Gross\ Verified\ Savings = Reported\ Unit\ Savings \times Desk\ Review\ RR \times Adjusted\ TRM\ CF \times ISR \times HOU\ adjustment \times Measure\ Quantity$$

A.1.6 Weatherization Measures

The NMR team verified weatherization measures were installed through a review of Hot2000 energy model files, photo verification, and audit documentation. However, there were no reported savings for any installed weatherization measures because all homes were wood-heated rather than electrically heated. The NMR team did not conduct a comprehensive engineering analysis of these measures, nor determine a RR, because there were no savings.

A.2 Cost-Effectiveness Methodology

This appendix presents additional details about the cost-effectiveness methodology. A summary of the methodology was provided in Section 1.2.

The cost-effectiveness analysis was completed using IESO's *Cost Effectiveness Tool* and in accordance with the IESO *Cost Effectiveness Guide for Energy Efficiency.*[15] The tool was populated with the following key information from the evaluation:

- First year energy and demand savings
- EUL
- End use load profile
- Incremental equipment and installation cost

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

- Net to gross ratios for energy savings and demand savings
- Adjustments in savings over the life of the program

Additionally, the IESO provided the following information for use in the cost-effectiveness calculation:

- Program administrative costs
- Incentive amounts

The IESO Cost Effectiveness Tool provides many outputs and varying levels of granularity. While the NMR team leveraged various outputs to develop findings and recommendations, the key outputs the team selected to directly present in this report are as follows:

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

A.3 Jobs Impact Methodology

This appendix provides additional details about the job impact methodology. A summary of the methodology was provided in Section 1.3.

The analysis of job impacts utilized the StatCan IO model to estimate direct and indirect job impacts. IO models are used to analyze the propagation of exogenous economic shocks throughout an economy. The models represent relationships, or flows, of inputs and outputs between industries. A system of linear equations represents how certain industries' outputs become the inputs for other industries, while other outputs become consumer goods. When an energy-efficiency program such as RFNEEPP is funded and implemented, it creates a set of "shocks" to the economy, such as demand for specific products and services, and additional household expenditures from energy bill savings. The shocks propagate throughout the economy and their impacts can be measured in terms of variables such as economic output and employment.

A.3.1 Statistics Canada IO Model

The Industry Accounts Division of StatCan maintains two versions of a Canadian IO model: a national, and an interprovincial model[16]. The models are classical Leontief-type open-IO models[17], in which some production is consumed internally by industries, while the rest is consumed externally. The models provide detailed information on the impact of exogenous demands for industry outputs. The impacts are quantified in terms of production, value-added components (such as wages and surplus), expenditures, imports, employment, energy use, and

[16] Statistics Canada - Industry Accounts Division System of National Accounts; (2009). User's Guide to the Canadian Input-Output Model. Statistics Canada. Ret

[17] Ghanem, Ziad; (2010). The Canadian and Inter-Provincial Input-Output Models: The Mathematical Framework. Statistics Canada – Industry Accounts Division.

pollutant emissions by industry. The StatCan IO Model is composed of input, output, and final demand tables. IO tables are published annually with a lag of approximately three years, so the model used for this analysis represents the Canadian economy from 2019. The model has been used to model employment impacts from a wide range of economic shocks, including structural changes to the Canadian economy[18], the bovine spongiform encephalitis (BSE) crisis in the early- to mid-2000s[19], and the construction of hydropower projects[20].

The supply and use tables (SUTs) for the Canadian IO model break the economy down into 240 industries and 500 SUPCs. They represent the economic activity of a specific Canadian province, or of the whole country. The SUTs show the structure of the Canadian economy, with goods and services flowing from production or import (supply tables) to intermediate consumption or final use (use tables). Intermediate consumption refers to domestic industries using goods and services to produce other products and services. Final use includes consumption of products by households, non-profit institutions serving households, and governments; capital formation; changes in inventory; and exports. Provincial SUTs are similar to national SUTs, but for the addition of interprovincial trade to go along with the international imports and exports.

StatCan offers the IO Model as a service but not as a product. StatCan economists work with researchers to develop the data and inputs to develop and answer specific research questions using the model. The product is a set of outputs from running the model.

A.3.2 Approach

The process for using the StatCan IO model followed three steps:

1. Developed specific set of research questions to address with the IO model, reflecting the exogenous shocks caused by the program.
2. Developed model inputs, which consisted of exogenous shock values (in dollars) to simulate the effects of RFNEEPP.
3. Ran the model and interpreted the results.

The following sections cover each step in more detail.

A.3.2.1 Developed Specific Research Questions

The first step in modeling the job impacts from RFNEEPP was to determine which specific research questions (RQs) the model would answer. In a scenario without the existence of RFNEEPP, customers receive electricity from IESO and pay for it via the monthly billing process. Delivering RFNEEPP introduces a set of economic supply and demand shocks to different sectors of the economy. The four research questions below illustrate these shocks:

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[18] Gera, S & Masse, P; (1996). Employment Performance in the Knowledge-Based Economy, Gouvernement du Canada - Industrial Organization 14, Gouvernement du Canada - Industry Canada.

[19] Samarajeewa, S. et al.; (2006). Impacts of BSE Crisis on the Canadian Economy: An Input-Output Analysis. Prepared for the Annual Meeting of the Canadian Agricultural Economics Society.

[20] Desrochers, R. et al.; (2011). Job Creation and Economic Development Opportunities in the Canadian Hydropower Market. Canadian Hydropower Association.

1. **What are the job impacts from new demand for energy-efficient measures and related program delivery services?** Funds collected for RFNEEPP generate a demand for efficient equipment and appliances. They also generate a demand for services related to program delivery, such as audits at customer premises, call center operations, and general overhead for program implementation and staffing. This demand creates jobs among firms that supply these products and services.
2. **What are the job impacts from household energy bill savings?** Once energy-efficient equipment is installed in households, the customers realize annual energy savings for the useful life of the measures. Households can choose to put this money into savings or to spend it on goods and services in the economy. This additional money and the decision to save or spend has implications for additional job creation. For instance, additional household spending on goods and services generates demand that can create jobs in other sectors of the economy.
3. **What are the job impacts from funding the energy-efficiency program?** IESO energy-efficiency programs are funded via volumetric bill charges for all customers, both residential and non-residential. This additional charge can reduce the money that households have for savings and for spending on other goods and services. It also impacts non-residential customers. This additional bill charge results in a negative impact on jobs in the Canadian economy.
4. **What are the job impacts from reduced electricity production?** The energy-efficient measures will allow households to receive the same benefit while using less electricity. The program as a whole will reduce the demand for electricity in the residential sector. This reduced demand could have upstream impacts on the utility industry (e.g., generation) and related industries, such as companies in the generator fuel supply chain.

A.3.3 Developed Model Inputs

The second step in modeling job impacts was to gather the data required for the StatCan IO model to answer each of the research questions. Model input data included the dollar values of the exogenous shocks from program delivery. The sources of data for each research question were as follows:

1. **Demand for energy-efficient measures and related program delivery services.** The StatCan IO Model divides the Canadian economy into 240 industry classifications and 500 SUPCs. Each measure installed as part of the program was classified into one of the SUPCs. The dollar value for each product-related demand shock was calculated using the measure cost and quantity data from the impact.

2. Services that were part of the delivery process were also classified into SUPCs. Most of these services were either audits or program administrative services. Customer audits had flat fees for calculating the value of the demand shock and the value of administrative services was obtained from program budget actuals.

3. It was necessary to specify the amount of each demand shock attributed to labor versus non-labor. For the product categories, we used the labor versus non-labor cost estimate proportions from the measure research conducted as part of the cost-effectiveness analysis. For the service categories, the IO model contained underlying estimates that defined the portion of labor versus overhead (non-labor).

4. **Household energy bill savings.** This value was calculated for the model as the net present value (NPV) of the discounted future stream of energy bill savings by participants. It was calculated by multiplying net energy savings[21] (in kWh) in each future year by that future year's retail rate ($/kWh). This calculation was performed for each future year through the end of the measure's expected useful life (EUL). Savings beyond the EUL were assumed to be zero. Measure-level energy saving estimates were obtained from the impact evaluation. The other calculation parameters (discount rate, measure EULs, and retail rate forecast) align with the cost-effectiveness analysis.

