

# **Technical Appendix – Methodology for Greenhouse Gas Reduction Estimates for CPRG Implementation Grant Application**

New Bedford Massachusetts

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## Introduction

This appendix is a supplement to the New Bedford, Massachusetts Area Implementation Grants General Competition application under the Environmental Protection Agency's (EPA) Climate Pollution Reduction Grant Program (CPRG). This appendix details methodologies, data, sources, assumptions, and results of quantitative assessments performed in support of the New Bedford One Stop Shop measure quantifications of estimated greenhouse gas (GHG) emissions reductions.

## Measure Description

The One Stop Shop will establish a centralized hub for home and building improvements that enhance indoor air quality and comfort, increase water and energy efficiency, and reduce utility bills. It will provide residents and businesses with the technical assistance, financial resources, and contractors needed to do the work. This action is meant to drive energy and emissions reductions in two ways that were quantified separately.

Direct impacts include reductions in household energy use that result from installation of energy conservation measures implemented directly with CPRG funds in income-qualifying households.

Indirect impacts are those that result from investments in energy conservation that are induced across New Bedford from education and support services available through the One Stop Shop to help all residents and businesses navigate the complex landscape of incentives for home energy and other health related improvements.

## Analysis Approach

Potential benefits estimated for the One Stop Shop are dependent on several key assumptions. Unlike discrete infrastructure projects, the potential reach and subsequent impact of the One Stop Shop will be determined by factors such as the total amount awarded, program implementation costs, and details of program design.

GHG Reduction potential and other benefits were estimated from a series of connected calculations:

- 1) Estimate the number of homes that could be upgraded with the requested funding amount.
- 2) Estimate the number of households that could be indirectly supported by the One Stop Shop, inducing action through education and other support.
- 3) Estimate the energy impacts of 'measure packages' applied across participating households.
- 4) Estimate reductions in GHGs for each year's reduction in energy use, accounting for changes to grid carbon intensity expected over the short term (2025-2030) and long term (2025-2050)
- 5) Sum annual reductions for cumulative reductions projected for 2025-2030 and 2025-2050.

## Tools and Models

The following section summarizes tools used in the analysis to support this grant application.

### *NREL ResStock End Use Savings Shapes (EUSS)*

The primary source of data for energy use reduction potential used is the National Renewable Energy Lab (NREL) ResStock, End Use Savings Shapes (EUSS), Typical Meteorological Year (TMY) datasets for the

state of Massachusetts<sup>1</sup>. This resource contains the results of building energy models testing common measure packages in a comprehensive set of model input parameters describing the US residential building stock in great detail. The EUSS dataset allows for developing reduction estimates that capture how the weather of a coastal community like New Bedford impacts the effectiveness of energy conservation measures across a range of home typologies and conditions that are likely to exist in the field. The EUSS dataset provides several pre-defined measure packages for varying levels of weatherization/building envelope measures and electrification (Table 1). This impact analysis is based on the average energy impact for select measure packages, which produce net energy savings estimates for each retrofit type.

*Table 1. NREL ResStock EUSS Measure Package Descriptions*

ResStock EUSS Measure Package	Description
Package 1: Basic Enclosure	<ul style="list-style-type: none"> <li>- Attic floor insulation</li> <li>- General air sealing</li> <li>- Duct sealing</li> <li>- Drill-and-fill insulation</li> </ul>
Package 2: Enhanced Enclosure	<ul style="list-style-type: none"> <li>- Measure Package 1</li> <li>- Foundation wall insulation and rim joint insulation</li> <li>- Seal vented crawlspaces</li> <li>- Insulate finished attics and cathedral ceilings</li> </ul>
Package 4: Heat Pumps, High-Efficiency, Electric Backup	<ul style="list-style-type: none"> <li>- Centrally ducted variable speed heat pump</li> <li>- Ductless variable speed mini-split</li> <li>- Backup heat provided by electric resistance</li> </ul>
Package 8: Whole-Home Electrification, High Efficiency	<ul style="list-style-type: none"> <li>- No enclosure measures</li> <li>- High-efficiency heat pump (Measure Package 4)</li> <li>- Heat pump water heater</li> <li>- Ventless heat pump dryer</li> <li>- Electric oven and induction range</li> </ul>
Package 9: Whole-Home Electrification, High Efficiency + Basic Enclosure	<ul style="list-style-type: none"> <li>- Measure Packages 1 &amp; 8</li> </ul>
Package 10: Whole-Home Electrification, High Efficiency + Enhanced Enclosure	<ul style="list-style-type: none"> <li>- Measure Packages 2 &amp; 8</li> </ul>

With a substantial number of model runs representing many possible combinations of conditions, the EUSS dataset is believed to be a better estimate of likely outcomes of home energy efficiency measures. It provides higher confidence than other single point estimates available in the literature or % based changes to energy use.

