

EPA Climate Pollution Reduction Grants – Implementation Grants
New England Heat Pump Accelerator
Appendix B: Technical Appendix

This Technical Appendix explains the methodology and assumptions used for developing the estimated greenhouse gas (GHG) emissions and co-pollutant emissions reduced for the New England Heat Pump Accelerator (Accelerator).

The first section (a) provides an overview of the methods used to estimate GHG and criteria air pollutant (CAP) emission reductions from the Accelerator. The following sections provide additional details on the models and tools used (b), measure characteristics (c), and GHG emission reduction estimate assumptions such as emissions factors (d), reference case scenario (e), measure activity data (f), and GHG emissions reductions results (g).

a. GHG Emission Reduction Estimate Method

The emissions changes for the Accelerator account for the net effect of decreased emissions from nonelectric, onsite fuel consumption and the increased emissions from the additional grid load from increased heat pump adoption. The emissions results show the net GHG and CAP emission reductions accounting for both sets of impacts.

GHG Emissions Impacts from Fuel Consumption

The energy savings estimates from reduced onsite fossil fuel consumption are based on modeling the building energy savings associated with installing heat pumps. Modeled savings are based on the National Renewable Energy Laboratory (NREL) ResStock End-Use Savings Shapes dataset.¹ Additional information on the ResStock and additional building upgrade scenarios modeled is provided in Section b: Models/Tools Used. To estimate savings, we calculated the change in energy usage when the electrification upgrade is applied to each residential building model, and then filter and aggregate them for building models which are part of the relevant New England geographies for this analysis (CT, MA, ME, NH, and RI). To calculate the CO₂e and CAP emissions impact of a given building upgrade, we multiplied the change in energy consumption for each fuel type by the fuel-specific CO₂e emissions factors provided in Section d: Emission Reduction Estimate Assumptions.

GHG Emissions Impacts from Electricity Consumption

For the increased emissions resulting from the additional load on the New England electricity grid due to building electrification, we estimated the GHG emissions from electricity usage using emissions factors from NREL's Cambium tool based on a 95% decarbonized electricity sector by 2050.² We used the long-run marginal emission factors for CO₂e for both pre-combustion (upstream methane leakage, emissions during extraction, etc.) and combustion. The long-run marginal emissions factor "is an estimate of the rate of emissions that would be either induced or avoided by a change in electric demand, taking into account how the change could influence both the operation as well as the structure of the grid." It is most appropriate for evaluating the GHG emissions impacts of a long-term intervention, like the installation of heat pumps. Emissions impacts from changes in electricity usage include both increased load on the grid from heat pump uptake, as well as decreases in usage when legacy, inefficient electrical appliances are upgraded with more efficient models. Additional information on NREL's Cambium tool is provided in Section b: Models/Tools Used. GHG and CAP emissions factors for electricity are provided in Section d: GHG Reduction Estimate Assumptions.

¹ NREL. (2024). *ResStock*. <https://resstock.nrel.gov/>.

² NREL. (2023). *Scenario viewer: Cambium 2023*. <https://scenarioviewer.nrel.gov/>.

b. Models/Tools Used

Energy Consumption Impacts

We used NREL's ResStock tool to calculate energy consumption impacts for air-source heat pumps (ASHPs) and heat pump water heaters (HPWHs) installed through the Accelerator. The ResStock tool and dataset consists of 550,000 simulated residential building models that statistically represent every residential housing unit in the contiguous United States. For each simulated building, ResStock uses EnergyPlus, the Department of Energy's open-source building energy modeling tool, to model the energy used by every appliance in the building.