5. Customers' intentions for whether to spend or save the money saved on energy bills was obtained via a short section on the customer surveys. The percentages that indicated what the customers would do with the bill savings were obtained from the participant surveys through the following two questions:

J1. What do you anticipate you will do with the money saved on electricity bills from the energy-efficient equipment upgrades?

1. Pay down debt or put the money into savings
2. Purchase more goods and/or services
3. Split – put some money into savings/debt payments and use some money to purchase more goods/services
4. Other. Please specify.
98. Don't know
99. I'd rather not answer

[BASE: IF RESPONDENT WILL SPLIT MONEY SAVED IN VARIOUS WAYS (J1=3)]

J2. Approximately what would be the split between savings/debt payments and purchasing more goods/services? [ALLOW MULTIPLE RESPONSE OPTION]

1. Percent saved or used to pay down debt [NUMERIC RESPONSE BETWEEN 0 and 100]
2. Percent used to purchase more goods and services [NUMERIC RESPONSE BETWEEN 0 and 100]
98. Don't know
99. I'd rather not say

[21] The net-to-gross ratio for HAP is 1, so the net energy savings are the same as gross savings.

6. For estimating job impacts, the key input value was the amount of bill savings that customers would spend rather than save.
7. **RFNEEPP funding.** IESO energy-efficiency programs are funded by a volumetric charge on electricity bills and, volumetrically, residential customers accounted for 35% of consumption and non-residential customers accounted for 65% in 2021[22]. The overall program budget was distributed between these two customer classes by these percentages.
8. **Reduced electricity production.** The NPV of retail savings (estimated as part of RQ2) was also the input for examining a potential impact of producing less electricity.

A.3.3.1 Run Model and Interpret Results

Determining the total job impacts from RFNEEPP required considering possible impacts from each of the four shocks represented by the research questions. Addressing the four research questions above required only two runs of the StatCan IO model, as certain components of the shocks could be consolidated, and others addressed without full runs of the model. The two shocks that were modeled were as follows:

1. Demand shock as outlined in RQ1, representing the impact of the demand for energy-efficient products and services due to RFNEEPP.
2. Household expenditure shock representing the net amount of additional spending that the residential sector will undertake. This was estimated by taking the NPV of energy bill savings and subtracting the residential contribution to program funding. Thus, the model run combined RQ2 with the residential component of RQ3.

The model output generated three types of job impact estimates: direct, indirect, and induced impacts, as described in Appendix C.2.

A.4 NON-ENERGY BENEFITS METHODOLOGY

This appendix provides additional details about the NEBs estimate methodology. A summary of the methodology was provided in Section 4.3.

A.4.1 Participant Survey

The *Non-Energy Benefits Study: Phase II* assessed the NEBs from energy efficiency projects funded by the IESO over the 2017 – 2019 period.[23] The PY2022 evaluation applied the same

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[22] Annual Planning Outlook – A view of Ontario's electricity system needs; 2022. IESO.
[23] Dunsky. (July 2021). *Non-Energy Benefits: Phase II; Quantified Benefits and Qualitative Insights*. https://www.ieso.ca/-/media/Files/IESO/Document-Library/conservation-reports/Non-Energy-Benefits-Study-Phase-II.ashx

methodology as the Phase II study to assess NEBs, using two different types of questions to determine the value of NEBs that program participants realized by installing program measures:

- **Relative scaling:** Relative scaling questions ask participants to state the value of an item of interest relative to some base. For this survey, participants were asked 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:** 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, participants were asked what they would be willing to pay for each relevant NEB.

All survey respondents were asked to value all NEBs using both techniques. The data collected from these questions was then used to quantify the NEBs.

A.4.2 NEBs Quantification

For each individual NEB, the total value across all participants was divided by the total gross savings values across all participants. This was completed using both Relative Scaling and Willingness to Pay NEB values. The team then calculated two hybrid approaches that are more representative of the sample:

- **Hybrid, relative scaling priority** – in which we give priority to the relative-scaling response value. 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.

As a final step we calculated the average value ($/kWh) for each NEB weighted by energy savings across all participants. Table 9 shows the average NEB values 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.

Table 9: Quantified NEBs by Participant and by Savings, PY2022 & Phase II

Average	Reduced financial stress	Thermal comfort	Improved indoor air quality	Improved lighting levels
Hybrid (min approach) ($/kWh)				
PY2022 - Per participant	$0.16	$0.11	$0.10	$0.11
PY2022 - Overall	$0.21	$0.09	$0.12	$0.10
Phase II - Per participant	$0.13	$0.22	$0.14	$0.24
Phase II - Overall	$0.09	$0.09	$0.06	$0.08
Hybrid (RS-priority) ($/kWh)				

Average	Reduced financial stress	Thermal comfort	Improved indoor air quality	Improved lighting levels
PY2022 - Per participant	$0.16	$0.48	$0.17	$0.20
PY2022 - Overall	$0.21	$0.35	$0.22	$0.18
Phase II - Per participant	$0.15	$0.31	$0.22	$0.35
Phase II - Overall	$0.11	$0.12	$0.06	$0.14

All recommended values in the Phase II study were based on the hybrid, minimum approach. More details on methodology and NEBs quantification can be found in the Phase II report.

Appendix B Additional Impact Evaluation Results

This appendix provides additional results associated with the impact evaluation activities. Higher-level results were provided in Section 2.

B.1 Detailed Impact Results

Table 10 presents the detailed measure-level results of the impact evaluation. The savings values in the table represent the measure-level savings for the entire CDM RFNEEPP population. The proportion of total program savings is included to show the relative impact of each measure's energy and demand RRs.

Table 10: Total Gross Verified Savings by Measure Type

Measure	Quantity Installed	Reported Savings - Energy (kWh)	Reported Savings - Demand (kW)	RR - Energy	RR - Demand	Verified Savings - Energy (kWh)	Verified Savings - Demand (kW)	Percent of Program Savings - Energy (kWh)	Percent of Program Savings - Demand (kW)
Lighting end-use									
14W - 18W ENERGY STAR® Qualified LED PAR 38	133	7,706	0.53	82%	89%	6,347	0.48	7%	7%
17W - 23W ENERGY STAR® Qualified LED A Shape	55	3,372	0.22	82%	89%	2,777	0.20	3%	3%
7W - 11W ENERGY STAR® Qualified LED A Shape	305	14,549	0.92	76%	83%	11,016	0.76	12%	12%
8W - 12W ENERGY STAR® Qualified LED PAR 30	40	2,256	0.16	86%	79%	1943	0.13	2%	2%
Lighting Total	**533**	**27,882**	**1.83**	**79%**	**85%**	**22,082**	**1.56**	**24%**	**24%**
Appliances									
Freezer Replacement (ENERGY STAR Qualified 14.5 – 16.0 cu ft)	9	927	0.13	-34%	-34%	-311	-0.04	0%	-1%
Refrigerator Replacement (ENERGY STAR Qualified 15.5 – 16.9 cu ft)	21	4,305	0.57	66%	65%	2,847	0.37	3%	6%
Appliance Total	**30**	**5,232**	**0.69**	**48%**	**47%**	**2,536**	**0.32**	**3%**	**5%**
Domestic Hot Water (DHW)									
Bathroom Aerator - Flow Rate < 3.8 L/min	62	3,050	0.31	68%	60%	2,066	0.19	2%	3%
Kitchen Aerator - Flow Rate < 5.7 L/min	64	8,032	0.77	108%	161%	8,696	1.24	9%	19%