One limitation faced in applying this tool was the tradeoffs between looking at targeted groups identifiable in the data set, such as low-income households, with the need to keep large numbers of model households to derive generalizable results. While this was desirable at the project outset, ultimately the analysis of GHG reduction potential samples from all types of residences.

<sup>1</sup> National Renewable Energy Laboratory. ResStock End Use Savings Shapes 2022.1 Release TMY3.  
<https://resstock.nrel.gov/datasets>

### *NREL Cambium Model*

The NREL Cambium Model<sup>2</sup> provided scenarios for projected emissions intensity of grid supplied electricity applied in future-year GHG reduction estimates. While Cambium provides a range of grid carbon intensity scenarios for this analysis, the “Mid-Case with 95% Decarbonization by 2050” was selected as the primary scenario to be modeled as it aligns best with the outcomes for economy wide GHG reductions sought by the Inflation Reduction Act. The Cambium Model provides outputs using eGRID regions that align with other analyses performed under CPRG. One limitation of Cambium is that it does not provide a continuous year-over-year projection of factors, requiring some interpolation between years.

## Calculation Steps

The first step in estimating reduction potential is to evaluate how far requested funding levels could reach if applied in New Bedford.

### Estimating Program Reach

The target award level for this program is \$32,593,942. Following development of the program implementation budget, it is assumed that 37% of funding (\$12,593,942) would go towards various support activities including overall administration of the One Stop Shop as detailed in the Budget Narrative. The remaining 63% of funds (\$20,000,000) would be reserved specifically for offsetting all costs associated with home energy retrofits and beneficial electrification in low-income households.

The analysis to support this application narrative was performed iteratively testing the impact of different combinations of energy savings potential and likely retrofit costs. The analysis demonstrated that by focusing on lower-cost measures, such as weatherization as opposed to full home decarbonization, the potential number of homes reached with \$20,000,000 changed significantly.

Further, the overall intent of this program is to braid program benefits with as many additional sources of funding available. However, it is recognized that there are limitations on combining funding from multiple Inflation Reduction Act grant programs, notably The Home Electrification and Appliance Rebates<sup>3</sup> and Home Efficiency Rebates Programs<sup>4</sup> from the US Department of Energy. In a review of likely benefits from those programs, it appeared that a larger gap may exist for supporting comprehensive weatherization activities than for appliances and equipment, which provides some guidance for cost effective targeting. Note that energy savings and GHG reductions calculated here for the impact of CPRG do not include savings that would occur from households taking advantage of other IRA grant programs even though doing so will be encouraged for additional measures not covered by the One Stop Shop.

Estimating the number of households that can be reached with \$20,000,000 requires an estimate of the costs of different retrofit packages. For this analysis estimated costs of each package were developed

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<sup>2</sup> Gagnon, Pieter; Cowiestoll, Brady; Schwarz, Marty (2023): Cambium 2022 Data. National Renewable Energy Laboratory. <https://scenarioviewer.nrel.gov>

<sup>3</sup> U.S. Department of Energy. Home Electrification and Appliance Rebates. <https://www.energy.gov/scep/home-electrification-and-appliance-rebates>

<sup>4</sup> U.S. Department of Energy. Home Efficiency Rebates. <https://www.energy.gov/scep/home-efficiency-rebates>

from a compilation of installed costs, cataloged by Lawrence Berkeley National Labs<sup>5</sup>, to best match with the components of each of the ResStock Measure Packages. Total households potentially reached by the program was determined by dividing \$20,000,000 across prioritized shares of measures and their costs after local utility administered rebates were accounted for.

