Sustainable Homes for All: Designing a Clean Energy Incentive for Boston's Section 8 HCV Landlords to Improve Tenant Quality of Life

by

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ABSTRACT

There is an urgent need for decarbonization in the residential sector given housing's significant contributions to greenhouse gas emissions. Low-income housing is particularly energy inefficient, contributing to harmful environmental outcomes and health and financial challenges for tenants. The Boston Housing Authority (BHA) can play a central role in residential decarbonization for low-income residents because it owns and controls a substantial portion of the housing stock. While there are significant efforts underway to decarbonize Boston's public housing stock, there are currently no initiatives aimed at decarbonization in the Section 8 Program. Thus, the BHA can broaden its influence beyond the public sector and incentivize residential decarbonization in the private sector through its relationships with over 15,000 landlords in the Section 8 HCV Program. This thesis develops the BHA Retrofit Rewards (BRR) Program: a Program that uses monthly 'rent boost' to financially incentivize Section 8 Housing Choice Voucher (HCV) landlords to implement clean energy upgrades in their units. This BRR Program was created through a two-step process. First, a comparative analysis of similar US programs identified the Atlanta Housing Authority's Energy Efficiency Rent Boost Program (EERB) as viable for replication in Boston. Second, a feasibility analysis was conducted to determine how the BHA's adaptation of the EERB Program would be financed, administered, and redesigned to fit the Boston context. The results of this analysis outline a framework for a BRR Program financed by leveraging regulatory flexibility that enables higher payments to landlords within federal limits. This thesis contributes to ongoing equity-focused decarbonization initiatives at the BHA and offers a roadmap for public housing authorities and cities more broadly seeking to address the dual challenges of climate change and housing inequity.

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Chapter 1 - Context

I) Introduction

There is an urgent global need for decarbonization initiatives in all sectors of the economy as the effects of global warming caused by greenhouse gas emissions (GHG) continue to intensify. It is essential that cities be at the forefront of the clean energy transition, as cities currently account for nearly 70% of global CO2 emissions related to energy consumption[1] and house over half of the global population.[2] Decarbonization efforts within the housing sector are particularly significant as residential energy use alone accounts for roughly 20% of greenhouse gas emissions in the United States.[3] In addition, it is essential that the transition to decarbonized housing be equitable. The impacts of climate change pose the greatest risk to vulnerable populations. Additionally, lower-income housing is often less energy efficient than market-rate housing, leading to negative health and financial impacts on residents.[4]

Because of their substantial ownership and control over housing that supports low-income individuals, housing authorities have the potential to play a central role in driving an equity-centered decarbonization movement in cities. Efforts to decarbonize the public housing stock are already underway in many U.S. cities including Boston. Boston is in a unique position to take action because all levels of government have pledged significant investment funds for housing and green energy retrofits. This is particularly important because "buildings in Boston account for nearly seventy percent of citywide greenhouse gas emissions".[5]

The Boston Housing Authority (BHA) is currently planning to retrofit its entire existing housing stock as part of an effort to comply with the City's Building Emissions Reduction and Disclosure Ordinance 2.0 (BERDO 2.0),[6] to fulfill the Mayor's calls for the BHA to be fossil fuel free by 2030,[7] and to fulfill the Governors calls to make the Commonwealth carbon neutral by

[1] Luqman, Rayner, and Gurney, "On the Impact of Urbanisation on CO2 Emissions."
[2] The World Bank, "Urban Development Overview."
[3] Goldstein, Gounaridis, and Newell, "The Carbon Footprint of Household Energy Use in the United States."
[4] Simon, "Energy Inequity in Low-Income Housing."
[5] "City of Boston Finalizes Regulations to Ensure Large Buildings Achieve Carbon Neutrality by 2050 | Boston.Gov."
[6] "Building Emissions Reduction and Disclosure | Boston.Gov."
[7] "Mayor Wu's 2023 State of the City Address | Boston.Gov."

2050.[8] Given that around 3% of Boston's population lives in BHA public housing,[9] decarbonization of the City's public housing stock could make a substantial contribution to Boston's clean energy transition. While this initiative to decarbonize the City's public housing stock is critical for the BHA's objectives, there remains a need to further explore strategies for supporting decarbonization of the BHA's Section 8 Housing Choice Voucher (HCV) units.

Considering this context, the BHA is evaluating how it can use its position to design a program that incentivizes clean energy retrofits in the private market. The BHA currently provides Housing Choice Vouchers for over 15,000 units that house around 7% of Boston's total population.[10] Because the BHA has established relationships with, and provides funding to, thousands of landlords, it would like to explore how it can leverage its position to incentivize Section 8 HCV landlords to decarbonize their housing units.

When surveying the country in search of relevant programs, there was a disappointing lack of innovation in the Section 8 HCV sector. While many housing authorities nationwide are working to decarbonize their public housing stock, few have established Section 8 HCV decarbonization programs. The exception to this was the Atlanta Housing Authority, whose award-winning Energy Efficiency Rent Boost Program provides Section 8 HCV landlords with financial incentives for implementing clean energy upgrades in their units.[11]

This client-based thesis project aims to contribute to the BHA's ongoing equity-focused decarbonization efforts by developing a framework for a Section 8 HCV, BHA Retrofit Rewards Program (BRR). The current political support for residential decarbonization, the split incentives problem, and the necessity of equity in the decarbonization movement all highlight the ideal circumstances for the BHA's present adoption of the BRR Program. The BRR Program was developed in two stages. First, through comparative analysis of relevant programs nationwide, the Atlanta Housing Authority's EERB Program is identified as prime for reproduction in Boston. Second, a feasibility study is conducted to determine how to effectively apply the existing EERB Program in the Boston context. Before finalizing the Program, relevant stakeholders, industry

[8] "Healey-Driscoll Administration Awards $27 Million to Decarbonize Affordable Housing Across Massachusetts | Mass.Gov."
[9] "Boston Housing Authority Internal Report."
[10] Ibid
[11] Yann.Mondon, "Sustainability Initiative Wins 2023 DOE Better Practice Award."

experts, and BHA staff are consulted for feedback. The result of this analysis is the first edition draft of the BRR Program. The BRR Program aims to leverage the BHA's relationships with Section 8 HCV landlords to incentivize clean energy upgrades in their units. Through implementation of the BRR Program, the BHA will be able to improve the health, financial burden, and quality of life of Section 8 HCV residents, while simultaneously advancing its decarbonization goals.

II) Background

A. Geographic and Organizational Context

The Boston Housing Authority is a public agency that receives state and federal funding to provide subsidized housing access to individuals and families with low to moderate incomes. The BHA is in charge of developing and managing housing projects and arranging leases through the Section 8 HCV Program. The BHA's mission is to "provide stable, quality affordable housing for low- and moderate-income persons; to deliver these services with integrity and mutual accountability; and to create healthy living environments which serve as catalysts for the transformation from dependency to economic self-sufficiency."[12]

The Boston City Council established the Boston Housing Authority (BHA) on October 1, 1935, following an order by the state legislature that enabled cities and towns in Massachusetts to establish housing authorities. The order mandated housing authorities to provide "suitable, safe, and sanitary housing" for families unable to afford it without public subsidies. The order also mandated that Massachusetts housing authorities clear dilapidated areas for redevelopment, but this responsibility ended upon the establishment of the Boston Redevelopment Authority in 1957.[13] The creation of the housing authority was also seen as a necessary body for obtaining and overseeing federal housing funds.[14]

The BHA does not operate as a municipal agency under the jurisdiction of Boston's Mayor because of changes to BHA management and governance in 1975. The separation of the

[12] "Boston Housing Authority."
[13] "Guide to the Boston Housing Authority Records Reports and Publications Relating to Public Housing."
[14] Vale, *From the Puritans to the Projects*.

BHA was catalyzed by a legal battle initiated by BHA tenants, represented by Greater Boston Legal Services, who brought forward grievances regarding substandard living conditions within BHA housing projects.[15] Following a ruling in favor of the tenants, a court-appointed master compiled a report outlining recommendations, forming the basis for a consent decree signed in 1977 by the BHA, Greater Boston Legal Services, and the Boston Public Housing Tenants Policy Council.[16] This decree delineated a series of improvements to be implemented by the BHA over a three-year period. The court-appointed "master" was tasked with overseeing the BHA's compliance with the consent decree, effectively giving the court-appointed master the power over major decisions taken by the BHA board and administrators. By 1979 however, it became evident that the BHA had fallen short of adequately meeting the decree's stipulations. This failure prompted a judge to place the BHA under receivership, replacing the existing board of commissioners and administrators.[17] A court-appointed receiver assumed control for over a decade, steering the BHA's operations. Since the conclusion of the receivership in 1990, the BHA has been overseen by an administrator whose activities are subject to review by a monitoring committee with nine members that is appointed by the Mayor of Boston.[18] The BHA Monitoring Committee "is responsible for reviewing matters relating to the management and performance of BHA and reporting these matters to the Mayor."[19] Today, the BHA remains somewhat separate from the Mayor's office. This separation is notable because it allows the BHA a degree of independence from the agenda of the current political administration.

The BHA can provide housing assistance to Boston's low-income residents in one of two ways: providing subsidized housing (Public Housing Program) and granting access to rental assistance programs (Section 8 Program).

The BHA Public Housing Program first began in 1935 when it began managing its first public housing project.[20] The first public housing project in Boston, named Mary Ellen

[15] "Guide to the Boston Housing Authority Records Reports and Publications Relating to Public Housing."
[16] Ibid
[17] Vale, *From the Puritans to the Projects*.
[18] "Guide to the Boston Housing Authority Records Reports and Publications Relating to Public Housing."
[19] "Boston Housing Authority."
[20] Vale, *From the Puritans to the Projects*.

McCormack (previously Old Harbor Village), opened in 1938 in South Boston as a part of a federal housing initiative. The BHA had acquired ownership of the property by the time of its opening. The McCormack project's prime location, massive size, and architectural features made it an instant success. It rests on 31 acres of land and contains 1,016 apartments comprising 152 row houses and 22-three story buildings.[21] Mary Ellen McCormack is still the second-largest housing project in the City of Boston.[22] Mary Ellen McCormack, along with all other housing projects at this time, was funded by federal programs. In 1948, state legislation initiated a separate complementary state-aided Public Housing Program.[23]

The BHA Public Housing Program continues to be funded by federal and state assistance today. Through its Public Housing Program, the BHA oversees 500 buildings in 56 housing developments across the City. The over 8,000 rental units provide housing to more than 15,000 residents.[24] 32 of the 56 housing developments are designated as elderly/disabled developments and 24 are designated as family developments.[25] The BHA's housing stock includes housing of all types from single-family houses to mid-rise apartments. The units vary in size from studio apartments to six-bedroom apartments.

B. The Role of Section 8 in Boston Housing

In addition to overseeing Boston's public housing stock, the BHA administers Boston's Section 8 Program. Section 8 of the US Housing Act was authorized in 1937 but did not formally begin until 1974. The goal of the Program was to use existing private rental housing to provide support for housing-insecure individuals.[26] The Boston Housing Authority currently provides housing for 42,722 residents through both Section 8 Programs.[27]

[21] Vale.
[22] DeCosta-Klipa, "In Southie, Boston's Oldest Public Housing Project Is Getting a Makeover."
[23] "Boston Housing Authority."
[24] "Boston Housing Authority Internal Report."
[25] "Boston Housing Authority."
[26] Valdez, "Series."
[27] "Boston Housing Authority Internal Report."

The two programs that make up the Section 8 Program are the Housing Choice Voucher Program and the Project-Based Rental Assistance Program.[28] The Housing Choice Voucher Program is the target of the BRR Program and this thesis.

The Project-Based Rental Assistance Program is "a form of rental subsidy that is attached to a unit of privately owned housing."[29] These units are reserved for low-income families who pay a reduced rent on the basis of their incomes. When the Section 8 Program first began in 1974, it was primarily used to support Project-Based Rental Assistance Program housing. However, by 1983, Congress had eliminated funding for new Project-Based Rental Assistance Program contracts due to criticism of the Program. Opponents argued that the Project-Based Rental Assistance Program was too expensive and clustered low-income families in areas of concentrated poverty.[30] Today, the BHA supports 3,847 units through the Section 8 Project-Based Rental Assistance Program.[31]

As an alternative to the Projected-Based Rental Assistance Program, Congress created the Housing Choice Voucher Program. The Housing Choice Voucher Program provides "portable subsidies that low-income families can use to lower their rents" in private, market-rate housing.[32] Housing Vouchers are tied to a family, rather than to a housing unit like in the Project-Based Rental Assistance Program. Recipients can use the Housing Choice Voucher to help subsidize market-rate housing. The idea was to provide Housing Choice Voucher recipients greater flexibility in housing location. In fact, BHA HCV recipients are not even required to live in Boston; they have the flexibility to live anywhere in the greater Boston area. Thus, not all HCV recipients living in Boston receive vouchers through the BHA. Some may receive their vouchers from nearby housing authorities like Cambridge or through the state. HUD provides each housing authority with a fixed number of vouchers they are permitted to administer. Today, the BHA supports 15,479 units through the Section 8 Housing Choice Voucher Program.[33]

[28] "An Overview of the Section 8 Housing Programs."
[29] Ibid
[30] Ibid
[31] "Boston Housing Authority Internal Report."
[32] "An Overview of the Section 8 Housing Programs."
[33] "Boston Housing Authority Internal Report."

The BHA Retrofit Rewards Program is specifically focused on incentivizing clean energy retrofits of Housing Choice Voucher units because HCV units are where decarbonization initiatives are lacking at the BHA. Additionally, Project-Based Rental Assistance Program units are located within massive buildings, some of which are owned by the BHA. The housing typology and ownership structure of Project-Based units make the decarbonization process more aligned with that of the Public Housing Program units.

The BHA Retrofit Rewards Program also only aims to incentivize decarbonization of federally funded HCV units. The Boston Housing Authority currently administers Housing Choice Vouchers funded by Boston's Housing Voucher Program, the State's Massachusetts Rental Voucher Program (MRVP), and the federally funded Housing Choice Voucher Program. The federal HCV Program is by far the largest, funding 94% of Boston's HCV units.[34] The BRR Program specifically targets the federally funded leased housing units because it is the largest subset of HCV units and because of how the BRR Program is financed (see Chapter 2).

Funding for BHA Administered HCV Units		
Total Units	15,479	100%
Federal Leased Housing	14,535	94%
State Leased Housing	681	4%
City Leased Housing	263	2%

Table 1. Funding Sources of the Boston Housing Authority's Housing Choice Voucher Units
Source: Boston Housing Authority

The Boston Housing Authority provides housing for 36,953 residents in 15,479 units through the Section 8 Housing Choice Voucher Program.[35] Through the Section 8 HCV Program, the BHA supports some of the lowest-income residents in Boston. Just less than two-thirds of residents identify as female. Almost a third of residents are between the ages of 25-50. The next most populous age group is residents between six and thirteen, demonstrating how many families there are in the Section 8 Program. 15% of residents are over the age of 62 and are therefore designated as elderly. The BHA's Section 8 population is also more racially and ethnically diverse than the city on average. Over half of Boston's Section 8 population is Black,

[34] "Boston Housing Authority Internal Report."
[35] Ibid

which is notably high given that Boston's Black population is only 25%. The other half of Boston's Section 8 population is seemingly white.

However, the method of aggregating data into Hispanic and non-Hispanic categories presents a limitation, as it inaccurately portrays the Section 8 Program as being almost half white. Relatedly, almost half of Section 8 residents identify as Hispanic, another notably high number given Boston's low Hispanic population. A quarter of all residents are disabled as well. Finally, the average net income of Section 8 residents in Boston is $20,074 - significantly lower than the Boston average.

Demographics of BHA Section 8 Residents	
Total	100%
Gender	
Male	39%
Female	61%
Age	
Age 0–5	8%
Age 6–13	17%
Age 14–17	10%
Age18–24	12%
Age 25–50	27%
Age 51–61	11%
Age 62+	15%
Race	
White	42%
Black	54%
Asian	2%
American Indian/Alaska Native	1%
Native Hawaiian/Other Pacific Islander	1%
N/A Race	1%
Ethnicity	
Hispanic	40%
Not Hispanic	60%
Designated Categories	
Disabled	26%
Elderly	15%
Average Net Income	$20,074

Table 2. Demographics of the BHA Section 8 Program
Source: Boston Housing Authority

Eligibility for the Section 8 HCV Program via the BHA is based on numerous factors. A person's income, housing situation or priority, and immigration status are all considered. In terms of income, a family is eligible for the HCV Program if they fall below a certain income limit: either low-income (50% or below Area Median Income (AMI)) or extremely low-income (30% or below AMI).[36] Area Median Income levels are set annually by HUD and can

[36] "An Overview of the Section 8 Housing Programs."

be defined as "the midpoint of a specific area's income distribution."[37] While those who qualify as low-income using the AMI definition can qualify for HCV, 75% of all Housing Choice Vouchers are required to be given to families who qualify as "extremely low-income."[38]

Annual Income Limits

# of Persons in Family	1	2	3	4	5	6	7	8
Housing Choice Voucher	$47,000	$53,700	$60,400	$67,100	$72,500	$77,850	$83,250	$88,600

Table 3. 2024 Income Limits of the BHA Housing Choice Voucher Program
Source: Boston Housing Authority

In addition to meeting the income requirements, Section 8 HCV applicants must have a housing circumstance that qualifies them as having "Priority 1" status. The priority classification indicates that an applicant is facing a housing-related situation that affects the household's current housing status. Applicants that fall into the following categories are considered to be Priority 1: Homeless or displaced or facing imminent displacement due to "Government Action, Natural Disaster, Domestic Violence, Victim of a Hate Crime, Fear of Reprisal/Witness Protection, Court Ordered No-Fault Eviction, Cost Burdened in Boston, Inaccessibility to the Unit, and Graduates of Project Based Housing and no longer in need of supportive services."[39] Applicants facing more than one of these circumstances will be further prioritized.

In most cases, Section 8 HCV residents "pay 30% to 40% of their total income toward rent."[40] The remainder of the rent is paid to the landlord through the BHA. The Boston Housing Authority currently determines the rent for Section 8 HCV properties according to several regulatory standards and procedures. Below is a review of the process for determining rent in Section 8 HCV units.

[37] "What Is Area Median Income (AMI)?"
[38] "An Overview of the Section 8 Housing Programs."
[39] "Boston Housing Authority - Application Process."
[40] "Boston Housing Authority - Housing Options."