Measure	Quantity Installed	Reported Savings - Energy (kWh)	Reported Savings - Demand (kW)	RR - Energy	RR - Demand	Verified Savings - Energy (kWh)	Verified Savings - Demand (kW)	Percent of Program Savings - Energy (kWh)	Percent of Program Savings - Demand (kW)
Shower Aerator - Flow Rate < 4.8 L/min	54	12,620	1.24	86%	79%	10,816	0.98	12%	15%
Water heating - Hot Water Tank Insulation - Fibreglass R10	64	6,349	0.64	94%	90%	5,942	0.58	6%	9%
Water heating - Per 3' Pipe Wrap (1/2" Pipe)	61	2,934	0.31	45%	39%	1,307	0.12	1%	2%
Water heating - Per 3' Pipe Wrap (3/4" Pipe)	22	1,582	0.15	54%	50%	856	0.08	1%	1%
DHW Total	**327**	**34,567**	**3.42**	**86%**	**93%**	**29,683**	**3.17**	**32%**	**50%**
Power Bars									
Smart Power Bar	70	3,248	0	512%	-	16,628	0.48	18%	7%
Power Bar Total	**70**	**3,248**	**0**	**512%**	**-**	**16,628**	**0.48**	**18%**	**7%**
Miscellaneous									
Block Heater Timer (just timer)	72	17,215	0	96%	-	16,576	0.00	18%	0%
Outdoor clotheslines or umbrella stand or indoor drying rack	72	6,984	4.68	92%	19%	6,437	0.87	7%	14%
Miscellaneous Total	**144**	**24,199**	**4.68**	**95%**	**19%**	**23,014**	**0.87**	**24%**	**14%**
Program Total	**1,104**	**95,129**	**10.62**	**99%**	**60%**	**93,942**	**6.41**	**100%**	**100%**

B.1.1 Lighting

The NMR team verified the savings for lighting measures using project file data and lighting specific information collected by RFNEEPP auditors. There are various light bulb products that are offered by the program for direct installation based on the replaced bulb type. The overall energy RR for lighting measures was 79%. In addition, the NMR team applied the ISR results from the participant survey (88%) to the gross verified savings. The impact of adjustments to lighting measures represents a significant driver to the program's overall RR as lighting measures account for roughly one-quarter (24%) of total verified savings for the program. The lighting end-use category is dominated by 7 – 11 watt A-line bulbs, which represents 11.8% of the program savings, while the 8 – 12 watt PAR 30 bulb contributes only 2% of program savings. A-line bulbs are very common bulb shapes in residential settings, often used in both hard-wired and plug-in fixtures. In addition, A-line bulbs are easily swapped out, whereas other bulb shapes that are common in certain fixture types that may not be common in the RFNEEPP participant home (i.e., candelabra shaped bulbs in a chandelier-type fixture or a reflector shaped installed into a recessed fixture).

B.1.2 Appliances

The NMR team verified the savings for appliances using the project file data and equipment specific information collected by RFNEEPP auditors. The NMR team conducted model number lookups to incorporate appliance-specific values into the desk reviewed savings calculations, instead of default reported savings input assumptions, for the installed equipment and, where possible, the existing equipment. This model-specific data typically included the size or capacity of the equipment and its annual energy consumption. During the desk reviews, the NMR team found no instances where the appliances replaced were not the same size as their replacement. Energy savings RRs were generally low among appliances (48%), particularly with freezers (-34%). Appliances accounted for only 3% of total program gross verified energy savings. The RR for appliance demand savings was also low at 47%, and they accounted for 5% of the program gross verified demand savings.

Refrigerators. The NMR team calculated verified savings based on appliance-specific annual energy consumption derived from model number lookups for the installed and existing refrigerators, while the reported savings applied the minimum requirements for meeting the ENERGY STAR efficiency specifications. The application of actual annual energy consumption values provides a more accurate savings estimate that does not rely solely on using the minimum ENERGY STAR specifications. Refrigerators accounted for 2,847 kWh in energy savings (66% RR) and 0.4 kW in demand savings (65% RR). Where available, project-specific energy consumption values for existing refrigerators were often dramatically lower than the existing refrigerator consumption otherwise assumed in IESO substantiation sheets.

Freezers. The NMR team calculated verified savings for freezers in a similar way to refrigerators, leveraging model numbers to look up annual energy consumption and comparing it against the ENERGY STAR minimum values used in deemed savings. Freezers accounted for -311 kWh in energy savings (-34% RR) and -0.04 kW in demand savings (-33%). The negative savings for freezers had two drivers:

- **High conservation case energy consumption.** Participants' newly installed freezers' energy consumption resulted in a 28% RR compared to default reported savings assumptions.
- **Low project-specific energy consumption.** In all but one case, project-specific energy consumption for existing freezers was lower than that of the newly installed freezers, resulting in negative savings.

B.1.3 Smart Power Bars

The incredibly high RR (512%) for the smart power bars is due to outdated reported savings values being used for smart power bars. The smart power bar measure accounted for the largest proportion of savings of any individual measure in the RFNEEP program (18%). However, there were no reported demand savings for power bars (70 units) in the tracking data. Due to this issue with reported demand savings in the tracking data, the NMR team could not calculate an RR for demand. The NMR team corrected demand savings for power bars in the verification process and they accounted for 8% of the program's gross verified demand savings.

B.1.4 Domestic Hot Water

Domestic hot water (DHW) measures are only offered to participants with electric water heating systems. The NMR team primarily verified savings for water heating measures by confirming the water heater fuel-type, the measure types, and quantities in the project files matched the program tracking data. The lower RRs for pipe wrap measures were due to reported savings calculations referencing the total linear feet of insulation installed, which is standard data collection practice by auditors in the field, while the input assumption for reported savings values is in three feet increments. This resulted in an overestimation of reported savings for these measures.

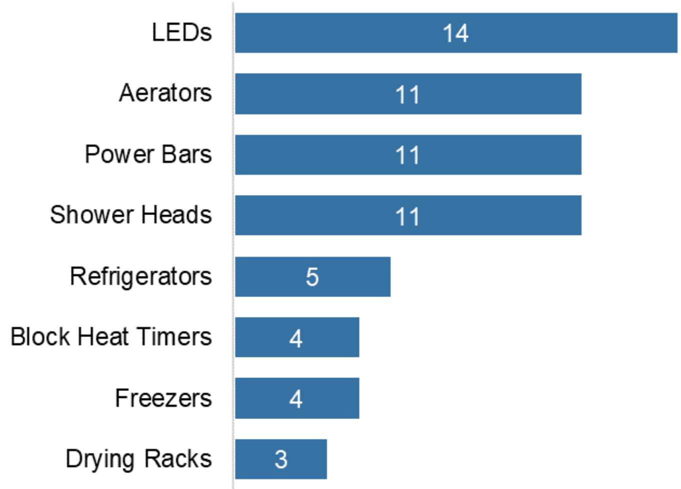
B.1.5 Miscellaneous Measures

The miscellaneous measure category only includes block heat timers and indoor drying racks or clotheslines (of which the latter two were aggregated and reported together). Like hot water measures, the NMR team verified savings for the miscellaneous measures by confirming the measure type and the quantity installed matched between the project files and the program tracking data. The block heaters had an RR of 96% and contributed 18% of FNEEPP's verified savings. The indoor drying rack or clothesline also had a high RR (92%) and was responsible for 7% of total verified energy savings, while also resulting in 0.9 kW in demand savings, which was 13.6% of the total verified demand savings. There are no demand savings associated with block heat timers.

B.2 In-Service Rate

Figure 6 displays the energy-efficiency upgrades respondents confirmed receiving. Most respondents received LEDs (14 out of 19 respondents). More than one-half of respondents received an aerator, power bar, and/or shower head (11 out of 19 respondents), and over one-quarter of respondents received a refrigerator (5 out of 19 respondents) and/or a block heat timer (4 out of 19 respondents, or 21%).