Table 2. Final Retrofit Package Costs per Household

ResStock EUSS Measure Package	Initial Cost per Retrofit <sup>6</sup>	Available Utility Rebate Value <sup>7,8,9</sup>
Package 1: Basic Enclosure	\$17,690	\$400 for weatherization
Package 4: Heat Pumps, High-Efficiency, Electric Backup	\$17,045	\$16,000 for SEER 19+ rated model
Package 9: Whole-Home Electrification, High Efficiency + Basic Enclosure Package	\$46,151	\$400 for weatherization, \$16,00 for SEER 19+ rated model, \$750 for heat pump water heater
Package 10: Whole-Home Electrification, High Efficiency + Enhanced Enclosure Package	\$55,707	

### Direct Program Participation

The share of implementation funds allocated to each type of retrofit was assumed to be 63% for weatherization and 37% for standard weatherization + whole home electrification in order to support full decarbonization of a targeted share of homes while extending the program's reach with lower-cost weatherization support. This share is based on the relative proportion of households in New Bedford identified through Department of Energy Low-Income Energy Affordability Data Tool (LEAD)<sup>10</sup> as below 100% for Package 9 and 200% of the FPL for Package 2. Note that share of how program dollars are split among the two EUSS Packages is coincidentally the same share of program admin to direct implementation dollars in the overall budget. Lastly, this split does not imply how income criteria would be used but represents a reasonable split for funds reserved for those households with the greatest need.

Table 3. Households Impacted by Direct Funding

Package Type	Final Cost per Household	Share of Program Funding	Target Gas Households	Target Oil Households
Basic Envelope (EUSS Package 1)	\$17,290	63%	580	145
Whole Home Electrification + Conventional Envelope (EUSS Package 9)	\$32,541	37%	206	52

<sup>5</sup> Less, et al. Lawrence Berkeley National Labs. August 2021. The Cost of Decarbonization and Energy Upgrade Retrofits for US Homes. doi:10.20357/B7FP4D. [https://eta-publications.lbl.gov/sites/default/files/final\\_walker\\_-\\_the\\_cost\\_of\\_decarbonization\\_and\\_energy.pdf](https://eta-publications.lbl.gov/sites/default/files/final_walker_-_the_cost_of_decarbonization_and_energy.pdf)

<sup>6</sup> Less, et al. Lawrence Berkeley National Labs. August 2021. The Cost of Decarbonization and Energy Upgrade Retrofits for US Homes. doi:10.20357/B7FP4D. [https://eta-publications.lbl.gov/sites/default/files/final\\_walker\\_-\\_the\\_cost\\_of\\_decarbonization\\_and\\_energy.pdf](https://eta-publications.lbl.gov/sites/default/files/final_walker_-_the_cost_of_decarbonization_and_energy.pdf)

<sup>7</sup> Mass Save. Heat Pump Water Heaters: Rebates. <https://www.energy.gov/scep/slsc/lead-tool> Accessed 3/11/24.

<sup>8</sup> Mass Save. Enhanced Heating & Cooling Equipment Rebates. <https://www.masssave.com/en/residential/programs-and-services/income-based-offers/save-with-enhanced-incentives/enhanced-incentive-heating-and-cooling> Accessed 3/11/24.

<sup>9</sup> Mass Save Building Insulation & Weatherization Incentives. <https://www.masssave.com/business/rebates-and-incentives/building-insulation-and-weatherization-incentives> Accessed 3/11/24.

<sup>10</sup> U.S. Department of Energy (DOE). Low-Income Energy Affordability Data Tool (LEAD). <https://www.energy.gov/scep/slsc/lead-tool> Accessed 3/11/24.

With \$20 million of funding reserved to offset costs for direct install retrofit projects, approximately 982 homes could receive direct support for implementation of energy conservation measures (Table 3). The current share of natural gas (80%) and oil (20%) heated homes in New Bedford – derived from the New Bedford Property Tax Assessor Database – were then applied to estimate target households by existing heating fuel type (Table 3).

### Indirect Program Participation

While the One Stop Shop will provide targeted direct assistance to low-income and disadvantaged communities to offset home improvement costs; resources to help all residents and building owners navigate the many potential incentives offered by other federal programs as well as local utility incentives is expected to create an uptick in the overall level of investment in energy retrofits above the current rate.

