Building Electrification Institute

CITIES DRIVING CHANGE

Boston Funding Gap Analysis for Residential Building Decarbonization

Completed March 2023, Updated February 2024

NEW ECOLOGY
Community-Based Sustainable Development

FIREFLY ENERGY CONSULTING

Table of Contents

Building Electrification Institute
CITIES DRIVING CHANGE

FIREFLY ENERGY CONSULTING

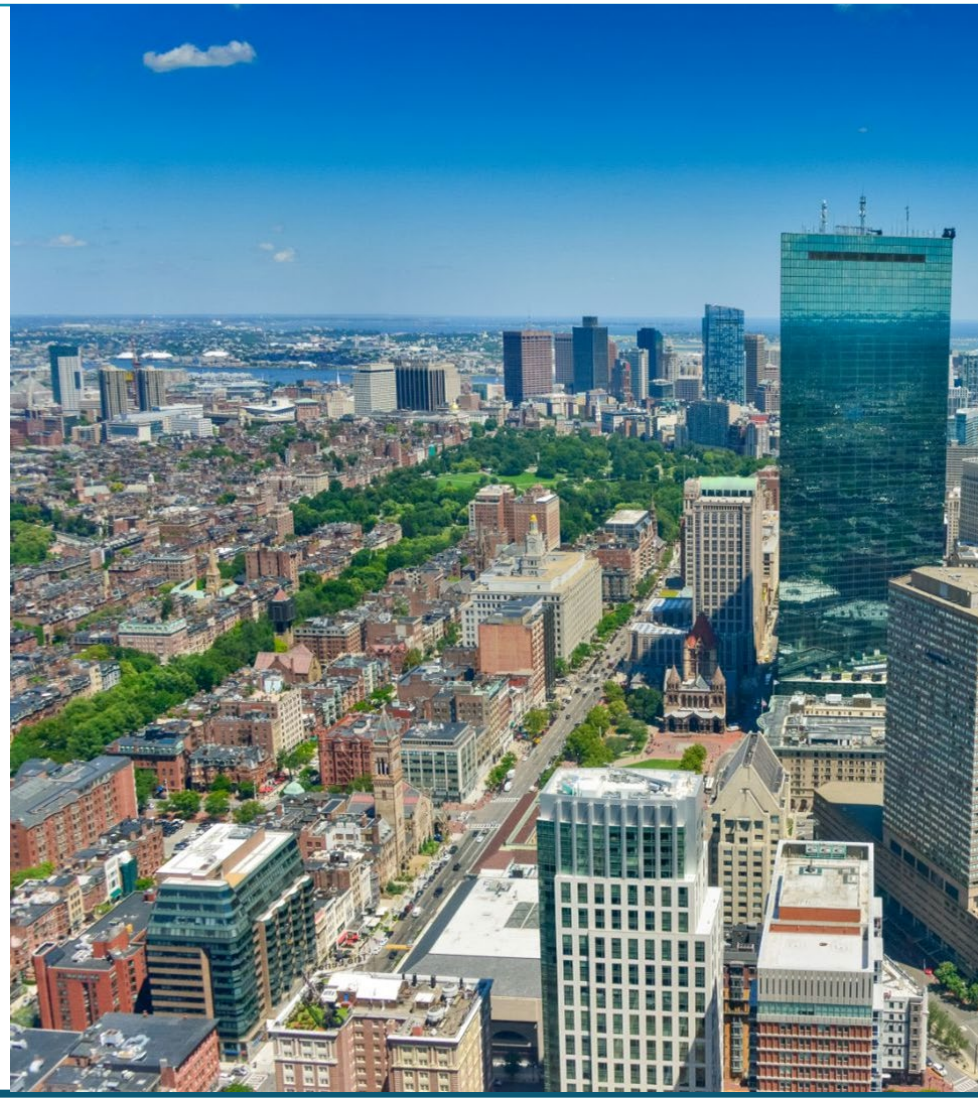
NEW ECOLOGY
Community-Based Sustainable Development

Project Overview | Background

Background and Summary of Project

The Building Electrification Institute (BEI) and the City of Boston worked from 2022-2023 to estimate the total costs and gaps in existing funding for comprehensive decarbonization upgrades in Boston's small and medium-sized residential buildings. The analysis includes all one- to four-unit homes and multifamily buildings up to six stories, with a focus on buildings housing low- and moderate-income residents. This analysis also assesses health and safety measures, which are often required prior to energy efficiency and decarbonization upgrades and are key to improving housing quality.

The goals of the analysis are to provide transparency about the total costs of decarbonizing small and medium-sized residential buildings in Boston and to provide recommendations for how to equitably address gaps in existing funding and programming. In addition to assessing state and regional funding sources, this analysis also includes federal funding from the 2022 Inflation Reduction Act (IRA) and 2021 Infrastructure Investment and Jobs Act (IIJA). The analysis team includes BEI, Firefly Energy Consulting, and New Ecology, Inc., a local energy program implementer.



Building Electrification Institute

FIREFLY ENERGY CONSULTING

NEW ECOLOGY
Community-Based Sustainable Development

Project Overview | Goals

This analysis estimates the gap in current funding to equitably decarbonize the nearly 70,000 small and medium-sized residential buildings in Boston, which represent 75% of the city's building stock.*

Project Goals:

- **Identify existing local, regional, state, and federal funding sources** that are available for building decarbonization in Boston, particularly for households with low and moderate incomes and for comprehensive building efficiency, electrification, health, safety, and resiliency needs.**
- **Understand how these programs work and opportunities to optimize and stack these funding sources,** particularly for funding streams related to housing quality, health, safety, and other non-energy specific sources.
- **Identify the gaps in existing funding sources and where new funding sources may be needed** to ensure the costs of decarbonization are not borne by those who can least afford them.

*Small and medium-sized residential buildings include all one- to four-unit homes, and multifamily buildings under seven stories. Certain vintages and mixed-use buildings were excluded.
**For purposes of this analysis, low- and moderate-income (LMI) households were defined as earning under 80% Area Median Income ($95,200 based on Boston metro area 2020 AMI).

Project Overview | Guiding Principles

What do we mean by "equitable building decarbonization"?

Building decarbonization includes converting fossil fuel appliances to high-efficiency electric equipment that can be powered by 100% clean energy as well as implementing efficiency improvements to the building.

The project team also assessed health, safety, electric readiness, and resilience needs in buildings. These upgrades must often be installed alongside building decarbonization measures and will significantly improve building quality and health outcomes for low- and moderate-income communities. Unfortunately, buildings that require significant health and safety upgrades are often deemed ineligible for energy programs and cannot access funding.

Benefits of an Equitable Decarbonization Transition

- Improved health outcomes and lower health-related expenses
- Potential to expand affordable housing and renter protections
- New high-quality job opportunities
- Potential to decrease utility bills and energy burden
- Divest from fossil fuels and invest in a clean, local economy

Project Overview | Analysis Approach

Given the City of Boston's commitment to ensuring equitable outcomes from building decarbonization, the project team made several key decisions about the analytical approach:

Calculating Installation Costs:

- **The analysis assesses total installation costs rather than incremental costs**.* While most building owners will replace equipment by 2050, some upgrades may happen earlier due to potential state and regional policies. Building owners will also need transparency on the full costs they face, and protections will be needed to prevent owners from passing the full costs on to low- and moderate-income renters.
- **The analysis includes health, safety, resilience, and electric readiness measures** to help ensure these needs are not a barrier to building decarbonization investments and programs.

Assessing the Funding Gap:

- **The gap analysis assumes an optimized stack of state and federal incentives**.** Although this will require programmatic coordination, the City has the opportunity to maximize existing funding sources before pursuing new funding streams.
- **The benefits of equitable decarbonization are not guaranteed and will require significant planning and public investment** to ensure they flow to low- and moderate-income communities. The goal of this analysis is to guide local and regional policymakers in determining how to design support to reach those most in need.

Building Electrification Institute | FIREFLY ENERGY CONSULTING | NEW ECOLOGY Community-Based Sustainable Development

*Incremental costs are the cost difference between the installation of electric or decarbonized systems and the replacement of gas equipment with new gas equipment.
**Research and modeling was completed with best available data as of March 2023.

Project Overview | Analysis Approach (cont.)

Health and Safety Repairs: Why were these costs included?

- **Many homes must address health and safety repairs first** before energy efficiency and electrification retrofits can be implemented. For example, mold and asbestos may need to be remediated before installing new equipment in various parts of the building, or the roof may need to be replaced to ensure structural soundness before installing new equipment.
- **Between 20% and 60% of program applicants may be deemed ineligible for energy incentive programs due to health and safety concerns in their homes,** including from both federal weatherization and utility incentive programs, which perpetuates existing inequities.*
- **Low- and moderate-income households typically have a higher prevalence of health and safety upgrade needs** than market rate homes, a byproduct of a history of racist and neglectful policies.**
- **Boston's 2019 Climate Action Plan makes a commitment to simultaneously address racial and social equity and environmental challenges**, specifically calling out communities of color and low-income neighborhoods as vulnerable populations that need support the most.

*Source: Benshoff, L. 2022. "A low-income energy-efficiency program gets $3.5B boost but leaves out many in need." National Public Radio. May 13, 2022. Based on federal surveys of state and local Weatherization Assistance Program implementers.
**Estimates adopted from national industry assumptions about upgrade costs in low- and moderate income (LMI) residential buildings and adjusted based on input from New Ecology on prevalence and severity by building type.

Project Overview | Phased Approach

This analysis was completed in four phases:

Phase 1: Cost Analysis

What is the total cost to equitably decarbonize Boston's housing?

- Identify 3-5 residential building typologies
- Identify efficiency, electrification, and additional measures needed
- Create cost assumptions based on existing Boston projects

Phase 2: Existing Funds

What funding sources exist that cover relevant costs?

- Compile federal, state, and local energy, housing, resilience, health, and workforce funding sources

Phase 3: Gap Analysis

What is the gap remaining in costs currently being covered?

- Assess relevance and feasibility of funding sources for each building typology, retrofit, and income group
- Calculate funding gaps and programmatic barriers

Phase 4: Opportunities

How might the City its partners address the funding gap?

- Identify considerations and recommendations for optimizing upcoming federal funding opportunities, designing programmatic retrofit support, and addressing long-term funding needs

Project Overview | Key Findings

With the right planning and capital investments, comprehensive building decarbonization could reduce housing health and safety disparities in Boston homes, improve public health, and create a $14-$16 billion local clean energy economy.

Low- and moderate-income (LMI) homes in Boston currently face a significant funding gap and will need public investments to address this gap and avoid passing costs on to vulnerable tenants.

- After incentives, the funding gap for LMI single family homes is estimated at $37,000 – $58,000 per unit.
- After incentives, the funding gap for LMI multifamily homes is estimated at $21,000 – $35,000 per unit.
- The largest gaps are for electrification and health and safety upgrades, and funding sources often do not cover electric readiness and soft costs.
- The majority of incentives available for Boston's small and medium-sized residential buildings are from Mass Save, but programmatic challenges limit their ability to reach many LMI buildings.
- Mass Save and IRA rebates are finite funding sources and will not be sufficient to support all small and medium-sized building in Boston.