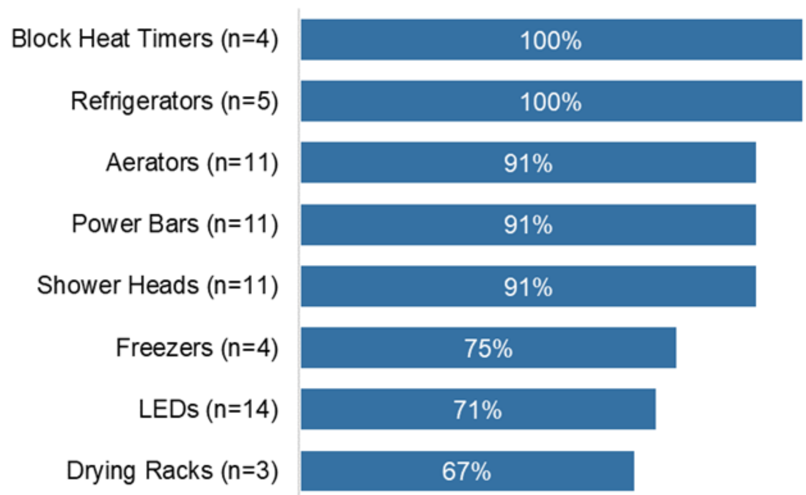
Figure 6: Energy-Efficiency Upgrades that Program Participants Received (n=19)



*Does not sum to 19 due to multiple response.

Figure 7 displays the ISRs for the respondents' upgrades. All the block heat timers, and refrigerators (100%) respondents received were still installed and functional at the time of the survey. Nearly all the aerators, power bars, and shower heads (91%), respondents received were still installed and functional. Only three upgrades had ISRs less than 90%: freezers (75%), LEDs (71%), and drying racks (67%).

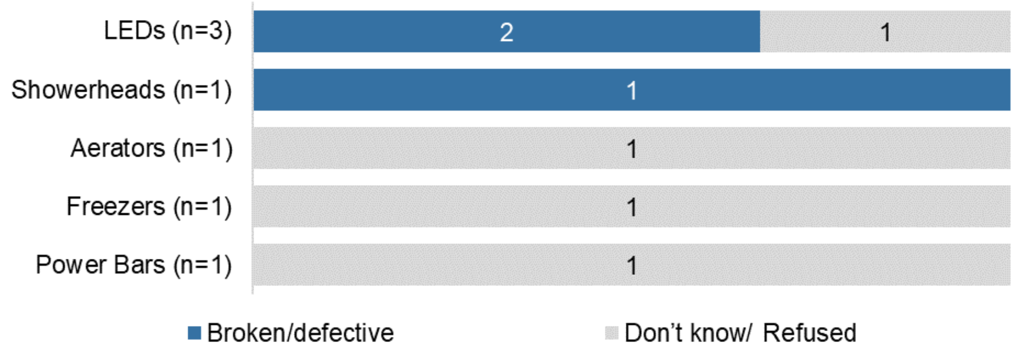
Figure 7: Energy-Efficiency Upgrade ISRs



*Does not sum to 100% due to multiple response.

Figure 8 displays the reasons respondents gave for uninstalling or removing upgrades. The most common reason for uninstalling shower heads (one respondent), and LEDs (two respondents) was that they were broken or defective.

Figure 8: Reasons Respondents Uninstalled or Removed Upgrades



B.3 Hours of Use

The participant survey collected HOU information for several upgrades that homeowners received through the program. Figure 9 and Figure 10 display the average number of program-provided LEDs installed by room type and the average hours per day respondents used their LEDs. The highest number of LEDs installed occurred in bedrooms (average of 4.3 bulbs) and the highest hours of use per day occurred in other rooms such as outdoors (average of 9.0 hours).

Figure 9: Average Number of LEDs Installed by Room Type

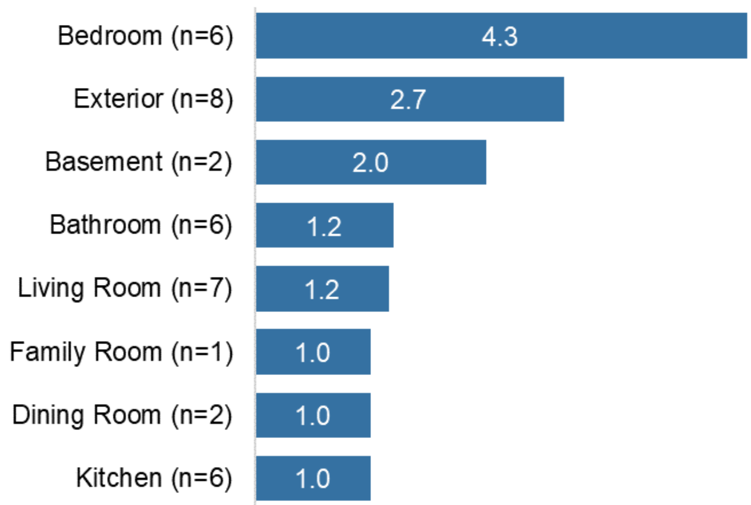
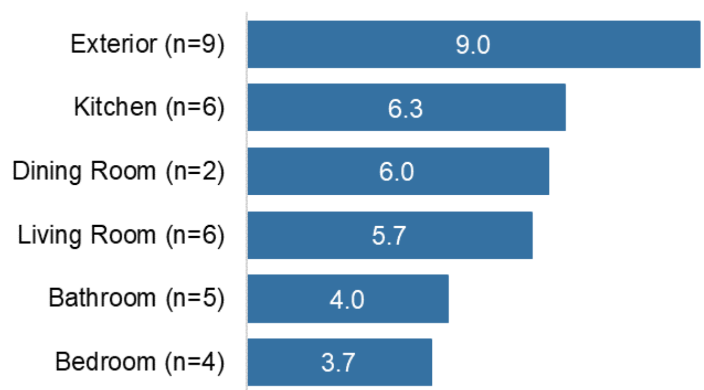


Figure 10: Average Hours per Day LEDs in Use by Room Type



To gain an understanding of the frequency with which showerheads are used, the survey asked respondents to estimate the average number of showers taken in the participating household per week as well as the average duration per shower. On average, respondents took 16 showers per week per household. The average duration of each shower was 14 minutes. Figure 11 and Figure 12 display the distribution of shower frequency and duration among respondents.

Figure 11: Showers per Week (n=10)

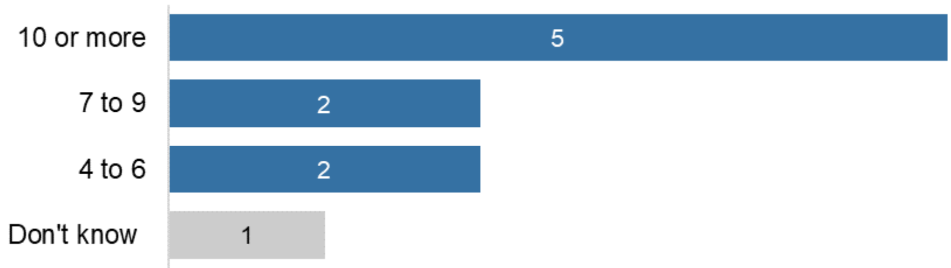
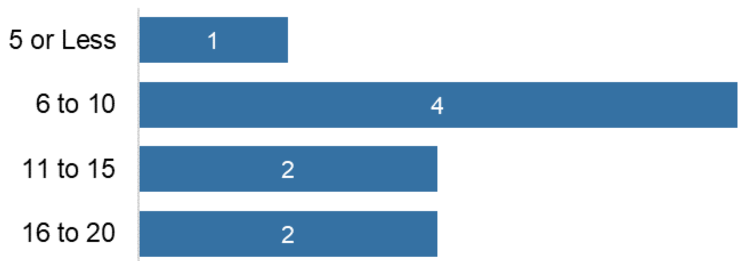


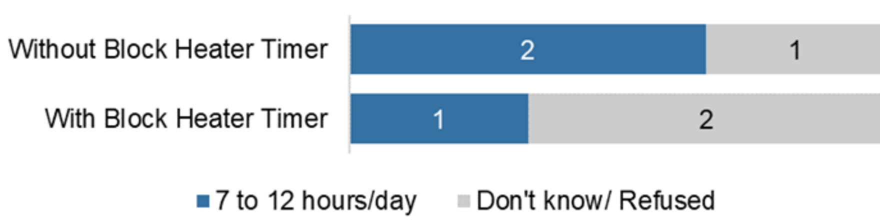
Figure 12: Minutes per Shower (n=9)



Three respondents used their kitchen aerators for 31 to 60 minutes per day. Two respondents used their bathroom aerators for 31 to 60 minutes per day.