ResStock includes 10 energy efficiency and electrification scenarios,³ simulating upgrades to each building model, with upgrades such as weatherization packages and swapping out fossil fuel appliances for efficient electric alternatives. These scenarios include:

1. Basic Enclosure Package
2. Enhanced Enclosure Package
3. Heat Pumps, Min-Efficiency, Electric Back-Up (SEER 15, HSPF 9)
4. Heat Pumps, High-Efficiency, Electric Back-Up (SEER 24, HSPF 13 for ducted heat pumps; SEER 29.3, HSPF 14 for ductless heat pumps)
5. Heat Pumps, Min-Efficiency, Existing Heating as Back-Up
6. Heat Pump Water Heaters
7. Whole-Home Electrification, Min Efficiency
8. Whole-Home Electrification, Max Efficiency
9. Whole-Home Electrification, High Efficiency + Basic Enclosure Package
10. Whole-Home Electrification, High Efficiency + Enhanced Enclosure Package

The upgrade packages for High-Efficiency Heat Pumps with Basic Enclosure Package and Heat Pump Water Heaters were used to simulate electrification retrofits in existing single-family and mobile-home homes in the five participating New England states. We assumed that the homes served will have at least the basic enclosure package because each state has long-running energy efficiency and weatherization programs and is actively promoting heat pump installations in homes that have already been weatherized.

Electricity Generation Emissions Impacts

As described in Section a, NREL's Cambium tool⁴ was used to estimate the GHG emissions impacts from electricity usage using long-run marginal emissions factors for CO₂e for both pre-combustion (upstream methane leakage, emissions during extraction, etc.) and combustion. NREL's long-run marginal emissions factors are based on a 95% decarbonized electricity sector by 2050. The long-run marginal emissions factor "is an estimate of the rate of emissions that would be either induced or avoided by a change in electric demand, taking into account how the change could influence both the operation as well as the structure of the grid."⁵ It is most appropriate for evaluating the GHG emissions impacts of a long-term intervention, like the installation of heat pumps. Emissions impacts from changes in electricity usage include both increased load on the grid from heat pump uptake, as well as decreases in usage when legacy, inefficient electrical appliances are upgraded with more efficient models. Emissions factors for electricity are provided in the GHG Reduction Estimate Assumptions section below.

³ NREL. (2021). *End-Use Savings Shapes: Residential Round 1: Technical Documentation and Measure Applicability Logic*. NREL. https://oedi-data-lake.s3.amazonaws.com/nrel-pds-building-stock/end-use-load-profiles-for-us-building-stock/2022/EUSS_ResRound1_Technical_Documentation.pdf.

⁴ NREL, *Scenario Viewer*.

⁵ Gagnon, P., Cowiastoll, B., & Schwarz, M. (2023). *Long-run marginal emission rates for electricity - Workbooks for 2022 cambium data | NREL data catalog*. NREL Data Catalog | NREL. <https://data.nrel.gov/submissions/206>.

Emissions Factors

Sources and methods used for calculating GHG and CAP emission factors for fuels are provided in Section d: Emission Reduction Estimate Assumptions.

Health Benefits Analysis

Health impacts were analyzed using EPA's CO-Benefits Risk Assessment (COBRA) screening model.⁶ COBRA takes sector-specific changes in emissions of primary fine particulate matter (PM_{2.5}) and precursors of secondary PM_{2.5}, including nitrogen oxides (NO_x), sulfur dioxide (SO₂), ammonia (NH₃), and volatile organic compounds (VOCs) and conducts multiple modeling steps to translate changes in emissions to changes in health effects. First, COBRA uses a simplified air quality model, the Source Receptor (S-R) Matrix, to estimate changes in total annual ambient concentrations of PM_{2.5}, including the formation of secondary PM_{2.5} from precursor pollutants. COBRA then uses a series of health impact functions, taken from peer-reviewed epidemiological literature, to estimate how changes in outdoor air quality result in changes in the incidence of a variety of health outcomes (e.g., premature mortality, heart attacks, asthma exacerbation, lost work days). Finally, COBRA multiplies the change in incidence for each health outcome by a monetary value specific to that outcome (e.g., the average cost of going to the emergency room for asthma symptoms or the cost of a lost work day) to determine the monetized health impacts.

c. Measure Implementation Assumptions

Implementation Measure Uptake

We assumed that \$400 million of the \$500 million requested for the Accelerator will be used to directly support heat pump measure installation through Market Hub midstream incentives and Innovation Hub project implementation over a five-year period. We made the following assumptions related to measure implementation:

- Based on a 15-year lifetime for both heating, ventilation, and air conditioning (HVAC) systems and water heaters, we assumed that approximately 6.7% of residential housing units will replace a system each year, or 33.5% of homes over a five-year period. Given the Accelerator's broad market reach through targeting wholesale distributors, we estimated that the program will reach 4%-10% of households over a five-year period, depending on the equipment type and existing fuel type, or 12%-30% of the households replacing HVAC and water heating systems over the five years.
- In New England, residential heating costs for households using fuel oil and propane are significantly higher than households using natural gas for heating.⁷ We therefore expect the heat pump adoption rate for households using delivered fuels to be about double that of households using natural gas. Households using electric resistance heating will also achieve significant cost savings by adopting heat pumps. Therefore, we assumed that, in combination with targeted program messaging about cost-effectiveness of heat pumps as compared to delivered fuels, a natural market result of the program's incentives will be that 9% of households across the region currently using fuel oil, propane, or electric resistance for heating will adopt ASHPs and 4.5% of households using natural gas will adopt ASHPs over the five years of program implementation.
- We assumed that 10% of households across the region will adopt HPWHs over the five-year period, regardless of fuel type, since HPWHs have lower upfront costs and better customer economics for customers across all fuel types. Actual adoption rates will be driven by market

⁶ COBRA Health Impacts Screening and Mapping Tool. (n.d.). U.S. EPA. <https://cobra.epa.gov/>.

⁷ Gabriel, N. (2023, April 3). *Fuel Oil and Propane Space Heating Across The United States*. Atlas Buildings Hub. <https://atlasbuildingshub.com/2023/04/03/fuel-oil-and-propane-space-heating-across-the-united-states/>.

conditions, rather than prescribed in a market transformation program; these assumptions are based on consumer economics and significant existing experience in the region.

- We assumed that heat pump installations are spread evenly across each of the five years of program implementation. This is a simplifying assumption because program setup will occur during year 1, and deployment (and resultant emissions reductions) will likely be lower in the first year than the following years. Once deployment begins, emissions reductions will begin immediately.
- Incentive levels for midstream distributor incentives are assumed to be \$1,000 per unit for ASHPs and \$500 per unit for HPWHs. Based on a review of successful midstream programs in other states, we determined that these incentive levels would be sufficient to drive increased market uptake through the supply chain, in tandem with rebates already available to end-use customers in the five states.

Measure Lifetime

We assume a 15-year average measure lifetime for both ASHPs and HPWHs.⁸ We assume that heat pumps installed during program implementation from 2025 through 2029 will continue to operate and deliver GHG reductions for 15 years. Therefore, no savings are assumed past 2044.⁹

Performance Data: Heat Pump and Building Characteristics

Performance characteristics, including heat pump efficiency levels and building distribution systems and weatherization, are incorporated into the building upgrade packages we modeled using ResStock. For ducted heat pump units, efficiency ratings of Seasonal Energy Efficiency Ratio (SEER) 24 and 13 Heating Seasonal Performance Factor (HSPF) are modeled, and for ductless units the assumed efficiency is SEER 29.3, 14 HSPF. For homes with existing ductwork, heat pumps are sized using Air Conditioning Contractors of America (ACCA) Manual S, which sizes heat pumps based on cooling load with an oversizing allowance to meet higher heating loads. An oversizing allowance of 30% is added in cold climates that are not dry (climate zones 5A, 6A, and 7A), which applies to New England. Electric resistance heating is assumed when the heat pump alone is not able to meet the load. These upgrades apply to dwelling units with ducts and either no heat pump or a less efficient heat pump (SEERs < 24; HSPFs < 13). For homes without ducts, the heat pumps modeled are ductless heat pumps sized to the larger of the cooling and heating load. These are applied to dwelling units without ducts and no heat pump or a less-efficient heat pump (multisource heat pump (MSHP) SEER 14.5, 8.2 HSPF or MSHP SEER 29.3, 14 HSPF not sized to max load).