An estimated $3-5 billion in additional public investments, or $100-200M annually, will likely be needed to equitably decarbonize Boston's LMI homes.*

Building Electrification Institute

FIREFLY ENERGY CONSULTING

NEW ECOLOGY Community-Based Sustainable Development

*If IRA incentives are extended or a similar level of federal support offered, the LMI gap is estimated to be $2.6 - 3.2B. Otherwise, the LMI gap is $2B higher, estimated at $4.6 - 5.2B.

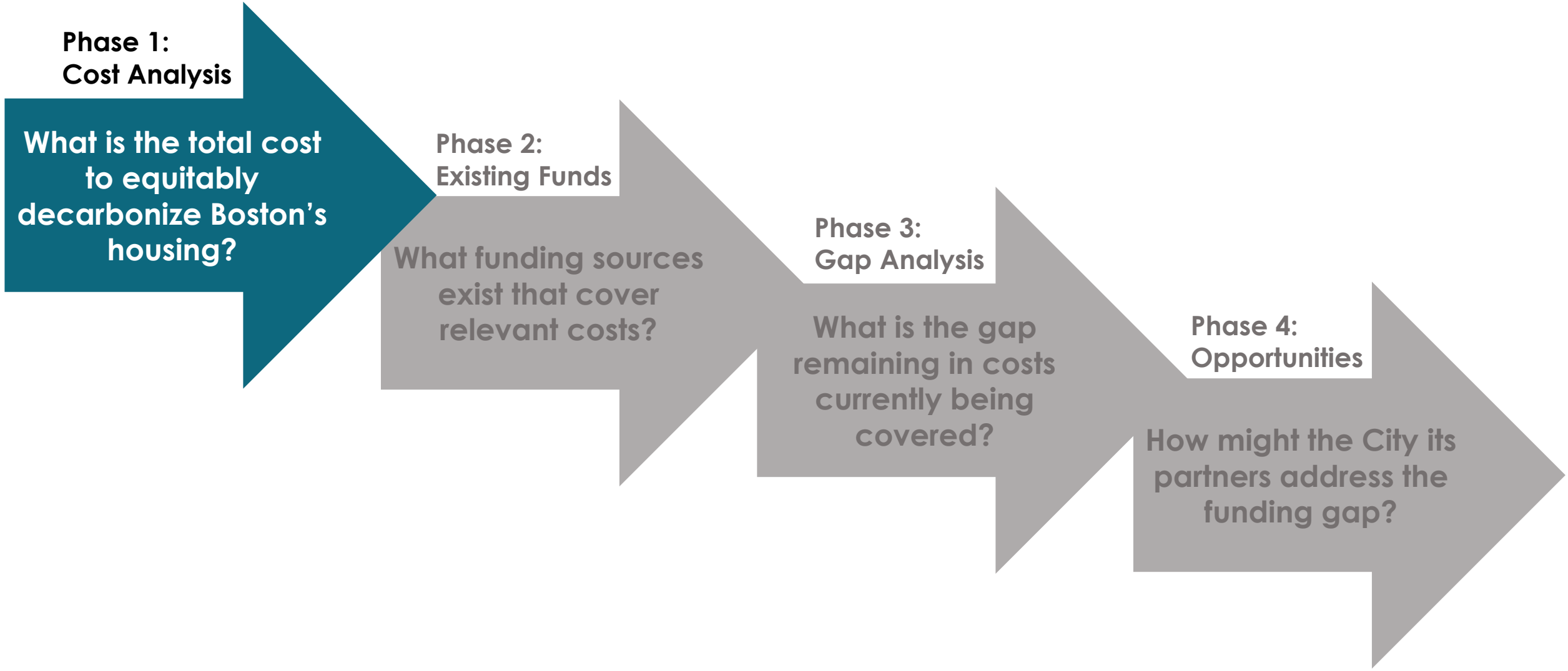
Project Overview | Recommendations

As Massachusetts' largest city, Boston has a crucial role to play in advocating for public investments at the state, regional, and federal levels and in designing localized programs that will equitably decarbonize LMI buildings.

Key Opportunities Include:

- **Build staff capacity** to collaboratively design and implement programmatic assistance that is tailored to the needs of LMI homes and communities, working closely with local community leaders and representatives.
- **Coordinate with state and regional policymakers and partners** to address funding and programmatic gaps in existing offerings and explore new solutions, such as a Massachusetts Climate Bank.
- **Invest in a local or regional retrofit accelerator** to ensure that LMI households can access Mass Save, IRA, and other funding sources. Providing a one-stop shop for technical and funding assistance to building owners can build on Boston's existing Retrofit Resource Hub and the Mayor's Office of Housing programs.

Phase 1 | Installation Cost Analysis



Installation Cost Analysis | Methodology

The project team reviewed existing reports and datasets to develop assumptions and model total installation costs by building typology, income categories, and upgrade measure types.*

UNDERLYING ASSUMPTIONS

Boston building stock data	Boston income data	Costs of retrofits to decarbonize building typologies	Other costs (e.g., soft costs, health and safety upgrades)

TOTAL INSTALLATION COST CATEGORIES

SMALL & MEDIUM RESIDENTIAL BUILDING TYPOLOGIES	INCOME CATEGORIES	RETROFIT MEASURE TYPES	SCENARIOS
▪ Single Family Home ▪ 2-4 Unit Homes ▪ Low-Rise Multifamily (1-3 floors) ▪ Mid-Rise Multifamily (4-6 floors)	▪ Low-Income (<60 % AMI) ▪ Moderate-Income (60-80% AMI) ▪ Market Rate (>80% AMI)	▪ Soft Costs ▪ Electrification ▪ Energy Efficiency ▪ Electric Readiness ▪ Health and Safety	▪ Base Case ▪ Low Case

TOTAL INSTALLATION COSTS (BEFORE INCENTIVES)

- **Average cost per unit, by building typology and income**
- **Average cost per building, by building typology and income**
- **Total upfront costs, by building typology, income, retrofit measure type, and scenario**

*For a full list of reports and data reviewed by project team, see Appendix page 54. See our Model Summary & Outputs spreadsheet for more details on our approach.

Installation Cost Analysis | Building Typologies

The project team identified four building typologies that best exemplify Boston's small- and medium-sized residential building stock, which represent 75% of buildings citywide and 98% of residential buildings citywide. Pulling from existing BEI analysis, the team identified median characteristics of each typology, including number of units, square footage, and year built.

Building Typology Summary	Total Number of Buildings (Percent of Citywide Buildings)	Median Number of Units	Median Square Footage	Median Year Built
Single Family Homes	**30,555** (33%)	1	2,690	1925
2-4 Unit Homes	**34,195** (37%)	3	4,448	1905
Low-Rise Multifamily (1-3 Floors)	**2,244** (2%)	13	10,023	1917
Mid-Rise Multifamily (4-6 Floors)	**2,660** (3%)	16	13,730	1909
Total buildings in analysis	**69,654** (75%)			

Installation Cost Analysis | Income Assumptions

The project team designated income levels for low-income, moderate-income, and market-rate housing, aligning closely with existing program eligibility criteria. These income categories were assigned to all small and medium-sized residential buildings by mapping census tract-level median income data to a citywide building inventory.*

Estimated Income Classifications by Building Typology

Income Category Definitions			Building Typologies				
Income Category	**Area Median Income (AMI) Definition** *(based on a family of four**)*		**Single Family Homes**	**2-4 Unit Homes**	**Low-Rise Multifamily (1-3 Floors)**	**Mid-Rise Multifamily (4-6 Floors)**	**Total Number of Buildings**
Low-Income (LI)	< 60% AMI	< $71,400	21%	35%	38%	20%	**19,770**
Moderate-Income (MI)	60-80% AMI	$71,400 - $95,200	18%	19%	20%	17%	**12,898**
Market-Rate	>80% AMI	> $95,200	61%	46%	42%	63%	**36,987**

Note: A recent study showed a post-tax salary of $120,000 is needed to comfortably afford a 2-bedroom apartment in the Boston area.*** This means that when using existing AMI levels, many moderate-income and even some lower market-rate income families are likely to need financial support to avoid increasing housing cost burden.

*Mapped 2020 census tract median income to building inventory developed for BEI's Multifamily Housing Stock Analysis. **Income categories based on 2020 Area Median Income (AMI) levels for metropolitan area.

***SmartAsset study based on MIT Living Wage Calculator and the 50/30/20 rule.

Installation Cost Analysis | Retrofit Measure Types

The project team developed the following types of measures that will be required to equitably decarbonize Boston's small and medium-sized residential buildings:

Retrofit Measure Type	Description and Rationale
Soft Costs	*Soft costs are included to account for the time required to analyze building needs, develop scopes of work, and coordinate and oversee multiple contractors. Older homes with extensive deferred maintenance can be particularly complex for smaller or less sophisticated building owners to manage.*
Electrification Upgrades	*Replacement of fossil-fuel based systems with highly efficient electric technology, like heat pumps and induction stoves, reduces climate pollution and delivers critical health benefits, such as improved indoor air quality and cooling for increasingly hot summers.*
Energy Efficiency Upgrades	*A variety of efficiency measures are assumed as part of the retrofit to effectively tighten the building and minimize the sizing of heating and cooling equipment needed for Boston's extreme weather. These upgrades lead to an assumed 35% modeled energy savings, helping to ensure comfort and avoid utility bill increases.*
Electric Readiness Upgrades	*Electric readiness measures include electric panel upgrades and outdated wiring ("knob and tube") replacement as needed. These are necessary precursors to electrification retrofits, but are not always eligible within existing incentive programs.*
Health and Safety Upgrades	*Many buildings have deferred health and safety maintenance needs, particularly those housing low- and moderate-income residents. In many cases, these upgrades must be addressed prior to efficiency and electrification upgrades.*

Note For a list of specific measures, see page 42. For additional considerations, see pages 43-44.

Installation Cost Analysis | Measures by Income

The project team assumed 100% of small and medium-sized buildings will install energy efficiency and electrification measures and will incur associated soft costs. The project team then estimated the proportion of buildings by income category that will require electric readiness upgrades and/or health and safety upgrades. Low- and moderate-income homes tend to face higher rates of deferred maintenance due to systemic disinvestment and the financial constraints of building owners.