1) Contract Rent and Rent Reasonableness: The Contract Rent refers to the rent for a Section 8 unit. The Contract Rent requested by an owner cannot exceed what the BHA determines to be the 'Reasonable Rent' when compared to similar units on the market. To determine the Reasonable Rent, a Rent Reasonableness assessment is completed by a BHA contractor based on a market review. The Rent Reasonableness Assessment ensures that a Section 8 HCV funded unit does not have a higher rent than comparable rental properties in the same geographic area. The assessment provides an estimate of what an appropriate monthly rent should be in a specific neighborhood.[41] When determining Rent Reasonableness, various factors are typically considered, including unit size, type, age, condition, location, amenities, housing services, maintenance, and utilities provided at the property. In addition, the Assessment surveys rental rates in the area using rental data from websites such as Craigslist, Zillow, Apartments.com, etc.[42] The justification for Rent Reasonableness is equity: if the prospective Section 8 HCV unit is identical to another unit in the geographic region, the two units should have the same rent. The primary goal is to ensure that the rent charged is fair and reflects market conditions while also ensuring that government funds are being used efficiently and effectively. In Boston, Rent Reasonableness Assessments are conducted by Affordablehousing.com (previously GoSection8.com). The Contract Rent, or the owner's requested rent for a Section 8 HCV unit, "cannot exceed what BHA determines to be the Reasonable Rent when compared to the market."[43]

2) Utility Allowance: The Utility Allowance is the amount the "BHA has determined that the tenant will likely pay for utilities based on annual studies of utility costs in the region."[44] The allowance is adjusted for the number of utilities the tenant is responsible for (e.g. if the tenant pays electricity, gas, and water vs. just electricity). The BHA deducts the Utility Allowance amount from the tenant's share of the rent thereby covering the majority of the utility costs. However a tenant is still responsible for paying their own utility bills. If a tenant's utility cost is higher than the Utility Allowance, the tenant is responsible for paying that difference.

[41] "Housing Choice Voucher Program Guidebook."
[42] "HUD Exchange - Rent Reasonableness."
[43] "Boston Housing Authority - Boston Housing Authority Landlord Information."
[44] "Boston Housing Authority - Boston Housing Authority Landlord Information."

3) Gross Rent: The Gross Rent refers to the Contract Rent amount plus the Utility Allowance amount. Gross Rent is an important concept because a unit's Gross Rent cannot exceed a separate standard known as the Payment Standard.[45]

4) Payment Standards: Payment Standards are set by HUD and are defined as the maximum monthly assistance payment (which includes rent and utilities) for a family assisted in the Section 8 HCV Program.[46] The Payment Standard amount is based on fair market rents (FMRs) that are determined by the U.S. Department of Housing and Urban Development (HUD) for different geographic areas and vary depending on the number of bedrooms per unit. However, this approach was refined in 2016 when HUD instructed Boston and other metropolitan regions to adopt a new system known as the Small Area Fair Market Rents (SAFMRs) as part of a demonstration program. SAFMRs are set at the Zip Code level and are intended to provide a more accurate reflection of rental market conditions by setting Payment Standards based on rental data from smaller geographic areas within a metropolitan area, rather than using a single Fair Market Rent (FMR) value for the entire metropolitan area.[47] Under this approach, the "Reasonable Rent (Contract Rent), plus the estimated utilities paid by the tenant, cannot exceed ZIP Code level 'Small Area Fair Market Rent' Payment Standard."[48] In other words, if the Payment Standard is more than the Gross Rent, the unit will be considered affordable because the tenant will pay no more than 30% of their income towards rent and utilities. In some situations, exceptions are made, and the Gross Rent of a unit can exceed the Payment Standard, but not by more than 10% of the tenant's monthly adjusted income. A unit will be deemed unaffordable (meaning a tenant cannot rent the unit and be supported by Section 8 HCV Program) "if the Gross Rent exceeds the Payment Standard by an amount greater than 10% of a prospective tenant's monthly adjusted income."[49] To help simplify this process for landlords, the BHA recently launched a calculator that enables landlords to estimate how much they might be able to ask for in rent

[45] "Boston Housing Authority Internal Report."
[46] "Housing Choice Voucher Program Guidebook."
[47] "Small Area Fair Market Rents | HUD USER."
[48] "Boston Housing Authority - Boston Housing Authority Landlord Information."
[49] "Boston Housing Authority - Boston Housing Authority Landlord Information."

under these standards, or how much they can request in annual rent increases.[50] The "Reasonable Rent" will consistently remain lower than the Payment Standard since it is determined by specific unit details, rather than mere area price averages, as with the Payment Standard.

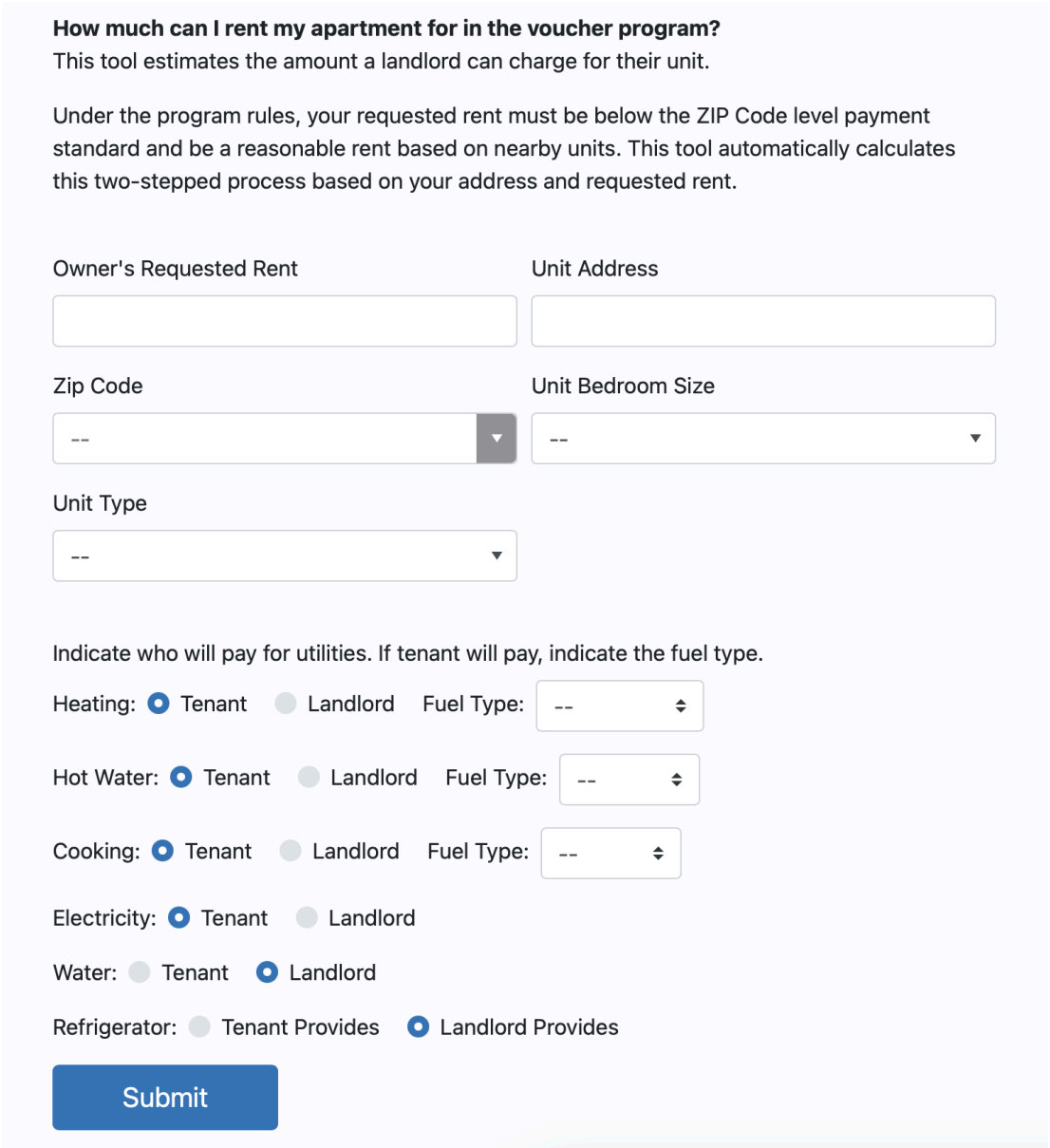

Figure 1. Boston Housing Authority Calculator that Helps Landlords Determine How Much They Can Charge For a Unit
Source: Boston Housing Authority

[50] "Boston Housing Authority - Boston Housing Authority Landlord Information."

5) Rent Gap: For the extent of this paper, I will be defining Rent Gap as the difference between the Payment Standard and the Gross Rent. The Rent Gap represents the difference between the Contract Rent plus Utility Allowance and what they could be receiving according to HUD Payment Standards. This gap will serve as an important financing mechanism in the funding of the BHA Retrofit Rewards Program.

Example Rent Calculation

Approved Contract Rent: $3,200
Utility Allowance: $174
Gross Rent: $3,200 + $174 = $3,374
Unit Size: 4 bedrooms
Voucher Size: 3 bedrooms
Payment Standards for unit's zip code: 4 bedroom -- $3,650 / 3 bedroom -- $3,350
Tenant's Adjusted Monthly Income: $1,000

In this example, the prospective tenant is seeking to rent a 4 bedroom unit, however they have only been approved for a 3 bedroom voucher. Therefore, the smaller 3 bedroom payment standard will be applied.

The Gross Rent (the requested contract rent plus the anticipated utility allowance) exceeds the applied Payment Standard by $24. Because this overage is less than 10% of the tenant's monthly income, the unit is considered affordable and the tenant can move in.

The BHA would pay the unit owner the Payment Standard (the maximum possible subsidy) minus 30% of the tenant's monthly income ($1,000 x 30% = $300). So the monthly BHA payment to the owner would be $3,350 - $300 = $3,050.

The tenant is then responsible for paying the owner the remainder of the Contract Rent ($3,200 - $3,050 = $150). In addition to this monthly payment of $150 from the tenant to the owner, it is estimated that the tenant will be responsible for an additional $174 per month in utilities. So, in total, the tenant will pay $324 per month toward rent and utilities, which is 30% of their monthly income ($300), plus the $24 by which the Gross Rent exceeds the Payment Standard.

Figure 2. Example Rent Calculation for a BHA Section 8 Housing Choice Voucher Unit
Source: Boston Housing Authority

C. Decarbonization in Housing

Building decarbonization can be understood as "activities and programs that reduce greenhouse gas emissions from buildings."[51] The decarbonization of buildings can "generally be accomplished by a combination of reducing energy use, buying renewable energy, and switching fossil fuel systems to electricity."[52] However, a "decarbonized" or "net-zero" building does not have a single definition in real estate. Rather, it can be understood as a framework. The non-profit environmental group, the Rocky Mountain Institute, provides a framework that approaches building decarbonization in five phases.[53]

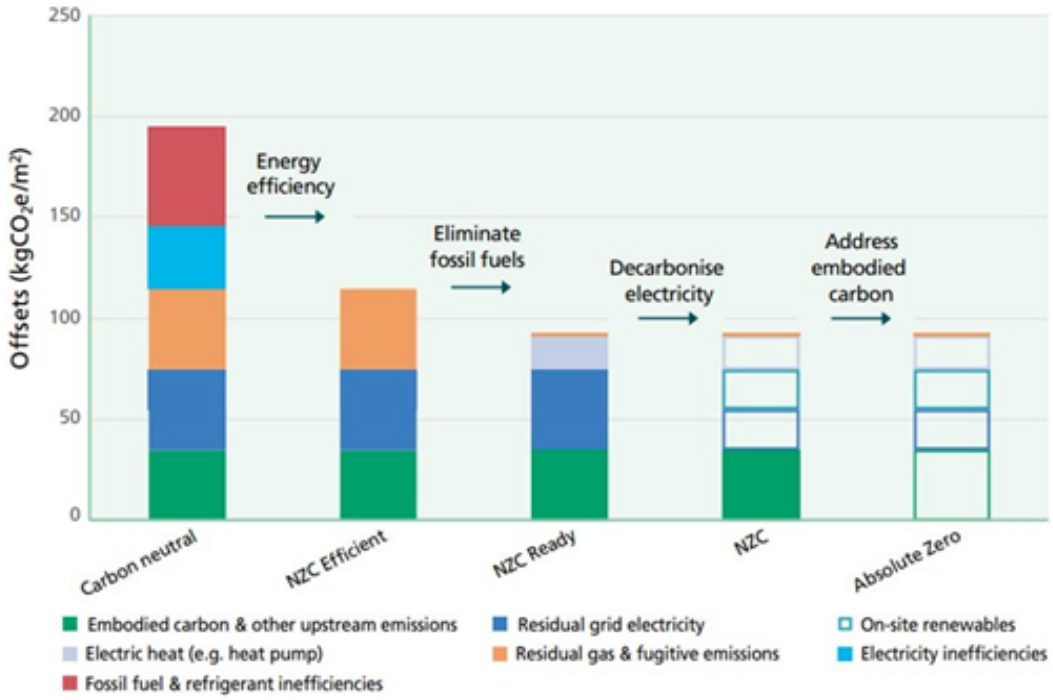

Figure 3. Variance in Building-Level "Zero Carbon" Definitions
Source: Rocky Mountain Institute

The Carbon Neutral classification represents buildings as they exist today (e.g. not energy efficient). However, it is theoretically possible for owners to be carbon neutral if they purchase carbon offsets. The Net-Zero Carbon (NZC) Efficient classification eliminates all energy

[51] California Energy Commission, "Building Decarbonization Assessment."
[52] City of Boston, "How To Decarbonize Your Building."
[53] Mills, "The Right Nudge."

inefficiencies in a building and its operations. This can be accomplished with actions such as replacing windows, improving the sealing of the building's exterior envelope, and increasing the building's insulation. The Net-Zero Ready classification requires the removal of all fossil fuels by electrifying the entire building. This requires actions like replacing the existing HVAC system with heat pumps and installing an electric-based water heater. A building is considered Net-Zero Carbon when it has "eliminated all emissions due to inefficiencies, has fully electrified, and only uses electricity from renewable sources."[54] Getting to this step requires the installation of solar panels or other renewable energy sources at the building. The classification, Absolute Zero, requires building owners to remove embodied carbon, or construction materials associated with CO_2 emissions, from the building. For the purposes of the BHA Retrofit Rewards Program, we are focused on incentivizing landlords to reach at least Net-Zero Carbon Efficient, with the hopes that they will eventually reach Net-Zero Carbon Ready and Net-Zero Carbon. However, it is important to note that all buildings and building types are slightly different, making the process of decarbonization slightly different in each case.

[54] Mills.

Figure 4. Example Residential Decarbonization Process
Source: MassCEC

III) Literature Review - Rationale for the BRR Program

A. The Policy Context

The local, state, and national policy context is one of unusually strong support for decarbonization of housing that supports low-income people, making it an opportune time to implement the BHA Retrofit Rewards Program. Political support can be an instrumental facilitator of residential decarbonization efforts. Clean energy retrofits are expensive, and a supportive political environment can provide financing and technical assistance to interested landlords. Policy can be used to 1) provide financial assistance for decarbonization through channels like tax breaks and rebates, 2) enact legislation requiring decarbonization measures, and 3) foster a clean energy economy that promotes private sector decarbonization efforts. In

this section, the local, state, and federal government policy context is reviewed, highlighting important legislation and other policy initiatives in order to understand the potential support for the BHA's goals of improving the energy efficiency and reducing the carbon footprint of BHA-supported housing units.

Federal

Since the Biden Administration took office in January of 2021, there has been growing support for low-income residential decarbonization. In 2021, in the midst of the COVID-19 pandemic, President Biden and Congress passed the American Rescue Plan Act (ARPA), which allocated $350 billion to state and local governments nationwide.[55] Many state and local governments were able to utilize this funding to support affordable housing efforts. For example, the City of Boston designated $234 million, almost half of its ARPA funding, to housing efforts in hopes that it would lead to a strong, resilient, and equitable pandemic recovery.[56]

In 2022, the Biden Administration and Congress passed the Inflation Reduction Act (IRA) - a historic piece of climate legislation that provided nearly $400 billion to support clean energy initiatives.[57] It has spurred investment in decarbonization across most sectors of the economy. Because the housing stock is responsible for or associated with such a large portion of US greenhouse gas emissions, several components of the legislation provided resources and incentives aimed at decarbonizing the US housing stock. In fact, almost 8.8 billion of the bill has been allocated for home energy rebates.[58] One of the relevant components of the IRA is the EPA's Greenhouse Gas Reduction Fund (GGRF), which provides money for clean energy upgrades in affordable housing. The Greenhouse Gas Reduction Fund authorizes a $27 billion investment aimed at mobilizing financing and private capital to help address the climate crisis. The goals of the fund are to deliver lower energy costs to consumers and revitalize communities that have been historically disadvantaged.[59] A second

[55] The White House, "President Biden Announces American Rescue Plan."
[56] "City of Boston American Rescue Plan Housing Funding | Boston.Gov."
[57] energy.gov, "Home Energy Rebates Programs."
[58] energy.gov.
[59] EPA, "Greenhouse Gas Reduction Fund."

component of the IRA that is relevant to affordable housing decarbonization is the HUD Green Resilient Retrofit Program (GRRP). The GRRP "provides funding for direct loans and grants to fund projects that improve energy or water efficiency, enhance indoor air quality or sustainability, implement the use of zero-emission electricity generation, low-emission building materials or processes, energy storage, or building electrification strategies, or address climate resilience, of eligible HUD-assisted multifamily properties."[60]

Federal support for residential decarbonization is also evident in the proposed 2025 fiscal budget. The Biden administration is hoping that the budget will include a historic $258 billion that "would build or preserve over 2 million housing units, support millions of first-time homebuyers, guarantee affordable housing for hundreds of thousands of extremely low-income veterans and youth aging out of foster care, and advance efforts to end homelessness."[61] However, the House has been cutting back on elements of this proposal, and it is unlikely it will pass in its proposed form.

The federal government has also indicated that there will be greater interagency communication and collaboration when it comes to decarbonizing the housing sector. In November of 2023, the U.S. Department of Energy (DOE) and the U.S. Department of Housing and Urban Development (HUD) entered a memorandum of understanding to formalize their coordination on efforts to decarbonize the building sector. The two agencies plan to coordinate on the "research, development, demonstration, and deployment of affordable and accessible retrofit solutions for existing HUD-owned and HUD-assisted housing to help ensure that new/expanded Infrastructure Investment and Jobs Act (IIJA) and Inflation Reduction Act (IRA) programs serve HUD communities and affordable housing."[62] Overall, while there has been immense federal support for housing and clean energy retrofits in recent years, these policies are contested by opposition groups and are therefore potentially subject to revision in the future. As a result, it may not be prudent to rely exclusively on the federal government for long-term, stable housing and decarbonization support.

[60] "Green and Resilient Retrofit Program (GRRP) | HUD.Gov / U.S. Department of Housing and Urban Development (HUD)."
[61] The White House, "FACT SHEET."
[62] "HUD and DOE Announce New Partnership to Decarbonize U.S. Building Sector at COP28."