The “one-stop-shop” approach to energy rebate programs has proven to be effective at driving additional adoption of energy conservation measures than just the availability of rebates. The estimated magnitude of these effects is based on the use of a “net-to-gross ratio”, which balances free ridership against spillover and other market effects induced by the program.<sup>11</sup> It is assumed that the One Stop Shop will have wider market effects stimulating energy retrofits across all household types based on the net-to-gross ratio of 1.21, reported in the Market Effects Analysis of the US Department of Energy Better Buildings Neighborhood Program.<sup>12</sup>

The net-to-gross ratio of 1.21 was applied to the current average annual participation rate of 1,276 households per year in the MassSave energy rebate program within New Bedford.<sup>13</sup> This value was derived from the number of active electric accounts (as of December 2020) multiplied by the unique electric location participation rates (2013-2019) for each block group. The estimated number of unique participating households for each block group was totaled and divided by 6 to determine the number of new households per year. The subsequent market impact is an annual increase of 268 participating households.

The mix of energy conservation measures for indirect households is assumed to be equivalent to those receiving full program support. Modeling suggests that due to the combination of electricity costs and winter heating loads, it is likely that pursuing electrification without efficiency measures would increase household energy costs. As such, the education resources of the One Stop Shop should guide spending to the high-impact but cost-effective whole home electrification + conventional weatherization package (EUSS Package 9) wherever heat pump retrofits are sought.

These participation splits – along with the current split between homes in New Bedford heated with natural gas (80%) and oil (20%) – were applied to the estimated annual increase in participating households to determine the additional households per existing heating type that will implement energy

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<sup>11</sup> Violette and Rathbun. National Renewable Energy Lab. September 2014. “Estimating Net Savings: Common Practices. Uniform Methods Project, Chapter 17”. <https://www.energy.gov/sites/prod/files/2015/01/f19/UMPCChapter17-Estimating-Net-Savings.pdf>

<sup>12</sup> U.S. Department of Energy Office of Energy Efficiency and Renewable Energy. June 2015. “Market Effects of the Better Buildings Neighborhood Program Final Evaluation Volume 5”. <https://www.energy.gov/eere/analysis/articles/market-effects-better-buildings-neighborhood-program-final-evaluation-volume>

<sup>13</sup> MassSave. Geographic Participation Maps. <https://www.masssavedata.com/Public/GoogleEarth> Accessed 2/27/24.

conservation measures every year, resulting in the additional retrofits detailed in Table 4. This level of increased activity is modeled to continue annually as the program is expected to become self-sustaining by the end of the CPRG implementation funding cycle.

*Table 4. Annual Households Impacted by Indirect Assistance*

Package Type	Estimate Share of Participation	Participating Gas Households	Participating Oil Households
Basic Envelope (EUSS Package 1)	63%	135	34
Whole Home Electrification + Conventional Envelope (EUSS Package 9)	37%	79	20

### Household Energy Savings Potential

The energy impact of building energy retrofits is based on estimates obtained from the NREL ResStock EUSS datasets for the state of Massachusetts.<sup>14</sup> This resource provides the most comprehensive set of energy conservation measure performance values across a range of real-world circumstances that could be matched to mix of homes in New Bedford. The measure packages included in this assessment are detailed in Table 1. Datasets for each measure package analyzed were filtered to only those that matched input variables selected to best reflect the homes that would be likely candidates for retrofit support. These include:

- In Bristol County, Massachusetts; to account for local weather conditions.
- Single-family detached or single-family attached buildings; to avoid mixing savings estimates from multi-unit apartment complexes with different equipment and performance characteristics.
- Use natural gas or oil for heating fuel; to avoid mixing savings from all-electric baseline homes.
- Excluding buildings with ducted heat pump heating types; to avoid diluting energy savings with low impacts to homes already equipped with high efficiency heat pumps.

These filters resulted in a dataset of 272 records for gas heated homes and 205 records for oil heated homes with other home characteristic inputs and model results. Some attempts were made to increase the sample size by widening the filters to include homes across the state, however this tended to increase the variability of energy impacts reported. Using Bristol County only was determined to better represent the savings potential since these results will incorporate the milder marine weather profile of a coastal community like New Bedford, relative to the rest of the State of Massachusetts.