Proportion of Buildings Assumed to Need Upgrades

Retrofit Measure Type	Specific Retrofit Measure *Proportion of buildings that require…*	Low-Income		Moderate-Income		Market Rate	
		Low Case	Base Case	Low Case	Base Case	Low Case	Base Case
Electric Readiness Upgrades	Panel upgrade	65%	100%	50%	95%	25%	70%
	100% knob-and-tube wiring replacement	20%	30%	15%	25%	0%	
	50% knob-and-tube wiring replacement	10%	20%	5%	15%	5%	15%
	10% knob-and-tube wiring replacement	0%		0%	5%	5%	25%
Health and Safety Upgrades	Basic health and safety upgrades	90%	100%	50%		0%	30%
	Ventilation upgrades	90%	100%	85%		70%	90%
	Structural or resilience upgrades	10%	15%	7%		0	8%

*The **"low case" scenario** assumes the low-end estimate for the proportion of buildings in need of upgrades. The **"base case" scenario** assumes conservative but reasonable assumptions based on current trends. A **"high case"** scenario was not considered given high costs and low likelihood of implementation at scale.**

*Assumptions were developed with New Ecology, then reviewed by City of Boston Environment Department, Office of Housing, and other program implementers. See page 45 for more detail.

Installation Cost Results | Average Costs

The analysis team calculated per-unit installation costs for the assumed proportion of each building typology that will need each upgrade type. This was used to calculate a range of average costs to equitably decarbonize a Boston home. These costs are:

- **Single family home:** $78,000 – $107,000
- **Multifamily home:** $54,000 – $80,000 per unit

Low- and moderate-income (LMI) homes generally face higher costs in all typologies.

See page 15-16 for the list of measures and the applied proportion for each building typology. See page 45 for more detail on the low and base case scenarios that informed the ranges listed here.
Research and modeling was completed with best available data as of March 2023.

Average Installation Costs Per Unit (before incentives)

Retrofit Measure Type	Building Typologies			
	Single Family	2-4 Unit Homes	Low Rise Multifamily (1-3 Floors)	Mid-Rise Multifamily (4-6 Floors)
Low Income	$ 90 – 107 k	$ 68 – 80 k	$ 63 – 74 k	$ 61 – 72 k
Moderate Income	$ 78 – 105 k	$ 60 – 78 k	$ 56 - 73 k	$ 54 – 71 k
Market Rate	$ 84 – 96 k	$65 – 73 k	$ 61 – 67 k	$ 57 – 66 k
Range of Average Installation Costs	**$ 78 – 107 k**	**$ 60 – 80 k**	**$ 56 – 74k**	**$ 54 – 72 k**

Average Installation Costs Per Building (before incentives)

Retrofit Measure Type	Building Typologies			
	Single Family	2-4 Unit Homes	Low Rise Multifamily (1-3 Floors)	Mid-Rise Multifamily (4-6 Floors)
Low Income	$ 90 – 107 k	$ 203 – 240 k	$ 822 – 961 k	$ 0.98 – 1.15 M
Moderate Income	$ 78 – 105 k	$ 179 – 235 k	$ 725 – 943 k	$ 0.86 – 1.13 M
Market Rate	$ 84 – 96 k	$ 196 – 218 k	$ 798 – 877 k	$ 0.92 – 1.04 M
Range of Average Installation Costs	**$ 78 – 107 k**	**$ 179 - 240 k**	**$ 725 – 961 k**	**$ 0.86 – 1.15 M**

Installation Cost Results | Citywide Investments

Equitably decarbonizing the nearly 70,000 small or medium-sized residential buildings will create a $14 – $16B local clean energy market, creating thousands of local jobs. The market will be supported by a combination of investments from building owners and the public sector, including local, state, and federal rebates and incentives.

Total Citywide Investments for Small Residential Buildings* (before incentives)

Retrofit Measure Type	Building Typologies				Total Installation Costs by Measure Type	Percent of Cost by Measure Type
	Single Family	2-4 Unit Homes	Low Rise Multifamily (1-3 Floors)	Low Rise Multifamily (4-6 Floors)		
Soft Costs	$ 0.06 – 0.09 B	$ 0.1 – 0.2 B	$ 0.05 B	$ 0.06 B	**$ 0.3 – 0.4 B**	*2 – 3%*
Electrification	$ 1.0 B	$ 3.1 B	$ 0.9 B	$ 1.3 B	**$ 6.3 B**	*40 – 47%*
Energy Efficiency	$ 0.8 B	$ 1.5 B	$ 0.3 B	$ 0.4 B	**$ 3.0 B**	*19 – 22%*
Electric Readiness	$ 0.2 – 0.5 B	$ 0.6 – 1.2 B	$ 0.2 – 0.4 B	$ 0.2 – 0.5 B	**$ 1.2 – 2.6 B**	*9 – 16%*
Health and Safety	$ 0.5 – 0.7 B	$ 1.4 – 1.7 B	$ 0.4 – 0.5 B	$ 0.5 – 0.7 B	**$ 2.7 – 3.5 B**	*20 – 22%*
Total Installation Costs by Typology	**$ 2.6 – 3.0 B**	**$ 6.7 - 7.8 B**	**$ 1.8 – 2.1 B**	**$ 2.4 – 2.9 B**	**$ 13.5 – 15.8 B**	
Percent by Typology	*19%*	*50%*	*13%*	*18%*	*100%*	
Number of Buildings	*30,555*	*34,195*	*2,244*	*2,660*	***69,654***	

*Small and medium-sized residential buildings include all one- to four-unit homes and multifamily buildings under seven stories. Market estimation is based on the low and base case installation cost estimates of this analysis across all typologies. See our Model Summary and Outputs spreadsheet for additional detail.

Installation Cost Results | Key Takeaways

A KEY SECTOR

Small and medium-sized residential buildings represent 75% of all buildings in Boston, and 98% of all residential buildings, and will be a key sector to decarbonize given their prevalence and the amount of LMI communities they house.

COST PER UNIT

The average cost to comprehensively decarbonize these buildings ranges from $78,000 – $107,000 for a single-family home and **$54,000 – 80,000 per unit for multifamily buildings**.

LMI HOMES

A substantial majority of LMI homes will need electric readiness upgrades and health and safety repairs in order to decarbonize, including electrical panel upgrades, replacement of knob and tube wiring, and other deferred maintenance.

CITYWIDE INVESTMENT

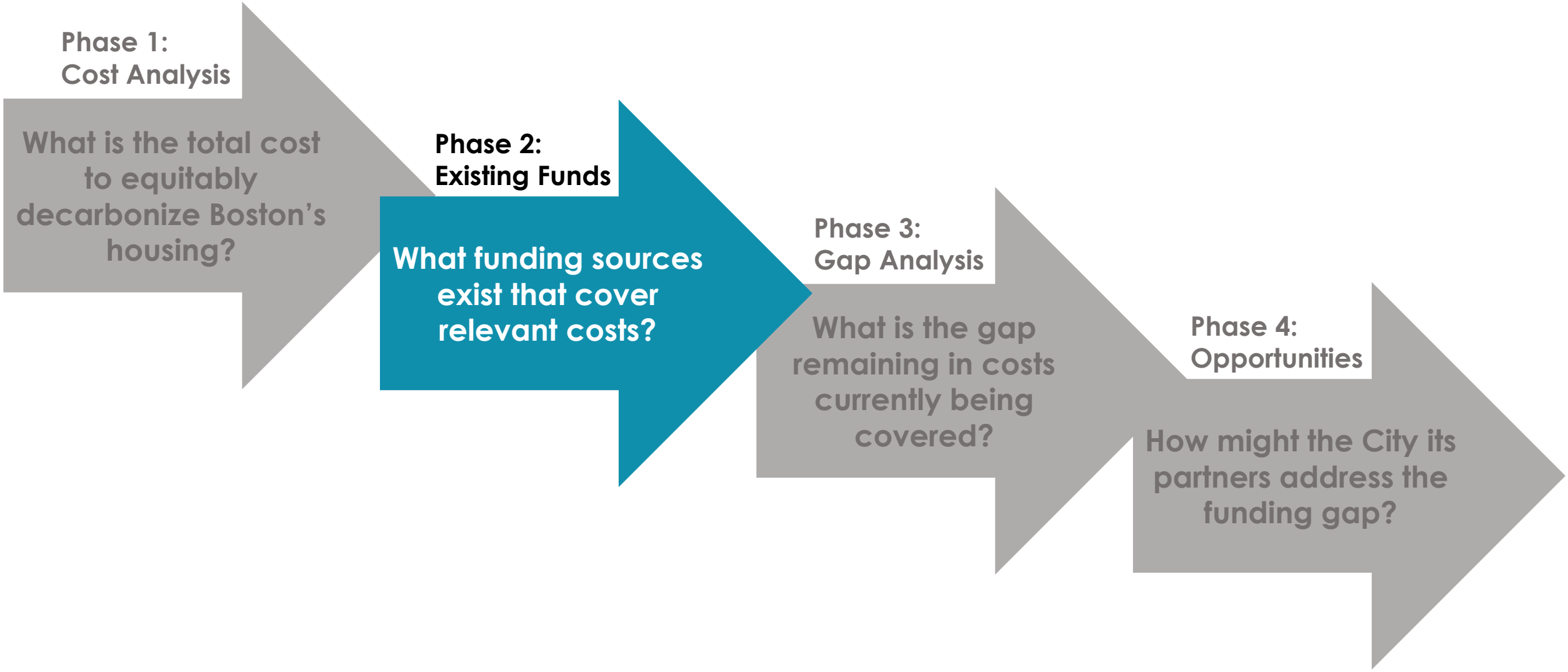
Comprehensively decarbonizing Boston's 70,000 small residential buildings will create a $13.5 – $15.8B local clean energy market. This includes needed investments for efficiency, electrification, electric readiness, as well as health, safety and resilience measures.

Half of the projected investments are needed in 2 to 4 unit buildings, the majority of which are Boston's classic "triple decker."

About 40% of the investments are for electrification of space and water heating.

Triple Decker Image Source

Phase 2 | Existing Funding



Existing Funding | Identifying Programs

A survey of existing funding sources and programs identified federal, state, regional, and local funding for energy efficiency, electrification, and health and safety upgrades.* These sources were then categorized and mapped to the building typologies and measures of this analysis.

Funding Category	Description
Federal	All federal programs that provide funding to states or localities, excluding competitive grants or financing programs (which are captured below). This includes recent federal funding from IRA and IIJA, including the U.S. DOE Home Energy Rebate Programs (also known as HOMES and HEEHRA rebates).**
Mass Save	All programs run by Mass Save that Boston residents are eligible for, excluding competitive grants (which are captured below). The Mass Save program disseminates a large majority of the overall funding available to small and medium-sized residential buildings in Boston. "Mass Save" is the umbrella program name for all state incentive programs implemented by utilities.
Other State Programs	All other incentive or funding programs offered in Massachusetts that Boston building owners are eligible for, such as programs that target low income households (such as Local Initiatives Support Corporation (LISC) Boston.
Competitive Grants	All federal, state, or local programs that require a competitive grant application. Competitive grants were not calculated into the gap analysis as they are not guaranteed sources of funding, however several opportunities were elevated to City staff for consideration.
Financing Programs	All federal, state, or local financing programs, including tax credits and loans. Although financing capital was not calculated into the gap analysis, see pages 25-26 for considerations on how these programs could significantly support market rate homes in electrifying.

