LOW-INCOME AND SOCIAL HOUSING ELECTRIFICATION ROADMAP

September 2023

BC HOUSING BC Hydro Vancity

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Executive Summary

Reducing carbon emissions from the building sector is a key and urgent priority, but how we achieve these reductions and the people that this movement benefits is just as important. This means ensuring that all British Columbians have access to the benefits of decarbonization, without the unintended consequences of increasing unaffordability, displacement, or the loss of affordable housing. To realize this vision, new approaches are needed to not only include affordable housing in decarbonization efforts but also to leverage decarbonization investments in ways that support and preserve affordable housing.

The purpose of this Low-income and Social Housing Electrification Roadmap ("Roadmap") is to identify barriers and mitigating actions to enable the rapid scale-up of decarbonization efforts in the affordable housing stock in British Columbia (BC), focusing on building electrification. The key objectives of this project are as follows:

Electrify most low-income and social housing buildings in the province by 2030

Provide low-cost heating and cooling to all residents to improve health and safety, and save lives

Decrease inequity, improve affordability, and maintain the existing affordable housing stock

Defining the Affordable Housing Stock

In BC, most affordable housing can be found in either social housing or aging market rental apartment buildings constructed before 1990. While this stock is crucial in terms of offering homes to lower income families, it also disproportionately contributes carbon emissions, given the age and deteriorating quality of their major building components and systems.

In this Roadmap, "affordable housing" refers to the subsectors of multi-unit residential buildings (MURBs) that house the majority of low-income households in province. This includes both:

- **Social housing**, or housing owned/operated by a public or not-for-profit institution, including BC Housing, non-profit housing societies, Indigenous non-profit housing societies, and non-profit housing co-ops. The demand for this housing is currently outpacing the supply, and waitlists average 2-5 years.
- **Low-income market rental (LIMR)**, or the naturally occurring form of affordable housing that is made up of market rental units that house low-income renters. Low-income residents in market rentals are more vulnerable to displacement and increasing costs (compared to those in social housing).

There are approximately 300,000 low-income households in BC, with about one third of living in social housing units, and the remaining two thirds assumed to live in market rental units.

Why Electrification?

Both social and low-income market rentals present a significant opportunity for electrification. **Electrification** refers to the process of replacing technologies that use fossil fuels—coal, oil, and natural gas—with those that use electricity as a source of energy. In BC, electrification has significant emissions reduction potential; with BC's low-carbon electricity grid, electrification effectively eliminates carbon pollution from a building's operations.

Electrification also results in a number of other "co-benefits" for building owners, tenants and the wider community, including:

- **Healthier indoor and outdoor air quality.** The elimination of fossil fuel-based systems from homes and buildings improves indoor and outdoor air quality.

- **Access to cooling.** Electrification with heat pumps can provide both heating and cooling to a building. BC is already experiencing extreme heat waves and will continue to face them with increasing frequency and intensity given climate change. Having cooling available improves occupant comfort and health and in some cases saves lives – particularly for households with medically vulnerable family members, elderly occupants, or children.
- **Increases efficiency, reducing utility bills.** Electrification with heat pumps results in significant efficiency gains (compared with a conventional heating system), energy savings, and often utility cost reductions, with the caveat that in some cases, with the current under-pricing of natural gas, electrification projects may break even or see an increase in utility costs. Pairing electrification projects with cost-effective energy efficiency measures can often improve payback periods and utility cost savings.
- **Avoided cost of future retrofits.** Electrifying heating and hot water systems at the end of the lifespan is the most cost-effective way to upgrade a building. Factoring in electrification and energy efficiency into short- and long-term capital planning allows building owners to stagger investments as building systems near the end of their life. Early adoption also enables building owners to take advantage of incentives, which may not be available to the same extent as regulations come into effect.

Barriers to Electrification

Despite their many benefits, as well as the increasing availability of technology, there are several barriers that building owners and managers may face in implementing electrification retrofits. Addressing these barriers will reduce the time, effort and costs associated with electrification projects, and improve their effectiveness.

Awareness and Capacity	Cost	Regulation and Policy	Industry and Technology
• Time and experience of building owners and managers • Emergency replacements • Inadequate information on forthcoming regulations	• Cascading retrofit costs after project initiation • The need for electrical capacity upgrades • Increasing utility bills resulting from electrification • Increasing O&M resulting from electrification • Complexity of incentives and financing landscape	• Access to electrical capacity data • Permitting timelines • Equitable cost allocation between landlord and tenants (i.e. Residential Tenancy Act)	• Access to qualified installers • Technology gaps

Recommendations

A comprehensive suite of actions to drive electrification is needed to address the financial, regulatory, technical, and social realities of the affordable housing sector. These actions have been designed to meet the needs of affordable housing residents and owners, and have the potential to create significant co-benefits and drive market transformation, while supporting populations most vulnerable to the impacts of climate change. The key strategies and objectives outlined below represent the main drivers for equitable electrification for the affordable housing sector.

Key Strategy #1: Create Market Demand

Objectives

1. Create and tailor electrification requirements for affordable housing
2. Raise levels of consumer awareness about the benefits of electrification
3. Increase transparency through energy and GHG benchmarking

The implementation of targets, requirements and information campaigns can help create market demand by (1) clearly signaling future requirement to building owners, (2) providing information on the benefits and opportunities of electrification, and (3) informing short- and long-term capital planning decisions.

There are a number of forthcoming local and provincial regulations that are expected to come into effect in the coming years for all building types. Social and LIMR housing should be prioritized for early adoption of these regulation, as opposed to receiving exemptions of extensions.[1] For governments, providing generous funding to support early adoption for the affordable housing can support climate and affordability objectives, while increasing market readiness for other building types. Conversely, exempting affordable housing from regulations (or providing leniency) will exclude low-income residents from the range of benefits that result from electrification. Regulations need to be designed with explicit considerations for the LIMR and social housing sectors to ensure they do not result in adverse affordability impacts.

Key Strategy #2: Improve Cost Competitiveness and Affordability

Objectives

1. Increase access to incentives and financing
2. Streamline and simplify retrofit process for building owners and managers
3. Level the playing field between electric and natural gas costs
4. Reduce electricity connection and system upgrade costs, and timeline delays

The upfront cost of electrification projects is often a barrier for building owners, especially if the electrification project triggers the need for an electrical service upgrade or other improvements (e.g. mould or asbestos remediation, or ventilation). Building owners need easy to access and streamlined incentive programs to support electrification retrofits and complementary measures. This includes ensuring that the incentives for electrification are competitive with equivalent programs for natural gas equipment, and building owners have access to coaching and guidance from a retrofit professional throughout the project.