Funding for Massachusetts multifamily affordable housing retrofits

As of October 2023

Program	Incentive	Administering Agency	Region
Green and Resilient Retrofit Program (GRRP)	$1B total to be administered (funding per unit varies)	US Department of Housing and Urban Development (HUD)	Nationwide
New Energy Efficient Home Credit (45L)	$500-$5K/unit	Internal Revenue Service (IRS)	Nationwide
Investment Tax Credit for Energy Property (Section 48)	30-50% off solar PV system cost (Section 48) plus 10-20% when applying for low income (48E) (tax-exempt entities can access direct pay)	Internal Revenue Service (IRS)	Nationwide
Home Energy Rebate Programs	Efficiency rebates up to $8K/unit, Electrification rebates up to $14K/unit (funding likely available in 2024)	Funded through the Inflation Reduction Act (IRA), administered by state agencies (varies)	Nationwide (administered per state)
Income-Eligible LEAN Deep Energy Retrofit Pathway	$350/MMBtu savings	Mass Save	Massachusetts
Low- and Moderate-Income Housing Decarbonization Grant Program	Up to $40K/unit	Massachusetts Department of Energy Resources (DOER)	Massachusetts
Climate Ready Housing Program	$1.6M for 2-3 projects per year	Massachusetts Executive Office of Housing and Livable Communities (EOHLC)	Massachusetts
Large Building Green Energy Retrofits Program	Up to $50K/unit; Up to $10k/project in analysis grants	City of Boston Mayor's Office of Housing (MOH)	Boston, Massachusetts
Greenhouse Gas Reduction Fund (GGRF)	$27B total (funding per unit varies, available in July 2024)	Environmental Protection Agency (EPA)	Nationwide
Massachusetts Weatherization Assistance Program (WAP)	An average of $4,725 in allowable energy efficiency measures per household	Massachusetts Executive Office of Housing and Livable Communities (EOHLC)	Massachusetts
Massachusetts Community Climate Bank	$50M total in seed funding for project financing	Massachusetts Office of Climate Innovation and Resilience	Massachusetts
The Zero Carbon Renovation Fund (ZCRF)	$300M total (in legislative process)	TBD	Massachusetts

Table 4. Funding Opportunities for Massachusetts for Multifamily Affordable Housing Retrofits
Source: The Rocky Mountain Institute

State

The Massachusetts government has also shown strong support for decarbonization of the housing sector. Massachusetts' Clean Energy and Climate Plan for 2050, launched in 2022, provides details on the actions the Commonwealth will undertake in coming years to achieve Net Zero greenhouse gas emissions by 2050.[63] The administration's Low- and Moderate-Income Housing Decarbonization Program, launched in 2023, also provides immense support for low-income residential decarbonization efforts.[64] The $50 million grant will be used to "fund deep energy retrofits and energy efficiency upgrades, building system electrification, and onsite renewable energy generation" in affordable housing developments across Massachusetts.[65] Also in 2023, Governor Maura Healey proposed legislation to create the Executive Office of Housing and Livable Communities.[66] The goal in creating the new office was to signal the importance of housing to her administration and to have an office specifically tasked with housing production. Governor Healey also created the Massachusetts Community Climate Bank (MCCB) - "the nation's first green bank dedicated to affordable housing."[67] The MCCB is organized to promote clean energy solutions for low- and moderate-income households by leveraging federal, state, and private funds.

Another major initiative, known as the Massachusetts Affordable Homes Act, was proposed by Governor Healey in the fall of 2023 and is currently making its way through the legislature. One key component of the bill is a $4 billion bond issue aimed at supporting housing construction and renovation. Some goals of the Affordable Homes Act and the bond issue are to 1) preserve, rehab, improve, or support 27,000+ MA housing units, 2) to modernize and improve the energy efficiency of 12,000+ low-income homes, 3) fund accessibility improvement for ~4,500 homes, and 4) support the decarbonization of ~3,000

[63] "Massachusetts Clean Energy and Climate Plan for 2050 | Mass.Gov."
[64] "Healey-Driscoll Administration Announces $50 Million Grant Program for Low- and Moderate-Income Electrification | Mass.Gov."
[65] "Healey-Driscoll Administration Awards $27 Million to Decarbonize Affordable Housing Across Massachusetts | Mass.Gov."
[66] "Governor Healey and Lieutenant Governor Driscoll Name Edward M. Augustus as Housing Secretary | Mass.Gov."
[67] "Governor Healey Announces Creation of Massachusetts Community Climate Bank, Nation's First Green Bank Dedicated to Affordable Housing | Mass.Gov."

public housing units.[68] Finally, last fall, Massachusetts submitted an application for federal funds to decarbonize low-income and affordable housing, which could impact 78,500 low-income and affordable housing households across the Commonwealth.[69]

City

Perhaps the most visible public support for affordable housing and decarbonization can be seen at the local level. The previous administration enacted the Building Emissions Reduction and Disclosure Ordinance 2.0 (BERDO 2.0) that "requires large buildings in Boston to reduce their greenhouse gas emissions overtime" in an effort to achieve carbon neutrality by 2050.[70] In the current Boston Mayor Michelle Wu's 2023 State of the City address, she announced her signing of an executive order "requiring all new City construction and major renovations in [Boston] schools, municipal buildings, and public housing, to be entirely fossil-fuel free."[71] In addition, she specifically called on BHA to end the use of fossil fuels in the City's public housing developments by 2030. These initiatives jumpstarted the BHA's decarbonization efforts in its public housing stock.

Even before she took office, Mayor Wu released plans for a Boston Green New Deal (GND), a "vision for tackling the climate crisis in Boston — with policies that address economic, social, and racial inequities, while advancing health, livability, and justice" for all Boston residents.[72] Since taking office in November 2021, the Wu administration has initiated many programs for housing and sustainability initiatives that further the vision of the GND. One such initiative is the Healthy and Green Retrofit Pilot Program, which provides select owner-occupied homes up to $50,000 per unit for decarbonization and technical assistance in the process.[73] In addition, the Wu administration has provided $3.5 million to launch its new Equitable Emissions Investment Fund aimed at supporting decarbonization in environmental justice communities. The fund will provide "monetary support for the

[68] "Bill H.4138 - The Affordable Homes Act."
[69] "Massachusetts Submits Application for Federal Funds to Decarbonize Low-Income and Affordable Housing | Mass.Gov."
[70] "Building Emissions Reduction and Disclosure | Boston.Gov."
[71] "Mayor Wu's 2023 State of the City Address | Boston.Gov."
[72] "Green New Deal Dashboard (Beta) | Boston.Gov."
[73] "Healthy and Green Retrofit Pilot Program | Boston.Gov."

implementation and administration of local building carbon abatement projects."[74] The Wu administration also granted $69 million to create and preserve 775 income-restricted homes across the city. Any of the new construction projects funded through this investment will be required to follow the Zero Emissions Building (ZEB) requirements.[75]

From this brief review, it is evident that the public policy outlook for housing production and access is promising across the federal/state/local spectrum. While the above review includes proposals that have not yet been enacted, it is clear that the current policy environment presents an unusual degree of combined policy support for housing and decarbonization initiatives among levels of government. Much of the enacted legislation is targeted specifically at affordable housing. All levels of government pushing in the same direction create a powerful ecosystem for change. The current supportive policy context is a key reason for the implementation of the BRR Program, as financial and technical assistance for decarbonization are more readily available in a supportive political environment.

B. The Split Incentive Problem

The lack of decarbonization financing and technical assistance for landlords, in addition to the split incentives problem, highlights the need for an external financial incentive (like the one proposed in the BRR Program) for Section 8 HCV unit decarbonization.

One may wonder why building owners even need financial incentives (like those proposed in the BHA Retrofit Rewards Program) to decarbonize their units. In an ideal world, would not all landlords be working hard to implement these changes on their own? However, due to various barriers to clean energy access, even the most well-meaning, environmentally-conscious landlords require incentives.

Residential decarbonization is difficult because it is expensive and logistically complicated. The Lawrence Berkeley National Laboratory recently completed a study that "showed that reaching at least 50% carbon reductions currently costs about $55,000 for a

[74] "City of Boston Finalizes Regulations to Ensure Large Buildings Achieve Carbon Neutrality by 2050 | Boston.Gov."
[75] "$69 Million Investment to Create and Preserve More Than 775 Income-Restricted Homes Across Boston | Boston.Gov."

typical single-family home."[76] For high-rise buildings, the Rocky Mountain Institute reports "that a deep energy retrofit of a standard 500,000 gross square foot, 12-story office building would cost $25 per square foot at minimum and potentially over $150 per square foot."[77] Despite this lofty price tag, cost is not the only barrier to residential decarbonization. A 2021 systematic review found that in addition to financial considerations, "complexities in managing rental properties; landlord-tenant relationships; landlords' values, beliefs, and knowledge; and property market factors were all found to affect retrofitting."[78]

Recent studies demonstrate what homeowners are willing to do when it comes to decarbonization and clean energy upgrades in their homes. A 2024 report by the American Council for an Energy-Efficient Economy (ACEEE) found that 65% of homeowners have the desire and ability to invest at least $1,000 in comprehensive home energy upgrades.[79] While this is an encouraging start, it is not nearly enough financing for residential decarbonization. However, the same study found that homeowners were willing to make more substantial clean energy upgrades when they had access to a zero-interest loan with no upfront costs.[80] This highlights the importance of government programs like the Inflation Reduction Act that provide incentives and tax rebates for residential decarbonization efforts. But these incentives will not be enough if they are "not complemented by behavioral-informed messaging strategies and program design elements that maximize the impact of these incentives."[81] The findings of this report, while encouraging, are mostly applicable to wealthy, college-educated homeowners. The residential decarbonization process looks quite different for renters and their landlords/owners.

Renters (including those in Section 8 HCV Program), even if they have the financing and time, cannot access clean energy programs like the IRA or implement clean energy upgrades in their units because of their lack of agency over their home. On the other hand, landlords do not experience adequate incentives to make decarbonization upgrades themselves.[82] This highlights the split incentive problem that exists in the decarbonization of rental homes.

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[76] Walker, Casquero-Modrego, and Less, "Challenges and Opportunities for Home Decarbonization."
[77] "Rocky Mountain Institute Guide to Building the Case for Deep Energy Retrofits."
[78] Lang et al., "Systematic Review."
[79] Sussman, Lewallen, and Conrad, "Messaging Comprehensive Retrofits."
[80] Sussman, Lewallen, and Conrad.
[81] Sussman, Lewallen, and Conrad.
[82] Walker, Casquero-Modrego, and Less, "Challenges and Opportunities for Home Decarbonization."

Split incentives can be defined as "a circumstance in which the flow of investments and benefits are not properly rationed among the parties to a transaction, impairing investment decisions."[83] Melvin (2018) provides an example of what this looks like in the case of clean energy upgrades in rental units.

> "Prior to a lease being signed, the landlord must make investment decisions regarding the energy efficiency of the housing unit, such as the quality of the space-heating system or the thickness of the insulation. After the lease is signed, the tenant must make energy-consumption decisions: should I open the windows or use the air conditioner? Thus, both entities must make decisions that impact the monthly utility bill for that household. However, only one entity actually pays the utility bill. Thus, whoever is not paying for the energy does not have to suffer the costs of any inefficient decision-making, and therefore will not behave optimally. This results in unnecessarily high energy usage, leading to higher utility bills and excessive carbon emissions."[84]

There is considerable evidence that split incentive problems are one of the key reasons that energy efficiency upgrades have been implemented at such low levels in rental housing.[85] Gillingham et al. (2012) found that when landlords pay the utility bill, tenants were significantly less likely to turn their thermostat down at night, and when tenants pay the utility bill, landlords are much less likely to install insulation in the ceiling and exterior walls - an essential step in home decarbonization.[86] In addition, Melvin (2018) found that landlords with tenants who pay the utility bill consistently underinvest in multiple categories of residential energy efficiency measures including space-heating, water-heating, window thickness, insulation, and weatherization.[87] This underinvestment is harmful to the environment, and to the health and wellbeing of tenants.

The split incentive problem in the decarbonization of rental housing highlights the need to provide landlords with external financial incentives like the ones proposed in the BHA Retrofit

[83] Bird and Hernández, "Policy Options for the Split Incentive."
[84] Melvin, "The Split Incentives Energy Efficiency Problem."
[85] Bird and Hernández, "Policy Options for the Split Incentive."
[86] Gillingham, Harding, and Rapson, "Split Incentives in Residential Energy Consumption."
[87] Melvin, "The Split Incentives Energy Efficiency Problem."

Rewards Program. This problem also highlights the need to prioritize low-income residents and units first in residential decarbonization efforts as they are the ones with the least energy-efficient housing and the ones most vulnerable to the harmful impacts of energy inefficient housing. As the Berkeley National Laboratory put it, "Decarbonizing the US economy will require solutions that can be deployed across housing types, climate zones, and income levels. In particular, affordable solutions for disadvantaged, low-, and mid-income households are the key to successfully achieving our primary target of zeroing out housing emissions. There must be simple solutions that are designed to meet the needs of disadvantaged communities, multifamily housing residents, and renters."[88]

C. The Argument for Equity in Residential Decarbonization

Housing that supports low-income residents tends to have a disproportionately negative impact on the environment compared to market-rate housing, which often leads to poor health outcomes and increased energy burdens for tenants.[89] This underscores the need to prioritize decarbonization of housing that supports low-income residents as "programs targeting low-income housing often have larger energy and equity impacts than more general residential sustainability programs."[90] The BRR Program will be able to spearhead the low-income decarbonization objectives in Boston because the BHA supports housing for thousands of low-income residents through its Section 8 HCV Program.

Low-income individuals like those in the Section 8 HCV Program are generally more likely "to live in older housing that is much less energy efficient than newer housing due to insufficient air sealing and insulation."[91] The energy inefficiency of these older homes can create health and financial challenges for tenants. Poor quality housing with substandard energy efficiency can cause or exacerbate health challenges already disproportionately experienced by low-income residents.[92] Insufficient air sealing and insulation in low-income housing can "cause

[88] Walker, Casquero-Modrego, and Less, "Challenges and Opportunities for Home Decarbonization."
[89] York et al., "Building Decarbonization Solutions for the Affordable Housing Sector."
[90] Simon, "Energy Inequity in Low-Income Housing."
[91] World Health Organization, "Roadmap to Improve and Ensure Good Indoor Ventilation in the Context of COVID-19."
[92] Rolfe et al., "Housing as a Social Determinant of Health and Wellbeing."

homes to be cold, drafty, damp, or worse still, allow mold and pests to infiltrate which can exacerbate or cause health challenges like asthma."[93] Inadequate insulation and air sealing can also increase air leakage between the inside and outside of a home. This disproportionately exposes low-income residents to extreme indoor temperatures which can cause, or worsen health outcomes.[94] Fossil fuels in the home can also exacerbate health issues. The combustion products of "gas stoves and ovens include nitrous oxides, carbon monoxide, and incompletely burned gas, and gas can also leak when the stove is off, all leading to poor indoor air quality."[95] Although gas stoves and ovens pose health risks to all households, these products pose a greater risk to low-income residents who already face greater health challenges.

Energy inefficient homes can also intensify financial challenges by increasing individuals' energy burden. Energy burden can be defined as "the percentage of household income that goes toward energy costs."[96] Studies show that "energy costs disproportionately burden low-income households, especially those living in multifamily rental housing."[97] In fact, low-income people receive the lowest amount of energy per dollar spent. Evidence suggests that "low-income households may spend 10% of their total income on energy, and beyond 20% for very low-income households as compared to an average 3.3% for non-low-income households…yet they receive the lowest amounts of energy per dollar spent because the weatherization and efficiency measures in their rental units are often at the lowest levels of efficiency."[98] Residents of energy inefficient homes must therefore make a tough decision: either utilize heating and AC systems to moderate extreme indoor temperatures for their comfort and health, or limit the use of HVAC systems in order to alleviate their energy burden and financial challenges.

As climate change escalates, the negative impacts of energy inefficient homes will intensify for low-income residents. For instance, extreme indoor temperatures will continue to

[93] World Health Organization, "Roadmap to Improve and Ensure Good Indoor Ventilation in the Context of COVID-19."
[94] Reames, "Targeting Energy Justice."
[95] Lebel et al., "Composition, Emissions, and Air Quality Impacts of Hazardous Air Pollutants in Unburned Natural Gas from Residential Stoves in California."
[96] "Explaining the Unique Energy Burden of Low-Income Households | ACEEE."
[97] "Inflation Reduction Act Investments in Green and Resilient Affordable Housing."
[98] Bird and Hernández, "Policy Options for the Split Incentive."

become more severe. Low-income residents are also disproportionately likely to live in climate-vulnerable areas and will thus experience more intensely these exacerbated effects of climate change. For example, as atmospheric temperatures continue to rise, the extreme indoor heat experienced by low-income residents in energy inefficient homes will intensify. Low-income individuals are also already more likely to live in heat-vulnerable areas like heat islands[99], further exacerbating the extreme indoor heat problem. Thus, "climate change and inequity are locked in a vicious cycle. The inequality-aggravating effect of climate change increases the exposure of the disadvantaged groups to the adverse effects of climate change; and increases their susceptibility to damage caused by climate change."[100]

Residential decarbonization can therefore help reduce greenhouse gas emissions, improve tenant health and wellbeing, and minimize tenant energy burdens. While the clean energy conversion of the entire housing stock is essential to meeting climate goals, decarbonization efforts must start with low-income residents who are most vulnerable to the effects of climate change. Given that housing authorities support the largest portion of low-income housing in the country, clean energy retrofits of housing authority-owned and subsidized units is imperative. While the BHA does not have direct control over energy efficiency measures in Section 8 HCV housing units, it does have the ability to incentivize landlords in the right direction. Therefore, the implementation of the BHA Retrofit Rewards Program is essential for ensuring that low-income Boston residents are first in line in the residential decarbonization process.

[99] EPA, "Heat Islands and Equity."
[100] Islam, Winkel, and Affairs, "Climate Change and Social Inequality."

Chapter 2 - Methods

I) Comparative Analysis

The first step in creating a Section 8 HCV decarbonization program at the BHA was to identify and analyze examples of low-income decarbonization programs across the country. I reviewed examples of multifamily affordable housing decarbonization projects led by private, non-profit, and public actors in the private and public markets. These multi-family affordable home decarbonization projects act as useful examples in our development of the BHA Retrofit Rewards Program. I then narrowed my search to identify programs specifically aimed at incentivizing Section 8 HCV unit decarbonization. The goal of this search was to find examples that could serve as inspiration for the BHA Retrofit Rewards Program.

A. Low-Income Residential Decarbonization Examples

There are several examples of successful affordable housing decarbonization and energy efficiency projects nationwide by private, non-profit, and public actors that can serve as useful blueprints for the BRR Program in Boston.

One example of a non-profit actor is Boston's Allston Brighton Community Development Corporation (CDC), whose mission is to "build a stronger, more stable community through implementation of deep energy retrofits (DER)."[101] As a part of that mission, the Allston Brighton CDC is undergoing a comprehensive review of its entire 10-property, 520-unit portfolio. They have joined REALIZE-MA (an entity of the Rocky Mountain Institute) 1,000 Apartment Challenge Program that aims to have 1,000 multifamily apartment units in Massachusetts under retrofit renovation by the end of 2024. As part of the challenge, the Allston Brighton CDC currently has 3 retrofit projects underway that aim to cut energy consumption by 55 percent across 103 residential units.[102] While this is an impressive accomplishment, the project's goal is to improve energy efficiency measures (Net-Zero Carbon Efficient classification), not reach electrification (Net-Zero Carbon Ready or Net-Zero Carbon).

[101] Mills, "A Blueprint to Decarbonize Affordable Housing."
[102] "1,000 Apartment Challenge."