*Survey did not include sources for renewable energy generation, electric vehicles (EVs) or EV charging infrastructure.
**Research and modeling was completed with best available data as of March 2023.

Existing Funding | Mass Save

Mass Save Program Model

Mass Save is a highly centralized state program that aims to provide a "one-stop shop" for retrofit support across Massachusetts by internally braiding together multiple funding sources. It represents the vast majority of state investments available to Boston's residential buildings.

Based on stakeholder interviews, there are some programmatic challenges that exist, including:

- **Cost-effectiveness rules can exclude beneficial measures** such as such as deeper envelope retrofits, which can mitigate grid peak load issues and help downsize electrified equipment. These rules also limit the replacement of gas stoves with induction technology in LMI homes, despite significant health and air quality benefits.
- **Support for certain health and safety upgrades remains siloed**. Mass Save offers up to $10k per unit for addressing health and safety repairs, which is more than many programs, but often does not cover the total costs. Additionally, participation of LMI buildings remains low due to a lack of one-on-one assistance needed to navigate complex retrofits or coordinate with external programs.
- **Language barriers and convoluted lines of communication** can exist between customers and program implementers, making it difficult for certain disadvantaged communities to participate.

Existing Funding | Mass Save

Current Program Reach

Mass Save provides significant incentives toward efficiency and electrification of residential buildings, but **Mass Save does not currently reach enough LMI homes in Boston each year to meet the City's housing quality needs nor achieve the city's 2050 carbon neutrality goal.**

It would take almost 100 years for Mass Save to reach all LMI homes in Boston at the current rate.*

Extensive and tailored outreach and engagement is needed to boost LMI enrollment. Programs must also provide **deeper handholding guidance to building owners and additional funding for comprehensive retrofits** (including health and safety repairs) to meet a higher rate of LMI participation and optimize incoming federal rebates.

*Estimated from program offerings as of January 2024. The program is evaluated and updated every three years and must serve communities statewide, which may affect future reach of the program.

Existing Funding | Federal Rebates

Incoming Federal Funding: IRA & IIJA

An historic amount of federal investment in climate initiatives from the **2022 Inflation Reduction Act (IRA) and 2021 Infrastructure Investment and Jobs Act (IIJA)** will be available to states and municipalities in the next few years, including tax credits and rebates from the U.S. Department of Energy's Home Energy Rebate Programs.*

Much of the incoming federal funding is earmarked for under-served communities, however **significant programmatic infrastructure and resources are needed at the local or regional levels to deliver these funds to LMI households** in ways that are accessible and address the complex needs of these buildings.

Based on currently available guidance, the project team **estimates LMI homes in Boston could receive approximately $20M in federal rebate dollars** from the Home Energy Rebate Programs, with around $15k-18k available per unit.**

*Based on available guidance as of January 2024.
**Estimated using Boston's percentage of low-income population in comparison to the state's. Note this does not include tax incentives, since LMI homes may not be able to access tax credit benefits.

Existing Funding | Market Rate Opportunities

Some barriers remain for market-rate homeowners to implement whole-home decarbonization. At the same time, market-rate households have several state and local financing options available to them that are inaccessible to LMI homes, including:

- **Cash Flows and Savings**
- **Home equity loans**
- **Financing offered by service provider/ manufacturer**
- **Other loans**

Specific financing products include:

- **Mass Save HEAT loans**: Offers 0% interest for eligible retrofits for up to $25,000 in capital investments (or $50,000 if installing a heat pump)**
- **Additional loan programs:** New loan programs likely to emerge with potential development of a Massachusetts Climate Bank

There may be financing options that are accessible to LMI households, although these must be designed carefully to avoid increasing debt and/or housing costs for these families. Promising models include Inclusive Utility Investments,* forgivable loans, and loans for market rate owners of buildings that house LMI tenants.

*See this EPA summary for more information on Inclusive Utility Investment (also known as Tariffed On-Bill Financing)
**Mass Save HEAT Loan website.

Existing Funding | Market Rate Opportunities

Market rate building owners can also access several federal programs and benefits that LMI households may not be eligible for or face barriers to accessing, including:

Federal IRA Tax Credits:

- **25C Energy Efficient Home Improvement Credit** for single family homes provides a tax credit of 30% of the investment cost for heat pumps and other efficiency measures, with an annual cap of $3,200.*
- **179D Energy Efficient Commercial Building Deduction** can be used for multifamily buildings and will allow a tax deduction of $0.50 to $5.00 per square foot to building owners, depending on the percentage of energy savings and whether the contractor pays prevailing wages.**

Federal Multifamily Loan Programs: Fannie Mae Green Rewards provides lower pricing, additional loan proceeds, and a free energy and water audit. Freddie Mac Green Advantage Program provides audit and borrowers who model 30% energy or water savings to obtain better loan pricing and access up to 50% of projected energy savings.***

*Source: Energy Efficient Home Improvement Credit
**Source: Energy Efficient Commercial Building Deduction
***Source: Fannie Mae and Freddie Mac programs

Existing Funding | Key Takeaways

Boston homes can take advantage of both centralized state funding and upcoming federal rebates, although challenges remain for LMI households to access these funding sources.

STATE

Mass Save program represents the majority of incentives available for small and medium-sized residential buildings, although programmatic barriers limit its ability to reach LMI households.

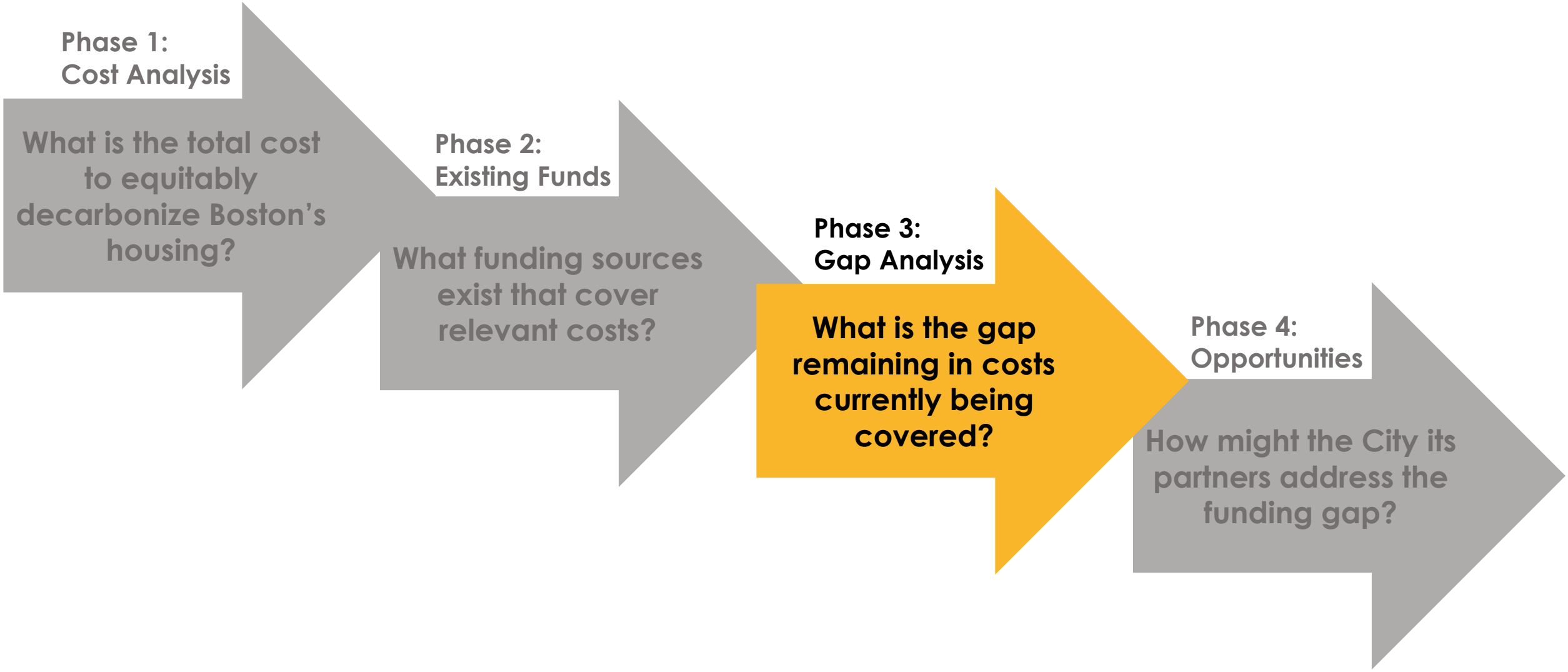
- It would take approximately 100 years for Mass Save to reach all of Boston's LMI small residential buildings at its current rate. Increased funding and deeper outreach and assistance will be necessary to reach housing and climate goals.

FEDERAL

Upcoming federal incentives are poised to make a big impact, providing up to $18,000 in incentives per LMI unit from the U.S. DOE's Home Energy Rebate Programs. However, without additional allocations, the project team estimates Boston is likely to receive only about $20M from the rebate programs, which is insufficient to reach all of Boston's LMI households.

Market rate households have access to a range of local, state, and federal financing products and tax credits to cover their upgrade costs after incentives. More local programming and assistance is needed to ensure LMI homes can complete comprehensive decarbonization upgrades.

Phase 3 | Funding Gap Analysis



Gap Analysis | Analysis Approach

To calculate the gap in funding by building typology, income-level, and retrofit measure, the project team compared installation costs (Phase 1 of analysis) to existing funding sources (Phase 2).

Phase 3: Funding Mapping + Gap Analysis

Step 1	Step 2	Step 3
Calculate optimal combination of existing, stackable funding sources by building typology, income category, and retrofit scenario	Calculate the total remaining funding needed to decarbonize Boston residential buildings by building typology, income category, and retrofit scenario	Determine the cost of addressing the funding gap faced by LMI households to ensure equitable access to electrification, energy efficiency, and healthy homes

Gap Analysis | Analysis Approach

Step 1: Calculate Optimal Funding Combinations

The project team mapped existing funding sources by measure and income category onto total installation costs, using the two major funding programs known at this time: **Mass Save and the U.S. DOE Home Energy Rebate Programs.***

Example: Average Gap for Low-Income 2-4 Unit Home (Base Case Scenario)

Retrofit Measure Type	Average Costs	Stacked Available Incentives			
		Mass Save	IRA HEEHRA	IRA HOMES	Total
Soft Costs	$ 5 k	--	--	--	$ 0
Electrification	$ 91 k	$ 60 k	$ 18 k	--	$ 78 k
Energy Efficiency	$ 45 k	$ 11 k	$ 5 k	$ 24 k	$ 40 k
Electric Readiness	$ 42 k	$ 18 k	$ 20 k	--	$ 37 k
Health & Safety	$ 57 k	$ 4 k	--	--	$ 4 k
Total Cost	**$ 240 k**	**$ 93 k**	**$ 42 k**	**$ 24 k**	**$ 159 k**

Analysis assumptions include:

- **Optimized Mass Save incentives** assuming best possible stacking, which will require significant coordination and program administration costs at both the state and local levels.
- **Ability to stack state and federal rebates** with relatively low lift from building owner, which would require program changes to Mass Save as federal programs begin to roll out.