[1] In jurisdictions with existing building decarbonization requirements (i.e. building performance standards), there are two common approaches to mitigate affordability impacts: (1) provide leniency and longer timelines for affordable housing, (2) increasing incentive and support programs to enable affordable housing to meet requirements without adverse equity impacts.

In some cases, building owners also require support after a retrofit project is complete to address unintended consequences, mainly higher utility costs that can result from poor system design, low quality installations, improperly sized equipment, highly inefficient buildings or ineffective operation and maintenance practices. These issues could be addressed by programs that set standards for system design and quality installations and post retrofit support programs that include resources, incentives for commissioning on ongoing technical support, and emergency funds for repairs or to cover additional utility costs. This support will help ensure positive retrofit outcomes and mitigate potential equity impacts.

Key Strategy #3: Preserve Affordable Housing

Objectives

1. Strengthen affordability and tenant protections through electrification projects
2. Increase data and transparency on low-income housing stock

Carefully designed policies can ensure that affordability and climate action objectives are achieved in concert –and not seen as competing priorities or necessary trade-offs. This lens has been used throughout the Roadmap, however, there are a few key policies that can be used to strengthen the protection of affordable housing and create a stronger foundation for equitable electrification. Policies to protect and restore affordable housing units, include increasing the supply of the non-profit building (e.g. providing financing and incentives for transitioning existing housing units into the non-profit sector), strengthening rent controls, and including anti-displacement measures in incentives and regulations.

For the low-income housing stock, one of the biggest challenges is the lack of data and transparency to identify these units. Monitoring the impacts electrification has on this building stock will require better insights on rental rates, vacancy, and basic building conditions.

Key Strategy #4: Expand Industry Capacity and Technology Availability

Objectives

1. Build industry knowledge, capacity and competence
2. Address equipment and technologies gaps for MURBs

There is a lack of skilled designers and installers, and equipment and technology to support the scale of electrification needed throughout the province. This issue is not isolated to social and low-income housing but applies to the entire MURB sector (and the broader building sector). Increasing training and outreach, standardizing electrification processes, and creating guidelines, templates and datasets targeted at the needs of the low-income and social housing sectors will help expand industry capacity, knowledge and competence.

Increasing access to a range of technologies and products to suit social and low-income buildings will help expedite timelines and improve the quality of installations by ensuring that proper equipment is being used. Existing technology gaps include low Global Warming Potential (GWP) heat pumps, hydronic heat pumps, small capacity in-suite heat pump units, and all-in-one heat pumps capable of operating efficiently in cold climates.

1 Introduction

Buildings represent a significant source of greenhouse gas emissions (GHG) in British Columbia (BC), making the accelerated decarbonization of our buildings crucial to achieving climate targets and avoiding the worst impacts of climate change.[2]

Reducing carbon emissions is a key and urgent priority, but how we achieve these reductions and the people that this movement benefits is just as important. This means ensuring that all British Columbians have access to the benefits of decarbonization, without the unintended consequences of increasing unaffordability, displacement, or the loss of affordable housing. To realize this vision, new approaches are needed to not only include affordable housing in decarbonization efforts but also to leverage decarbonization investments in ways that support and preserve affordable housing.

In BC, most affordable housing can be found in either social housing or aging apartment buildings constructed before 1990. While this stock is crucial in terms of offering homes to lower income families, it also disproportionately contributes carbon emissions, given the age and deteriorating quality of their major building components and systems. Fortunately, the technology to decarbonize these units is available today and can provide a range of other benefits to occupants and owners alike, improving indoor and outdoor air quality, providing access to life-saving cooling and ventilation, and lowering utility bills. However, many building owners lack the financial capacity, time, experience, and support to modernize these buildings. There is also a clear and present risk that decarbonization could drive increasing costs and the loss of existing affordable housing stock.

As such, the following three objectives are being used to guide the development of this *Low-Income and Social Housing Electrification Roadmap* ("Roadmap"):

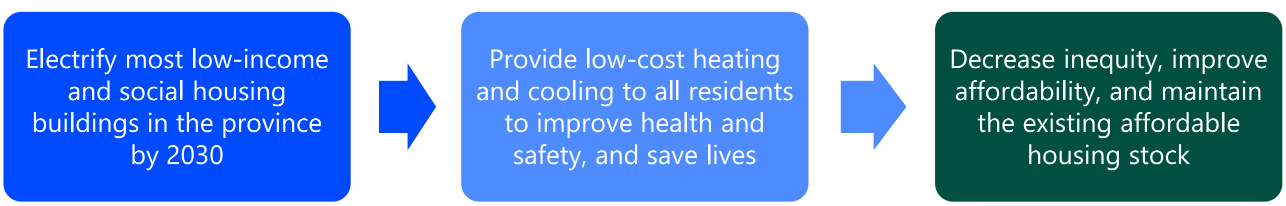

Figure 1. Roadmap Core Objectives

The decarbonization of the low-income and social housing building stock is an immense undertaking encompassing extensive retrofitting that will need robust, cross-sector collaboration and support to navigate the intricate challenges associated with such a widespread transformation. The purpose of this Roadmap is to identify barriers and mitigating actions to enable the rapid scale-up of decarbonization efforts in the affordable housing stock in BC, focusing on building electrification. The Roadmap includes the following sections:

- **Section 2** provides a definition of the affordable housing stock and the opportunity for electrification
- **Section 3** identifies the benefits and co-benefits of electrification
- **Section 4** identifies the barriers that building owners and managers face in electrifying and the potential risks to tenants
- **Section 5** outlines actions recommended for achieving the equitable electrification.

[2] BC has ambitious decarbonization goals to reduce emissions by 40% by 2030, 60% by 2040, and 80% by 2050. In March 2021, to help meet provincial GHG targets, the Province established new 2030 emission reduction targets for key sectors, including a 59-64% reduction in emissions from buildings and communities (below 2007 levels).