In addition, housing authorities across the country are working to decarbonize their public housing stock. In Boston, the city government and BHA have set an ambitious target to achieve full electrification in its public housing stock by 2030. The BHA is also required to meet or exceed relevant local government emissions requirements and other relevant climate action targets by 2030 as is mandated in the Building Energy Reporting and Disclosure Ordinance (BERDO 2.0).[103] In addition to the environmental benefits, the retrofit process will improve indoor air quality, health equity, and thermal comfort of BHA residents in public housing. The ambitious 2030 goal has meant that numerous public housing sites are undergoing intensive retrofits. One such public housing site is Mildred C. Hailey in Boston's Jamaica Plain neighborhood. The plans for this multi-family housing complex include upgrades to 456 housing units in eighteen buildings, including 5 seven-story elevator buildings and 13 three-story walk-up apartment buildings. The apartments will undergo substantial renovations including: 1) installation of new air-source heat pumps for space heating and cooling in all residential units; 2) "improvements to the building envelope including new windows, insulation, and air/vapor barrier;" 3) installation of heat pumps for domestic hot water heating; 4) installation of new LED lighting fixtures for building common spaces; and 5) installation of new solar panels on the roofs of the buildings.[104]

In New York City, the New York City Housing Authority (NYCHA) has launched the Accelerating Community-Empowered Shared Solar (ACCESSSolar) Program, which aims to develop community solar projects on its properties. Specifically, NYCHA wants to site 30 megawatts (MW) of clean energy capacity with solar power on its properties by 2026.[105] ACCESSSolar is just one of NYCHA's projects being implemented to reach their sustainability agenda goals which included reducing greenhouse gas emissions by 80% by 2050.[106]

Investigation into programs aimed at Section 8 HCV decarbonization yielded significantly fewer results. In addition to there being very few examples of Section 8 HCV decarbonization programs, there was very little information about Section 8 HCV decarbonization efforts in the literature.

[103] "Building Emissions Reduction and Disclosure | Boston.Gov."
[104] "Mildred C. Hailey Apartments Internal Energy Conservation Report."
[105] "ACCESSolar - NYCHA."
[106] "NYCHA's Sustainability Agenda."

One example of a Section 8 HCV decarbonization program is Minnesota's Metropolitan Council of the Twin Cities Metro Area's Solar-for-Vouchers Technical Assistance Program. The goal of the Program is "to help multifamily rental property owners install solar panels and reduce their energy costs. Property owners can take advantage of the savings resulting from this technical assistance in exchange for a commitment to rent some of their units at market rates to Section 8 Housing Choice Voucher Program participants."[107] As the largest Housing Choice Voucher Program in the state of Minnesota, the Metropolitan Council has been able to successfully encourage the expansion of the Section 8 HCV Program and green energy retrofits.

While each of these examples provide useful framing for the BHA Retrofit Rewards Program, none were as directly useful and applicable as Atlanta's EERB Program.

B. Atlanta's Energy Efficiency Rent Boost Program

The Atlanta Housing Authority (AHA) Energy Efficiency Rent Boost Program (EERB) provides the most notable example of a Section 8 HCV clean energy program (Figure 2). The AHA became the first housing authority to implement this kind of program in 2021. The EERB Program was originally developed after a Georgia Tech study reported that Atlanta low-income residents' energy burden (or percentage of household income that is spent on energy) was the 3rd highest in the country despite Atlanta's mild climate.[108] The (EERB) Program provides landlords additional monthly compensation if they have installed qualifying clean energy efficiency updates to their units. In addition to other incentive programs, the EERB Program "enables property owners to take advantage of special discounts, rebates, capital, and increased rental income when they make energy improvements to their properties."[109] In doing so, the EERB Program is able to "empower property owners to retain more tenants, increase revenue and save money, while reducing energy costs for tenants and keeping pace with climate-focused advancements."[110] The AHA finances the EERB Program with the Rent Gap, or the funds between the Gross Rent and Payment Standard. To create the EERB Program, the AHA teamed

[107] "Solar-for-Vouchers Technical Assistance Program."
[108] "The Low-Income Energy Burden of Atlanta Households | Climate and Energy Policy Laboratory."
[109] Yann.Mondon, "Sustainability Initiative Wins 2023 DOE Better Practice Award."
[110] Yann.Mondon.

up with Southface,[111] a nonprofit promoting sustainable homes, workplaces, and communities, and Georgia Power.[112] Together, they developed a tiered system of incentives (*Table 5*).

The EERB Program has already seen promising results, awarding 324 units with rent boosts in the Program's first 10 months and becoming the US Department of Energy's (DOE) Best of the Better: 2023 Better Practice Winner. As of 2024, 397 Section 8 HCV units are enrolled in the EERB Program, 79% of which are in multi-family housing and 21% in single-family housing. Around half (47.36%) of all participating units are in Level 1 of the EERB Program, 2.27% are in Level 2 of the EERB Program, and 50.38% are enrolled in Level 3 of the EERB Program.[113] Level 3 has high enrollment because several landlords who had some type of renovation project planned during the project's launch altered their renovation plans to fit the EERB Program's requirements - thereby maximizing their return on investment. On the tenant side, the AHA anticipates that the EERB Program will provide Section 8 HCV tenants with better health outcomes, reduced energy burdens, and more comfortable homes. They have also seen some reduction in tenant turnover when landlords have implemented energy efficiency measures in part because the energy costs are lower.[114]

[111] "Southface Institute."
[112] "Georgia Power."
[113] Informal Interview with the Atlanta Housing Authority.
[114] Informal Interview with the Atlanta Housing Authority.

Energy Efficiency Rent Boost (EERB) Criteria

Energy Efficiency Rent Boost Level	Energy Efficiency Boost System Type	Description of Upgrade	Minimum Requirement	Documentation/Verification Required	Possible Rebates	Sustainable Energy Efficient Rental Loan (SEER)
LEVEL 1: SILVER $50	Lighting System	Replace inefficient bulbs with LED Bulbs	• Replacement of Incandescent bulbs with LED Bulbs	• AH inspector will verify that all incandescent light bulbs have been replaced with LED Bulbs	• Georgia Power up to $4.50 per bulb Click here	Yes
	Low-Flow Water Upgrades	Install low-flow faucets, showerheads, aerators, and toilets	• Toilet(s)uses 1.28 gallons or less per flush • Low flow faucet aerators and showerheads.	• AH Inspector Verification	• Up to $100 from Atlanta Watershed Click here	Yes
	Insulation	Install additional Insulation	• Install insulation in attic to meet or exceed an R-38 value where applicable • For unconditioned basement or crawl space, install floor insulation to meet or exceed R-19	• AH Inspector Verification	• Rebates: 50% of cost up to $600 per year Click here	Yes
Energy Efficiency Rent Boost Level	**Energy Efficiency Boost System Type**	**Description of Upgrade**	**Minimum Requirement**	**Documentation/Verification Required**	**Possible Rebates**	**SELF Green Loan Financing Eligible**
LEVEL 2: GOLD $125	Air Sealing	Professional Weather Sealing	• Weather sealing must be completed per Table 402.4.2 of the Georgia Energy code	• Verified by a third party ICC Certified Residential Energy Inspector or equivalent as approved	• Up to $1150 from Georgia Power Click here	Yes
	Energy Star Appliances	Energy Star Rated Appliances	• Energy Star Refrigerator	• AH Inspector Verification • Landlord must supply model number and serial number to the inspector • Verification of Energy Star Product: https://www.energystar.gov/products	Click here	No
LEVEL 3: PLATINUM $175	HVAC System	New/like new or recently replaced central heating and air conditioning system	• Furnace • Central A/C or Energy Star Qualified PTAC Unit • 16 SEER or better exterior condenser • Proper seal of duct work • Programmable thermostat	• AH Inspector Verification • Landlord must supply model number and serial number to the inspector		Yes
	Windows	Energy Efficient Windows	• Replacing all single pane windows with Low Emissivity (Low-E) Glass Windows	• AH Inspector Verification		Yes

Table 5. The Atlanta Housing Authority's Energy Efficiency Rent Boost Program
Source: The Atlanta Housing Authority

II) Feasibility Analysis

The BHA's goal in this project is to determine how to incentivize Section 8 HCV landlords to implement green energy upgrades in their units to improve the health and well-being of residents. Investigation into the academic literature on decarbonization in Section 8 HCV housing found a notable scarcity of information. In addition, upon reviewing the landscape across the United States for relevant examples of decarbonization of Section 8 HCV, Atlanta's EERB Program was the only example in which a housing authority had implemented a program uniquely targeted to address the issue at hand (decarbonization of Section 8 HCV). Given the success of Atlanta's EERB Program and its alignment with the BHA's Section 8 HCV decarbonization goals (and that it was the only example of a program of this type), the BHA decided to attempt implementation of a similar program in Boston.

It is not uncommon for municipalities to reproduce each other's programs and policies. The process by which "knowledge about policies, administrative arrangements, institutions, and ideas in one political setting (past or present) being used in the development of policies, administrative arrangements, institutions, and ideas of another political setting" is known as policy transfer and is very common in the United States.[115] Related is the concept of policy diffusion, which can be understood as the process by which "policymaking in one government affects and influences policy-making in other governments."[116] Thus imitation of another municipality's program, like the BHA is trying to do with Atlanta's EERB Program, is one of the central methods of policy creation in the US. As Shipan and Volden (2012) argue, "In order for governments to fully serve their roles as laboratories of democracy, policymakers must act as scientists, watching those experiments and learning from them."[117]

Once the BHA decided to attempt the implementation of a program similar to Atlanta's EERB Program in Boston, an analysis was needed to determine how to effectively apply the

[115] Marsh and Sharman, "Policy Diffusion and Policy Transfer."
[116] Gilardi, Shipan, and Wüest, "Policy Diffusion."
[117] Shipan and Volden, "Policy Diffusion."

existing EERB Program into a new policy, demographic, housing, climate, etc. context. The BHA team established a process that established the necessary analytical steps for determining implementation feasibility in Boston. The goal of the process was to create a program that is fair to tenants (does not increase energy costs), fair to landlords, does not require an immense additional BHA administrative load, and has the greatest impact on improved sustainability, financial health, and quality of life for tenants. The process for determining the implementation feasibility of Atlanta's EERB Program in Boston required analysis that answered three key research questions:

1. How is the BHA going to finance the BHA Retrofit Rewards Program? Is there a sufficient rental gap to leverage in order to fund the incentive?
2. How is the BHA going to technically administer this BHA Retrofit Rewards Program? Are administrative and technical resources available to administer the BHA Retrofit Rewards Program effectively?
3. Given the policy context, would the decarbonization objectives and specific details of the EERB Program need to be altered in the Boston context?

A. Financing the Program

A number of financial avenues were considered when determining if there was funding available that could feasibly be used to finance the BHA Retrofit Rewards Program. Some financial avenues included private and public grants, excess money from HUD in the budget, and the Rent Gap that Atlanta used to fund their EERB Program. To determine if the first financial avenue, grant money, was feasible, I spoke with staff members at the BHA who had knowledge of the types of green energy grants and programs we could apply to to finance our proposed BHA Retrofit Rewards Program. While grant money for affordable housing retrofits does exist, this financial avenue did not seem feasible for the long-term success of the BHA Retrofit Rewards Program. For one, grants are time-limited and would require BHA staff members to constantly be searching for new grants to fund the BRR Program. Secondly, few grants offered the amount of financing needed to make the BHA Retrofit Rewards Program available to the over 15,000 landlords in the Section 8 HCV Program.

The second financial avenue considered involved determining whether there was excess money in the existing budget for the BRR Program. As was expected, after consulting with BHA staff, it was determined that there was no extra money in the budget for the BHA Retrofit Rewards Program.

The third and final financial avenue considered to fund the BHA Retrofit Rewards Program was the Rent Gap. As in Atlanta, the BHA hoped to be able to fund its EERB Program by leveraging the Rent Gap that currently exists between the Gross Rent and Payment Standards for individual units. When initially reviewing financial avenues for the BRR Program, the BHA hoped this financing option would be feasible. Unlike the other options, in the Rent Gap financing option, the rent boosts would be paid for through HUD. Regulatory flexibility allows for increased federal payments to landlords, thus utilizing money that the BHA can already access through HUD. However, this money could not be used to finance other BHA initiatives. It is money that is allocated to an existing process that is designated for items related to building conditions. Because clean energy upgrades like energy efficiency measures are inherently building condition related, the Rent Gap money can be used to fund this BRR Program. Financing the BHA Retrofit Rewards Program through the Rent Gap is therefore advantageous because it requires no extra funding, no administrative work to acquire the extra funding (as with grants), and no end date to the financing. Thus, the only obstacle would be confirming that a sufficient gap exists between Boston's Payment Standard and Gross Rent. Given that Boston is a more expensive city than Atlanta, there was initial concern that there would not be a rental gap large enough to utilize.

However, Atlanta's mean Rent Gap was not large enough to guarantee landlord eligibility for all levels of the EERB Program. For example, Level 1 of Atlanta's EERB Program provides landlords with $50 per month. But for some Section 8 HCV units, the Rent Gap between the Payment Standard and the Gross Rent would be less than $50 - meaning that not all landlords could participate in the EERB Program. In other circumstances where there is a small Rent Gap, landlords may be eligible for the more inexpensive levels of the EERB Program, but not the more expensive levels. Despite potential concerns that this limits equal access to the EERB Program, the AHA reported that so far, they have not received any negative feedback regarding

this issue.[118] Still, this limitation highlights an important concern with financing via the Rent Gap.

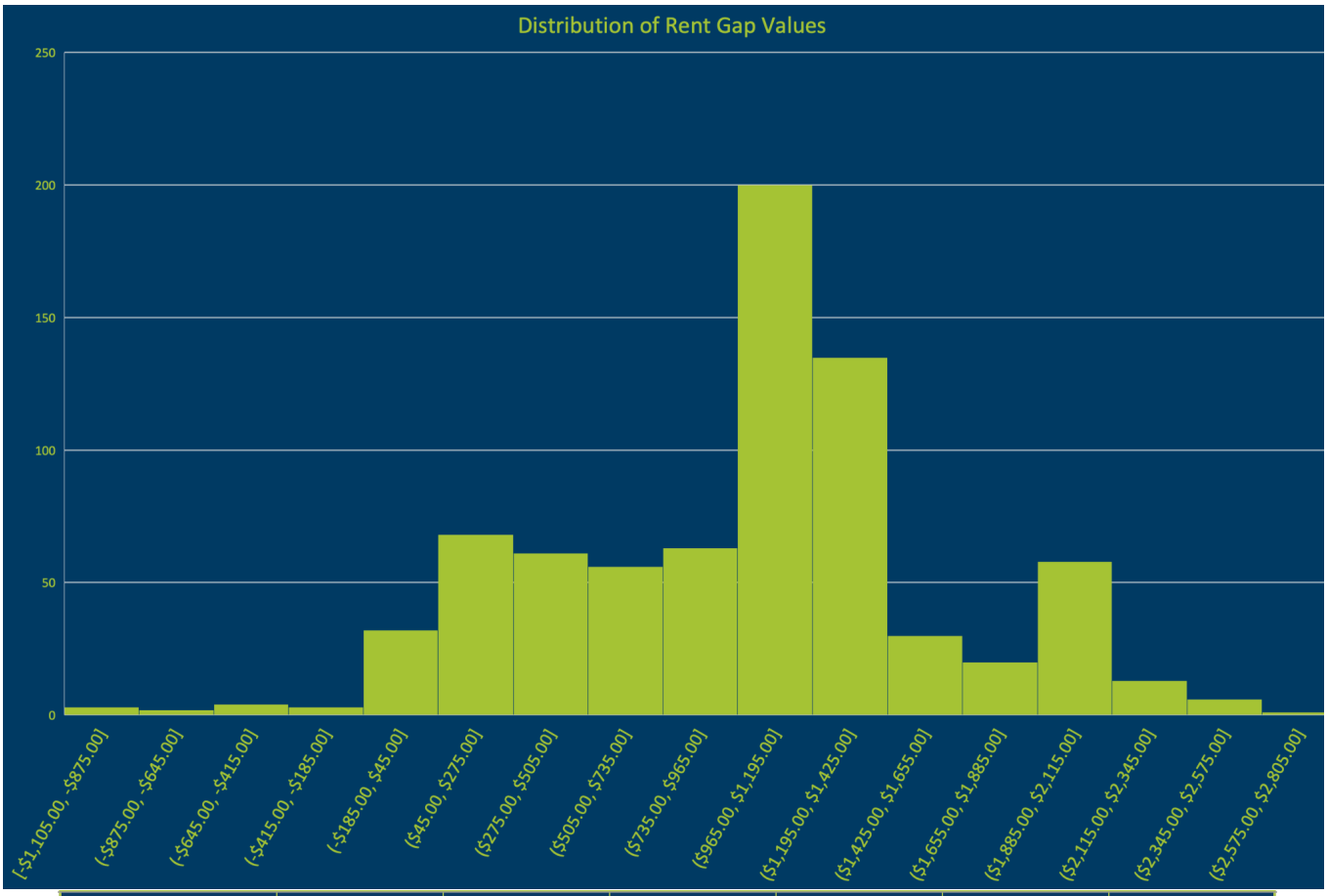
Additionally, HUD's switch from FMR Payment Standards to SAFMRs in cities including Boston and Atlanta had the potential to increase the Rent Gap between Gross Rent and Payment Standards. As was discussed in Chapter 1, SAFMRs are set at the zip code level, rather than the metropolitan area level. This change allows Payment Standards to more accurately reflect the nuances of local markets. Because the SAFMRs consider neighborhood-level price differentials (e.g. Back Bay is more expensive than East Boston), Boston's Payment Standards are higher than they would have been under the FMR system. Thus, Boston and Atlanta's adoption of SAFMRs likely increased the Rent Gap, providing a potential avenue for financing new programs like the BHA Retrofit Rewards Program and EERB Program.

To determine if the Rent Gap was large enough to fund the BHA Retrofit Rewards Program, the following steps were taken. First, I acquired information on Payment Standards for each Greater Boston neighborhood. Second, I was granted access to anonymized individual-level data on all Housing Choice Voucher recipients and units. This data included all of the necessary information for determining the average Rent Gap, including the zip codes, Utility Allowance, Contract Rent, and Gross Rent. It also included the number of bedrooms in each unit, which is necessary to determine the applicable Payment Standard. I then used the Excel function "Vlookup" to add the applicable Payment Standards from the Payment Standard spreadsheet to the individual-level HCV spreadsheet using the zip code and bedroom number data for matching. From there, I used Excel functions to find the rental gap for each individual unit, and then the average Rent Gap amount for all units.

Through my analysis, I found that the average difference between the Gross Rent and Payment Standard of Boston's 15,480 Housing Choice Vouchers was $532.03. The Rent Gap values had a standard distribution (*Figure 5*). The Rent Gap values ranged from -$1,400.00 to $4,256.00 (*Figure 5*), which seemed to be impossible extremes. However, the first quartile was $162.00 and the 3rd quartile was $811.00, highlighting how the minimum and maximum are outliers that represent unique circumstances. The median Rent Gap value was $414.00 and the

[118] Informal Interview with the Atlanta Housing Authority.

mean RentGap value was $532.03. Around 2% of the units listed in the individual HCV spreadsheet did have information on the units' bedroom numbers, which made it impossible to apply the relevant Payment Standard. The median and mean values indicate that there is sufficient financial capacity to provide the vast majority of landlords rent boosts through the BHA Retrofit Rewards Programs.



Metric	Minimum	1st Quartile	Median	Mean	3rd Quartile	Maximum
Rent Gap Values	-$1,400.00	$162.00	$414.00	$532.03	$811.00	$4,256.00

Figure 5. Statistical Overview of Rent Gap Values
Source: Boston Housing Authority

B. Technical Administration

With a feasible financing plan for the BRR Program, the next step was to determine how it could be technically implemented into existing systems. Three aspects of the rental process that needed to be updated for the BHA Retrofit Rewards Program were the inspection procedures, the BHA calculator, and the AffordableHousing.com Rent Reasonableness calculation.