*The Home Energy Rebate Programs include both the HOMES and HEEHRA programs. Based on guidance published as of January 2024, rebates from the Home Energy Rebate Programs cannot be applied to the same measure but can both be applied to a single home. Note "Mass Save" is the program umbrella for state incentive programs implemented by utilities.

To see funding stack and gaps for every typology, see the Model Summary and Outputs spreadsheet. Incentive amounts and program caps based on best available data as of March 2023.

Gap Analysis | Analysis Approach

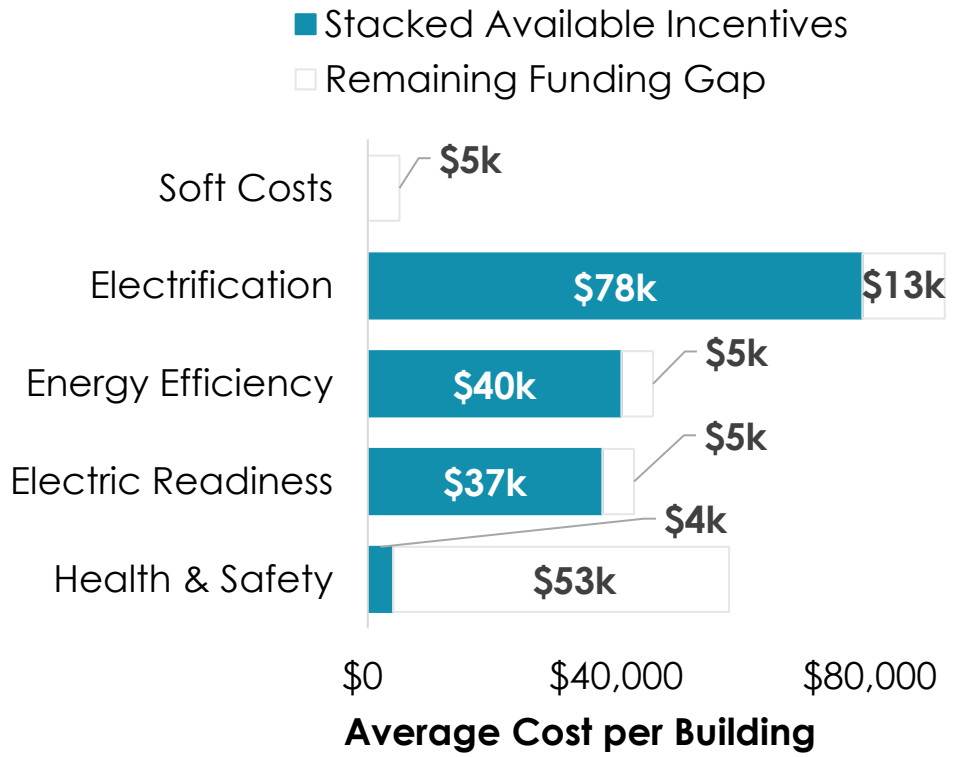
Step 2: Calculate Total Net Costs

After netting out the stacked available incentives, a gap remains across all small and medium-sized building typologies.

Example: Average Gap for Low-Income 2-4 Unit Home*

Retrofit Measure Type	Average Costs	Stacked Available Incentives				Total Funding Gap
		Mass Save	IRA HEEHRA	IRA HOMES	Total	
Soft Costs	$ 5 k	--	--	--	$ 0	$ 5 k
Electrification	$ 91 k	$ 60 k	$ 18 k	--	$ 78 k	$ 13 k
Energy Efficiency	$ 45 k	$ 11 k	$ 5 k	$ 24 k	$ 40 k	$ 5 k
Electric Readiness	$ 42 k	$ 18 k	$ 20 k	--	$ 37 k	$ 5 k
Health & Safety	$ 57 k	$ 4 k	--	--	$ 4 k	$ 53 k
Total Cost	**$ 240 k**	**$ 93 k**	**$ 42 k**	**$ 24 k**	**$ 159 k**	**$ 81 k**

*Base Case Scenario



To see funding stack and gaps for every typology, see the Appendix page 46-53 and the Model Summary and Outputs spreadsheet. Incentive amounts and program caps based on best available data as of March 2023. Note: the $4k of funding for health and safety was remainder assumed after $10k from Mass Save covered electric readiness costs.

Gap Analysis Results

Step 3: Results

Pairing Mass Save and the U.S. DOE's Home Energy Rebates results in the following:

- **LMI building owners can stack approximately $40,000 and $66,000 in funding per unit** to cover comprehensive decarbonization costs.
- **Market rate homeowners can stack approximately $18,000 in funding per unit,** and can also access tax credits.

The estimated funding gap for small and medium-sized buildings in Boston ranges from $21,000 and $77,000 per unit, not including federal tax credits.*

Estimated Average Funding Gap by Typology and Income (per unit)

Income Categories	Building Typologies							
	Single Family		2-4 Unit Homes		Low Rise Multifamily (1-3 Floors)		Low Rise Multifamily (4-6 Floors)	
	Low Case	Base Case	Low Case	Base Case	Low Case	Base Case	Low Case	Base Case
Low-Income	$ 37 k	$ 41 k	$ 22 k	$ 27 k	$ 21 k	$ 28 k	$ 21 k	$ 28 k
Moderate-Income	$ 48 k	$ 58 k	$ 29 k	$ 35 k	$ 22 k	$ 31 k	$ 23 k	$ 31 k
Market Rate	$ 59 k	$ 77 k	$ 41 k	$ 54 k	$ 35 k	$ 49 k	$ 38 k	$ 48 k

*The 25C Energy Efficiency Home Improvement Credit allows homeowners to deduct 30% of the cost of eligible investments up to an annual cap of $1,200 (exception of $2,000 for installing a heat pump). Multifamily building owners can access the 179D tax deduction which provides $0.50 to $5 per square foot for achieving 25% energy savings, depending on location and labor standards.

Gap Analysis Results | LMI Funding Gap

Estimated Average Funding Gap for LMI Homes

A significant gap in funding remains for LMI households to complete comprehensive decarbonization retrofits, even after optimizing multiple state and federal incentives.

- **LMI single family homes** face an estimated average gap of **$37,000 - $58,000**
- **LMI multifamily homes** (2+ units) face an estimated average gap of **$21,000 - $35,000**

Estimated Average Funding Gap by Typology and Income (per unit)

Income Categories	Building Typologies							
	Single Family		2-4 Unit Homes		Low Rise Multifamily (1-3 Floors)		Low Rise Multifamily (4-6 Floors)	
	Low Case	Base Case	Low Case	Base Case	Low Case	Base Case	Low Case	Base Case
Low-Income	$ 37 k	$ 41 k	$ 22 k	$ 27 k	$ 21 k	$ 28 k	$ 21 k	$ 28 k
Moderate-Income	$ 48 k	$ 58 k	$ 29 k	$ 35 k	$ 22 k	$ 31 k	$ 23 k	$ 31 k
Market Rate	$ 59 k	$ 77 k	$ 41 k	$ 54 k	$ 35 k	$ 49 k	$ 38 k	$ 48 k

Gap Analysis | Federal Rebates

How far does the IRA go?

- U.S. DOE's Home Energy Rebate Programs are **estimated to cover between $15,000 - $18,000 of the funding gap for an LMI home**. Boston should move quickly to secure these resources to help address citywide LMI needs.
- The project team estimates that **Boston homes could receive approximately $20M of federal rebates**, assuming Boston homes receive a share proportional to its LMI population**.** Although significant, **this will not cover the gap for all LMI homes in Boston**.

Federal incentives totaling $20M can comprehensively decarbonize:

300 Low-Income Triple Deckers

5% *of the 6,400 LI triple deckers citywide*

OR

1,000 Low-Income Single Family Homes

8% *of the 12,000 LI single family homes citywide*

Image sources: Triple Decker | Single Family Home

Gap Analysis Results | Market Rate

Market rate building owners also face a large funding gap. However, they have a range of options available to address this gap over time.

- **Market rate building owners can utilize financing and tax incentives to make their investments over time** (see pages 25-26 for more information). These owners can access up to $3,200 per year in new IRA tax credits and can take on financing for needed repairs as equipment reaches end of life or during other renovations.
- Still, **households at the lower end of market rate incomes may require programmatic and funding assistance** to cover major upgrade costs, such as health, safety, and electrification upgrades.

Estimated Average Funding Gap by Typology and Income (per unit)

Income Categories	Building Typologies							
	Single Family		2-4 Unit Homes		Low Rise Multifamily (1-3 Floors)		Mid-Rise Multifamily (4-6 Floors)	
	Low Case	Base Case	Low Case	Base Case	Low Case	Base Case	Low Case	Base Case
Low-Income	$ 37 k	$ 41 k	$ 22 k	$ 27 k	$ 21 k	$ 28 k	$ 21 k	$ 28 k
Moderate-Income	$ 48 k	$ 58 k	$ 29 k	$ 35 k	$ 22 k	$ 31 k	$ 23 k	$ 31 k
Market Rate	$ 59 k	$ 77 k	$ 41 k	$ 54 k	$ 35 k	$ 49 k	$ 38 k	$ 48 k

Gap Analysis Results | Citywide Investment

Citywide Gap for Comprehensive Decarbonization of LMI Households

Low- and moderate-income households are least responsible for the causes of climate change and cannot afford to pay the full cost of climate mitigation.

- As such, the City has determined that **public investments should be prioritized for low- and moderate-income households** to deliver health and safety benefits and reduce the risk of increased housing costs or tenant displacement as a result of decarbonization upgrades.
- Mass Save and IRA incentives help cover the costs, but a **significant funding gap of approximately $3B-$5B remains for LMI households in Boston**, even if state and federal incentive dollars are optimally stacked and coordinated. **This amounts to a $100 – 200M annual investment through 2050.**

	Low Case	Base Case
Low-Income Total Gap	$ 1.4 B	$ 1.8 B
Moderate-Income Total Gap	$ 1.2 B	$ 1.4 B
LMI Total Gap*	**$ 2.6 B**	**$ 3.2 B**

*If IRA incentives are extended or a similar level of federal support offered over the long-term, the LMI gap is estimated to be $2.6B - $3.2B. Otherwise, the LMI gap is $2B higher, estimated at $4.6B - $5.2B.

Gap Analysis | Key Takeaways

LMI FUNDING GAP

LMI single family homes face an estimated funding gap of $37,000 – $58,000, while LMI multifamily buildings face a gap of $21,000 – $35,000 per unit. These homes need public investments to decarbonize and improve health and safety for residents without increasing costs to tenants. The largest gaps are for electrification and health and safety upgrades, although little funding is available for critical wiring and soft costs.