Collaboration and alignment with other actors and initiatives were also central to the development of this Roadmap. The achievement of the actions outlined in this document will require a significant and coordinated effort with contributions from government, utilities, industry associations, non-profit organizations, financial institutions, and housing providers. These groups provided input into this process through workshops, focus groups, case studies, and interviews. The Roadmap additionally leverages the significant work that is underway to address climate change and affordability in the province by building off existing strategies, including the Building Electrification Roadmap, CleanBC Roadmap to 2030, and StrongerBC Homes for People.

2 Defining the Affordable Housing Stock

Despite efforts in recent years to address ballooning housing costs, many families are still living in unaffordable or unsuitable housing. In 2020, there were over 400,000 families living on low-income in BC, with a median after-tax income of $19,000. This accounts for approximately 17% of families in the province.[3]

In this Roadmap, "affordable housing" refers to the subsectors of multi-unit residential buildings (MURBs) that house the majority of low-income households. This includes both social housing and naturally occurring affordable market rental buildings ("low-income market rental housing"). Based on this definition, there are approximately 300,000 low-income households that are renting or living in social housing. Approximately one third of these households live in social housing units, while the remaining two thirds are assumed to live in market rental units (see Figure 6). Note that these estimates combine data from different sources with very different quality levels, and so should be used as a first approximation.

Text Box 1. Core housing need

Core housing need[4] is another measure of housing affordability that is not limited to low-income residents, and measures housing affordability, adequacy, and suitability. In 2021, 13% of households in BC were living in core housing need, which is higher than the Canadian average of 10% and the second highest of all Canadian provinces and territories (behind Nunavut). In a 2012 report by BCNPHA, it was projected the number of households in core housing need will increase by 40% between 2011 and 2036.

2.1 Social housing

Social housing is housing that is owned/operated by a public or not-for-profit institution, including:

- **BC Housing** is a crown corporation that reports to the Minister of Housing. BC Housing owns and operates social housing buildings, and provides funding and supports for non-profit housing providers and rental assistance for those living in market housing.
- **Non-profit housing societies** and **Indigenous non-profit housing societies** provide rental housing that is owned and operated by community-based non-profit societies. The mandate of these societies is to provide safe and secure affordable homes to individuals and families with low to moderate incomes. Most non-profit housing societies receive some form of financial assistance from the government to enable them to offer affordable rents. Each society operates independently under the direction of a volunteer board of directors. Most employ staff to manage the day-to-day operations, though volunteers run some smaller societies.
- **Non-profit housing co-ops** generally provide below market secure rentals to residents with a range of incomes. A board of directors oversees the day-to-day of a co-op and acts in a role similar to a traditional landlord: vetting prospective tenants, taking care of repairs and tallying capital costs that

[3]Statistics Canada. After-tax low-income status of census families based on Census Family Low-income Measure (CFLIM-AT), by family type and family composition. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1110002001&pickMembers%5B0%5D=1.145&pickMembers%5B1%5D=3.1&cubeTimeFrame.startYear=2016&cubeTimeFrame.endYear=2020&referencePeriods=20160101%2C20200101

[4] Core housing need refers to whether a private household's housing falls below at least one of the indicator thresholds for housing adequacy, affordability or suitability, and would have to spend 30% or more of its total before-tax income to pay the median rent of alternative local housing that is acceptable (attains all three housing indicator thresholds).

ultimately help establish what each co-op member pays to live there. Unlike other housing types, residents are neither tenant or landlord and are, therefore, not subject to the Residential Tenancy Act.

The social housing stock is generally subsidized and has a mandate to provide stable and affordable housing. Although the ownership groups appear to be distinct, many non-profit and Indigenous non-profit housing societies, and some co-ops, have operating agreements with BC Housing to access reliable funding and support for capital replacements/renewal. This also allows BC Housing to have a level of control over the retrofit process and establish standards and targets. Social housing is estimated to house up to one third of low-income residents in the province. The supply of this housing is currently outpaced by the growing demand, meaning that many low-income residents are not able to access this housing or are stuck on waiting lists for years at a time.

BC Housing, BC Non-Profit Housing Association (BCNPHA), Aboriginal Housing Management Association (AHMA) and the Co-op Housing Federation of BC (CHFBC) collect detailed data about social housing buildings in the province, which was analysed to identify key trends for this building stock. From this analysis, it is apparent that social housing buildings are primarily aging apartment buildings located mostly in the Lower Mainland. Most of these buildings were constructed between the 1970s and the 1990s, with a peak occurring during the period of 1990-1999 (see Figure 2).

High-rise MURBs account for 27% of the total floor area, while low-rise and mid-rise MURBS account for with 24% and 23%, respectively. Single family homes –although not the focus of this Roadmap –have been included in this analysis and account for just 3% of floor area (but 40% of total buildings). Most social housing buildings rely on natural gas as the primary fuel source for both space heating and domestic hot water provision. However, there are a significant number of buildings where the fuel source is unknown (Figure 4 and Figure 5).

The non-profit and Indigenous non-profit sectors account for 85% of buildings (63% and 22% respectively) and the majority of the sector's emissions (Figure 3). As a whole, the sector emits nearly 200,000 tCO_2e annually.

Appendix C provides a more detailed set of findings.