The building energy modeling also assumes that homes are weatherized to some extent by participating in existing state and federal programs. The assumed weatherization package includes attic floor insulation up to IECC-Residential 2021 levels (R-60 in New England climate zones for homes with R-38 insulation or less), general air sealing to achieve a 30% reduction in ACH50, duct sealing to 10% leakage, and R-13 drill-and-fill insulation (if the home currently has wood stud walls with no insulation).

LIDAC Incentive Allocations

The Accelerator will direct at least 40% of program funding to LIDACs. The program will invest \$300 million in midstream incentives to distributors and contractors to drive heat pump adoption through the Market Hub and \$100 million on Innovation Hub projects. We assume that 20% of Market Hub installations will occur in LIDACs. Households in LIDACs make up 17% of the households in the region,¹⁰ and the Market

⁸ InterNACHI. (n.d.). *InterNACHI's standard estimated life expectancy chart for homes*. <https://www.nachi.org/life-expectancy.htm>; Jacobs, A. (2022, September 14). *How long do water heaters last? (Water heater lifespans)*. Jacobs Heating & Air Conditioning. <https://jacobsheating.com/blog/how-long-do-water-heaters-last/>.

⁹ Note that this is a simplifying assumption because the 15-year measure lifetime is for an average system.

¹⁰ *ResStock analysis tool*. NREL. <https://www.nrel.gov/buildings/resstock.html>.

Hub will also target incentives to heat pump equipment types needed in housing types occupied by lower income households, such as multifamily buildings.

All heat pump installations funded by the \$100 million in Innovation Hub projects will occur in LIDACs because that program pillar will exclusively fund projects that overcome persistent barriers to heat pump adoption for low-income households and disadvantaged communities. Innovation Hub projects will include programs targeting manufactured/mobile homes, geothermal networks, heat pumps for large multifamily buildings, and emergency replacement programs.

Households in LIDACs are more expensive to serve. For the purposes of calculating GHG reductions, we assumed that the \$100 million allocated to the Innovation Hub, directed toward LIDACs, will have 80% of the cost-effectiveness (in \$/MTCO₂e) compared to the rest of the \$300 million allocated toward the Market Hub. This 80% cost-effectiveness (i.e. higher cost per ton of carbon abatement) is also applied to 20% of the Market Hub, in recognition that higher incentive levels may be needed to reach LIDACs (for example, through an incentive adder for distributors and contractors serving LIDACs).

Attribution of Savings to the Accelerator

As described in Section 1.B of the Workplan, coalition states have access to other funding sources to support heat pump adoption, such as utility rebates and IRA tax credits for heat pumps. The Accelerator is thoughtfully designed to complement these existing customer-facing rebates by targeting incentives to distributors, thereby filling a critical gap in the program landscape. To quantify the savings attributable solely to CPRG implementation grant funding, we estimated the number of households participating in the Accelerator that would also be expected to participate in each state's existing heat pump programs and to receive federal tax credits. GHG emissions impacts for these customers were reduced to the proportion attributable to the Accelerator, per EPA's guidance.

To account for attributable impacts, we used the following methodology:

- We examined the number of heat pump installations that existing programs in the five coalition states reached annually in 2022 or 2023. We also examined the funding level for these existing state programs, which varies by state (see Appendix D).
- We assumed that 60% of households reached through the Accelerator will also take advantage of the federal tax credit (\$2,000) for heat pumps.¹¹ This is based on data showing that 40% of U.S. households do not have the level of tax liability needed to pay income taxes and therefore would not be eligible for the tax credit.¹²
- We then calculated the percentage of households that would take advantage of the various state and utility incentives and applied percentages to derive an allocation factor for the entire program.
- Note that we assumed no participants would be eligible for the Department of Energy (DOE) Home Energy Rebates program for heat pump rebates because that program does not allow stacking two sources of federal grants for the same equipment.
- We also accounted for the market effects, sometimes referred to as market lift, for the Accelerator. Market effects are the additional energy savings that occur because of a change in the market structure that leads to increased adoption of energy efficiency measure, services, or

¹¹ IRS. (2023, August 17). *Energy efficient home improvement credit*. Internal Revenue Service. <https://www.irs.gov/credits-deductions/energy-efficient-home-improvement-credit>.