First, BHA unit inspection procedures need to be updated to incorporate the verification of BHA Retrofit Rewards Program clean energy upgrades. BHA HCV inspections occur before a landlord's tenants move in, and on a biannual basis thereafter. Each of the BHA Retrofit Rewards Program's clean energy upgrades has a verification requirement that inspectors can use to determine whether a landlord is eligible for different levels of the BRR Program. For example, "energy efficient appliances" can be verified by their "Energy Star Rated" label. The BHA inspectors will need additional training to learn how to document and verify each clean energy upgrade. This training will provide the added benefit of bolstering the resumés of BHA inspectors.

I worked with the BHA's inspections coordinator to determine what clean energy upgrade verification processes were and were not feasible for BHA inspectors. Feasibility was based on how expensive and how much extra training the verification process required. While progress was made towards establishing updated inspection procedures, the process of finalizing BHA inspection procedures for the clean energy upgrades is still ongoing as verification of certain clean energy upgrades can be incredibly complex. For example, the most common method for validating air sealing is called the Blower Door Test. The Blower Door Test is a diagnostic tool used to determine how much air enters or exits your home. To conduct the test, a powerful fan is temporarily mounted to the frame of a unit's exterior doorway and turned on to reduce air pressure inside the home. Once the home has a lower air pressure, a home energy professional uses infrared cameras to determine how fast, and where, the high-pressure air from outside leaks back into the home.[119] Thus due to the complicated nature of verifying certain clean energy upgrades, additional research and decision-making by BHA staff members needs to occur before the inspection procedures are finalized.

[119] "Blower Door Tests."

Aside from verification of specific clean energy upgrades, conversations with the inspections coordinator resulted in decisions about general inspection processes with the new BHA Retrofit Rewards Program. To prove eligibility for the BHA Retrofit Rewards Program, HCV landlords must request a clean energy inspection from the BHA. If the landlord wants to have the clean energy inspection happen alongside the standard biannual inspection, they may do so. However, the landlord must alert the BHA inspection team beforehand. This rule aims to enable inspectors, who conduct thousands of inspections each year, to be efficient with their time. Knowing beforehand which units are enrolled in the BHA Retrofit Rewards Program will ensure that the inspectors only spend extra time verifying clean energy upgrades in units that want to qualify for the BRR Program. After the initial inspection verifying a landlord's eligibility in the BHA Retrofit Rewards Program, inspectors will certify continued eligibility during the unit's biannual inspection.

Second, the BHA calculator needed to be updated to incorporate the rent boosts from the BHA Retrofit Rewards Program so that landlords can have an accurate rent estimate. The BHA calculator is a tool on the BHA website that helps landlords estimate how much they can receive in rent from a unit based on SAFMR Payment Standards and Reasonable Rent calculations.[120] To provide an estimate, the BHA calculator asks landlords to provide the rent they are requesting, and the unit's address, building type, and bedroom size. In addition, landlords must provide the unit's utility fuel types and indicate who will pay for each: the tenant or the landlord. With the implementation of the BHA Retrofit Rewards Program, the BHA calculator needs to be updated to include questions about the presence of relevant clean energy upgrades in the landlord's unit. I created a draft of what the BHA calculator could look like with the addition of the new clean energy questions (*Figure 6*). To design this new draft, I uploaded a photograph of the existing calculator to Adobe's Photoshop software. I then used the software's tools to incorporate questions about clean energy upgrades into the existing format. With the incorporation of these questions, the calculator will be able to tell landlords which of the rent boost levels they are eligible for and how much money they will be able to

[120] "Boston Housing Authority - Boston Housing Authority Landlord Information."

receive each month with the addition of the rent boost. In future iterations, the BHA would like to program the calculator so that in addition to telling landlords how much they could charge for their unit, the calculator could provide landlords an estimate of how many months it will take for the rent boosts to cover the costs of each clean energy upgrade in the BRR Program. This calculation would also consider the rebates and financial assistance landlords could access through various public and private entities. Programming such a calculator would be difficult given how building typology and unique building features can drastically alter the cost of certain clean energy upgrades. However, such a feature would be incredibly useful for helping landlords understand the financial aspects of the residential decarbonization process.

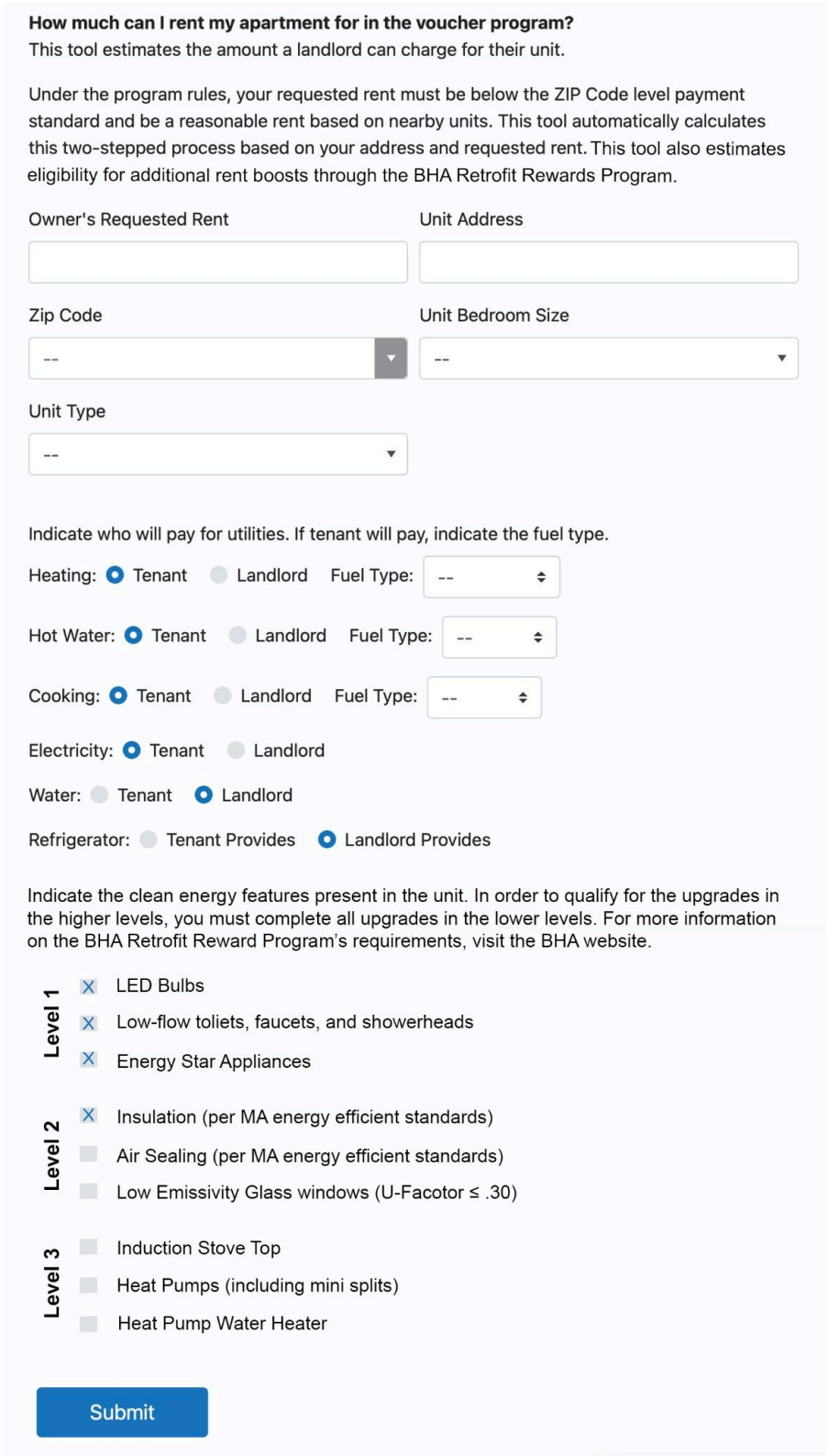


Figure 6. Updated BHA Calculator Design
Source: The Boston Housing Authority

Third, the Rent Reasonableness calculation done by the BHA contractor, AffordableHousing.com, needed to be updated to include the BHA Retrofit Rewards Program's rent boosts. As was established in Chapter 1, AffordableHousing.com is the organization that conducts the Rent Reasonableness assessments for the BHA, thus setting the standard for the total amount landlords can receive in rent. For the BHA Retrofit Rewards Program to be implemented, AffordableHousing.com needs to include rent boosts in its calculation of the total rent a landlord can receive. Because the Rent Reasonableness calculations are done by an independent contractor, this update is the most difficult to implement. AffordableHousing.com has established partnerships with over 700 government agencies across the United States, including HUD, local municipalities, cities, counties, state agencies, and housing authorities.[121] Over 500 of these housing agencies, including the biggest housing authorities in the U.S., such as those in NYC, LA, and Chicago, use AffordableHousing.com's Rent Reasonable software. Their Rent Reasonable software, RentWatch, "allows housing agencies to see real-time comparable rental data and automatically calculate HUD-compliant rent reasonable reports."[122] Because all of their housing authority partners use this same software, it would be potentially difficult for AffordableHousing.com to upgrade their software to include the BHA Retrofit Rewards Program for Boston without it impacting other housing authorities' Rent Reasonableness calculations. To work through this challenge, the BHA organized meetings with AffordableHousing.com staff members. The outcomes of these meetings were promising. Specific details of these meetings, changes to the product, or final decisions about implementation are not included in this thesis because of the company's privacy wishes.

In the initial meeting, the AffordableHousing.com team was excited by our proposed BHA Retrofit Rewards Program and eager to help. A key takeaway was that the specific clean energy upgrades included in the BHA Retrofit Rewards Program could not be incorporated directly into the Rent Reasonableness calculation. The Rent Reasonableness calculation relies on comparables for its analysis, meaning that it compares a unit to similar ones nearby based on size, number of bedrooms, amenities, etc., to determine a reasonable price. This calculation

[121] "About | Affordable Housing."
[122] "AffordableHousing.Com Products."

therefore requires that this information on a unit's features be available. Unlike with information such as number of bedrooms or size, information about a unit's clean energy features is not easily available or does not exist. Thus, the additional money landlords receive through the BHA Retrofit Rewards Program would have to be added as a "rent boost" on top of the standard Rent Reasonableness Calculation. The AffordableHousing.com team speculated that this rent boost addition would be possible to implement in their software.[123] Over the following weeks they developed an altered version of their Rent Reasonable Software incorporating the BHA Retrofit Rewards Program rent boosts that could be piloted in Boston. As of this thesis publication, the development of the final product is still ongoing. These meetings were an essential step in verifying that technical implementation of the BRR Program into the AffordableHousing.com software was possible.

C. Incentive Level Details

Implementation of the BHA Retrofit Rewards Program also necessitates determining whether and which specifics of the Atlanta EERB Program, like the levels of clean energy upgrades, are feasible and make sense in the Boston context. The aspects of the EERB Program that needed to be evaluated to see if they made sense in the Boston context included the specific energy efficiency upgrades being incentivized, the "level" or category of the clean energy upgrades, the minimum requirements for each clean energy upgrade, and the possible rebates that exist for each clean energy upgrade.

There are a number of differences between the Boston and Atlanta contexts that could necessitate changes to the specifics of the EERB Program.

One noteworthy distinction when considering the appropriate decarbonization upgrades to incentivize is the climate context. According to the 2021 International Energy Conservation Code, Atlanta is classified as a 3A climate. The 3A climates are primarily considered warm and humid.[124] Boston is classified as a 5a climate, defined by its cool and humid environment. The differences in environment influence the type and requirements of energy upgrades.

[123] Informal Interview with AffordableHousing.com Team.
[124] "IECC Climate Zone Map | Building America Solution Center."

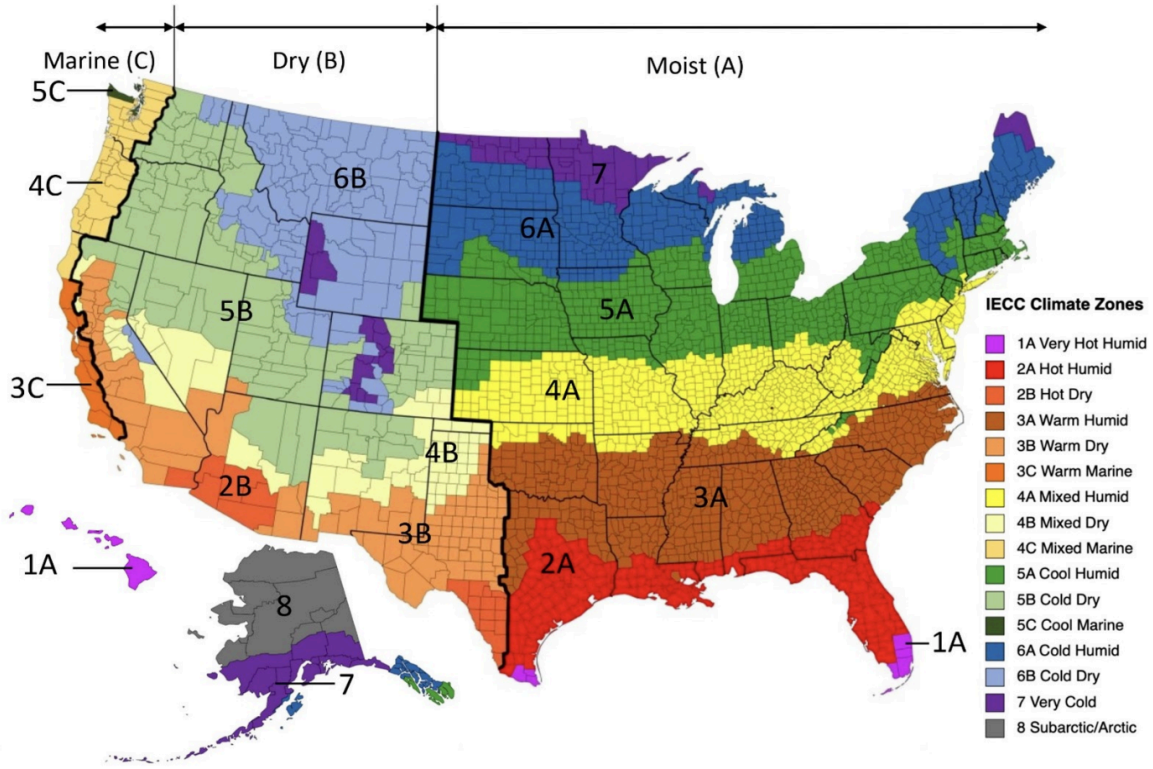


Figure 7. 2021 International Energy Conservation Code Map
Source: Energy.gov

For example, in the HVAC world, there are three primary seasons. Peak heating season refers to the winter months when it is cold outside and indoor heating is required. Peak cooling season occurs during the summer when it is hot outside and air conditioning may be required. The transitional seasons are known as "shoulder seasons" and are defined by lower energy use because neither heat nor AC may be required.[125] Because of its warmer climate, Atlanta has a primary cooling season, or a season that requires air conditioning, and Boston's colder climate requires a primary heating season, or a season that requires substantial heating. These differences highlight how climate can influence HVAC system needs. Climate can also influence the requirements (not just the type) of certain clean energy upgrades. For example, the amount of insulation needed in a building varies depending on how cold an area is. Thus requirements around what it takes to insulate a home to be "energy efficient" vary.[126]

[125] "Tagup - HVAC Shoulder Seasons."
[126] "Recommended Home Insulation R–Values | ENERGY STAR."

As a result of these climate differences, it was determined that some clean energy upgrades' "minimum requirements" would need to be altered to fit the Boston context.

A second noteworthy distinction between Boston and Atlanta (that could influence changes to the Atlanta model in the Boston context) is differences in political context. Political support for sustainability efforts at the state and local levels can dramatically alter the feasibility of residential decarbonization. Policy can be used to provide financial opportunities for decarbonization (including rebates and tax breaks), enact regulations that require energy efficiency upgrades, and foster a clean energy economy that enables the success and availability of decarbonization contractors. In recent times, both Boston and Atlanta have had political administrations at the local level that support climate action. In 2019, the Atlanta City Council even released a Green Energy Plan that aims to get to 100% green energy by 2035.[127] However, despite Atlanta's progress, its policy support for climate action still trails behind Boston. In ACEEE's 2019 City Clean Energy Scorecard tracking policy efforts to advance renewable energy and energy efficiency, Boston was ranked #1 and Atlanta was ranked #22.[128] While both scored highly, there is still clearly more support for decarbonization efforts in Boston than in Atlanta.

[127] Margolis, "How Atlanta Plans to Get to 100% Green Energy by 2035."
[128] "US Cities Boost Clean Energy Efforts but Few on Track to Meet Climate Goals | ACEEE."

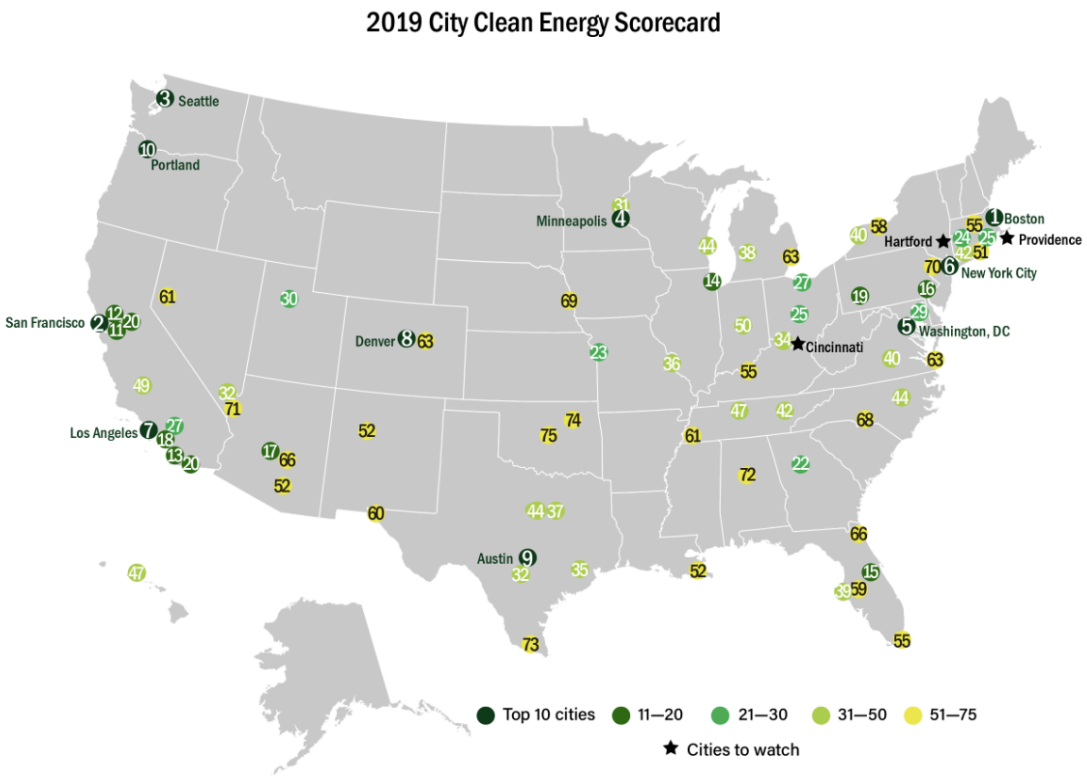


Figure 8. ACEEE 2019 City Clean Energy Scorecard that Tracks Municipal Policy Efforts to Advance Renewable Energy and Energy Efficiency
Source: ACEEE

On the state level, Atlanta has far less support for decarbonization than Boston. Overall, Georgia has not made significant progress on climate action at the state level.[129] The passage of the IRA in 2021 enabled Georgia to make some progress towards climate action, with the state creating its first-ever climate plan in 2023.[130] However, the state is still behind nationwide. The ACEEE's 2022 State Energy Efficiency Scorecard, which measures the state's energy efficiency policies and programs, ranked Massachusetts as #2 and Georgia as 39.[131]

[129] "Georgia - Climate-XChange State Climate Policy Network Map."
[130] Kann, "Georgia Is Creating Its First-Ever Climate Plan. Here's What to Expect."
[131] "The State Energy Efficiency Scorecard | ACEEE."