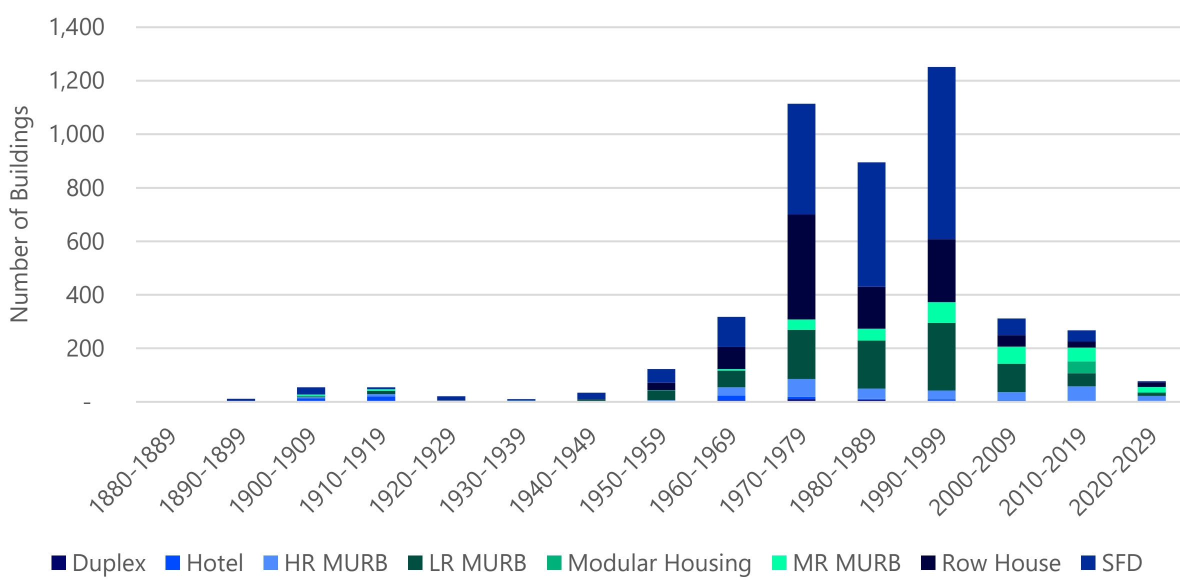

Figure 2. Building Stock Vintage by Archetype

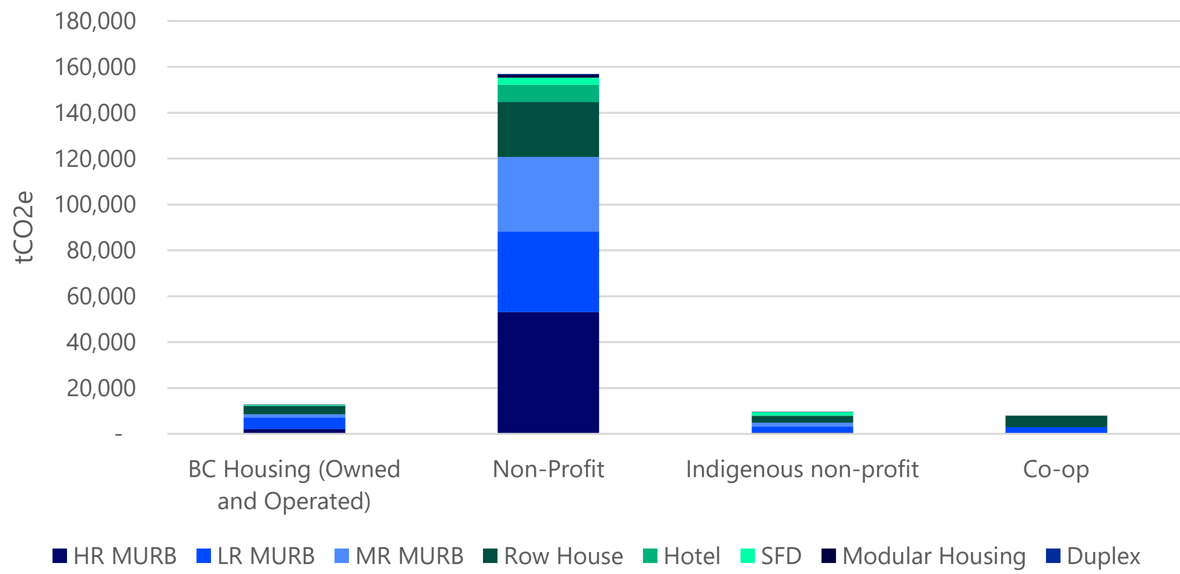

Figure 3. GHG Emissions by Ownership and Archetype

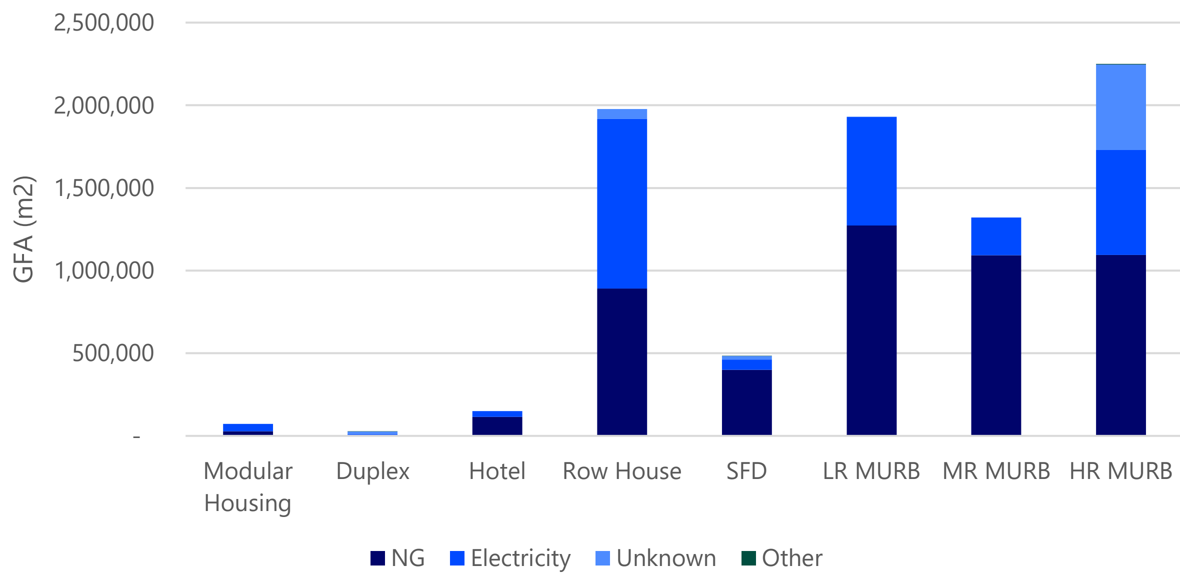

Figure 4. Space Heat Fuel Type by Archetype (Floor Area)