Before receiving the block heater timers provided by the program, the three respondents used their block heaters for eight hours per day on average. After installing the block heater timers, respondents used their block heaters for an average of eight hours per day affirming no change. Figure 13 displays the distribution of hours per day that respondents used their block heaters before and after receiving the block heater timers. Prior to receiving and using the program provided block heat timer, two respondents used engine block heaters for 7 to 12 hours per day and one respondent did not know how many hours they used their block heater. After receiving the block heater timer through the program, one respondent used the block heater for the same amount of time, 7 to 12 hours per day and two said they did not know much they used it.

Figure 13: Hours per Day Block Heater in Use (n=3)



B.4 Refrigeration Baseline Energy Consumption

This memo provides the results of evaluating the appliance energy consumption values used in substantiation sheet algorithms and the IESO Audit and Retrofit Protocols to determine program eligibility and calculate program savings.[24]

B.4.1 IESO Assumptions

Table 11 documents the minimum energy consumption for existing refrigerators and freezers to qualify for replacement during an audit. The minimum consumption thresholds do not account for the different appliance sizes and classes documented in the IESO substantiation sheets (Table 12 and Table 13).

Table 11: Refrigeration Energy Consumption Thresholds for Replacement
(Source: Audit and Retrofit Protocols, Energy Affordability Program, v1.0)

Appliance	Replacement threshold, kWh/year
Refrigerator	925
Freezer	615

Substantiation sheets document the assumed unit energy consumption (UEC) values for existing and baseline (i.e., minimally code-compliant) refrigeration equipment when calculating program savings. Equation 3 shows the algorithm used to calculate unit refrigerator and freezer savings in program tracking data, where UEC values appear.

Equation 3: IESO Energy Savings Algorithm

$$\boldsymbol{\Delta kWh = kWh_b - kWh_{ee}}$$

$$kWh_b = UEC_{exist} * \%EREP + UEC_{base} * \%REMAIN$$

$$kWh_{ee} = UEC_{ee}$$

UEC_{exist} refers to the annual energy consumption of the removed appliance, while UEC_{base} refers to the federal minimum annual energy consumption. UEC_{ee} refers to the estimated annual consumption of the conservation measure, whether refrigerator or freezer. %EREP refers to the percentage of the equipment's effective useful life (EUL) during which savings are calculated using the existing equipment's energy consumption as the baseline, assumed to be 33%. %REMAIN refers to the remaining percentage of the EUL, assumed to be 67%, during which savings are calculated using the federal minimum energy consumption as the baseline. Table 12 shows assumed UECs for refrigerators in the IESO substantiation sheets, and Table 13 shows them for chest and upright freezers.

[24] Independent Electricity System Operator, "Audit & Retrofit Protocols, Energy Affordability Program," version 1.0, July 6, 2021.

Table 12: Exiting and Baseline Refrigeration Unit Energy Consumption (UEC)

Product Class	UEC_{exist} (kWh/yr)	UEC_{base} (kWh/yr)
Refrigerator-freezers - automatic defrost with top-mounted freezer without an automatic ice maker (10.0 - 12.5 cu ft)	790.81	338.72
Refrigerator-freezers - automatic defrost with top-mounted freezer without an automatic ice maker (15.5 - 16.9 cu ft)	925.20	386.22
Refrigerator-freezers - automatic defrost with top-mounted freezer without an automatic ice maker (17.0 - 18.4 cu ft)	965.93	404.19
Refrigerator-freezers - automatic defrost with bottom-mounted freezer without an automatic ice maker (10.0 - 12.5 cu ft)	790.81	436.77
Refrigerator-freezers - automatic defrost with bottom-mounted freezer without an automatic ice maker (15.5 - 16.9 cu ft)	925.20	494.00
Refrigerator-freezers - automatic defrost with bottom-mounted freezer without an automatic ice maker (17.0 - 18.4 cu ft)	965.93	502.75
Refrigerator-freezers - automatic defrost with bottom-mounted freezer with through-the-door ice service (17.0 - 18.4 cu ft)	965.93	672.00

Table 13: Existing and Baseline Freezer Unit Energy Consumption (UEC)

Product Class	Measure Name	UEC_{exist} (kWh/yr)	UEC_{base} (kWh/yr)
Upright Freezers with automatic defrost	Freezer Replacement (ENERGY STAR Qualified 12-14.4 cu ft)	623.03	434.21
Upright Freezers with automatic defrost	Freezer Replacement (ENERGY STAR Qualified 12-14.4 cu ft)	596.33	415.70
Upright Freezers with automatic defrost	Freezer Replacement (ENERGY STAR Qualified 14.5 - 16.0 cu ft)	658.34	458.70

Product Class	Measure Name	UEC_{exist} (kWh/yr)	UEC_{base} (kWh/yr)
Upright Freezers with automatic defrost	Freezer Replacement (ENERGY STAR Qualified 14.5 - 16.0 cu ft)	663.35	462.18
Chest Freezers	Freezer Replacement (ENERGY STAR Qualified 14.5 - 16.0 cu ft)	411.20	305.17
Chest Freezers	Freezer Replacement (ENERGY STAR Qualified 7.75≤ and <12.0cu ft)	562.64	395.51
Compact Chest Freezer	Freezer Replacement (ENERGY STAR Qualified <7.5 cu ft)	262.45	262.45

B.4.2 Desk-Reviewed Appliances

Table 14 compiles the counts, ages, baseline and new energy consumption values, and verified energy savings associated with refrigeration measures sampled for desk review. It compares these values from the RFNEEPP desk reviews with the equivalent values from PY2022 and PY2021 Energy Affordability Program (EAP) impact evaluations. The table excludes cases where there was insufficient information to look up project-specific baseline and/or conservation case consumption values.

Table 14: Average Desk Review Refrigeration Consumption and Savings

Program	Measure	Projects Sampled	Age	Baseline kWh	Conservation Case kWh
RFNEEPP	Refrigerator	47	2007	509	363
RFNEEPP	Freezer	21	2005	339	461
EAP (PY22)	Refrigerator	73	2003	510	348
EAP (PY22)	Freezer	24	2001	383	261
EAP (PY21)	Refrigerator	88	1999	667	355
EAP (PY21)	Freezer	86	1997	513	264

B.4.3 Cross-Jurisdictional Scan

Updated versions of the technical reference manuals (TRMs) that informed the PY2019 substantiation sheet review also contain deemed values for appliance energy consumption:[25]

[25] See “Secondary Data Review of TRMs” (Section 2.1.2) in the Methodology section of the PY2019 HAP Evaluation.

- Illinois Technical Reference Manual, version 10, effective 2022[26] (IL TRM)
- Massachusetts Technical Reference Manual, 2022 Plan-Year Report, effective 2022[27] (MA TRM)
- New York Technical Resource Manual, version 9, effective 2022[28] (NY TRM)
- Pennsylvania Technical Reference Manual, effective 2021[29] (PA TRM)

The IL TRM explicitly tabulates UEC_{exist} values for refrigerators, but not freezers. The NY TRM is the only one to explicitly tabulate appliance energy consumption using a low- and moderate-income (LMI) baseline, for both refrigerators and freezers. They also provide separate deemed consumption values for different appliance ages and sizes. While these values are not equivalent to UEC_{exist} values, they serve as useful points of comparison for the RFNEEPP population.

B.4.4 Existing Refrigerator Unit Energy Consumption

Figure 14 compares the IESO Audit & Retrofit Protocol consumption threshold for refrigerators with the average refrigerator UEC_{exist} value derived from IESO substantiation sheets, multiple Illinois TRM UEC_{exist} values, as well as average desk review results from recent IESO impact evaluations.