### Reference Scenario

While not explicitly modeled under a business-as-usual forecast, the approach utilizing the ResStock EUSS datasets implies a reference scenario defined by homes continuing to operate according to their baseline (pre-retrofit) efficiency. Savings estimates for each of the retrofit packages were obtained by matching baseline energy use to post-retrofit energy use per heating type by building model IDs. Thus, savings are estimated for each of the EUSS Measure Packages in each of the 272 gas and 205 oil model homes in the dataset relative to their baseline performance.

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<sup>14</sup> National Renewable Energy Laboratory. ResStock End Use Savings Shapes 2022.1 Release TMY3. <https://resstock.nrel.gov/datasets>



## Uncertainty in Savings Estimates

Although this action is intended to primarily target low-income households, the average savings values used in this analysis reflect the mean savings across all households matching the filters specified above. Early iterations of the analysis explored different savings levels by Federal Poverty Level (“FPL”) classifications included in each model input values. Separating savings by income resulted in relatively low numbers of observations within each set, particularly the low-income divisions of interest. Since there were only 15 gas and 13 oil records between the 0-100% and 100-150% FPL, a decision was made to utilize the complete sample size of 272 gas and 205 oil modeled home records.

Multiple attempts were made at assessing uncertainty utilizing the filtered EUSS dataset. Minimum and maximum values from across the set of modeled homes were applied in full impact calculations as well as ranges developed by adding and subtracting the standard deviation from the mean savings all model results. Unfortunately, due to the characteristics of the data set, the results of these exercises did not yield meaningful insights for uncertainty. The boundaries provided by both approaches did not result in scenarios that would be likely in real world conditions, as it is highly unlikely that anywhere near all homes impacted by the project would perform at either the high or low end of the savings estimates.

The average savings rates for each measure package are assumed to be representative of the expected outcomes of implementing different measure packages. Final savings estimates per heating type for each package are summarized in Table 5. Results for the impacts of uncertainty assessments using the approach of average savings +/- one standard deviation are included in the estimate of total GHG reduction potential.

*Table 5. Average Annual Energy Reduction Potential of ResStock Measure Packages and Uncertainty Estimates.*

ResStock Measure Package	Gas Households		Oil Households	
	Electricity Savings per Household (kWh)	Gas Savings per Household (therms)	Electricity Savings per Household (kWh)	Oil Savings per Household (gallons)
Package 1: Basic Enclosure (Average)	345	338	409	252
Package 1: ( -1 Standard Deviation)	-2,721	60	0.7	34
Package 1: ( +1 Standard Deviation)	717	615	817	471
Package 9: Whole-Home Electrification, High Efficiency + Basic Enclosure Package (Average)	-4,750	1,195	-4,445	854
Package 9: ( -1 Standard Deviation)	-8,408	612	-8,547	384
Package 9: ( +1 Standard Deviation)	-1,093	1,774	-343	1,325

## Applying Measure Package Savings Estimates

Raw outputs from ResStock reported savings in kWh for all fuel types. Natural gas and oil use results were converted to therms and gallons, respectively. Energy savings for each fuel type were normalized to terms of savings per square foot based on the ResStock input building area, “in\_sqft” field for each of the 272 gas and 205 oil model homes, allowing them to be applied to a generic New Bedford household to estimate program savings.

The estimated average annual energy savings per households for each measure package (Table 5) was calculated by applying the average savings per square foot by the average household size of 1,952 square feet, derived from the New Bedford Property Tax Assessor Database.

### Direct Program Ramp-Up

It is recognized that some time will be needed to get up to speed. An assumed ramp-up schedule was devised to spread program activities as even as possible across the period. With momentum gained in the pilot program supported through EECBG funding, the One Stop Shop aims to upgrade 98 homes in calendar year 2025, 10% of the 5-year target. The annual rate of projects completed will ramp up and peak during program years 2027 and 2028, and then begin to close out prior to the end of 2029, allowing for additional time for final project evaluations. The ramp up schedule and associated changes are provided in Table 6.