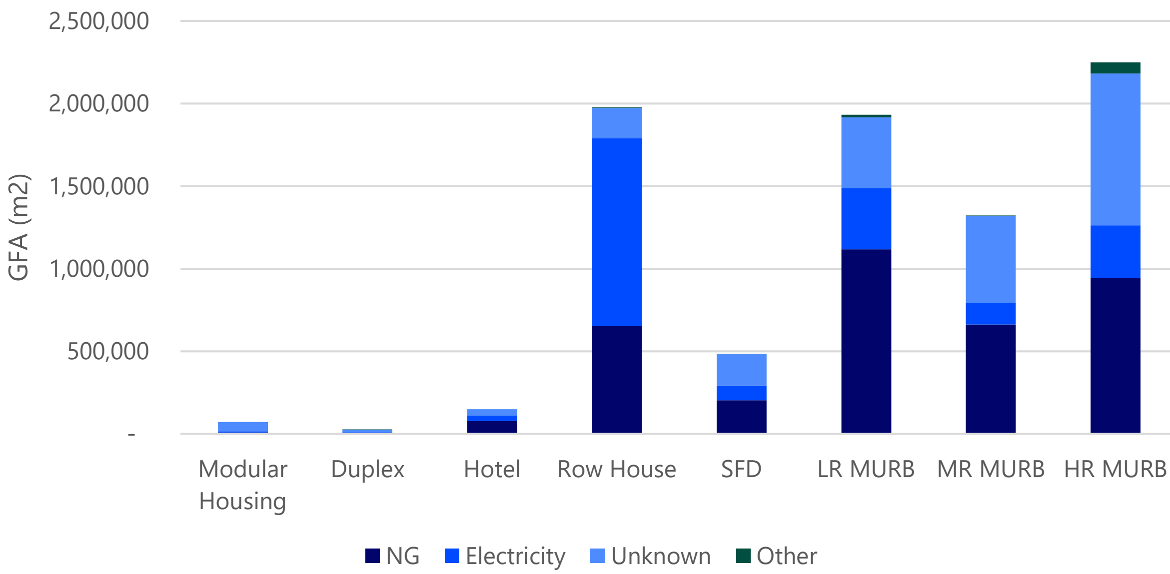

Figure 5. DHW Fuel Type by Archetype (Floor Area)

2.2 Low-Income Market Rental Housing

For the purpose of this Roadmap, low-income market rental (LIMR) refers to market-rental apartment buildings in which at least 50% of the units house low-income households.[5] In comparison to social housing, there is very little data available on LIMR. However, based on a rough initial analysis, the LIMR stock is estimated at just under 200,000 units. While specific data on the location, vintage, condition, or energy use of these buildings is not yet available, anecdotally this housing stock is largely made up of older buildings (pre-1990) that are run by independent landlords, with a higher proportion of long-term renters. The characteristics of these buildings and units likely vary significantly; however, in some cases the below market rent may be associated with poor building conditions and issues such as mould, vermin, and overheating.

[5] Based on Statistics Canada's Low-Income Cut-Offs (LICO) multiplied by 160%

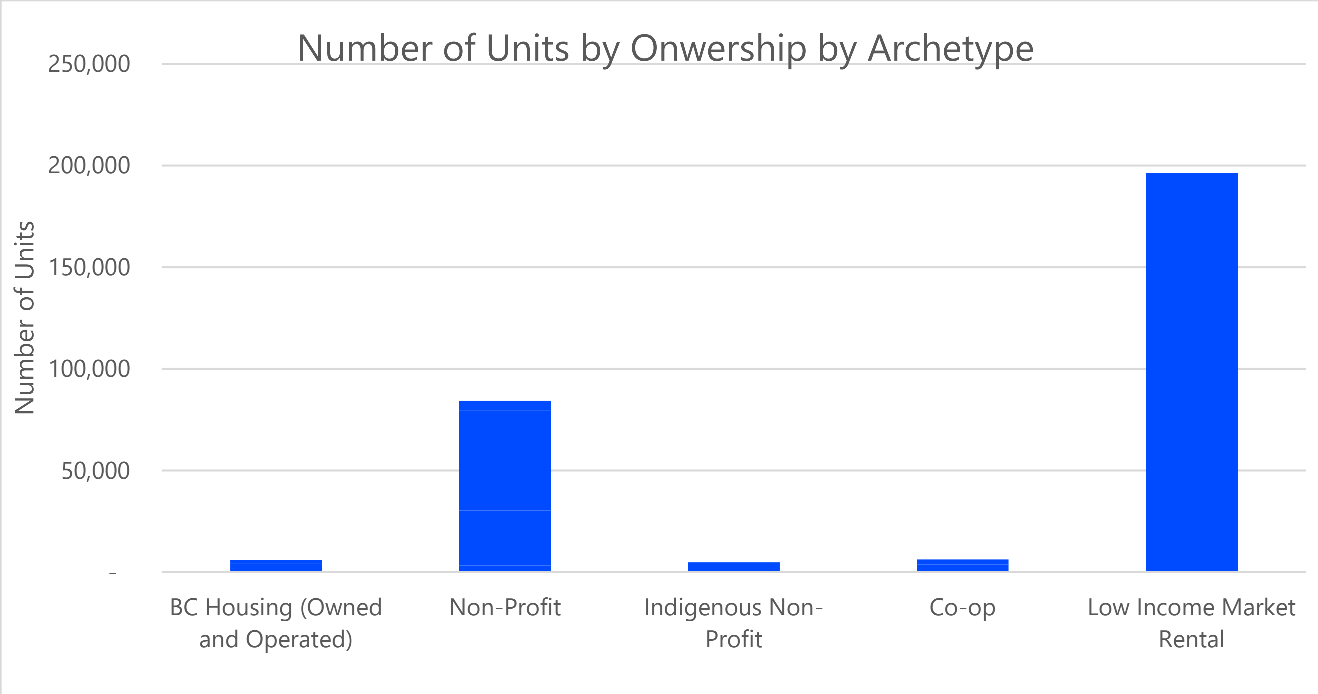

Figure 6. Relative Size of Low-Income Market Rental Stock Compared to Social Housing

In BC, rent controls are tied to the rental agreement, and not the unit itself. Under this model, rental rates are usually adjusted to current market value when tenant's turnover. This provides a mechanism for landlords to pay for unit and building upgrades, and cover rising operation and maintenance costs. However, with BC's tight rental market, the number of affordable housing units has been decreasing – fifteen affordable private units (renting for $750 or less) were lost for every new affordable unit built between 2011-2016, and this trend appears to be continuing.[6]

There are several data gaps for LIMR, including the location and number of low-income households, building ownership, and building characteristics and condition. This makes it challenging to either target programs and outreach to this sector, or track the impacts of electrification programs. Increasing our understanding of this sector will be an important step in developing relevant policy and monitoring progress.