Using the IL TRM as a reference, the Audit & Retrofit protocol threshold for refrigerator energy consumption implies that the only models eligible for replacement would be those with side-mounted freezers or lacking automatic defrost. Typical top- or bottom-mounted freezer models would not be eligible. Using the average of all substantiation sheet UEC_{exist} values instead of the protocol threshold yields the same result, though the sheets specify different UEC_{exist} for different refrigerator sizes.

The average consumption results from the three desk review efforts are well below the more-conservative estimates outlined in the IESO substantiation sheets and the Illinois TRM. Both PY22 and PY21 desk reviews yielded existing refrigerator consumption values more aligned with deemed baseline unit energy consumption (UEC_{base}) values in the IESO substantiation sheets (Table 12), suggesting that deemed UEC_{exist} values overestimate the actual consumption of refrigerators replaced through RFNEEPP.

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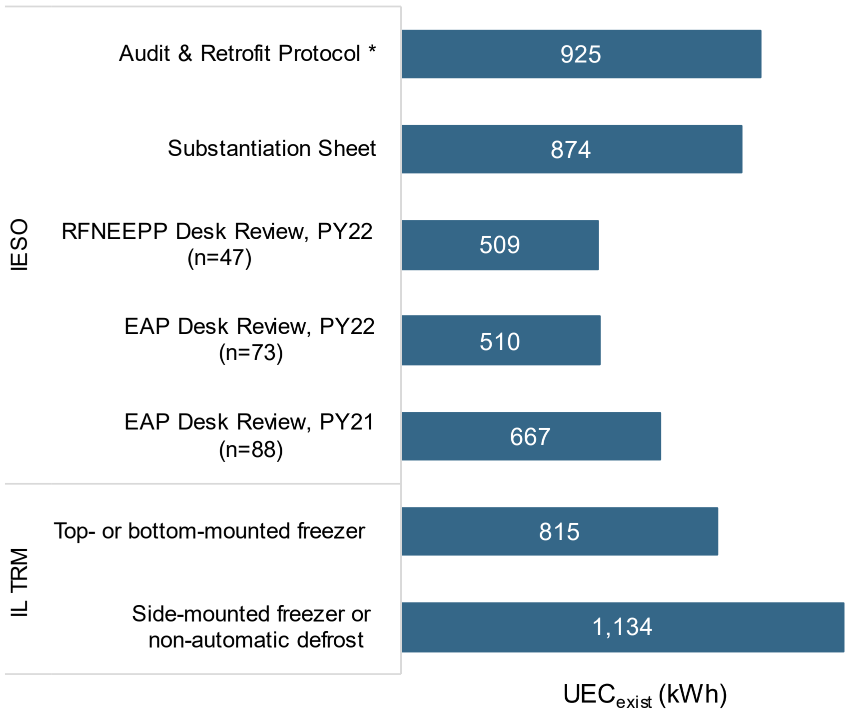
[26] Illinois Commerce Commission, "2022 Statewide Technical Reference Manual for Energy Efficiency: Version 10, Volume 3: Residential Measures", accessed June 2023, https://icc.illinois.gov/downloads/public/2022%20IL-TRM%20Version%2010.0%20Volume%203%20Residential%20Measures%20(Final).pdf.
[27] Massachusetts Department of Public Utilities, "2022 Plan-Year Report Technical Reference Manual", accessed June 2023, https://etrm.anbetrack.com/#/workarea/home?token=6d6c45766e692f527044.
[28] New York Department of Public Service, "New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs: Version 9", accessed June 2023, https://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/72c23decff52920a85257f1100671bdd/$FILE/NYS%20TRM%20V9.pdf.
[29] Pennsylvania Public Utilities Commission, "2021 Technical Reference Manual, Volume 2, Residential Measures", accessed June 2023, https://www.puc.pa.gov/pcdocs/1692531.docx.

Figure 14: Comparison of Existing Refrigerator Unit Energy Consumption Values



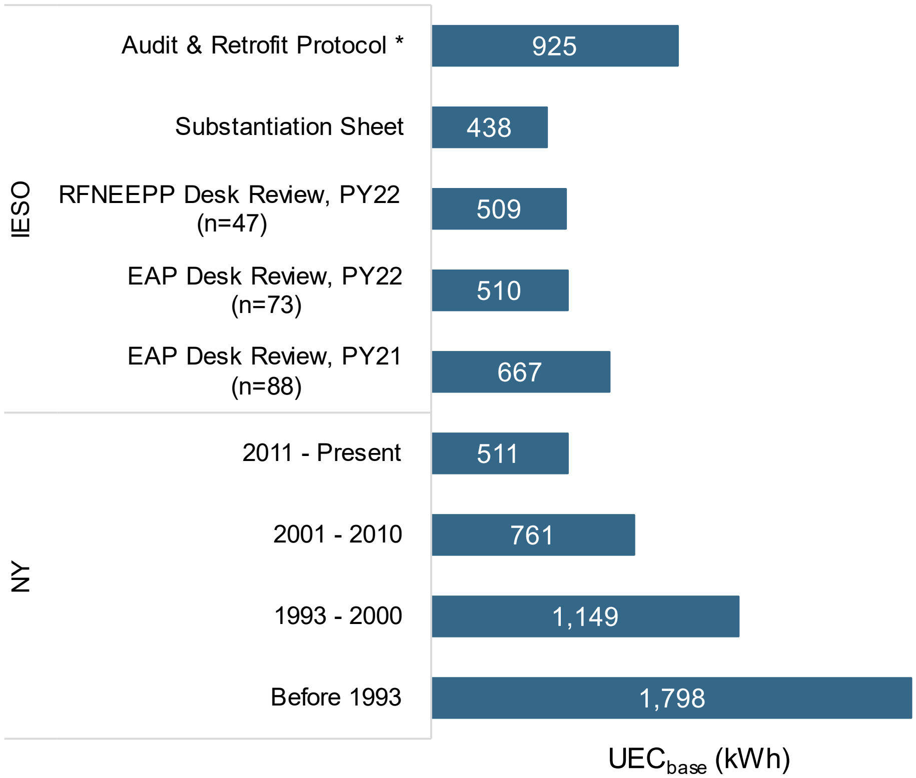
*Indicates the minimum energy consumption for an existing refrigerator to qualify for replacement during an audit

B.4.5 Low- and Moderate-Income Appliance Energy Consumption

Figure 15 compares the IESO Audit & Retrofit Protocol consumption threshold for refrigerators with the average refrigerator UEC_{base} value derived from IESO substantiation sheets, multiple NY TRM LMI baseline (UEC_{base}) values, as well as average desk review results from recent IESO impact evaluations.

Using the NY TRM LMI baseline as a reference, the Audit & Retrofit protocol threshold for refrigerator energy consumption implies that only models older than 2001 would be eligible for replacement. This conflicts with the stated eligibility threshold of 2011 or earlier in IESO data collection forms reviewed during desk review.