Table 5. Estimated Ramp-Up Schedule for Direct Program Support

	2025	2026	2027	2028	2029
Share of Target Reached Each Year	10%	20%	25%	25%	20%
Calendar Year Gas Upgrades Made	79	157	197	197	157
Year-End Cumulative Gas Upgrades	79	236	432	629	786
Calendar Year Oil Upgrades Made	20	39	49	49	39
Year-End Cumulative Oil Upgrades	20	59	108	158	197
<b>Total Calendar Year Upgrades Made</b>	<b>98</b>	<b>197</b>	<b>246</b>	<b>246</b>	<b>197</b>
<b>Total Year-End Cumulative Upgrades</b>	<b>98</b>	<b>295</b>	<b>541</b>	<b>786</b>	<b>982</b>

### Indirect Impacts Ramp-Up

It is expected that the indirect impacts of the program will ramp up to their full impact much more quickly as they are driven primarily by information availability and other light-touch services than what is required for arranging direct installation of measures. This analysis assumes 10% of the indirect impact potential is reached in year 1, 50% in year 2, and 100% every year thereafter. Unlike direct-impact households, it is expected that the One Stop Shop will at a minimum continue to exist as an information resource and continue to drive home energy above the current market rate. The cumulative reductions of these homes are included in the estimates for 2050 reduction potential as a representation of the transformative impact the One Stop Shop is expected to bring to the region.

### Energy Use Reductions

Target households per heating fuel for each measure package were multiplied by the ramp-up schedules for direct installations and indirect support, respectively, to determine the number of households retrofitted in each year. The average energy reduction potential of the ResStock measure packages were applied to the annual target households to estimate incremental use savings. These incremental savings were aggregated such that annual reductions for each calendar year incorporate the total energy use reductions that resulted from all prior year retrofits.

### Accounting for Cleaner Electricity

Forward looking projections for grid carbon intensity were obtained from the National Renewable Energy Laboratory's (NREL) 2022 Cambium Model.<sup>15</sup> While there are many available scenarios to choose from, this analysis selected the "Mid-Case 95% Decarbonization Scenario". Cambium Model exports provide projected emissions factors for target years through 2050 (Table 8) in terms of the Average Emissions Rate for the Electric Load in the region. Under this scenario, the projected carbon intensity of electricity

<sup>15</sup> Gagnon, Pieter; Cowiestoll, Brady; Schwarz, Marty (2023): Cambium 2022 Data. National Renewable Energy Laboratory. <https://scenarioviewer.nrel.gov>

in the NEWE eGRID region is 108.4 kg CO<sub>2</sub> per MWh in 2030 and 27.1 kg CO<sub>2</sub> per MWh in 2050. A linear decrease was assumed to estimate emissions factors for interim years between those provided by Cambium. Annual emissions factors were applied to estimated changes in electricity use to avoid overestimating GHG reduction potential.

Table 8. Cambium Model Electricity Emissions Factors

	2024	2026	2028	2030	2035	2040	2045	2050
kg CO <sub>2</sub> per MWh	128.2	120.4	113.6	108.4	85.3	84.0	95.5	27.1

## GHG Reductions

Annual electricity savings were multiplied by the respective Cambium Model projected emissions factor to determine CO<sub>2</sub> annual emissions savings from electricity use. Annual natural gas and oil savings were multiplied by standard EPA emissions factors<sup>16</sup> for CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O to determine emissions savings per fuel type. The Global Warming Potentials (GWP) from the IPCC Fifth Assessment Report (AR5)<sup>17</sup> were applied to CH<sub>4</sub> and N<sub>2</sub>O to estimate total emissions savings in MTCO<sub>2</sub>e.

Annual GHG reductions for each calendar year incorporate the total energy use reductions that result from all prior year retrofits delivered through the program. Cumulative GHG reductions achieved through 2030 represent a sum of each year's annual reduction for the program period. Annual reductions and cumulative reductions are included in Table 9 and Table 10, respectively. Additional details for 2050 cumulative reductions can be found in the attached calculation workbook.