Text Box 2. Low-Income Tenants in BC

Low-income tenants in market rental buildings represent some of the most vulnerable households in BC. In many cases, market rental buildings are a last resort as the wait times for getting into social housing currently range from 3-5 years and sometimes even longer. Market rental buildings do not have a mandate to provide affordable housing, and market rental rates are unaffordable for most low-income residents. In 2023, the average rent for a studio apartment in BC is $1,800 and $2,200 for a one-bedroom. Meanwhile, the shelter allowance for income assistance is just $375 per person, and affordable rent (i.e. 30% of income) for someone at the low-income cut-off is a maximum of $880. This discrepancy leads to low-income renters staying in poor quality units as they cannot afford to move, or accepting any unit they can afford, regardless of its suitability. Tenants may not have the means or awareness to advocate for themselves if an issue arises, which can be exacerbated by factors such as language, literacy, mental health challenges, substance use, and lack of social networks.

[6] Focus Consulting. Why Canada needs a non-market rental acquisition strategy. May 2020. https://www.focus-consult.com/why-canada-needs-a-non-market-rental-acquisition-strategy/

3 Why Electrification?

Both social and low-income market rentals present a significant opportunity for electrification. **Electrification** refers to the process of replacing technologies that use fossil fuels—coal, oil, and natural gas—with those that use electricity as a source of energy. In BC, electrification has significant emissions reduction potential; with BC's low-carbon electricity grid, electrification effectively eliminates carbon pollution from a building's operations.[7]

Electrification also results in a number of other "co-benefits" for building owners, tenants and the wider community:

- **Healthier indoor and outdoor air quality.** The elimination of fossil fuel-based systems from homes and buildings improves indoor and outdoor air quality.
    - Natural gas equipment and appliances, specifically natural gas stoves, release nitrogen oxides into homes and buildings which can exacerbate pre-existing health conditions like chronic obstructive pulmonary disease (COPD), heart disease, and diabetes.
    - Poorly adjusted, maintained, or ventilated gas appliances can result in gas leaks or incomplete combustion that expose individuals to dangerous and potentially fatal levels of carbon monoxide.
    - Burning fossil fuel in furnaces vents pollutants, specifically PM2.5, into the atmosphere. PM 2.5 has been linked to short and long-term respiratory issues.
- **Access to cooling.** Heat pumps can provide both heating and cooling. This means that for an apartment that doesn't have air conditioning, changing the space heating from a gas furnace to a heat pump can introduce this capability. BC is already experiencing extreme heat waves and will continue to face them with increasing frequency and intensity given climate change. Having cooling available improves occupant comfort and health and in some cases saves lives – particularly for households with medically vulnerable family members, elderly occupants, or children.
- **Increases efficiency, reducing utility bills.** Electrification with heat pumps results in significant efficiency gains (compared with a conventional heating system), energy savings, and often utility cost reductions, with the caveat that in some cases, with the current under-pricing of natural gas, electrification projects may break even or see an increase in utility costs. Pairing electrification projects with cost-effective energy efficiency measures can often improve payback periods and utility cost savings.
    - **Increasing cost of natural gas.** Increases to the carbon tax will result in higher costs for gas heating over the medium and long-term. Market fluctuations also create volatility and can lead to higher costs. Additionally, the natural gas system may become a stranded asset as an increasing number of buildings move towards electrification, meaning that buildings that remain on natural gas will bear the costs to upkeep the aging gas infrastructure through higher monthly bills.[8]
- **Avoided cost of future retrofits.** Electrifying heating and hot water systems at the end of the lifespan is the most cost-effective way to upgrade a building. Factoring in electrification and energy efficiency into short- and long-term capital planning allows building owners to stagger investments as building systems near the end of their life. Early adoption also enables building owners to take advantage of incentives, which may not be available to the same extent as regulations come into effect.

[7] Natural gas produces over 15 times more GHG emissions than electricity. The GHG intensity (GHGI) for natural gas is 180 gCO2e/KWh, and the GHGI for electricity is 11.5 gCO2e/KWh.

[8] Kaitlin Thompson. Towards Net Zero Heating: An Analysis of Technology and Policy Pathways for Decarbonizing Building Heat in British Columbia. 2018. https://theses.lib.sfu.ca/file/thesis/7588

Text Box 3. The "Right to Cool"

The BC Coroners Service (BCCS) confirmed that the extreme heat event that occurred from June 25 to July 1, 2021 resulted in 619 heat related deaths. Key recommendations of the BCCS include the implementation of extreme heat prevention and long-term risk mitigation strategies that include improving access to active cooling measures (like installing heat pumps) and passive cooling measures (like improving building efficiency through other retrofits). Since 2021, a variety of measures have been implemented or explored to help protect vulnerable residents, including an increased number of cooling centres, education campaigns, free portable AC units for low-income residents, and an exploration of policy levers to enshrine tenants' "right to cooling."

These initiatives are closely connected to the electrification of low-income and social housing. Building electrification projects that provide space cooling represent an opportunity to both decarbonize buildings and address a life-safety risk. Portable air conditioners can fill a critical short-term need but have limited operating capacity and are not efficient, leading to higher electricity costs. Heat pumps are a more effective, sustainable, and long-term solution to improve the life-safety of the province's most vulnerable populations.

3.1 Electrification Technologies

There are a wide range of technologies available to electrify mechanical systems in MURBs, ranging from low-efficiency electric baseboard heating to high-efficiency heat pump technologies. This Roadmap is focused on efficient electrification using heat pumps, because these systems can help reduce utility costs (and affordability impacts) and incorporate cooling. Below are some basic primary electrification technologies that are used in MURBs, with further explanation provided in Appendix A.

Text Box 4. The Role of Energy Efficiency

Electrification is often paired with energy efficiency improvements ranging from minor (e.g. air sealing) to major (e.g. building envelope renewal). Depending on the condition of a building, energy efficiency improvements may be critical for the business case of electrification projects, by reducing the required heating load to allow for smaller heat pump system, less energy use and lower utility bills.

With an electrification retrofit, a 'building as a system' approach should be taken. The building as a system concept recognizes that a building is a complex multi-component system made up of insulation, heating and cooling, windows, doors, ventilation and exterior walls, foundation and siding. Taking into account the condition and interactions of all these systems will help inform upgrades and their sequencing to optimize retrofit measures and create cost efficiencies.