¹² Tax Policy Center. (2022, October 27). *T22-0132 - Distribution of Tax Units with Zero or Negative Individual Income Tax, By Expanded Cash Income Percentile, 2022*. <https://www.taxpolicycenter.org/model-estimates/tax-units-with-zero-or-negative-federal-individual-income-tax-oct-2022/t22-0132>.

behavior and can be attributed to the program market intervention.¹³ In many jurisdictions with large-scale energy efficiency programs that are designed to transform market, regulators stipulate an “adder” to the calculated value of attributable savings, e.g., 5% in Hawaii and California, where net-to-gross values are adjusted upward by 5 percentage points.¹⁴ Following those approaches approved by utility regulators for efficiency programs, we assumed a 5% market lift applied to the analysis of the New England Heat Pump Accelerator.

The following calculations show how we applied this attribution methodology:

$$\begin{aligned}
 & ([\$1000 \text{ Accelerator incentive} / \text{total incentives}^{15} * \% \text{ households receiving total incentives}] \\
 & + [\$1000 \text{ Accelerator incentive} / \text{total incentives} * \% \text{ households receiving state and Accelerator} \\
 & \text{incentives but no federal tax credit}] \\
 & + [\$1000 \text{ incentive Accelerator} / [\text{Accelerator} + \text{tax credit incentives}] * \% \text{ households receiving} \\
 & \text{Accelerator and tax credit but no utility/state incentives}] \\
 & + [\$1000 \text{ incentive Accelerator} / [\text{Accelerator} + \text{tax credit incentives}] * \% \text{ households receiving} \\
 & \text{Accelerator and tax credit but no utility/state incentives}] \\
 & + [5\% \text{ market effects adder}]) \\
 & [80\% \text{ cost-effectiveness factor for portion of funds going to LIDACs}] \\
 & = \text{Allocation factor (\%)}
 \end{aligned}$$

This allocation factor is estimated for each state, ranging from 20% to 57%, and applied as a discount factor for emissions reductions in each state. In aggregate, the attribution analysis finds that about 32% of emissions reductions from heat pump adoptions across the coalition states would be attributable to the Accelerator. These factors are then applied to the impacts in each state to discount all emissions reductions and derive the attributable GHG and CAP emissions reductions for the Accelerator.

d. Emission Reduction Estimate Assumptions

GHG Emission Factors

Table 1 shows the CO₂e emission factors used to calculate GHG emission reductions for changes in residential onsite fossil fuel combustion due to heat pump installation. These values are static and do not change over time.

Table 1 CO₂e Emission Factors

CO ₂ e Emission Factors	
Natural gas	147.3 lb CO ₂ e/MMBtu (228.0 kg/MWh)
Propane	177.8 lb CO ₂ e/MMBtu (182.3 kg/MWh)
Fuel oil	195.9 lb CO ₂ e/MMBtu (303.2 kg/MWh)

The emission factors for fuels include both the combustion and pre-combustion (e.g., methane leakage for natural gas) CO₂e emissions. These values are from Table 7.1.2(1) National Average Emissions Factors for Household Fuels from draft ANSI/RESNET/ICC 301 Standard for the Calculation and Labeling of the Energy Performance of Dwelling and Sleeping Units using an Energy Rating Index. The original source for the emissions factors is the EPA’s Compilation of Air Pollutant Emissions Factors from Stationary Sources

¹³ DOE’s Uniform Methods project: <https://www.energy.gov/sites/prod/files/2015/01/f19/UMPChapter17-Estimating-Net-Savings.pdf>

¹⁴ CA PUC. (2020, April). *Energy Efficiency Policy Manual*. California Public Utilities Commission. <https://www.cpuc.ca.gov/-/media/cpuc-website/files/legacyfiles/e/6442465683-ee-policy-manual-revised-march-20-2020-b.pdf>.

¹⁵ Total incentives include Accelerator incentive of \$1,000 per ASHP, the \$2,000 federal tax credit, and additional state or utility program incentives that vary by state, ranging from \$1,000-\$13,000.