FEDERAL REBATES

Upcoming federal rebate programs will help close the gap, which are estimated to cover between $15,000 - $18,000 of the gap for a typical LMI home. However, these programs will not reach all of Boston's LMI homes. Boston should move quickly to ensure this funding reaches as many LMI buildings as possible.

MARKET RATE

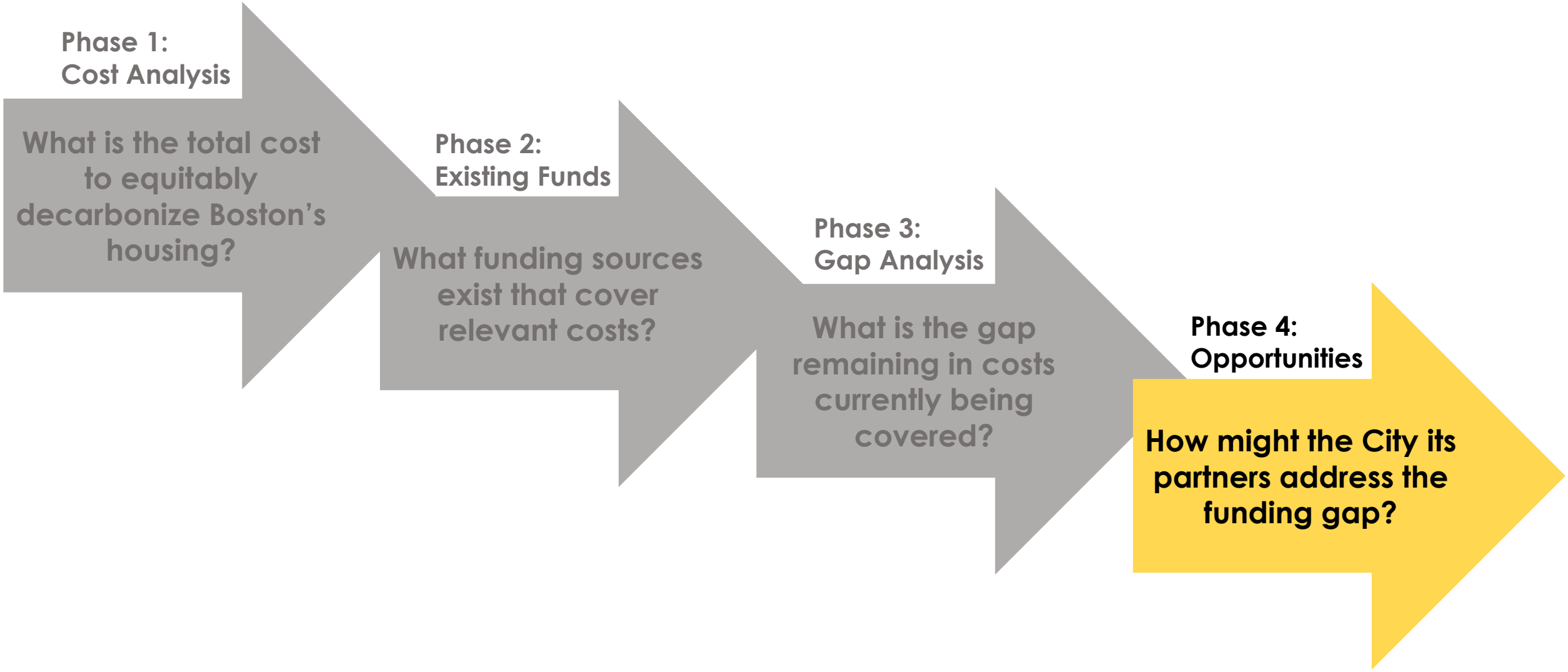
Market rate homes face large funding gaps, but also have a range of financing and tax credit options available to address that gap over time. Still, certain market rate homes with lower household incomes or significant deferred maintenance may need programmatic and funding assistance.

CITYWIDE LMI INVESTMENTS

Both Mass Save and IRA rebates are finite resources and will only reach a small proportion of LMI households in Boston. **Additional investments of $2.6 B – $5.2 B will be necessary to equitably transition all Boston LMI homes.***

*If IRA incentives are continued or other federal support offered, the gap estimate is $2.6 – $3.2B. Otherwise, it is $2B higher at $4.6 – $5.2B. Note that rebates and costs may shift over time, and this reflects current conditions as of March 2023.

Phase 4 | Opportunities



Opportunities | Recommendations

As Massachusetts' largest city, Boston has a crucial role to play in advocating for public investments at the state, regional, and federal levels and in designing localized programs that will equitably decarbonize LMI buildings.

- **Build staff capacity**
  - Near-term staff capacity is needed to work collaboratively with local groups representing LMI communities to design Boston's Retrofit Resource Hub programming that is tailored to and prioritizes the needs of LMI households.
  - Staff capacity is needed to leverage Mass Save and incoming IRA dollars and to identify new funding options to cover health, safety, and electric readiness upgrade costs for LMI homes.
- **Coordinate with state policymakers and partners**
  - Mass Save serves as the backbone of program implementation in Massachusetts. Boston staff can work with state and regional partners and policymakers to advocate for changes to Mass Save that will address the funding and programmatic gaps identified. Boston staff can also engage in the design of additional financing solutions through the Massachusetts Community Climate Bank.
- **Invest in a local or regional one-stop retrofit hub**
  - Boston and its regional partners should also provide localized technical and funding assistance to building owners to address the funding gap for LMI homes. This should include unlocking new ways to stack funding sources, for example by expanding Boston's Retrofit Resource Hub and Mayor's Office of Housing programs.


BEI
Building
Electrification
Institute
CITIES DRIVING CHANGE

Appendix


Building
Electrification
Institute
CITIES DRIVING CHANGE


FIREFLY
ENERGY CONSULTING


NEW ECOLOGY
Community-Based Sustainable Development

Installation Cost Analysis | Specific Measures

Retrofit Measure Type	Specific Measures
Soft Costs	• Energy audit • Scope development and construction management • Engineering design and permitting
Electrification Upgrades	• Air-source heat pump systems replacing oil or gas-powered HVAC (Heating, Ventilation & Air-Conditioning)* • Heat pump water heaters replacing gas-powered water heating systems • Electric induction cooking ranges replacing gas stoves and ovens • Heat pump clothes dryers replacing gas clothes dryers
Energy Efficiency Upgrades	• Insulation of roof, wall, basement and critical junctions between floors • Air sealing • Remove unneeded chimneys and repurpose vents
Electric Readiness Upgrades	• Replacement of outdated wiring (mainly unsafe "knob-and-tube" wiring common in older buildings) • Electric panel upgrade, ensuring sufficient electrical capacity for updated electric equipment
Health and Safety Upgrades	• Basic health and safety upgrades, including radon, mold, lead, and asbestos remediation • Relocation of basement equipment for buildings at risk for flooding • Additional ventilation upgrades needed with tight building envelope • Other structural needs (such as roof replacements, damaged windows, or any measure that would lower the effectiveness of energy efficiency measures)

*Several technologies may have applications here, such as ground-source heat pumps and air-to-water systems, however these costs reflect air-source heat pumps as the main technology being adopted. For more detail on the retrofit measure cost assumptions, see the Model Summary and Outputs spreadsheet.

Return to Page 15

Installation Costs | Additional Considerations

The following concerns were discussed by the project team and ultimately not integrated in the estimated installation costs, but may affect the costs of a comprehensive decarbonization upgrade:

- Investing in **ultra-efficient envelope improvements** beyond what is currently supported by utility programs can offer significant system-wide benefits while the grid is updated to accommodate electrification at scale. However, given the high costs of ultra-efficient envelopes, such as Passive House standards, this analysis only considers envelope improvements to levels that have been seen to be cost-effective in the field. The analysis does not reflect the level of efficiency that is technically feasible with additional budget and expertise.
- Investing heavily in **gas system optimization** may also help achieve additional savings for those who continue to use gas until the end of their equipment's useful life. However, some advocates consider gas system optimization measures a sunk cost into gas-related infrastructure that will ultimately be removed or replaced. This analysis did not include those additional gas system optimization measures.
- **Prevailing wage** is not currently required across all building projects, and due to this and a lack of available data, it was not included in this analysis. However, it is important that the City consider how to encourage high quality job standards, including living wage, and evaluate how much this may add to installation costs across different trades. The analysis reflects current costs as seen in the field.

Installation Costs | Additional Considerations (Cont.)

The following concerns were discussed by the project team and ultimately not integrated in the estimated installation costs, but may affect the costs of a comprehensive decarbonization upgrade:

- This analysis assumes majority of small residential buildings will need **panel upgrades** to accommodate whole-home electrification. However, certain heat pump equipment is becoming available that can use a 120V outlet, and therefore may not require electrical upgrades in certain applications. Given this technology is still burgeoning on the market and may pose a cost premium, the project team assumed a percentage range of homes that need panel upgrades, with lower scenarios to reflect these upcoming technological opportunities.
- Air-source heat pumps – mini-splits and Variable Refrigerant Flow systems (VRFs) – use **high Global-Warming Potential (GWP) refrigerants**, which pose a significant climate risk when leaked or disposed improperly. Legislation and technology improvements will need to address these refrigerant concerns. This analysis still assumes a high rate of adoption of air-source heat pumps (using R-410 refrigerant being phased out in Massachusetts) given the promise of this technology deployed at scale. This assumes legislation, contractor training, and technology improvements can address or significantly mitigate this refrigerant concern over time.*
- **Historic buildings** and buildings within historic districts may face additional restrictive codes that may pose a challenge to electrification. These include limitations to changes on the exterior appearance of the building that could eliminate certain envelope improvement measures. This analysis did not consider the higher costs these buildings may face.
- **Temporary tenant relocation costs** were not included due to lack of data but are an important cost to cover due to the social, financial, and stability impacts of relocation, although most measures can be completed while avoiding relocation altogether.

Return to Page 15

*Alternative refrigerant options have flammability concerns that must be considered. Air-to-water systems may be another promising alternative but may be a higher upfront cost.

Installation Cost Analysis | Scenarios

Given a lack of publicly available data, the project team developed a **"low case" scenario**, assuming the lower end of reasonable assumptions, and a **"base case" scenario**, assuming still somewhat conservative but reasonable assumptions based on current trends. These two scenarios flow through the model to determine ranges for all outputs in the analysis.

Note a **"high case" scenario**, including Passive House standards, was not considered given high costs and low likelihood of implementing them at scale. See table below for further rationale of what influenced the ranges included in the final cost model.