Heat Pump Space Heating Units

Heat pumps offer an energy efficient alternative to furnaces and air conditioners for all climates. Like a refrigerator, heat pumps use electricity to transfer heat between spaces, making the cool space cooler and the warm space warmer. Because they transfer rather than generate heat, heat pumps can efficiently provide comfortable temperatures for homes and buildings. There are three main types of heat pumps: air-to-air, air-to-water, and geothermal. Air-to-air, also known as air-source heat pumps, are the most commonly used systems, and these can be ducted centralized systems, or ductless in-suite units. The most common approaches for MURBs include the following:

- **Electrifying In-Suite Heating.** This approach involves shifting from central hydronic gas heating to decentralized in-suite heating using air source heat pumps.[9]

[9] FRESCo. *MURB Retrofits: Opportunities for Electrification.* https://landlordbc.ca/wp-content/uploads/2021/06/FRESCo_MURB-Retrofits-Summary-Guide_-Final.pdf

- **Hybrid Electric Central Hydronic Heating.** This "hybrid" approach involves complementing fossil-fuel fired central hydronic boilers with central air source heat pump (ASHPs). In certain situations, especially during extremely cold weather, central heat pumps may be unable to meet a building's entire heating demand. In this hybrid approach, the building primarily relies on the central heat pump system for heating but maintains a gas-fired system to provide additional heating when outdoor temperatures drop too low for the heat pump to meet the heating requirements. Hybrid systems enable buildings to retain a central system, while still achieving a significant GHG reduction. [10]

Heat Pump Make Up Air (MUA) Systems

MUA systems deliver tempered (i.e. heated) outdoor air to the hallways and other common areas of the building to "make up" for heat lost via local exhaust from suites. Heat pump MUA systems are a viable solution for electrifying these systems and are increasingly being installed in BC. While standard gas MUA systems are rated 80% efficiency and are often very oversized, heat pump MUA systems are two to three times more efficient. Heat pump MUA units can also provide some cooling as well as heating and in some cases can be a cost-effective way to reduce building greenhouse gas emissions. When a heat pump MUA system is well-designed, it can be "right sized" to reduce capital costs, operational costs, and excess heated air.

Heat Pump Water Heaters (HPWH)

HPWHs heat water instead of indoor space. CO_2 HPWH systems are emerging as the most viable solution for electrifying central natural gas domestic hot water heating systems. This is because they can operate in lower outdoor air temperatures (~-25 °C), are modular with larger systems available, and use CO_2 as a coolant, which has much lower global warming potential (GWP) than other refrigerants[11]. Electrifying central domestic hot water with CO_2 heat pump hot water system retrofits has proven successful in BC and other locations like New York City and California. Prior to upgrading any equipment, it is recommended that fixtures (e.g. shower heads) be upgraded to reduce hot water consumption.

Text Box 5. Heat Pump Retrofits in Cold Climates

Retrofitting buildings with heat pumps in colder zones offers significant potential for energy and greenhouse gas emission reductions. However, in cold climate retrofits, heat pump technologies may face limitations due to reduced efficiency in lower temperatures. Cold climate heat pumps operate within defined minimum temperatures, typically -15 to -30°C, and when temperatures drop below this range, auxiliary heat is needed. Hybrid systems, combining heat pumps with gas or electric backup, ensure continuous heating during low temperatures. While heat pumps can operate without backup in Climate Zones 4 and 5, supplementary heating may be required in Climate Zone 6 and higher. Recognizing these constraints and strategically deploying hybrid systems is crucial for optimizing heat pump effectiveness in cold climates.

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[10] FRESCo. *MURB Retrofits: Opportunities for Electrification*. https://landlordbc.ca/wp-content/uploads/2021/06/FRESCo_MURB-Retrofits-Summary-Guide_-Final.pdf

[11] The Global Warming Potential (GWP) metric examines each greenhouse gas's ability to trap heat in the atmosphere compared to carbon dioxide (CO2).

3.2 Forthcoming Regulations and Policies

There are a number of key regulations that will drive the uptake of electrification technologies of the new and existing building stock, including affordable housing.

- **Zero Carbon Step Code (2023):** The BC Zero Carbon Step Code is a new regulation introduced as part of the 2023 BC Building Code updates that limits GHG emissions from new construction. Local governments can now voluntarily implement requirements for buildings to meet any of the four carbon performance levels of the code –measure only, moderate, strong, or zero. The provincial government has also committed to phasing in these requirements beginning in 2024 and achieving a zero-carbon performance level by 2030.
- **Province of BC Alterations Code (2024):** Although the details for BC's Alterations Code have not been formally released. It is anitcipated they will require prescriptive energy performance improvements at the time of renovation for existing buildings. The energy performance improvements will vary based on the scope of the renovation. Minor repairs and like-for-like replacements will likely be exempt from the Alterations Code requirements. In contrast, significant renovations may be required to meet the prescriptive energy requirement equivalent to the current building code.
- **Province of BC Highest Efficiency Equipment Standards (2030):** As outlined in the CleanBC Roadmap to 2030, the BC's Highest Efficiency Equipment Standards will require all new space and water heating equipment sold and installed in BC to be at least 100% efficient by 2030. This regulation will effectively require heat pumps, electric baseboard heating, or hybrid electric heat pump and natural gas systems for all new and replacement heating systems beginning in 2030, as conventional boilers and furnaces cannot exceed 100% efficiency.
- **City of Vancouver Carbon Pollution Limits (2030):** The City of Vancouver has committed to implementing carbon pollution standards for existing buildings. This requirement sets a maximum carbon intensity for existing buildings. Buildings whose emissions exceed this carbon limit will be required to retrofit to improve performance. MURBs over 4,645 m^2 (50,000 ft^2) will have to begin reporting on energy and carbon emissions in 2026. The timeline for implementing regulations for this building type has not been announced.
- **Metro Vancouver Carbon Pollution Limits (TBD):** Metro Vancouver is also pursuing GHG regulation for existing buildings outlined in their Clean the Air Plan and Climate 2050 Buildings Roadmap. Like the City of Vancouver, this requirement is expected to set a maximum carbon intensity for existing buildings. Buildings whose emissions exceed this carbon limit will be required to retrofit to improve performance. Details on implementation timelines, targets, and metrics have not been announced.

Text Box 6. BC Housing Targets and Guidelines

BC Housing is also driving electrification and early adoption for social housing buildings they own, manage and fund, using the following targets and guidelines:

- **BC Housing Retrofit Targets (2023):** In 2023, BC Housing created internal policy for buildings they own and/or manage to reduce emissions from each retrofit project by 50% (relative to current emissions level).
- **BC Housing Design Guidelines and Construction Standards:** BC Housing's current new construction guidelines state that most projects must meet a Greenhouse Gas Intensity (GHGI) limit of 3kgCO2/m^2 or be fully electric.