(AP-42),¹⁶ supplemented with additional lifecycle analysis to model the pre-combustion emission factors from the U.S. Life Cycle Inventory Database.¹⁷

CO₂e emission factors for electricity were modeled using NREL's electric grid forecasting model Cambium and vary by year and by state, depending on the electricity generation mix.

CAP Emission Factors

Table 2 shows the average CAP emissions factors for each fuel type and pollutant for the states included in this analysis, expressed in lb/MMBtu. CAP emissions quantities are reported by the 2020 National Emissions Inventory (NEI).¹⁸ Emissions factors are taken from the EPA's Compilation of Air Pollutant Emissions Factors from Stationary Sources (AP-42),¹⁹ supplemented with additional lifecycle analysis to model the pre-combustion emission factors from the U.S. Life Cycle Inventory Database.²⁰

Table 2 CAP Emission Factors

Fuel	CAP Emission Factors (lb/MMBtu)				
	NH ₃	NO _x	PM _{2.5}	SO ₂	VOCs
Fuel Oil	0.0073	0.1313	0.0155	0.0016	0.0052
Natural Gas	0.0194	0.0910	0.0004	0.0006	0.0053
Propane	0.0005	0.1465	0.0004	0.0006	0.0057
Electricity	0.0011	0.0317	0.0031	0.0110	0.0041

To estimate CAP emissions associated with changes in residential fossil fuel combustion due to heat pump installation, we first estimated CAP emissions at a high spatial granularity using a combination of American Community Survey (ACS) data published by the U.S. Census Bureau,²¹ NEI data published by EPA,²² and state-level energy consumption estimates for the residential sector published by EIA.²³ To calculate the CAP emissions factors specific to each onsite fossil fuel combustion type, we divided NEI-reported total CAP emissions quantities from the residential sector for each fuel type at the state-level by EIA-reported state-level energy consumption of each fuel type by the residential sector. NEI data was used to calculate the fuel emissions factors, rather than using AP-42 factors directly, because using the AP-42 factors did not align with pollutant volumes published by NEI. Using NEI data to calculate fuel emissions factors is also preferred by the EPA in its eGRID analysis.²⁴ We then applied these emission factors, represented as tons of pollutant per unit of energy consumption for each fuel type, to the energy savings impacts we modeled using ResStock.

¹⁶ AP-42: Compilation of air emissions factors from stationary sources. (2024, February 29). U.S. EPA. <https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emissions-factors-stationary-sources>.

¹⁷ U.S. life cycle inventory database. NREL. <https://www.nrel.gov/analysis/lci.html>.

¹⁸ 2020 National Emissions Inventory (NEI) data. (2023, May 31). U.S. EPA. <https://www.epa.gov/air-emissions-inventories/2020-national-emissions-inventory-nei-data>

¹⁹ AP-42: Compilation of air emissions factors from stationary sources. (2024, February 29). EPA. <https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emissions-factors-stationary-sources>.

²⁰ U.S. life cycle inventory database. NREL. <https://www.nrel.gov/analysis/lci.html>.

²¹ US Census Bureau. (2023, August 16). American community survey data. Census.gov. <https://www.census.gov/programs-surveys/acs/data.html>.

²² National emissions inventory (NEI). (2023, May 26). U.S. EPA. <https://www.epa.gov/air-emissions-inventories/national-emissions-inventory-nei>.

²³ RECS (Residential Energy Consumption Survey). (n.d.). U.S. Energy Information Administration (EIA). <https://www.eia.gov/consumption/residential/reports.php>.

²⁴ Estimating Particulate Matter Emissions for eGRID. (2020). eGRID. https://www.epa.gov/sites/default/files/2020-07/documents/draft_egrid_pm_white_paper_7-20-20.pdf.

To estimate the CAP emissions from changes in residential electricity consumption due to heat pump installation, we employed a similar process. First, we calculated forward-looking CAP emissions factors for electricity generation using CAP emissions quantities reported by the 2020 NEI, annual electricity generation figures reported by the EIA, and NREL's electric grid forecasting model Cambium. The NEI reports CAP emissions quantities associated with different fuel types from electricity generation locations throughout the U.S. We summarized these at the state, fuel source, and pollutant level. We divided these totals by the total annual electricity generation figures published by EIA. The baseline emissions factors represent the tons of pollutants associated with each kWh of generation in the present day.