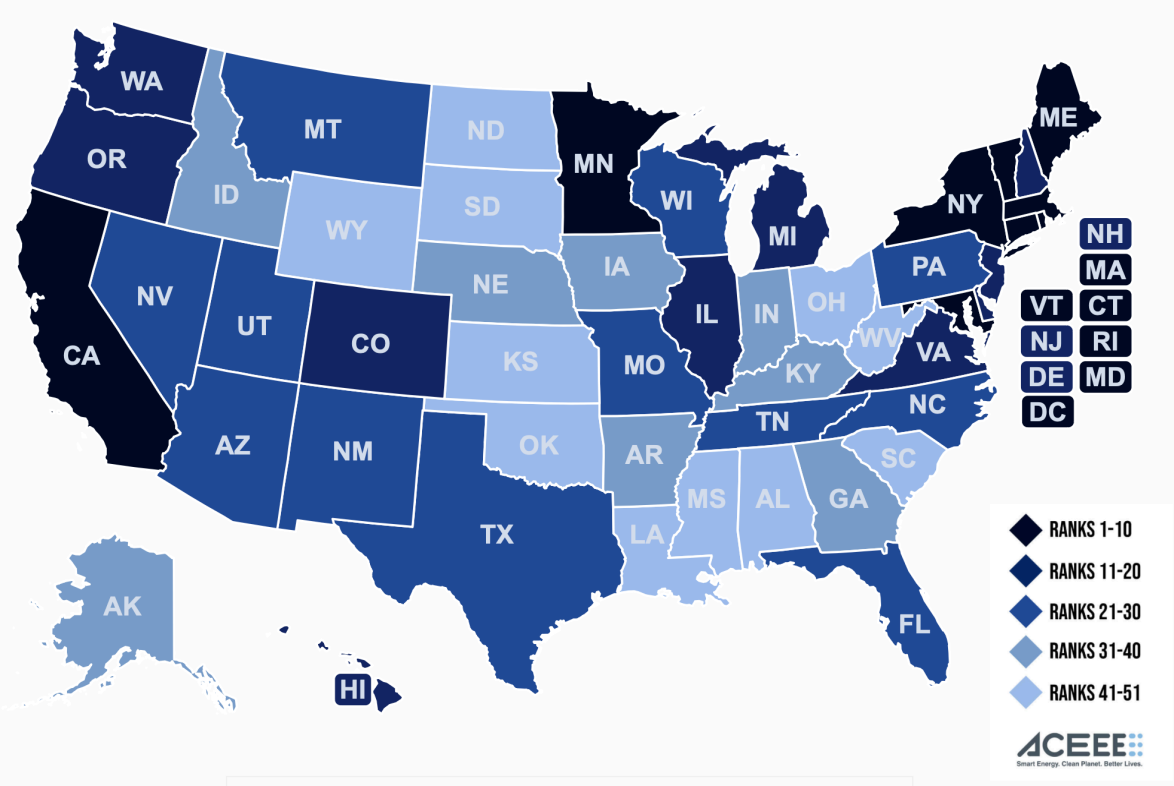


Figure 9. ACEEE 2022 State Energy Efficiency Scorecard that Tracks Policy Efforts to Advance Renewable Energy and Energy Efficiency
Source: ACEEE

Given Boston's greater political support for decarbonization efforts, the BHA determined that altering the clean energy upgrades and the "levels" of Atlanta's EERB Program to fit the Boston context made sense. Moreover, the BHA decided to alter the goalpost altogether. Atlanta's EERB Program currently aims to improve the energy efficiency of Section 8 HCV units, or in other words, reach 'Net-Zero Carbon Efficient' status. This goal makes sense given homeowners' political resources for decarbonization efforts in the city. However, Boston's political context empowers the BHA to look beyond that goal and design a program that incentivizes energy efficiency, electrification, and even clean energy production in Section 8 HCV homes (reaching NZC Ready or NZC status).

After determining that Atlanta's EERB Program needed to be changed to fit Boston's political and climate context, additional research was conducted to finalize the BHA Retrofit Rewards Program details. More specifically, we needed to finalize the specific energy efficiency

upgrades being incentivized, the “level” or category of the clean energy upgrades, and the amount we were willing to pay for each upgrade. For each clean energy upgrade being incentivized, we also needed to determine the minimum requirement (threshold of acceptability), the documentation/ verification process, the possible rebates, the estimated cost, and the potential health benefits to tenants.

To finalize these BRR Program details, I reviewed the decarbonization literature, evaluated public and private energy efficiency and decarbonization recommendations, examined Massachusetts energy codes, and analyzed energy upgrade costs. The BHA also sought out the advice of three clean energy experts: one from a private sector home decarbonization company, one from a sustainability-focused public sector agency, and one from a conservation-focused quasi-public agency. The three experts requested that their specific identities and comments not be included in this thesis. However, they provided invaluable recommendations on the specific clean energy upgrades, upgrade levels, and minimum requirements that should be included in the BHA Retrofit Rewards Program. The finalized BHA Retrofit Rewards Program is presented in the next section.

Chapter 3 - Outcomes

I) The BHA Retrofit Rewards Program Overview

The goal of the BHA Retrofit Rewards Program is to incentivize Section 8 HCV landlords to implement clean energy upgrades in their units to improve environmental outcomes and residents' health and energy burdens. Through consultation with the Atlanta Housing Authority and residential decarbonization experts, as well as additional analysis and research, I created the first edition of the BHA Retrofit Rewards Program. This section provides an overview of the BHA Retrofit Rewards Program (*Table 6*).

Our goals in designing the BRR Program were to have a low threshold for enrollment and a simple format to encourage wide participation in the BHA Retrofit Rewards Program. The design of the BRR is directly sourced from Atlanta's EERB Program. The EERB Program design was appealing because it provides all of the necessary information for landlords in a simple, 1-page format - a somewhat daunting task given the complexity of the content matter. In addition to the BHA Retrofit Rewards Program table, a one-pager was created that provides interested parties with background on the BRR Program and any additional information they may need (*Appendix 1*).

BHA Retrofit Rewards Program

To receive level 1 rent boost, you must satisfy all elements; to receive level 2 boost, you must implement all level 1 elements and all level 2 elements.
To receive level 3, you must all of level 1 and 2 in addition to level 3.
Rent boost eligibility subject to requirement that gross rent of unit not exceed payment standard (to not increase tenant costs), which will be analyzed via BHA calculator.
Amount subject to above gross rent criteria; landlords may receive up to amounts below as long as gross rent plus below rent boosts is below payment standard.

Rent Boost Levels	Description of Upgrade	Minimum Requirement	Possible Rebates
LEVEL 1 SILVER: Basic Efficiency ($600/year)	**LED Bulbs**	• Replacement of Incandescent bulbs with LED Bulbs	• https://www.masssave.com/business/rebates-and-incentives/lighting-and-controls/instant-lighting-incentives
	Low-Flow Water Upgrades	• Toilet(s) uses 1.28 gallons or less per flush • Low flow faucet, aerators, and showerheads: 1.5 GPM	• https://www.masssave.com/blog/residential/go-with-the-low-flow
	Energy Star Appliances	• Energy Star Refrigerator • Energy Star Dishwasher • Energy Star Washing Machine • Energy Star "Most Efficient" Rated Electric Clothes Dryer	• https://www.masssave.com/en/residential/rebates-and-incentives/appliances-and-products/clothes-washers • https://www.masssave.com/en/residential/rebates-and-incentives/appliances-and-products/clothes-dryers
LEVEL 2 GOLD: Building Envelope Improvements ($1800/year)	**Insulation**	• Install insulation to meet or exceed an R-49 value where applicable • For unconditioned basement or crawl space, install floor insulation to meet or exceed R-30 • Install insulation in attic to meet or exceed an R-49 value	• https://www.masssave.com/residential/rebates-and-incentives/insulation-and-windows/insulation-and-air-sealing
	Air Sealing	• Air sealing must be completed per MA energy code	• https://www.masssave.com/residential/rebates-and-incentives/insulation-and-windows/insulation-and-air-sealing
	Energy Efficient Windows	• Low Emissivity (Low- E) glass windows that have a U-Factor ≤ .30	• https://www.masssave.com/en/residential/rebates-and-incentives/insulation-and-windows/windows
LEVEL 3 EMERALD: Electrification ($3000/year)	**Induction Stove**	• Energy Star Rated Electric Induction Stove	• https://www.masssave.com/en/residential/rebates-and-incentives/appliances-and-products/inductionstove
	Heat Pump	• Successful installation of verified Energy-Star rated Heat Pump. All types of heat pumps will be accepted including (but not limited to) air-source heat pump (duct or ductless), ground-source heat pump, and geothermal heat pump	• https://goclean.masscec.com/clean-energy-solutions/air-source-heat-pumps/ • https://www.masssave.com/en/residential/rebates-and-incentives/heating-and-cooling/heat-pumps/air-source-heat-pumps
	Heat Pump Water Heater	• Successful installation of verified Energy-Star rated Heat Pump Electric Water Heater	• https://www.masssave.com/residential/rebates-and-incentives/water-heating/water-heaters/heat-pump-water-heaters

Table 6. BHA Retrofit Rewards Program Table

The first portion of the BRR Program Table provides users with two important disclaimers about how the BRR Program operates. The first disclaimer states that a landlord must complete each level's energy efficiency upgrade requirements before qualifying for a higher level. In other words, landlords must satisfy all the elements of Level 1 to receive the Level 2 boost, and landlords must implement all of the Level 1 and Level 2 elements (in addition to the Level 3 elements) in order to qualify for the Level 3 boost. The purpose of this rule is to ensure that clean energy upgrades are implemented in the order that experts recommend. Higher-level clean energy upgrades such as electrification measures, should not be implemented before energy efficiency measures are taken. Energy efficiency upgrades are more cost-effective than electrification, reduce total energy demand, maximize the benefits of electrification, and improve residents' comfort and health.[132]

The second disclaimer reminds landlords that the rent boost amount they can receive through this BRR Program is subject to their unit's Rent Gap. Landlords may receive up to the full amount of each level's rent boost, as long as the Gross Rent plus rent boost is below the Payment Standard. For example, if a landlord is eligible for a Level 1 rent boost of $600 per/year, but has a Rent Gap of only $570 per/year, then the rent boost value is limited to $570. The remainder of the BRR Program Table outlines the three rent boost levels, the clean energy upgrades required for each level, the minimum requirements and current verification process required for each clean energy upgrade, and information on potential rebates for each clean energy upgrade.

A. Rent Boost Values

A fixed amount of "rent boost" money is associated with each of the BHA Retrofit Rewards Program's three levels. Landlords who are eligible for Level 1 will receive a rent boost of $600 per year ($50 per month), landlords who are eligible for Level 2 will receive a rent boost of $1800 per year ($150 per month), and landlords who are eligible for Level 3 will receive a rent boost of up to $3000 per year ($250 per month). The BHA plans to give qualifying landlords

[132] "Electrification and Efficiency."

these rent boosts on a monthly basis in perpetuity. The sufficient Rent Gap that enables financing of the BRR Program should remain for years to come. Payment Standards are updated annually, and Rent Reasonableness calculations inherently adapt to rent increases over time. Thus, even as rents continue to rise, the Rent Gap money that finances the BRR Program should remain. While this may require the BHA in the future to determine a fixed amount of time in which a landlord can receive the rent boosts, it serves as a useful incentive in the meantime.

The rent boost values for each level were inspired by the values used in Atlanta's EERB Program. In Atlanta's EERB Program, landlords received $50 per month for Level 1, $124 per month for Level 2, and $175 per month for Level 3. The exact numbers for Levels 2 and 3 were increased slightly for a few reasons. First, the BHA Retrofit Rewards Program is going beyond energy efficiency to incentivize unit electrification. Electrification is a more expensive process, which encouraged the BHA to provide additional funding for the higher levels. Second, the higher-than-expected average Rent Gap for Boston's Section 8 HCV units allowed the BHA to provide landlords with higher rent boost amounts. Finally, the few energy experts the BHA and I spoke to agreed that these numbers made sense when considering the upgrades the BHA is incentivizing.

While the BHA would like to cover the costs of implementing the clean energy upgrades it is incentivizing through the BRR Program, it understands that the rent boost values will most likely not provide landlords with enough funding to cover the upgrades in one year. However, the BHA's goal in this BRR Program is not to provide landlords with all the financing they need to implement these clean energy upgrades. Rather, the BHA's goal is to provide additional incentives that, on top of other organizations' work, can be one piece of a larger financing puzzle. As is shown in the BHA Retrofit Rewards Program Table, there are numerous rebates, tax incentives, and financing opportunities available in Boston that landlords can use in addition to the rent boost money to cover the costs of clean energy upgrades. Organizations like Action for Boston Community Development (ABCD) and MassSave have sustainability programs aimed at low-income resident households that landlords could use to help finance implementation of the clean energy upgrades. In fact, ABCD's Energy Service Program will provide households with

most of the Level 1 clean energy upgrades for no cost.[133] Thus the BHA hopes the BHA Retrofit Rewards Program can act as a missing piece for some landlords in the decarbonization financing puzzle.

II) Level 1 – Basic Efficiency

Level 1 is deemed the "Silver" level and is focused on incentivizing basic energy efficiency upgrades in the home. Landlords who meet the level requirements will be eligible to receive up to $600 per year ($50 per month). The three energy upgrade requirements in Level 1 are 1) LED light bulbs, 2) low-flow water upgrades, and 3) Energy Star-rated appliances. Level 1 was curated with the goal of including clean energy upgrades that were relatively inexpensive and easy to implement. The BHA believed that setting a relatively low bar for Level 1 qualification could increase landlord enrollment during the BRR Program launch and ultimately serve as a tool for increasing awareness about the BRR Program. With increased landlord engagement, there would be greater engagement with landlords, which would catalyze their interest in higher-level rent boosts.

A. Lighting Systems

The first upgrade in Level 1 targets lighting systems. To meet the requirements, landlords must replace all incandescent light bulbs with LED bulbs. This energy efficiency upgrade has already been implemented in many US households. In fact, the Biden administration's new energy efficiency standards will effectively prohibit the sale of incandescent light bulbs in coming years.[134] However, it still seemed a necessary upgrade to include because it is low-cost and can reduce energy costs for tenants.

[133] "ABCD Energy Services - Action for Boston Community Development."
[134] "U.S. Department of Energy - Energy Efficiency and Renewable Energy."

B. Low-Flow Water Upgrades

The second upgrade requires landlords to install low-flow faucets, showerheads, and aerators that produce less than 1.5 gallons per minute (GPM) and toilets that use 1.28 gallons or less per flush. The minimum requirements for this upgrade are based on the EPA standard.[135] These low-flow water upgrades are unique in this BRR Program as they are not upgrades that contribute directly towards decarbonization in a traditional sense. Rather, they focus on reducing water usage, another important but separate sustainability initiative. However, low-flow water upgrades could help reduce the amount of hot water being used, which would in turn decrease energy usage and reduce energy costs.

C. Energy Star Appliances

The third upgrade in Level 1 targets appliances. To meet this requirement, landlords must have energy-star-rated refrigerators, dishwashers, and washing machines. In addition, landlords must have Energy Star "Most Efficient" rated electric clothing dryers.[136] Including the Energy Star appliances in Level 1 is a deviation from Atlanta's EERB model. In the EERB model, appliances were a Level 2 upgrade and the minimum requirement only included Energy Star refrigerators. However, through our research, we determined that in Massachusetts, Energy Star appliances are already so ubiquitous and affordable that we should require them in Level 1. BHA inspectors will verify the appliances using the "Energy Star" label.

III) Level 2 – Building Envelope Improvements

Level 2, the "Gold" level, includes more elaborate energy efficiency upgrades that focus on sealing the building's envelope. Landlords who meet the requirements of Level 2 will be eligible to receive up to $1800 per year ($150 per month). The three energy upgrade requirements in Level 2 are 1) insulation, 2) air sealing, and 3) energy-efficient windows. The goal of Level 2 is to prepare the unit for electrification upgrades by ensuring maximum energy efficiency.

[135] EPA, "EPA WaterSense."
[136] "Energy Efficient Products | ENERGY STAR."

A. Insulation

The first upgrade in Level 2 requires landlords to improve their unit's insulation in order to make it more energy efficient. The minimum requirement for this upgrade is wall and attic insulation meeting or exceeding an R-49 value and floor insulation in crawl space or unconditioned basement meeting or exceeding an R-30 value. The R-value requirements for insulation in the BHA Retrofit Rewards Program had to be changed from what was listed in Atlanta's EERB Program because of the two cities' climate differences.[137] Atlanta's EERB Program also had insulation listed as a Level 1 requirement. The energy experts we consulted recommended moving it to Level 2 because of the increased R-value Massachusetts requires and the logistical difficulties of re-insulating a home. We also considered separating insulation into two steps: attic insulation and complete insulation. A couple of the energy experts recommended separating attic insulation in Level 1 because insulating an unfinished attic is much less expensive and labor-intensive than insulating other portions of a home, as the attic falls within the exterior envelope of a building. Unfinished attics are also an easy target for increased energy efficiency because these spaces typically lack insulation. However, we ultimately decided against this because of a desire to keep the BHA Retrofit Rewards Program simple.

B. Air Sealing

The second upgrade in Level 2 is air sealing or exterior envelope sealing. Air sealing aims to reduce the amount of air that leaks in and out of a unit.[138] Air leakages not only reduce the energy efficiency of units, but the conversion of cold air and hot air in the walls can cause problems like mold and mildew from condensation. Two simple and effective air-sealing techniques that cut energy costs and create healthier indoor environments are caulking and weatherstripping. Caulking is "generally used for cracks and openings between stationary house components such as around door and window frames, and weatherstripping is used to seal

[137] "Recommended Home Insulation R–Values | ENERGY STAR."
[138] energy.gov, "Air Sealing Your Home."

components that move, such as doors and operable windows."[139] The minimum requirement for air sealing is established in the Massachusetts Building Energy Code.[140]

C. Energy Efficient Windows

The third upgrade in Level 2 is the installation of energy-efficient windows. In Atlanta's EERB Program, the minimum requirement for windows was that they all have a special coating to create low emissivity (Low-E) glass. Low-E glass "reflects heat either into or out of the house, further enhancing insulation."[141] While this is also a requirement for our BHA Retrofit Rewards Program, it was decided that the windows also must have a U value of .30 or less.[142] The U-factor measures how well a window insulates. The lower the U-Factor, the better the window insulates. Given Boston's colder climate, effective, insulating windows are an essential piece of energy efficiency. Windows present the greatest threat to a unit's energy efficiency because they are essentially holes in the wall. Initially, we believed that the window requirement be focused on the number of panes per window (e.g. requiring a double pane window or a triple pane window). However the experts consulted informed us that the number of panes is less important for effective insulation when compared to how the window is installed and sealed. Thus, the requirement became that landlords should have windows that have the lowest U-Factor possible (are most energy efficient). Energy efficient windows are in Level 3 in Atlanta's EERB Program but were moved to Level 2 in the BHA's BHA Retrofit Rewards Program. This change was the result of conversations with experts, the differences in climate conditions between the two cities, and the addition of electrification measures in the Boston BRR Program.