Table 9. Annual GHG Reductions (MTCO<sub>2</sub>e / Year)

Participant Type	Energy Source	2025	2026	2027	2028	2029	2030
Direct Installation	Electricity	(12)	(34)	(61)	(86)	(105)	(103)
	Natural Gas	235	704	1,291	1,878	2,347	2,347
	Fuel Oil	83	249	457	664	830	830
Indirect Support	Electricity	(5)	(29)	(76)	(119)	(161)	(201)
	Natural Gas	74	446	1,190	1,933	2,676	3,420
	Fuel Oil	26	158	421	684	947	1,210

\*Note totals may not sum perfectly due to rounding

Table 10. Cumulative GHG Reductions (MTCO<sub>2</sub>e)

Participant Type	Energy Source	2025	2026	2027	2028	2029	2030
Direct Installations	Electricity	(12)	(46)	(107)	(194)	(299)	(402)
	Natural Gas	235	939	2,230	4,108	6,456	8,803
	Fuel Oil	83	332	789	1,453	2,283	3,113
Indirect Support	Electricity	(5)	(34)	(110)	(229)	(390)	(592)
	Natural Gas	74	520	1,710	3,643	6,319	9,739
	Fuel Oil	26	184	605	1,288	2,235	3,445
Total							24,106

\*Note totals may not sum perfectly due to rounding

<sup>16</sup> U.S. Environmental Protection Agency (EPA). Emission Factors for Greenhouse Gas Inventories (2021). [https://www.epa.gov/system/files/documents/2023-04/emission-factors\\_sept2021.pdf](https://www.epa.gov/system/files/documents/2023-04/emission-factors_sept2021.pdf)

<sup>17</sup> Intergovernmental Panel on Climate Change (2014). IPCC Fifth Assessment Report (AR5).

### Cost Effectiveness

The total award amount of \$ 32,593,942 was divided by the total 2030 cumulative GHG reduction of 24,106 MTCO<sub>2</sub>e to arrive at a cost effectiveness estimate of \$1,352/MTCO<sub>2</sub>e reduced.

### Uncertainty Results

The results of uncertainty estimates using +/- one standard deviation in energy savings from the EUSS data set result in 2030 cumulative savings ranging from 7,122 to 34,784 MTCO<sub>2</sub>e, and 2050 cumulative savings from 122,980 to 487,624 MTCO<sub>2</sub>e.

### Permanence

When assessing the future impact of energy conservation measures, it is common to incorporate considerations for the effective useful life of each energy conservation measure. The focus of the One Stop Shop will be weatherization measures and improvements to heating, ventilation, and air conditioning (“HVAC”) systems, which have effective useful lives which are longer than the 2025-2030 horizon and all savings are expected to remain intact by 2030. The changes made in typical home energy retrofit projects have an effective useful life of the equipment or weatherization measures resulting in diminishing future savings.

- For fuel switching measures, unlikely that customers will revert back to combustion-based space conditioning, water heating, and cooking. Impacts are assumed permanent.
- Assumption that the impacts for weatherization will last 30 years and the impacts for heat pumps and other equipment is 12 years.<sup>18</sup>
- Savings adjustments to account for effective useful life were estimated from the performance of a heat pump operating in a highly insulated home as opposed to the pre-weatherization condition of the home. This value was determined by sampling the difference in average electricity savings between EUSS Package 3 and Package 4, to illustrate the difference between a high-performance heat pump and potentially a minimal efficiency replacement. Impacts were filtered for homes with high levels of insulation to represent the impacts within a home that has been weatherized, which all participating homes should be.

Applying the impact of effective useful life followed methods utilized in other analysis using EUSS datasets, with some simplification for the sake of spreadsheet modeling. For equipment related savings, 1/2 of the savings were removed in the first year of its effective useful life and the remaining savings removed in the following year. These adjustments begin in 2037, 12 years after the implementation of measures in 2025. For the electrification actions that occur from direct participants, the result is 531,254 kWh of savings are eliminated by 2050.

Adjustments for effective useful life are more significant among the indirect program beneficiaries that continue to install energy conservation measures beyond 2025. By 2041, 12 years after the maximum level of implementation is reached, net savings are reduced by 203,853 kWh each year as older equipment wears out from 12 years prior. This adjustment applies for the duration of the assessment period to 2050. Cumulative adjustments to the 2050 impacts for indirect participants total 2,466,624 kWh.

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<sup>18</sup> Mayernick and Stenger. National Renewable Energy Laboratory. “Overview of the Inflation Reduction Act of 2022 (IRA) Home Energy Rebate Tool. Table 3. <https://www.nrel.gov/docs/fy23osti/86700.pdf>