Specific Retrofit Measures	Low Case Scenario	Base Case Scenario
Soft Costs	Assumes slightly lower soft costs for 1-4 unit homes to reflect the potential for supportive programming to minimize soft costs borne by the building owner. Costs assumed for low case: $2,000 for single family homes, $3,000/unit for 2-4 unit homes.	Assumes slightly higher soft costs for 1-4 unit homes given lack of current supportive programming to minimize these costs. Costs assumed for base case: $3,000 for single family homes, $5,000/unit for 2-4 unit homes.
Electric Panel Upgrade	Low case scenario reflects where low-voltage appliances and smarter integrated planning may reduce need for electric panel upgrades across the building stock.	Base case scenario reflects panel upgrades in majority of homes given the age of Boston buildings and requirements of equipment currently readily available in the market.
Knob and Tube repairs	Given lack of data available on the percentage of homes that may need knob and tube wiring replacement, the low and base case scenarios were designed to reflect a reasonable range of assumptions, based on high-level estimates from partners (for example, Eversource interviews estimated 30%). Proportions were adjusted for lower-income households, assuming they may have had less ability to upgrade all or part of their wiring compared to market rate buildings. The final table of ranges were reviewed by several stakeholders.	
Basic Health & Safety, Ventilation, & Structural Upgrades	Given the lack of data available around the percentage of homes that may need these upgrades, the low and base case scenarios were designed to reflect a reasonable range developed by analysis team based on qualitative data across different markets and vetted with local implementers for general accuracy.	

See Model Summary and Outputs spreadsheet for more detail. Return to Page 16

Funding Gap Analysis | Results

Single Family Homes (Low Case)

Specific measures	Low Income						Moderate Income					
	Upfront Costs	Optimal Incentive Stack				Gap	Upfront Costs	Optimal Incentive Stack				Gap
		Mass Save	IRA HEEHR	IRA HOME	Total			Mass Save	IRA HEEHR	IRA HOME	Total	
Soft Costs	$ 2,000	$ -	$ -	$ -	$ -	$ 2,000	$ 2,000	$ -	$ -	$ -	$ -	$ 2,000
Electrification	$ 34,276	$ 24,092	$ 5,899	$ -	$ 29,991	$ 4,285	$ 34,276	$ 17,300	$ 6,609	$ -	$ 23,909	$ 10,367
Energy Efficiency	$ 24,692	$ 5,800	$ 1,600	$ 8,000	$ 15,400	$ 9,292	$ 24,692	$ 4,000	$ 1,600	$ 4,000	$ 9,600	$ 15,092
Electric Readiness	$ 11,777	$ 5,277	$ 6,500	$ -	$ 11,777	$ -	$ 9,540	$ 3,750	$ 4,145	$ -	$ 7,895	$ 1,645
Health & Safety	$ 22,350	$ 1,200	$ -	$ -	$ 1,200	$ 21,150	$ 19,150	$ -	$ -	$ -	$ -	$ 19,150
Caps			$14,000						$ 14,000			
Total	$ 95,095	$ 36,369	$ 13,999	$ 8,000	$ 58,368	*$ 36,727*	$ 89,658	$ 25,050	$ 12,354	$ 4,000	$ 41,404	*$ 48,254*

	Market Rate					
	Upfront Costs	Optimal Incentive Stack				Gap
		Mass Save	IRA HEEHR	IRA HOME	Total	
Soft Costs	$ 2,000	$ -	$ -	$ -	$ -	$ 2,000
Electrification	$ 34,276	$ 11,300	$ -	$ -	$ 11,300	$ 22,976
Energy Efficiency	$ 24,692	$ 3,750	$ -	$ 4,000	$ 7,750	$ 16,942
Electric Readiness	$ 4,145	$ -	$ -	$ -	$ -	$ 4,145
Health & Safety	$ 12,600	$ -	$ -	$ -	$ -	$ 12,600
Caps			$14,000			
Total	$ 77,713	$ 15,050	$ -	$ 4,000	$ 19,050	*$ 58,663*

See Model Summary and Outputs spreadsheet for more detail.

Funding Gap Analysis | Results

Single Family Homes (Base Case)

Specific measures	Low Income						Moderate Income					
	Upfront Costs	Optimal Incentive Stack				Gap	Upfront Costs	Optimal Incentive Stack				Gap
		Mass Save	IRA HEEHR	IRA HOME	Total			Mass Save	IRA HEEHR	IRA HOME	Total	
Soft Costs	$ 3,000	$ -	$ -	$ -	$ -	$ 3,000	$ 3,000	$ -	$ -	$ -	$ -	$ -
Electrification	$ 34,276	$ 24,092	$ 5,899	$ -	$ 29,991	$ 4,285	$ 34,276	$ 17,300	$ 6,609	$ -	$ 23,909	$ 23,909
Energy Efficiency	$ 24,692	$ 5,800	$ 1,600	$ 8,000	$ 15,400	$ 9,292	$ 24,692	$ 4,000	$ 1,600	$ 4,000	$ 9,600	$ 9,600
Electric Readiness	$ 19,080	$ 12,580	$ 6,500	$ -	$ 19,808	$ -	$ 16,251	$ 7,000	$ 5,626	$ -	$ 12,626	$ 12,626
Health & Safety	$ 26,000	$ 1,200	$ -	$ -	$ 1,200	$ 24,800	$ 25,050	$ -	$ -	$ -	$ -	$ -
Caps			$14,000						$ 14,000			
Total	$ 107,048	$ 43,672	$ 13,999	$ 8,000	$ 58,368	*$ 41,377*	$ 103,269	$ 28,300	$ 13,835	$ 4,000	$ 46,135	*$ 46,135*

	Market Rate					
	Upfront Costs	Optimal Incentive Stack				Gap
		Mass Save	IRA HEEHR	IRA HOME	Total	
Soft Costs	$ 3,000	$ -	$ -	$ -	$ -	$ 3,000
Electrification	$ 34,276	$ 11,300	$ -	$ -	$11,300	$ 22,976
Energy Efficiency	$ 24,692	$ 3,750	$ -	$ 4,000	$ 7,750	$ 16,942
Electric Readiness	$ 14,606	$ -	$ -	$ -	$ -	$ 14,606
Health & Safety	$ 19,650	$ -	$ -	$ -	$ -	$ 19,650
Caps			$14,000			
Total	$ 96,224	$ 15,050	$ -	$ 4,000	$ 19,050	*$ 77,174*

See Model Summary and Outputs spreadsheet for more detail.

Funding Gap Analysis | Results

2-4 Unit Homes (Low Case)

Specific measures	Low Income						Moderate Income					
	Upfront Costs	Optimal Incentive Stack				Gap	Upfront Costs	Optimal Incentive Stack				Gap
		Mass Save	IRA HEEHR	IRA HOME	Total			Mass Save	IRA HEEHR	IRA HOME	Total	
Soft Costs	$ 3,000	$ -	$ -	$ -	$ -	$ 3,000	$ 3,000	$ -	$ -	$ -	$ -	$ 3,000
Electrification	$ 90,828	$ 60,274	$ 17,699	$ -	$ 77,973	$ 12,855	$ 90,828	$ 51,900	$ 20,025	$ -	$ 33,900	$ 56,928
Energy Efficiency	$ 45,149	$ 11,009	$ 4,800	$ 24,000	$ 39,809	$ 5,340	$ 45,149	$ 11,009	$ 4,800	$ 12,000	$ 23,009	$ 22,140
Electric Readiness	$ 26,331	$ 6,831	$ 19,500	$ -	$ 26,331	$ -	$ 21,120	$ 3,750	$ 12,435	$ -	$ -	$ 9,435
Health & Safety	$ 49,319	$ 5,209	$ -	$ -	$ 5,209	$ 44,111	$ 43,341	$ -	$ -	$ -	$ -	$ 30,450
Caps		$42,000						$42,000				
Total	$ 214,627	$ 83,322	$ 41,999	$ 24,000	$ 149,321	*$ 65,306*	$ 203,438	$ 66,659	$ 37,260	$ 12,000	$ 56,909	*$ 121,953*

	Market Rate					
	Upfront Costs	Optimal Incentive Stack				Gap
		Mass Save	IRA HEEHR	IRA HOME	Total	
Soft Costs	$ 3,000	$ -	$ -	$ -	$ -	$ 3,000
Electrification	$ 90,828	$ 33,900	$ -	$ -	$ 33,900	$ 56,928
Energy Efficiency	$ 45,149	$ 11,009	$ -	$ 12,000	$ 23,009	$ 22,140
Electric Readiness	$ 9,435	$ -	$ -	$ -	$ -	$ 9,435
Health & Safety	$ 30,450	$ -	$ -	$ -	$ -	$ 30,450
Caps		$42,000				
Total	$ 178,862	$ 44,909	$ -	$ 12,000	$ 56,909	*$ 121,953*

See Model Summary and Outputs spreadsheet for more detail.

Funding Gap Analysis | Results

2-4 Unit Homes (Base Case)

Specific measures	Low Income						Moderate Income					
	Upfront Costs	Optimal Incentive Stack				Gap	Upfront Costs	Optimal Incentive Stack				Gap
		Mass Save	IRA HEEHR	IRA HOME	Total			Mass Save	IRA HEEHR	IRA HOME	Total	
Soft Costs	$ 5,000	$ -	$ -	$ -	$ -	$ 3,000	$ 5,000	$ -	$ -	$ -	$ -	$ 3,000
Electrification	$ 90,828	$ 60,274	$ 17,699	$ -	$ 77,973	$ 12,855	$ 90,828	$ 51,900	$ 20,025	$ -	$ 71,925	$ 18,903
Energy Efficiency	$ 45,149	$ 11,009	$ 4,800	$ 24,000	$ 39,809	$ 5,340	$ 45,149	$ 11,009	$ 4,800	$ 12,000	$ 27,809	$ 17,340
Electric Readiness	$ 42,240	$ 17,740	$ 19,500	$ -	$ 37,240	$ 5,000	$ 36,753	$ 10,500	$ 16,877	$ -	$ 27,377	$ 9,377
Health & Safety	$ 56,728	$ 3,600	$ -	$ -	$ 3,600	$ 53,128	$ 55,157	$ -	$ -	$ -	$ -	$ 55,157
Caps			$42,000						$42,000			
Total	$ 239,945	$ 92,623	$ 41,999	$ 24,000	$ 158,622	*$ 81,323*	$ 232,887	$ 73,409	$ 41,702	$ 12,000	$ 127,110	*$ 105,777*

	Market Rate					
	Upfront Costs	Optimal Incentive Stack				Gap
		Mass Save	IRA HEEHR	IRA HOME	Total	
Soft Costs	$ 5,000	$ -	$ -	$ -	$ -	$ 5,000
Electrification	$ 90,828	$ 33,900	$ -	$ -	$33,900	$ 56,928
Energy Efficiency	$ 45,149	$ 8,256	$ -	$ 12,000	$20,256	$ 24,892
Electric Readiness	$ 31,818	$ -	$ -	$ -	$ -	$ 31,818
Health & Safety	$ 44,855	$ -	$ -	$ -	$ -	$ 44,855
Caps			$42,000			
Total	$ 217,649	$ 42,156	$ -	$ 12,000	$ 54,156	*$ 163,493*

See Model Summary and Outputs spreadsheet for more detail.