Then, to adequately capture the impact that a decarbonizing electricity sector will have on CAP emissions, we used grid forecast scenarios from Cambium. We chose the grid forecast associated with a 95% carbon-free grid by 2050, which models an increase in solar and wind electricity production and an associated fall in both greenhouse gases and CAPs. Cambium publishes the estimated generation by energy source per state through the year 2050. We used this generation forecast to calculate how the emissions factor for each state would change through 2038 (representing the approximate life span of a heat pump that is installed in 2023). We calculated the adjusted emissions factor by weighting each fuel's emissions factor by the forecasted electricity generation from that fuel in each year, to arrive at an aggregate emissions factor for electricity generation in each state. Finally, we translated state level emissions factors to EPA's eGRID subregions, which were developed to minimize the import and export of electricity outside state boundaries to reflect the fact that electricity demand in one state may not be fully met by generation within that state.

e. Reference Case Scenario

Program emissions reductions are calculated as incremental reductions resulting from deployment of heat pumps. This bottom-up analysis did not use a top-down reference case scenario for fossil fuel residential space heating and water heating emissions in the New England states. However, the analysis used NREL's Cambium as a reference case to model electricity-sector emissions impacts from heat pump deployment. Another source that could be used for reference case scenario analysis is NREL's [SLOPE Scenario Planner](#), which gives estimates in a business-as-usual case projection for electricity supply and energy demand sectors, incorporating the potential impacts of the Inflation Reduction Act. The electricity generation mix evolves over time based on existing policies and default market and technology assumptions. From this modeling, the residential sector across the five states in the coalition would emit 116 MMTCO₂e annually in 2030, and 84 MMTCO₂e annually in 2050 (for the entire residential sector). However, this estimate was not used for modeling the projected emissions reductions of the Accelerator.

f. Measure-Specific Activity Data and Implementation Tracking Metrics

The program is estimated to install heat pumps in 115,445 homes on average each year over the five years. Through reporting from contractors and distributors, and collaboration with local community groups and governments, the regional implementer will track installations incentivized by the midstream program that are completed across the region, in each state, and in LIDACs. The implementer will also track measure installations through the Innovation Hub and participation in workforce development programs.

g. GHG and Co-Pollutant Emissions Reduced

Based on the methods and assumptions provided throughout this Technical Appendix, implementation of the New England Heat Pump Accelerator will reduce **2,455,236** MTCO₂e cumulatively from 2025-2030, and **10,057,729** MTCO₂e cumulatively from 2025-2050. Table 3 shows the cumulative GHG emission reductions for both 2025-2030 and 2025-2050 in total and by Hub. Table 4 shows the cumulative GHG emission reductions for 2025-2030 and 2025-2050 by state and in total across the coalition.

Table 3 Cumulative GHG Emission Reductions for Market and Innovation Hubs

Priority Measure	Cumulative GHG Emission Reductions (MTCO ₂ e)	
	2025-2030	2025-2050
New England Heat Pump Accelerator	2,455,236	10,057,729
Market Hub (\$300 million)	1,921,489	7,871,266
Innovation Hub (\$100 million)	533,747	2,186,463

Table 4 Cumulative GHG Emission Reductions for New England Heat Pump Accelerator by State

State	Cumulative CO ₂ e Savings (2025-2030, MT)	Cumulative CO ₂ e Savings (2025-2050, MT)
CT	564,704	2,313,278
MA	810,228	3,319,051
ME	392,838	1,609,237
NH	368,285	1,508,659
RI	319,181	1,307,505
Total	2,455,236	10,057,729

Table 5 shows the average annual criteria air pollutant (CAP) and hazardous air pollutant (HAP) reductions for the 2025-2030 period across the coalition.

Table 5 Average Annual CAP and HAP Reductions for New England Heat Pump Accelerator, 2025-2030

CAP or HAP	NH ₃	NO _x	PM _{2.5}	SO ₂	VOCs
Emissions Reductions Per Year, 2025-2030 (kg)	296	8,242	802	2,868	1,077

Table 6 shows the monetized health impacts savings from reducing CAP emissions across the coalition, calculated as described in Section b.