[139] energy.gov.
[140] "Building Energy Code | Mass.Gov."
[141] energy.gov, "Consumer Guide to Energy-Efficient Windows Fact Sheet."
[142] energy.gov.

IV) Level 3 – Electrification

Level 3, known as the "Emerald" level, incentivizes electrification measures in the home. Landlords who meet the level requirements will be eligible to receive up to $3000 per year ($250 per month). The three energy upgrade requirements in Level 3 are 1) induction stoves, 2) heat pumps, and 3) heat pump electric water heaters. Level 3 was curated with the goal of reducing or eliminating fossil fuel usage in the home by switching all power sources to electricity. Additionally, all Level 3 upgrades require (or strongly encourage) a professional contractor for installation. Because they are electrification measures, none of the clean energy upgrades in Level 3 were in Atlanta's EERB Program.

A. Induction Stove

The first upgrade in Level 3 is the installation of induction stoves. The minimum requirement of induction stoves is that they be Energy Star rated.[143] Induction stoves are on a separate level from the other appliances in the BRR Program because they are more logistically and financially intensive to install. While an induction stove is relatively expensive, the installation of the cooktop is the real challenge. Before an induction stove can be installed, the gas pipes attached to the old stove must be removed. However, induction stoves can greatly reduce cooktop energy usage. It is estimated that the "per unit efficiency of induction Cooking Tops is about 5-10% more efficient than conventional electric resistance units and about 3 times more efficient than gas."[144] Additionally, induction stoves can have immense health benefits for residents compared to a traditional gas cooktop. Unlike a gas cooktop, an "induction stove does not release methane, benzene, nitrogen dioxides, or other chemical emissions, and it does not create volatile organic compounds (VOCs) when you turn it on."[145] Private and public organizations in Massachusetts are also currently providing rebates that lower the cost of induction stoves making them more accessible to a wider range of people.[146]

[143] "Energy Efficient Products | ENERGY STAR."
[144] "2021-2022 Residential Induction Cooking Tops | ENERGY STAR."
[145] Wharton, "Is an Induction Stove for You?"
[146] "Induction Stoves } Mass Save."

B. Heat Pumps

The second upgrade in Level 3 is the installation of heat pumps. A heat pump is a type of HVAC system (Heating. Ventilation, and Air Conditioning) that uses electricity to provide both heating and cooling by transferring heat from one location to another.[147] During the heating season (winter), heat pumps can remove heat from the outside air (air-source heat pump), ground (ground-source heat pump), or water source (water-source heat pump) and move it indoors. In the cooling season (summer), heat pumps can remove heat from indoors and transfer it outside.[148] Beyond just reducing GHG emissions, heat pumps are advantageous because they can help reduce your "electricity use for heat by approximately 65% compared to electric resistance heating such as furnaces and baseboard heaters."[149] Because heat pumps also double as air conditioners, requiring this upgrade will also provide Section 8 HCV tenants with a necessary defense against dangerous summer heat waves.[150] The minimum requirement for this upgrade is for the heat pump to be Energy Star-rated.[151] A specific heat pump type (e.g. air-source vs. ground-source) is not required because each unit has unique features that may make one heat pump type more or less optimal. Additionally, to lower the threshold for participation, it is not required that the heat pumps have a specific heating or cooling energy capacity or that the heat pumps replace entirely the existing HVAC system. Heat pumps are unique in that certain models, like mini-split heat pumps, can be used to complement existing HVAC systems. This allows landlords, who may not have the financing or capacity for complete HVAC electrification, the opportunity to still reduce GHG emissions and improve the quality of life for tenants. However, one energy expert who was consulted felt that in their experience, tenants with both heat pumps and traditional HVAC systems only use the heat pumps for air conditioning (Conversation with Energy Expert). However, the BHA felt that air conditioning was still an important step. The heat pump requirement is a notable change from Atlanta's EERB Program. While the EERB Program also had HVAC requirements in Level 3, the requirements were focused on improving the energy efficiency of fossil fuel-powered HVAC systems. While

[147] "How Do Heat Pumps Work?"
[148] energy.gov, "Heat Pump Systems."
[149] energy.gov.
[150] Semenza Jan C. et al., "Heat-Related Deaths during the July 1995 Heat Wave in Chicago."
[151] "Air-Source Heat Pumps | ENERGY STAR."

more energy-efficient HVAC systems are helpful for decreasing energy usage and costs, we determined that we did not want to incentivize the purchase of new natural gas-based HVAC systems. The public and private support for residential decarbonization in Massachusetts also makes heat pump upgrades more feasible.

C. Heat Pump Water Heater

The third upgrade in Level 3 is the installation of a Heat Pump Water Heater. Unlike traditional water heaters that burn gas or oil to heat water, heat pump water heaters "take advantage of existing heat in the air and transfer it into the water."[152] Heat pump water heaters are also up to three times more efficient than conventional water heaters.[153] The transition to heat pump water heaters can lead to significant energy cost savings as 18% of electricity costs come from heating water.[154] The minimum requirement for this upgrade is for the heat pump water heater to be Energy Star certified. A specific heat pump type or efficiency standard is not required for this upgrade, as the goal is to reduce the threshold for participation.

[152] Crail, "Heat Pump Water Heaters: Costs, Pros & Cons – Forbes Home."
[153] "Heat Pump Water Heater Rebates I Residential I Mass Save."
[154] Crail, "Heat Pump Water Heaters: Costs, Pros & Cons – Forbes Home."

Chapter 4 - Discussion

I) Limitations and Future Considerations

There are a number of outstanding questions and challenges that need to be addressed before the BHA Retrofit Rewards Program can be implemented. First and foremost, the BHA Retrofit Rewards Program was designed by policy experts and urban planners. While the BHA team is deeply knowledgeable, we do not have the same training and expertise as residential decarbonization experts or architects. The residential decarbonization process is immensely complex. Although the BHA team consulted residential decarbonization professionals in the development of the BRR Program, further collaboration and consensus among these professionals is needed to finalize the minimum requirements and technical details of the BRR Program before implementation proceeds.

The central challenges for the BRR Program are the ways unit variation creates nuances in the residential decarbonization process, and the tension between representing these challenges in the BRR Program or keeping the BRR Program simple to enable broader participation.

A. Unit Variation Challenges

Many existing challenges of the BRR Program stem from the nuances of the residential decarbonization process. Each unit, building, and building type presents unique challenges and opportunities for clean energy upgrades. Boston's Section 8 HCV housing stock exhibits vast diversity in building typology. The most common building typology in the portfolio is the duplex or triple-decker. Triple-deckers are ubiquitous in Boston and were originally constructed at the turn of the twentieth century to house the influx of immigrant workers. The high percentage of triple-deckers in the Section 8 HCV Program is a promising sign for the success of the BRR Program. The triple-deckers are ideal for the Program because "there is little to no variation in the structures, so retrofits can be applied uniformly."[155] The next most common housing

[155] Flint and Comments48, "Triple-Deckers Can Rise Again for the 21st Century - The Boston Globe."

typologies in the Section 8 HCV Program, low-rise or garden-style apartments, create greater challenges for retrofit because of the commonly brick exterior.

Section 8 HCV Building Typology	
Total Units	15,479
Duplex/triple-decker	41.62%
Low-Rise/Garden	27.37%
High-Rise With Elevator	18.65%
(+5) Low-Rise/Garden	4.48%
Single Family Detached	3.25%
Rowhouse/Townhouse/Garden	2.15%
(+5) Walkup/Multi-Family Apartment	2.06%
Walkup/Multi-Family Apartment	0.35%
(+5) Rowhouse/Townhouse/Garden	0.08%

Table 7. BHA Section 8 Housing Choice Voucher Building Typologies
Source: Boston Housing Authority

However, there is not one specific housing typology that creates challenges for the BRR Program. Rather, the variety in the building typology in Boston's Section 8 HCV Program makes it difficult to craft a single, all-inclusive minimum requirement for each clean energy upgrade in the BRR Program. It also left us with a series of outstanding questions on how to deal with these nuances.

For example, in the BHA Retrofit Rewards Program, landlords must install low emissivity windows with a U-Factor of less than 0.30. The cost and installation burdens for this clean energy upgrade could vary wildly between units based on factors such as the number of windows that need to be replaced and window type. Window type is important as standard-sized windows are cheaper and easier to install than more unique types. Thus, under the current BRR Program, a unit with 4 standard windows, and a unit with 12 windows, including a sliding door, receive the same rent boost despite extreme disparities in upgrade costs. Some proposed solutions to this problem included only requiring a certain number of windows, only requiring windows on the south side of a building, and finding workarounds for

unique windows like heat-absorbing curtains for sliding doors. However, the process of identifying a solution is still ongoing.

An additional example of this kind presents itself with the Energy Star-rated appliances. In the first edition of the BHA Retrofit Rewards Program, landlords are required to have Energy Star-rated refrigerators, dishwashers, washing machines, and electric clothes dryers. But what if a unit does not have a dishwasher, washing machine, or dryer to begin with? Are they required to purchase all of these just to qualify for the rent boost? Under the first edition version of the BHA Retrofit Rewards Program, landlords are only required to upgrade the appliances they already have to meet the minimum requirements. However, this strategy creates a significant differential in upgrade costs between landlords depending on the number of appliances in their units.

A second example of how differences in building typology present challenges for the first edition of the BHA Retrofit Rewards Program is air sealing. A building's entire exterior envelope needs to be sealed for air sealing to be maximally efficient. This upgrade therefore requires a landlord to have total control over the building. However, there are instances in which a Section 8 HCV landlord may only own one unit in a building and thus does not have the power to impose upgrades on the entire building. Another possibility is that a landlord may own an entire apartment building but only a few of the units are enrolled in the Section 8 HCV Program. Does the BHA then require the landlord to complete air sealing on the non-Section 8 HCV units as well? The current plan for addressing this concern is to only require landlords to complete air sealing in individual HCV units. However, this is less energy efficient and contributes to huge price differences in clean energy upgrade costs between landlords who do and do not own their whole building. The insulation, heat pump, and heat pump water heater upgrades also present similar problems. Complete energy-efficient insulation requires insulating a unit's attic, floor, and exterior walls. If a landlord does not have control of those units, or those units are not included in the Section 8 HCV Program, complete insulation has its challenges. Relatedly, landlords who own one unit in a building may not have control over the HVAC and water heater systems and thus do not have the agency to make all Level 3 upgrades.

Depending on a building's typology, implementation of clean energy upgrades could also significantly inconvenience tenants. Of course in all units, installation of clean energy upgrades would be burdensome to tenants on some level. For example, the installation of a heat pump hot water heater would require temporarily turning off water and electricity to a unit. However, depending on the characteristics of a unit, clean energy upgrades may be so extensive that they necessitate the relocation of tenants. For example, brick buildings, which are common in Massachusetts, pose difficulties when insulating. Not only is brick itself a poor insulating material, but the design requires that insulation be completed from inside a unit, which would require residents to vacate. If a landlord does not want to inconvenience tenants, they can " wrap" the brick building from the outside with "continuous insulation." However, this requires the construction of a secondary exterior facade and a building permit from the city.[156] The BHA's current plan for managing upgrades that require tenants to relocate is to only allow landlords to make such upgrades when they are in between tenants. This is of course not a practical solution. The BHA is continuing to work with clean energy experts to identify other solutions like "continuous insulation" of brick buildings.

B. Simplicity vs. Complexity

Despite the significance of these challenges for the implementation of the BHA Retrofit Rewards Program, the BHA team opted to keep these nuances out of the first edition of the BRR Program Table. The omission of these important nuances in the BRR Program Table highlights a central tension in the creation of the BRR Program: the tension between wanting to keep the Program simple and digestible for participants vs. fully capturing the complex reality of residential building decarbonization. Residential decarbonization is a complex challenge and can look completely different in every project. As represented in the BHA Retrofit Rewards Program Table, the process for financing and installing clean energy upgrades requires the involvement of multiple parties such as inspectors, contractors, and rebate/finance partners. However, not all of the nuances (such as the ones reviewed in this section) were included in the final BRR Program Table. For instance, I did not include specifics about what percentage of windows a

[156] Informal Interview with Passive House Expert.

landlord needs to update in order to qualify for the rent boost. These nuances were omitted because the process of determining the best solutions is still ongoing and because of the desire for Program simplicity. The BHA staff members determined that the BRR Program would be more marketable and successful if the Program Table was digestible and simple. The idea is that potentially skeptical landlords would be more likely to enroll in the BHA Retrofit Rewards Program if the steps for qualifying are straightforward. While the steps may become more complicated as the clean energy upgrades are implemented, the goals of each level are laid out plainly for landlords to see, which will ultimately contribute to greater Program success.

The desire to keep the BRR Program simple - with 3 levels and 3 clean energy upgrades per level - also led to the omission of three clean energy upgrades that were initially included. One omitted upgrade was the addition of requiring upgrades to a unit's electrical capacity. Before installing multiple electrification upgrades like heat pumps, a unit needs to be prepared for the increased electrical load a home will require. Many homes, especially older homes, only have a 100-ampere electrical panel that connects it to the electrical grid.[157] If a unit is going to be fully electrified, a higher-capacity electrical panel is required. While this clean energy upgrade is an essential step for landlords before they can implement all Level 3 upgrades, it was ultimately cut from the BRR Program list because it itself is not technically a clean energy upgrade and thus adds an unnecessary complicating factor to the Program Table.

The second clean energy upgrade omitted from the BRR Program Table is home ventilation upgrades. As units undergo energy efficiency upgrades that improve air sealing and insulation, the amount of natural, fresh airflow into the home is significantly reduced. The reduction of natural airflow into the home creates new challenges as air circulation is critical for filtering carbon dioxide and humidity out of the home and maintaining healthy indoor air quality.[158] Thus, installation of mechanical ventilation is required using either HRV (Heat Recovery Ventilation) equipment or ERV (Energy Recovery Ventilation) equipment.[159] Mechanical ventilation also has the potential to increase electricity costs given that ventilation that once occurred naturally now requires power. This clean energy upgrade is another essential

[157] Coren, "Advice | Want to Electrify Your Home?"
[158] James, "How Does Passive House Construction Impact Indoor Air Quality?"
[159] Boyer, "The Difference Between an HRV and an ERV."

step in the residential decarbonization process that was removed from the BRR Program because of the desire for simplicity. The BHA is going to continue to consult with clean energy experts about where this upgrade could fit into the BRR Program in the future.

The third clean energy upgrade of note that was ultimately cut from the BRR Program was the installation of solar panels. Solar panels were initially a key part of the BHA Retrofit Rewards Program. However, solar panels were cut from the Program for two key reasons. The first was that the installation of solar panels is incredibly expensive and administratively intensive. There are also specific building requirements like roof angle and geographic orientation that make it hard for all buildings to qualify.[160] Second, it made more sense to incentivize the landlords to reach a "Net-Zero Carbon Ready" classification before incentivizing on-site power generation. This relates back to the sentiment of trying to incentivize clean energy upgrades in the correct, expert-certified order. Thus, the installation of solar panels was cut from the first edition of the Program Table. However, it is possible that solar panels will be added as a Level 4 upgrade in later editions of the BRR Program.

Additional limitations to the first edition of the BHA Retrofit Rewards Program will be addressed in the next phases of the BRR Program's development and implementation.

II) Next Steps

A. Stakeholder Feedback

Before the BHA Retrofit Rewards Program can be launched this fall (2024), implicated stakeholders need to be consulted. A key limitation of the BHA Retrofit Rewards Program's first edition draft was that the key stakeholder groups, HCV landlords and tenants, were not included in the BRR Program's development process. The idea behind not consulting landlords and tenants in the initial development of the BHA Retrofit Rewards Program was that the BHA wanted to have something drafted to show stakeholder groups for feedback. When I first started working on the BHA Retrofit Rewards Program, the project was still just in its ideation

[160] Brooks, "What Is The Best Angle And Orientation For Solar Panels?"

phase, and there was nothing concrete on which to receive feedback. Additionally, given that there was no funding to compensate landlords and tenants for their involvement in the BRR Program's development, including tenants and landlords in the project's development process could have created an additional burden for them. However, one could argue that landlords and tenants still could have been involved in the initial drafting process.

Given this limitation, the first step in refining the BHA Retrofit Rewards Program is to meet with landlords and tenants and receive their feedback on the first edition. Speaking with Section 8 HCV landlords about the BHA Retrofit Rewards Program will be invaluable for refining the BRR Program. They will play a central role in taking the BRR Program from working in theory to working in practice. As all practitioners know, the way a program is designed and the way a program operates when implemented can look completely different. Often, this discrepancy is the result of program designers not considering the experiential knowledge of those impacted by a policy or program. In this situation, the landlords we consult will be able to use their experiential knowledge to tell us which of the clean energy upgrades in the BHA Retrofit Rewards Program are feasible. Specifically, the landlords will be able to tell us which clean energy upgrades they are and are not willing to implement, the amount of incentive money they would need to receive to make the upgrade, and any technical assistance they require.

For similar reasons, receiving feedback from HCV tenants will be critical in refining the BHA Retrofit Rewards Program. Tenants are particularly important to consult because they rely on the BHA to provide them with one of humanity's basic needs: safe and stable housing. The clean energy upgrades incentivized by the BHA Retrofit Rewards Program would directly impact tenants' livelihoods within their homes. Thus the BHA is committed to only implementing a version of the BHA Retrofit Rewards Program that is tenant-approved. In the process of refining the BRR Program, Section 8 HCV tenants will provide critical insight into what clean energy upgrades will and will not be beneficial to their lives. For example, the BHA has already heard secondhand that low-flow shower heads inconvenience tenants and as a result, tenants often remove them. The BHA also plans to work with tenants to make a 'tenant side' of the BHA Retrofit Rewards Program. The 'tenant side' of the BHA Retrofit Rewards Program would

provide tenants with information and tools (like utility usage monitoring equipment) they could use to help lower their electric bills.

Additionally, the BHA would like to determine a way to incorporate the City of Boston's Community Choice Electric (BCCE) Program into the tenant side of the BRR Program. The BCCE Program allows Boston residents and businesses to choose renewable energy options for their electricity supply.[161] The City's purchasing power reduces buyers' costs compared to purchasing renewable energy in the private market. Through the BCCE Program, tenants would be able to guarantee that a certain percentage of their electricity comes from renewable sources, furthering the clean energy goals of the BRR Program. However, the BCCE Program would lead to increased utility costs for tenants. Therefore, the BHA wants to work with tenants to identify methods like financial incentives that would enable them to be able to join the BCCE Program.

The exact processes for receiving landlord and tenant feedback will be finalized before the start of the summer.

B. Utility Allowance Updates

A key next step in implementing the BRR Program involves verifying potential shifts in tenants' utility expenses and revising the annual study used to determine BHA Utility Allowances.