Funding Gap Analysis | Results

Low-Rise Multifamily (1-3 Stories) (Low Case)

Specific measures	Low Income							Moderate Income						
	Upfront Costs	Optimal Incentive Stack					Gap	Upfront Costs	Optimal Incentive Stack					Gap
		Mass Save	IRA HEEHR	IRA HOME	LISC	Total			Mass Save	IRA HEEHR	IRA HOME	LISC	Total	
Soft Costs	$ 23,000	$ 7,000	$ -	$ -	$ 6,000	$ 13,000	$ 10,000	$ 23,000	$ -	$ -	$ -	$ 6,000	$ 6,000	$ 17,000
Electrification	$ 388,440	$ 260,911	$ 97,499	$ -		$ 358,410	$ 30,030	$ 388,440	$ 212,421	$ 97,499	$ -		$ 309,920	$ 78,520
Energy Efficiency	$ 141,093	$ 47,704	$ -	$ 93,389		$ 141,093	$ -	$ 141,093	$ 47,704	$ -	$ 93,389		$ 141,093	$ -
Electric Readiness	$ 114,101	$ -	$ 84,500	$ -		$ 84,500	$ 29,601	$ 91,520	$ -	$ 75,270	$ -		$ 75,270	$ 16,250
Health & Safety	$ 197,637	$ -	$ -	$ -		$ -	$ 197,637	$ 178,121	$ -	$ -	$ -		$ -	$ 178,121
Caps		$182,000							$182,000					
Total	$ 864,271	$ 315,615	$ 181,999	$ 93,389	$ 6,000	$ 597,003	*$ 267,268*	$ 822,173	$ 260,125	$ 172,769	$ 93,389	$ 6,000	$ 532,283	*$ 289,891*

	Market Rate					
	Upfront Costs	Optimal Incentive Stack				Gap
		Mass Save	IRA HEEHR	IRA HOME	Total	
Soft Costs	$ 23,000	$ -	$ -	$ -	$ -	$ 23,000
Electrification	$ 388,440	$ 176,250	$ -	$ -	$176,250	$ 212,190
Energy Efficiency	$ 141,093	$ 35,778	$ -	$ 52,000	$ 87,778	$ 53,315
Electric Readiness	$ 40,885	$ -	$ -	$ -	$ -	$ 40,885
Health & Safety	$ 131,950	$ -	$ -	$ -	$ -	$ 131,950
Caps						
Total	$ 725,368	$ 212,028	$ -	$ 52,000	$264,028	*$ 461,340*

See Model Summary and Outputs spreadsheet for more detail.

Funding Gap Analysis | Results

Low-Rise Multifamily (1-3 Stories) (Base Case)

Specific measures	Low Income							Moderate Income						
	Upfront Costs	Optimal Incentive Stack					Gap	Upfront Costs	Optimal Incentive Stack					Gap
		Mass Save	IRA HEEHR	IRA HOME	LISC	Total			Mass Save	IRA HEEHR	IRA HOME	LISC	Total	
Soft Costs	$ 23,000	$ 7,000	$ -	$ -	$ 10,000	$ 13,000	$ 10,000	$ 23,000	$ -	$ -	$ -	$ 6,000	$ 6,000	$ 17,000
Electrification	$ 388,440	$ 260,911	$ 97,499	$ -		$ 358,410	$ 30,030	$ 388,440	$ 212,421	$ 97,499	$ -		$ 309,920	$ 78,520
Energy Efficiency	$ 141,093	$ 47,704	$ -	$ 93,389		$ 141,093	$ -	$ 141,093	$ 47,704	$ -	$ 93,389		$ 141,093	$ -
Electric Readiness	$ 183,040	$ -	$ 84,500	$ -		$ 84,500	$ 98,540	$ 159,263	$ -	$ 84,500	$ -		$ 84,500	$ 74,763
Health & Safety	$ 225,916	$ -	$ -	$ -		$ -	$ 225,916	$ 221,362	$ -	$ -	$ -		$ -	$ 221,362
Caps		$182,000							$182,000					
Total	$ 961,489	$ 315,615	$ 181,999	$ 93,389	$ 10,000	$ 597,003	*$ 364,486*	$ 933,158	$ 260,125	$ 181,999	$ 93,389	$ 6,000	$ 541,513	*$ 391,645*

	Market Rate					
	Upfront Costs	Optimal Incentive Stack				Gap
		Mass Save	IRA HEEHR	IRA HOME	Total	
Soft Costs	$ 23,000	$ -	$ -	$ -	$ -	$ 23,000
Electrification	$ 388,440	$ 146,250	$ -	$ -	$146,250	$ 242,190
Energy Efficiency	$ 141,093	$ 35,778	$ -	$ 52,000	$ 87,778	$ 53,315
Electric Readiness	$ 137,878	$ -	$ -	$ -	$ -	$ 137,878
Health & Safety	$ 186,562	$ -	$ -	$ -	$ -	$ 186,562
Caps						
Total	$ 876,973	$ 182,028	$ -	$ 52,000	$234,028	*$ 642,945*

See Model Summary and Outputs spreadsheet for more detail.

Funding Gap Analysis | Results

Mid-Rise Multifamily (4-6 Stories) (Low Case)

Specific measures	Low Income							Moderate Income						
	Upfront Costs	Optimal Incentive Stack					Gap	Upfront Costs	Optimal Incentive Stack					Gap
		Mass Save	IRA HEEHR	IRA HOME	LISC	Total			Mass Save	IRA HEEHR	IRA HOME	LISC	Total	
Soft Costs	$ 23,000	$ 7,000	$ -	$ -	$ 6,000	$ 13,000	$ 10,000	$ 23,000	$ -	$ -	$ -	$ 6,000	$ 6,000	$ 17,000
Electrification	$ 478,080	$ 321,180	$ 119,940	$ -		$ 441,120	$ 36,960	$ 478,080	$ 228,000	$ 119,940	$ -		$ 347,940	$ 130,140
Energy Efficiency	$ 147,911	$ 58,712	$ -	$ 89,199		$ 147,911	$ -	$ 147,911	$ 58,712	$ -	$ 89,199		$ 147,911	$ -
Electric Readiness	$ 140,432	$ -	$ 104,000	$ -		$ 104,000	$ 36,432	$ 112,640	$ -	$ 104,000	$ -		$ 104,000	$ 8,640
Health & Safety	$ 244,878	$ -	$ -	$ -		$ -	$ 244,878	$ 220,132	$ -	$ -	$ -		$ -	$ 220,132
Caps		$224,000							$224,000					
Total	$ 1,034,301	$ 386,892	$ 223,940	$ 89,199	$ 6,000	$ 706,031	*$ 328,270*	$ 981,763	$ 286,712	$ 223,940	$ 89,199	$ 6,000	$ 605,851	*$ 375,912*

	Market Rate					
	Upfront Costs	Optimal Incentive Stack				Gap
		Mass Save	IRA HEEHR	IRA HOME	Total	
Soft Costs	$ 23,000	$ -	$ -	$ -	$ -	$ 23,000
Electrification	$ 478,080	$ 180,000	$ -	$ -	$180,000	$ 298,080
Energy Efficiency	$ 147,911	$ 14,678	$ -	$ 64,000	$ 78,678	$ 69,233
Electric Readiness	$ 50,320	$ -	$ -	$ -	$ -	$ 50,320
Health & Safety	$ 162,400	$ -	$ -	$ -	$ -	$ 162,400
Caps						
Total	$ 861,711	$ 194,678	$ -	$ 64,000	$258,678	*$ 603,033*

See Model Summary and Outputs spreadsheet for more detail.

Funding Gap Analysis | Results

Mid-Rise Multifamily (4-6 Stories) (Base Case)

Specific measures	Low Income							Moderate Income						
	Upfront Costs	Optimal Incentive Stack					Gap	Upfront Costs	Optimal Incentive Stack					Gap
		Mass Save	IRA HEEHR	IRA HOME	LISC	Total			Mass Save	IRA HEEHR	IRA HOME	LISC	Total	
Soft Costs	$ 23,000	$ 7,000	$ -	$ -	$ 10,000	$ 13,000	$ 10,000	$ 23,000	$ -	$ -	$ -	$ 6,000	$ 6,000	$ 17,000
Electrification	$ 478,080	$ 321,180	$ 119,940	$ -		$ 441,120	$ 36,960	$ 478,080	$ 261,500	$ 119,940	$ -		$ 381,440	$ 96,640
Energy Efficiency	$ 147,911	$ 58,712	$ -	$ 89,199		$ 147,911	$ -	$ 147,911	$ 58,712	$ -	$ 89,199		$ 147,911	$ -
Electric Readiness	$ 225,280	$ -	$ 104,000	$ -		$ 104,000	$ 121,280	$ 196,016	$ -	$ 104,000	$ -		$ 104,000	$ 92,016
Health & Safety	$ 279,864	$ -	$ -	$ -		$ -	$ 279,864	$ 274,078	$ -	$ -	$ -		$ -	$ 274,078
Caps		$224,000							$224,000					
Total	$ 1,154,135	$ 386,892	$ 223,940	$ 89,199	$ 10,000	$ 706,031	*$ 448,104*	$ 1,119,085	$ 320,212	$ 223,940	$ 89,199	$ 6,000	$ 639,351	*$ 479,734*

	Market Rate					
	Upfront Costs	Optimal Incentive Stack				Gap
		Mass Save	IRA HEEHR	IRA HOME	Total	
Soft Costs	$ 23,000	$ -	$ -	$ -	$ -	$ 23,000
Electrification	$ 478,080	$ 180,000	$ -	$ -	$180,000	$ 298,080
Energy Efficiency	$ 147,911	$ 44,034	$ -	$ 64,000	$108,034	$ 39,877
Electric Readiness	$ 169,696	$ -	$ -	$ -	$ -	$ 169,696
Health & Safety	$ 230,159	$ -	$ -	$ -	$ -	$ 230,159
Caps						
Total	$ 1,048,846	$ 224,034	$ -	$ 64,000	$ 288,034	*$ 760,812*

See Model Summary and Outputs spreadsheet for more detail.

Resources and Supporting Materials

- **Existing Boston-focused studies & datasets**
  - BEI Multifamily Housing Stock Analysis (2020)
  - BERDO development analysis (2021)
  - Carbon Free Boston Report (2019)
- **Regulatory documents**
  - 2022-2024 Energy Efficiency Order (2022)
    - Eversource BCR dataset
  - MA Multifamily Heat Pump Barriers Study (2022)
  - MA Small Multifamily Barriers Study (2022)
  - MA Heat Pump Hot Water Heaters Quick Hit Study (2021)
- **Relevant Reports**
  - A Better City's Thermal Electrification of Large Building in the Commonwealth (2020)
  - Technical Report of the MA 2050 Decarbonization Roadmap Study: Building Sector Report (2020)
  - CT Weatherization barriers report
- **Other websites/organizations**
  - Boston Retrofit Resource Hub
  - MA Clean Energy Center
  - MA DPU
  - MA DOER
  - NEEP
  - MA LEAN
  - A Better City
  - LISC 10000 Apt Challenge