Table 6 Annual Monetized Health Impacts from CAP Emissions Reductions, 2025-2030

Health Endpoint	Cases, Annual		Dollars, Annual	
	Low	High	Low	High
Mortality	0.022	0.051	\$239,038	\$541,076
Nonfatal Heart Attacks	0.002	0.023	\$389	\$3,613
Infant Mortality	0.000	0.000	\$992	\$992
Hospital Admits, All Respiratory	0.004	0.004	\$199	\$199
Hospital Admits, Cardiovascular	0.004	0.004	\$261	\$261
Acute Bronchitis	0.026	0.026	\$16	\$16
Upper Respiratory Symptoms	0.479	0.479	\$21	\$21
Lower Respiratory Symptoms	0.336	0.390	\$8	\$8
Emergency Room Visits, Asthma	0.015	0.015	\$7	\$7
Asthma Exacerbation	0.510	0.510	\$38	\$38
Minor Restricted Activity Days	16.589	16.589	\$1,454	\$1,454
Work Loss Days	2.813	2.813	\$563	\$563
Total Health Effects			\$242,986	\$548,248

Table 7 provides annual GHG emission reductions by state in the coalition for the 2025-2050 period. Due to the assumed average measure lifetime of 15 years, annual emissions reductions from the Accelerator peak in 2039 and then are assumed scale down to zero by 2045.

Table 7 Annual MTCO2e Emissions Reductions by State

State	2025	2026	2027	2028	2029	2030
CT	34,396.13	69,075.75	104,178.73	139,870.18	176,324.60	177,372.25
MA	36,852.35	74,347.92	113,417.22	153,581.38	193,750.80	195,967.53
ME	10,376.47	21,044.53	32,228.11	43,756.32	55,077.93	55,494.91
NH	23,580.46	47,387.39	71,542.53	96,507.49	123,110.45	125,344.45
RI	13,326.20	26,902.15	41,305.79	55,755.55	71,031.68	72,328.63
Total	118,531.62	238,757.75	362,672.39	489,470.92	619,295.47	626,507.78

State	2031	2032	2033	2034	2035	2036	2037
CT	178,020.77	179,032.79	179,933.40	180,825.04	181,727.70	182,681.55	183,566.89
MA	196,674.13	197,468.38	198,229.27	198,904.86	199,500.53	200,453.68	201,394.30
ME	55,609.23	55,691.93	55,756.96	55,798.72	55,843.80	55,994.94	56,255.93
NH	126,525.12	127,441.56	128,683.52	129,913.30	131,061.39	132,221.55	133,295.50
RI	72,822.92	73,219.59	73,622.20	74,036.51	74,376.42	74,801.05	75,118.56
Total	629,652.16	632,854.24	636,225.35	639,478.43	642,509.85	646,152.76	649,631.18

State	2038	2039	2040	2041	2042	2043	2044
CT	184,792.82	185,886.51	94,914.21	92,725.07	90,414.20	88,096.18	85,811.35
MA	202,339.89	203,290.43	146,775.69	145,423.06	143,987.01	142,588.89	141,178.98
ME	56,507.83	56,763.55	26,626.97	26,160.42	25,713.49	25,279.40	24,839.99
NH	134,620.01	135,822.21	74,520.15	73,053.46	71,476.07	69,910.74	68,307.54
RI	75,320.25	75,731.47	31,429.13	31,425.68	31,422.24	31,418.80	31,415.36
Total	653,580.79	657,494.16	374,266.15	368,787.69	363,013.02	357,294.01	351,553.22

State	2045	2046	2047	2048	2049	2050
CT	0.00	0.00	0.00	0.00	0.00	0.00
MA	0.00	0.00	0.00	0.00	0.00	0.00
ME	0.00	0.00	0.00	0.00	0.00	0.00
NH	0.00	0.00	0.00	0.00	0.00	0.00
RI	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.00	0.00	0.00	0.00	0.00	0.00