The foremost principle guiding the development of the BHA Retrofits Rewards Program has been controlling for negative tenant impact. The BHA is steadfast in its commitment to refrain from launching the BRR Program if potential harms to tenants are identified, as the central goal of the BRR Program is to improve tenants' well-being. Therefore, a crucial next step is BRR Program development is ensuring that the Program does not increase expenses for tenants.

A major concern we had when creating the BRR Program was that the electrification of BHA units could increase tenants' utility costs. Currently in Boston, the price of heating and hot water with heat pumps or electricity is still slightly more expensive than with natural gas.[162]

[161] "Community Choice Electricity | The Program Will Give Bostonians Greater Control over the Electricity That Powers Their Lives."
[162] Moura, "How 'greener' Steam Could Help Boston Buildings Cut Climate-Warming Emissions."

While this may change in the future as MA utilities procure additional renewable sources of electricity generation, it is still a major concern for today. Given that reality, electrification measures have the potential to increase a unit's utility costs. While the exterior envelope sealing required in Level 2 of the BRR Program should help reduce energy costs, it is hard to guarantee it will be enough to make up for the increased utility costs.

Fortunately, Section 8 HCV tenants receive a Utility Allowance, which is the amount the BHA has determined that the tenant will likely pay for utilities based on annual studies of utility costs in the region. The total Utility Allowance takes into account the variation in cost between different utility types. Thus, if a unit switches from natural gas to heat pumps, the Utility Allowance a tenant receives will increase to account for the difference (Table 8). While this makes sense in theory, it still needs to be established in practice. Before the BHA launches the BRR Program, sample calculations will be conducted to ensure that the Utility Allowance will cover the incremental tenant costs due to the introduction of electrification measures in the home. To do this, we plan on taking real tenant utility bills and working with clean energy experts to understand how the bills would change with the energy efficiency and electrification upgrades. Through this process, the BHA will be able to confirm that tenants' utility costs will not increase. However, this still does not account for tenants' perception of utility cost increases.

Tenants receive their monthly Utility Allowance in the form of a rent reduction. In other words, the BHA takes the amount the tenant would pay in rent and subtracts the specific Utility Allowance from that amount.[163] This means that while tenants receive a stipend for their utility costs, they are still responsible for paying the utility companies. If a tenant's unit switches from natural gas to electric, the tenant will receive a higher Utility Allowance from the BHA, which will come in the form of a rent reduction. However, the amounts listed on their utility bills will increase. Even though the BHA plans for the increased Utility Allowance to cover the increased utility costs via rent reduction, the shock factor of a significantly more expensive utility bill could be stressful for some residents. The BHA acknowledges how this experience could be upsetting and is working to design preventative measures through tenant education and partnerships. The

[163] "Boston Housing Authority - Utility Allowance."

BHA also believes that being able to show tenants the example calculations of how their utility bills will change will be helpful in reducing concerns.

A related next step focuses on the alterations to the study that calculates Utility Allowance amounts based on average utility costs in a region. Currently, the Utility Allowances are calculated annually based on building typology, bedroom number, and number and type of utilities. For example, a unit heated with gas will receive a different Utility Allowance than a unit heated with oil. As is shown in *Table 8*, the Utility Allowance study has already incorporated certain energy efficient electrification measures like heating with a heat pump. This means that they have calculated the average costs of utilities for units that are heated with a heat pump. However, the annual Utility Allowance study still does not specify other energy efficient electrification measures including cooking with an induction stove and hot water heat pumps. The Utility Allowance study will need to be updated in the near future to include average costs of these utilities. The BHA is working to determine what an implementation process could look like. However, it is theoretically more difficult to calculate accurate regional averages given how few units currently have these electrification features.

In the meantime, the omission of these clean energy upgrades could actually be beneficial to tenants. Induction stoves and hot water heat pumps are much more energy efficient and thus cost effective than the traditional electric counterparts. Given that the Utility Allowance for traditional electric is higher than natural gas and heat pumps, a tenant with an induction stove and hot water heat pump could receive a Utility Allowance that is disproportionately high compared to actual utility costs. While this would be cost ineffective for the BHA in the long-run, it could serve as a useful incentive for furthering tenant support in the BRR Program.

Apartments (2-3, Row House, Garden)	SRO	0	1	2	3	4	5	6
Heating: Gas	54	72	85	91	98	104	110	123
Heating: Elec.	70	93	110	142	175	208	241	270
Heating: Heat Pump	55	73	86	102	115	127	140	157
Heating: Oil	133	177	209	224	240	256	272	305
Heating: Propane	125	166	195	210	225	239	254	284
Other Electric	62	79	91	122	154	186	217	242
Water & Sewer	51	68	75	125	200	275	350	392
Cooking: Gas	4	5	6	8	10	13	15	17
Cooking: Elec.	12	15	18	25	33	41	49	55
Cooking: Propane	9	11	13	18	24	30	35	39
Hot Water: Gas	11	14	17	24	32	39	47	53
Hot Water: Elec.	36	48	57	73	89	104	120	134
Hot Water: Propane	25	33	39	56	73	90	108	121
Hot Water: Oil	27	35	41	60	78	97	115	129
Refrigerator	21	21	21	21	21	21	21	21
Range	18	18	18	18	18	18	18	18
Monthly Charge for Use of Electricity	10	10	10	10	10	10	10	10
Monthly Charge for Use of Gas	10	10	10	10	10	10	10	10

Table 8. 2024 Utility Allowances for BHA HCV Row House or Garden Style Units
Source: Boston Housing Authority

C. Implementation Procedures

In addition to finalizing inspection procedures, updating the BHA calculator, and implementing changes to the AffordableHousing.com website, there are two essential steps the BHA is planning to enact for successful implementation of the BHA Retrofit Rewards Program. First, the BHA is planning to foster new and existing partnerships with relevant organizations that are doing related work in the Boston area. As was discussed in Chapter 3, the BHA Retrofit Rewards

Program's rent boosts can only cover a portion of the upfront costs of the clean energy upgrades. In addition, the BHA does not have the administrative capacity to help landlords coordinate the installation of clean energy upgrades. The higher level clean energy upgrades the BHA Retrofit Rewards Program is incentivizing involve a lot of coordination to implement. A landlord needs to find a trusted contractor to implement the clean energy upgrades and navigate the world of rebates to figure out how to finance the project. Because the BHA does not have the capacity to provide administrative assistance for these upgrades, it aims to connect with partner organizations that can assist landlords in their implementation efforts.

The BHA has already begun this partnership process with the Metropolitan Area Planning Council (MAPC). Before the BHA Retrofit Rewards Program even began, the MAPC, BHA, and a local organization named ACE (Alternatives for Community and Environment) were awarded an Empower Massachusetts Implementation Grant to execute their "Green and Healthy Affordable Homes" Project.[164] The Project encourages landlords to rent to HCV recipients and make use of energy efficiency and healthy homes retrofit programs. For this project, MAPC will provide landlords and tenants in at least 30 housing units with technical assistance and support for whole-building energy and healthy home retrofits. Thus MAPC, through this grant, will be helping 30 Section 8 HCV units through the residential decarbonization process - making them eligible for the BHA Retrofit Rewards Program rent boosts.

The Local Initiatives Support Corporation (LISC) is another organization that the BHA could partner with to assist their landlords in the residential decarbonization process. The LISC has launched a "Decarbonization Hub" that walks multifamily affordable housing owners through the process of retrofitting their buildings.[165] The hub provides contractor's contact information, contact information of organizations that do building decarbonization assessments, and information on rebates and funding sources.

Additionally, the BHA aims to partner with healthcare providers to further the tenant wellbeing-related goals of the BHA Retrofit Rewards Program. Healthcare providers across the Commonwealth know well the relationship between poor quality, non-energy efficient homes

[164] "EmPower Massachusetts Projects."
[165] "Decarbonization Hub | LISC Massachusetts."

and poor health outcomes in lower income residents like those in the Section 8 HCV Program. By partnering with the BHA on the BHA Retrofit Rewards Program, healthcare providers could help identify patients in need of clean energy retrofits and could help educate patients on the benefits of clean energy upgrades.

The BHA also hopes that having partners in the BRR Program will help with the second step of successful implementation of the BHA Retrofit Rewards Program: advertising towards landlords by-in. While the specifics are beyond the scope of this paper, advertising to landlords will be a critical step in the launch of the BHA Retrofit Rewards Program. The BHA wants to make sure that each of the thousands of landlords in the Section 8 HCV Program is aware of the rent boosts they can access in the BHA Retrofit Rewards Program. This is where the BHA has a huge advantage when compared to private and non-profit organizations trying to incentivize similar clean energy upgrades. The BHA is already in regular contact with the thousands of landlords they compensate through the Section 8 HCV Program. These relationships ensure that the BHA will successfully be able to get their message out. In part of their advertising plan the BHA plans to provide the landlords with resources on residential decarbonization. Some of these resources included the Allston Brighton CDC's Guide for Building Owners,[166] the City of Boston's Retrofit Resource Hub,[167] and Mass Save's no-cost Home Energy Assessment.[168] Hopefully through the process of advertising to, and working with landlords, the BHA can help demystify the residential decarbonization process.

D. Evaluation Protocol

Once the BHA Retrofit Rewards Program is launched in the fall, processes for evaluating key performance indicators will need to be established. Plans for BRR Program evaluation are yet to be determined. However, my recommendations include the following. One method for evaluating the success of the BHA Retrofit Rewards Program could be comparing the types of

[166] Mills, "A Blueprint to Decarbonize Affordable Housing."
[167] "Retrofit Resource Hub | Boston.Gov."
[168] "Home Energy Assessments | Residential."

utilities being used in HCV units. Currently, around 12.5% of HCV units use electricity for heating.[169] The BHA could compare how that number fluctuates before and 1-year after the BRR Program is implemented. The percent increase in the number of HCV units using electricity for heating or hot water heating could be used as an evaluation metric. Another method for evaluating the success of the BHA Retrofit Rewards Program would be to compare the energy usage of all HCV units from year to year. In theory, if the BHA Retrofit Rewards Program works successfully, the HCV units should be more energy efficient, thus decreasing total energy usage. However, it is very difficult to access data on energy usage in just BHA HCV units.

A third method for evaluating the success of the BHA Retrofit Rewards Program would be to evaluate the number of landlords enrolled in each level of the BRR Program compared to the total number of HCV landlords. If the BHA Retrofit Rewards Program succeeds, landlord enrollment in the Program should increase over time. As was outlined in Chapter 3, the BHA hopes to enroll 100% of landlords in the BRR Program's Level 1 in the first year as most of the clean energy upgrades are logistically easy and inexpensive. The final number of landlords enrolled in the BRR Program at the end of the first year will provide a metric for the success of this initiative. Developing plans for evaluating the success of the BHA Retrofit Rewards Program, including these metrics and more, will be an essential next step for the BHA.

III) Conclusion

This thesis adds to the continuous equity-centered decarbonization efforts within the BHA. In all, it details the development of the BHA Retrofit Rewards Program: a program that uses monthly "rent boosts" to incentivize Section 8 HCV landlords towards implementing clean energy upgrades in their units. Program goals include better environmental outcomes, improved tenant health and well-being, and reduced tenant energy burden. The current political support for residential decarbonization efforts, the challenge of the 'split incentive', and the need to prioritize low-income individuals in the residential decarbonization movement, all underscore the rationale of the BHA's forthcoming adoption of the BRR Program.

[169] "Boston Housing Authority Internal Report."

The BRR Program was established through a two-part process. Initially, a comparative study of analogous US programs pinpointed the Atlanta Housing Authority's Energy Efficiency Rent Boost Program (EERB) as a feasible model for adoption in Boston. Subsequently, a feasibility assessment was undertaken to evaluate the financial, administrative, and contextual adaptations required for the BHA to adapt the EERB Program effectively within the Boston framework. Based on the feasibility assessment, the proposed BRR Program offers landlords three levels of monthly 'rent boosts', each with three required clean energy upgrades. Financing for the 'rent boosts' will be available in perpetuity due to regulatory flexibility that enables higher federal payments to landlords within federal limits.

The BRR Program will benefit all relevant stakeholder groups, including Section 8 HCV tenants, landlords, and the BHA. First and most importantly, the BRR Program aims to improve the lives of Section 8 HCV tenants. Section 8 HCV tenants disproportionately live in energy-inefficient housing which can cause health and financial challenges. Through the BRR Program, tenants will be able to live in a renovated, temperature-controlled home without increasing their monthly rent or utility payments. Clean energy upgrades in the home will also improve tenants' health outcomes and well-being by removing natural gas in the home and sealing the unit's exterior envelope. Additionally, energy efficiency measures can decrease a tenant's energy burden, thereby improving their financial situation. Hopefully, these measures ensure lower tenant turnover and greater tenant quality of life.

Second, the BRR Program will be beneficial to Section 8 HCV landlords. Section 8 HCV landlords will be able to increase their monthly earnings without increasing costs for their tenants. The BHA's partnerships with entities that provide financial and technical assistance with residential decarbonization will also help landlords to more easily fund and administer clean energy retrofits. In the short and long term, the clean energy retrofits will increase the landlord's property and unit value. Moreover, the BRR Program was designed to ensure that the landlord would not be motivated to leave the Section 8 HCV Program because they would lose access to the BRR Program rent boosts if they moved to the private market. Additionally, a clean energy retrofit would reduce tenant turnover in a landlord's property lowering their administrative burden. Third, the BRR Program can help the BHA become a leader in the

residential decarbonization movement for Boston's low income residents. Through the BRR Program, the BHA will be incentivizing decarbonization in 15,000 units of Boston's housing stock. This will also assist the BHA, and the city of Boston in its efforts to achieve carbon neutrality by 2050 by incentivizing decarbonization of smaller buildings not regulated under BERDO 2.0. Greater clean energy usage in Section 8 HCV units should also reduce BHA energy costs in the long term as electricity from renewables becomes cheaper than oil and natural gas. The BHA also hopes that the financial incentives available through the BRR Program will increase landlord interest and enrollment in the Section 8 HCV Program.

The BRR Program also has the potential to influence Section 8 HCV decarbonization efforts across the country. The BRR Program, along with Atlanta's EERB Program, can act as a blueprint for cities aiming to tackle the intertwined issues of climate change and housing inequality. Housing authorities nationwide have the ability to leverage "Rent Gap" money utilized by both Boston and Atlanta to fund decarbonization programs. Thus, Boston's successful adaptation of the BRR Program could serve as a guide to other housing authorities seeking to implement Section 8 HCV decarbonization programs. The widespread adaptation of BRR-type programs could have a significant impact on greenhouse gas emission reduction and tenant wellbeing nationwide.

At its core, this thesis and the BRR Program, embody the pursuit of social equity within the environmental movement. Climate change is on track to wreak unimaginable harm onto our planet and its population. Those first in line in the path of destruction are vulnerable populations like those in the Section 8 HCV Program. To avoid unwittingly furthering a humanitarian crisis induced by climate change, action needs to be taken in all sectors to reduce greenhouse gas emissions. The BHA's Retrofit Rewards Program demonstrates how entities in their specific worlds can take action to reduce greenhouse gas emissions and protect populations most vulnerable to the impacts of climate change.

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Appendix

Boston Housing Authority

A home for every story

The BHA Retrofit Rewards Program

Summary: The Boston Housing Authority is developing the BHA Retrofit Rewards (BRR) Program. The program aims to incentivize Section 8 Housing Choice Voucher landlords into implementing clean energy upgrades in their units to improve the health and well-being of tenants.

Problem:

- Energy inefficient homes in Boston are contributing to the climate crisis and creating health problems for tenants. Low-income residents like HCV recipients are the population most negatively impacted by inefficient housing.
- Financing and technical assistance for low-income residential decarbonization is available but organizations have a difficult time connecting with landlords.

Opportunity:

- The BHA can leverage the relationship it has with over 15,000 HCV landlords to provide financing and technical assistance for residential decarbonization.
- The BRR program is financed by leveraging regulatory flexibility that allows for increased federal payments to landlords.

Program Development:

- The BHA Retrofit Rewards program was developed using Atlanta's Energy Efficiency Rent Boost (EERB) Program as a model. Specific elements of the EERB program were altered to fit the political and climate context of the Boston area.

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BHA Retrofit Rewards Program

To receive level 1 rent boost, you must satisfy all elements; to receive level 2 boost, you must implement all level 1 elements and all level 2 elements.
To receive level 3, you must all of level 1 and 2 in addition to level 3.
Rent boost eligibility subject to requirement that gross rent of unit not exceed payment standard (to not increase tenant costs), which will be analyzed via BHA calculator.
Amount subject to above gross rent criteria; landlords may receive up to amounts below as long as gross rent plus below rent boosts is below payment standard.

Rent Boost Levels	Description of Upgrade	Minimum Requirement	Possible Rebates
LEVEL 1 SILVER: Basic Efficiency ($600/year)	**LED Bulbs**	• Replacement of Incandescent bulbs with LED Bulbs	• https://www.masssave.com/business/rebates-and-incentives/lighting-and-controls/instant-lighting-incentives
	Low-Flow Water Upgrades	• Toilet(s) uses 1.28 gallons or less per flush • Low flow faucet, aerators, and showerheads: 1.5 GPM	• https://www.masssave.com/blog/residential/go-with-the-low-flow
	Energy Star Appliances	• Energy Star Refrigerator • Energy Star Dishwasher • Energy Star Washing Machine • Energy Star "Most Efficient" Rated Electric Clothes Dryer	• https://www.masssave.com/en/residential/rebates-and-incentives/appliances-and-products/clothes-washers • https://www.masssave.com/en/residential/rebates-and-incentives/appliances-and-products/clothes-dryers
LEVEL 2 GOLD: Building Envelope Improvements ($1800/year)	**Insulation**	• Install insulation to meet or exceed an R-49 value where applicable • For unconditioned basement or crawl space, install floor insulation to meet or exceed R-30 • Install insulation in attic to meet or exceed an R-49 value	• https://www.masssave.com/residential/rebates-and-incentives/insulation-and-windows/insulation-and-air-sealing
	Air Sealing	• Air sealing must be completed per MA energy code	• https://www.masssave.com/residential/rebates-and-incentives/insulation-and-windows/insulation-and-air-sealing
	Energy Efficient Windows	• Low Emissivity (Low- E) glass windows that have a U-Factor ≤ .30	• https://www.masssave.com/en/residential/rebates-and-incentives/insulation-and-windows/windows
LEVEL 3 EMERALD: Electrification ($3000/year)	**Induction Stove**	• Energy Star Rated Electric Induction Stove	• https://www.masssave.com/en/residential/rebates-and-incentives/appliances-and-products/inductionstove
	Heat Pump	• Successful installation of verified Energy-Star rated Heat Pump. All types of heat pumps will be accepted including (but not limited to) air-source heat pump (duct or ductless), ground-source heat pump, and geothermal heat pump	• https://goclean.masscec.com/clean-energy-solutions/air-source-heat-pumps/ • https://www.masssave.com/en/residential/rebates-and-incentives/heating-and-cooling/heat-pumps/air-source-heat-pumps
	Heat Pump Water Heater	• Successful installation of verified Energy-Star rated Heat Pump Electric Water Heater	• https://www.masssave.com/residential/rebates-and-incentives/water-heating/water-heaters/heat-pump-water-heaters

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Appendix 1. BHA Retrofit Rewards Program 1-Pager