Figure 15: Comparison of Baseline Refrigerator Unit Energy Consumption Values

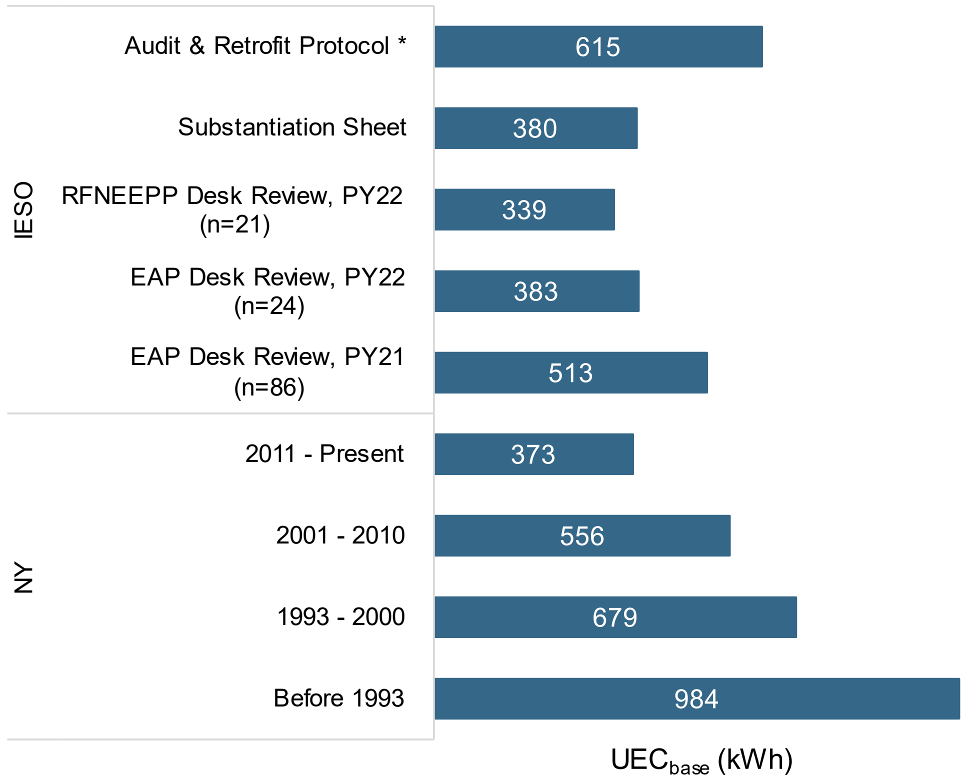


*Indicates the minimum energy consumption for an existing refrigerator to qualify for replacement during an audit

Figure 16 and Figure 17 compare the IESO Audit & Retrofit Protocol consumption thresholds for chest and upright freezers, respectively, with the average freezer UEC_{base} value derived from IESO substantiation sheets, multiple NY TRM LMI baseline (UEC_{base}) values, as well as average desk review results from recent IESO impact evaluations.

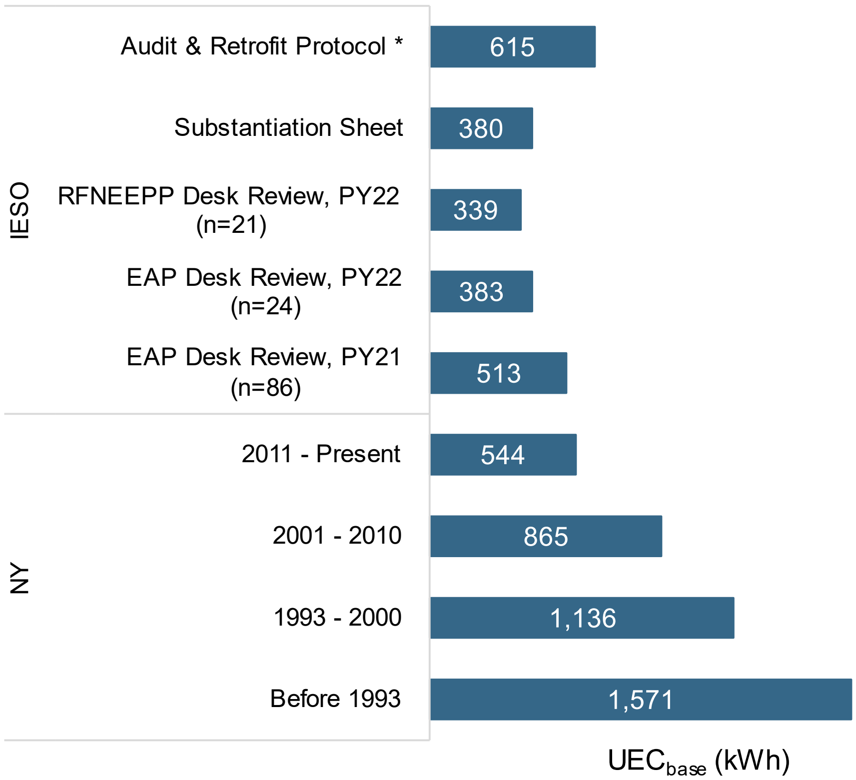
Using the NY TRM LMI baseline as a reference, the Audit & Retrofit protocol threshold for freezer energy consumption implies that only chest freezer models older than 2001 would be eligible for replacement, compared to upright models older than 2011, which aligns with the age threshold program technicians use.

Figure 16: Comparison of Baseline Chest Freezer Unit Energy Consumption Values



*Indicates the minimum energy consumption for an existing freezer to qualify for replacement during an audit

Figure 17: Comparison of Baseline Upright Freezer Unit Energy Consumption Values



*Indicates the minimum energy consumption for an existing freezer to qualify for replacement during an audit

Appendix C Additional Jobs Impact Results

This appendix provides additional results associated with the jobs impact analysis. Higher-level results were provided in Section 4.2.

Input-Output models are informative for understanding the potential magnitudes and dynamics of economic shocks created by policies and programs. While useful, the StatCan IO Model is a simplified representation of the Canadian economy and thus has limitations. The model assumes fixed technological coefficients. It does not take into account economies of scale, constraint capacities, technological change, externalities, or price changes. This makes analyses less accurate for long term and large impacts, where firms would adjust their production technology and the IO technological coefficients would become outdated. Assuming firms adjust their production technology over time to become more efficient implies that the impact of a change in final demand will tend to be overestimated. For household consumption, the model is based on the assumptions of constant consumption behavior and fixed expenditure shares relative to incomes.

C.1 Input Values

The model was used to estimate the impacts of two economic shocks – one representing the demand for energy-efficient products and services from RFNEEPP and the other from the increased household expenditures due to bill savings (and net of program funding). Table 15 shows the input values for the demand shock representing the products and services related to RFNEEPP. Each measure installed as part of RFNEPP was categorized according to the StatCan IO Supply and Use Product Classifications (SUPCs).

The first four rows of the table contain the categories corresponding to products, which were the measures installed in homes. The last two rows contain the services. Of the four product measures, *Major appliances* had the highest total cost ($22,000). *Other miscellaneous manufactured products* was second highest at just over $21,000. Each measure's cost was divided into labor and non-labor. *Electric light bulbs and tubes* and *Other miscellaneous manufactured products* did not have any assumed labor costs for measure installation. *Small electric appliances* included thermostats, which had installation costs around 50% of the total. The installation cost for the *Major appliances* category was roughly 11%.

For the two service categories in Table 15, *Office administrative services* included general overhead and administrative services associated with program delivery, such as program management and staffing, call center operations, and IESO admin labor. The *Other professional, scientific and technical services* included the audits. The total demand shock represents the sum of the audit fees. The labor and non-labor amounts are not specified for these services, as the IO Model has assumptions incorporated for the relative proportions of each for these categories.

Table 15: Summary of Input Values for Demand Shock

Category Description	Non-Labor ($ Thousands)	Labor ($ Thousands)	Total Demand Shock ($ Thousands)
Major appliances	20	2	22
Other miscellaneous manufactured products	21	0	21
Electric light bulbs and tubes	6	0	6
Small electric appliances	1	2	3
Other professional, scientific, and technical services	-	-	33
Office administrative services	-	-	1,392
Total			**1,476**

Table 16 shows the calculations and input value for the household expenditure shock.[30] This shock represents the net additional amount that households would inject back into the economy through spending. The model does not distinguish between participants and non-participants in the residential sector, so the net amount of additional money households (as a whole) would have available is the difference between the bill savings (Net Present Value (NPV) = $146,000) and the portion of all energy-efficiency programs funded by the residential sector (35%, or $517,000). The difference is -$371,000 and represents the additional money that households could either spend on goods and services or save, pay off debt, or otherwise not inject back into the economy[31]. The surveys administered to participants as part of the RFNEEPP process evaluation included several questions about what households would do with the money that they saved on their electricity bills. From the survey responses, we estimated that 54% of household bill savings would be spent. Thus, the household expenditure shock would be -$201,000.

[30] The model is actually run with a normalized value of $1 million in extra household expenditures and the job results can be scaled by the actual demand shock.
[31] Note: Under normal program activities, enough measures are installed that the NPV of installed measures outweighs the residential portion of costs associated with running the program. This was not the case for RFNEEPP, and as a result a the residential shock this year is negative. While in real world applications this may not be the case, for the purposes of the model a negative shock will result in jobs being removed from the overall total.

Table 16: Summary of Input Values for Household Expenditure Shock

Description	Demand Shock *($ Thousands)*
NPV of energy bill savings	146
Residential portion of program funding	(517)
Net bill savings to residential sector	**(371)**
Percent spent on consumption (vs. saved)	54%
Total Shock	**(201)**

C.2 Model Results

The StatCan IO Model generated results based on the input values detailed in Appendix C.1. Table 17 shows the results of the model run for the demand shock for products and services. This shock represented all the job impacts realized in 2022. As the two right columns show, the model estimated that the demand shock will result in the creation of 12 total jobs (measured in person-years) in Canada, all of which will be in Ontario. Of the 12 jobs, 6 were direct, 3 were indirect, and 3 were induced. In terms of FTEs, the numbers are slightly less, with 9 FTEs created in Ontario and 10 in total across the country. Of these 10 FTEs, 5 were direct, 2 indirect, and 2 induced. As the table shows, the direct and indirect job impacts were realized exclusively in Ontario. As we move to induced jobs, impacts are dispersed outside of the province.

Table 17: Job Impacts from Demand Shock

Job Impact Type	FTE *(in person-years)* Ontario	FTE *(in person-years)* Total	Total Jobs *(in person-years)* Ontario	Total Jobs *(in person-years)* Total
Direct	5	5	6	6
Indirect	2	2	3	3
Induced	2	2	3	3
Total	**9**	**10**	**12**	**12**

Table 18 shows the results of the model run for the household expenditure shock. This shock is run off a normalized $1 million bundle of extra household spending, which can then be scaled by the actual household expenditure shock. The extra household spending of -$201,000 would result in the loss of 1 direct FTEs and 2 direct total jobs in Canada. One of the two jobs lost stemming from the household expenditure shock this year was in Ontario.

Table 18: Job Impacts from Household Expenditure Shock

Job Impact Type	FTE *(in person-years)* Ontario	FTE *(in person-years)* Total	Total Jobs *(in person-years)* Ontario	Total Jobs *(in person-years)* Total
Direct	-1	-1	-1	-1
Indirect	0	0	0	0
Induced	0	0	0	0
Total	**-1**	**-1**	**-1**	**-2**

The other factors included in the research questions were the impact of program funding on the non-residential sector and the impact from reduced electricity consumption. Assuming that businesses absorb the increases in electricity costs to fund the program, there would be no impact on jobs. There would be an impact on direct GDP (value-added), equivalent to the profit loss resulting from the increase in electricity bills from program funding. The StatCan IO Model has production functions that cannot be adjusted, so electricity price changes would be modeled by assuming that surplus would be reduced by the extra amount spent on electricity.

The economic impact of the reduction of electricity production because of the increase in energy efficiency must be examined closely. It can be estimated using StatCan Input-Output multipliers[32] without running the model. The multiplier is 5.0[33] (per $ 1 million) and the NPV of decreased electricity bills (retail) was $146,000 million. Thus, the model would predict that the reduction in electricity production would cause a job loss of 0.7 person-years over the course of 20 years (the longest EUL in the portfolio of RFNEEPP measures). However, the IO model is linear, and not well-suited to model small decreases in electricity production. Total electricity demand has been increasing over time and is projected to continue increasing.[34] RNFEEPP first year energy savings represented less than 0.01% of total demand in PY2022. This relatively small decrease in overall consumption may work to slow the rate of consumption growth over time but would likely not result in actual job losses in the utility industry or upstream suppliers. The linearity of the IO model means that it will provide estimates regardless of the size of the impact. Given the nature of electricity production, it is reasonable to conclude that the linear IO multiplier is not appropriate for estimating job impacts. This analysis assumes that job losses from decreased electricity production are negligible.

Table 19 shows the total estimated job impacts by type – combining Table 17 and Table 18. Almost all (10 out of the 11 estimated total jobs) were in Ontario. All the direct and indirect jobs created were created in Ontario. A slightly smaller share of the induced jobs was in Ontario, with 2 out of 3 induced total jobs within the province. The FTE estimates are slightly less, with a total of 8 FTEs (of all types) created in Ontario and 9 FTEs added throughout Canada. All direct FTEs

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[32] Table 36-10-0595-01. The relevant industry is Electric power generation, transmission and distribution [BS221100].
[33] Statistics Canada. Table 36-10-0595-01 Input-output multipliers, provincial and territorial, detail level
DOI: https://doi.org/10.25318/3610059501-eng
[34] Annual Planning Outlook – A view of Ontario's electricity system needs; 2022. IESO.

were realized in Ontario, with this number representing 5% of the total FTEs added in Ontario and 44% of FTEs added in Canada.

Table 19: Total Job Impacts by Type

Job Impact Type	FTE *(in person-years)* Ontario	FTE *(in person-years)* Total	Total Jobs *(in person-years)* Ontario	Total Jobs *(in person-years)* Total	Total Jobs per $1M Investment *(in person-years)*
Direct	4	4	5	5	3.5
Indirect	2	2	3	3	2.0
Induced	2	2	2	3	2.0
Total	**8**	**9**	**10**	**11**	**7.4**

Calculating relative performance as a function of jobs created per $1 million of program budget is helpful in comparing RFNEEPP between years. This year, each $1 million investment resulted in the creation of 7.4 jobs. Programs can increase in effectiveness—in terms of jobs created per $1M of budget—when the incentives catalyze spending by participants on EE measures. Given that RFNEEPP covers 100% of measure costs, the relative proportion of participant spending is removed as a driver of variability, and as such the number of jobs per $1M investment is expected to remain relatively consistent from year to year. Program activities were significantly lower than anticipated for RFNEEPP in PY2022. This caused a negative household reinvestment shock and resulted in lower than expected jobs created per $1M of program spend. Should the amount of measures installed increase in future years, then the household reinvestment shock might be positive and thus add more jobs to the total, which could serve to increase the number of jobs created per $1M of investment.

Table 20 shows the job impacts in more detail, with jobs added by type and by industry category. Industries are sorted from top to bottom by those with most impacts to least, with industries that showed no impacts not included in the table. The table shows that the industry with the largest impacts was *Administrative and support, waste management and remediation services*, which added seven jobs across Canada; all the jobs created in this category were realized in Ontario. This category is large and non-specific, and reflects the need to hire individuals to fill a large range of roles based on program need (e.g., office administration, call center operations, program management, etc.). *Professional, scientific and technical services* added a total of 1 job, the second most of any industry, which was solely created in Ontario.

Table 20: Job Impacts by Industry

Job Impact Type	**FTE** *(in person-years)* **- Ontario**	**FTE** *(in person-years)* **- Total**	**Total Jobs** *(in person-years)* **- Ontario**	**Total** Jobs *(in person-years)* **- Total**
Administrative and support, waste management and remediation services	5.4	5.5	6.6	6.7
Professional, scientific and technical services	0.5	0.6	0.7	0.8
Retail trade	0.4	0.5	0.6	0.6
Accommodation and food services	0.3	0.3	0.4	0.5
Finance, insurance, real estate, rental and leasing and holding companies	0.3	0.4	0.4	0.4
Transportation and warehousing	0.2	0.3	0.3	0.4
Other services (except public administration)	0.2	0.2	0.3	0.3
Manufacturing	0.1	0.2	0.2	0.2
Wholesale trade	0.1	0.2	0.2	0.2
Information and cultural industries	0.1	0.1	0.1	0.2
Arts, entertainment and recreation	0.1	0.1	0.1	0.1
Repair construction	0.1	0.1	0.1	0.1
Health care and social assistance	0.1	0.1	0.1	0.1
Educational services	0.0	0.0	0.1	0.1
Total	**8**	**9**	**10**	**11**

[1] Columns may not add to totals due to rounding. Total values are rounded to nearest whole number and the per-industry impacts do not sum exactly to the whole number total in every column. Values presented in this table are rounded to the nearest 0.1 to better show the distribution of small jobs impacts.