A number of supporting policies and incentives are also being offered to drive early adoption and prepare industry for forthcoming regulation (see Table 1).

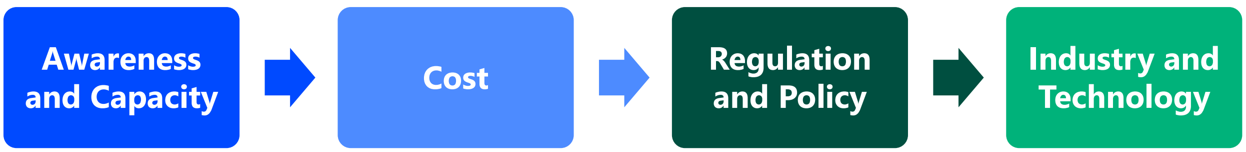
Table 1. Existing Funding Programs

Existing Funding Programs	**Eligible Buildings**		
	BC Housing	**Non-profit Housing**	**Market Rental**
BC Housing Capital Renewal Fund	✓	✓	
BC Housing Energy Efficiency Retrofit Program (EERP)		✓	
Clean BC Social Housing Incentive Program (SHIP)	✓	✓	
BC Hydro Social Housing Retrofit Support Program (SHRSP)	✓	✓	
BC Hydro Energy Conservation Assistance Program (ECAP)	✓	✓	✓
BC Hydro Low Carbon Electrification Program	✓	✓	
Vancity Non-Profit Housing Retrofit Program	✓	✓	
CleanBC Custom Lite Program	✓	✓	✓
CleanBC Custom Program	✓	✓	✓
CleanBC Commercial Express Program	✓	✓	✓
Clean BC Indigenous Communities Conservation Program		✓	
Green Municipal Fund Sustainable Affordable Housing Offer	✓	✓	
CMHC Preservation Funding for Community Housing	✓	✓	✓
CMHC National Housing Co-Investment Fund: Renovation	✓	✓	✓
CMHC Canada Greener Affordable Housing	✓	✓	
Natural Resources Canada Greener Homes (low-rise MURBs)	✓	✓	✓
BC Government Clean Buildings Tax Credit		✓	✓
BCNPHA Non-Profit Resilient Retrofit Grant Program		✓	
City of Vancouver Rental Apartment Retrofit Accelerator			✓
CMHC MLI Select	✓	✓	✓
BCNPHA Retrofit Coaching		✓	
Government of Canada Clean Technology Investment Tax Credit			✓

3.3 Barriers to Electrification

Despite their many benefits, as well as the increasing availability of technology, there remain a number of barriers that building owners and managers face in implementing electrification retrofits. These barriers will not be applicable to every building, nor are they insurmountable. However, addressing these barriers will reduce the time, effort and costs associated with electrification projects, and improve their effectiveness.

At a high level, these barriers fit into four main categories: awareness and capacity, cost, regulation and policy, and industry and technology.



3.3.1 Awareness and Capacity

- **Time and experience.** Retrofit projects are complex to initiate, approve, and manage. Landlords, co-op boards, and non-profit housing societies often lack the knowledge, experience, and time that is needed to get these projects off the ground. They are also juggling many urgent and competing priorities, and proactively electrifying building systems rarely rises to the top of this list.
- **Emergency replacements.** Many buildings continue to implement like-for-like replacements of existing systems when they are nearing the end of their life, or at the time of failure. Once the equipment has failed it's often too late to complete an electrification project, as these projects require longer timelines.
- **Inadequate information.** Many smaller building owners, co-ops and housing societies are unaware of forthcoming regulations that are going to drive decarbonization of existing buildings (e.g. Carbon Pollution Limits), and are not factoring this information into their short or long-term capital planning.
- **Targeting electrification for low-income households.** Low-income people live in a wide range of building types with different ownership structures, making it difficult to identify and target low-income households with electrification programs.

3.3.2 Costs

- **Cascading retrofit costs.** Many owners experience a growing list of costs and upgrades once a retrofit is underway. Issues that can arise through an electrification project – including mould and asbestos remediation, ventilation upgrades, and energy efficiency improvements – can add significant costs and are generally not included in incentive programs.
- **Electrical capacity upgrades**. One of the common barriers that residential and commercial building owners face in electrifying buildings is the need for a distribution system upgrade if they do not have adequate power to meet the additional load on their site. Currently, the cost is determined based on the "cost causation principle." That is, those who initiate an infrastructure upgrade must pay for it. Determining these costs – which are critical to determining the feasibility of a project – requires basic design and the payment of a deposit to BC Hydro. The process can be time consuming, costly, and unpredictable — to the point that it can make an electrification project financially unviable.[12]

[12] Note: BC Hydro is currently in the process of updating the *Distribution Extensions Policy*, which should address many of these issues.

- **Increasing utility bills resulting from electrification.** There are several examples of electrification projects in the affordable sector that resulted in increases in utility bills. This can be a result of the relatively lower cost of natural gas compared to electricity, improperly installed or sized systems, highly inefficient buildings, and/or the use of inefficient electric heating (like electric resistance heating). Where such costs are significant, it can result in financial hardship for building owners and occupants. Many non-profit housing providers have expressed a need for post-retrofit financial support options for repairs, commissioning, or to cover additional utility costs in the short-term.
- **Increasing O&M resulting from electrification.** Electrification projects can also result in an increase in operation and maintenance (O&M) costs; for example, the need for maintenance staff to more frequently access suites to change filters in HRVs or mini-split heat pumps. In some rural, remote and northern communities, limited access to local trained technicians for servicing heat pump can also increase O&M costs.
- **Complexity of incentive and financing landscape.** While there are several incentive programs for social and low-income housing, these have proven to be insufficient in achieving the necessary rate of retrofits. These existing incentive programs can be complex to navigate, have conflicting timelines and/or criteria, and may not be "stackable". This results in the creation of an administrative and time-consuming task that building owners and managers may not have the time or capacity to take on.

3.3.3 Regulation and Policy

- **Access to data**. Many building owners face barriers in accessing historical utility data (i.e. KW demand) that they need to complete electrical load capacity calculations.
- **Permitting timelines.** A building retrofit project can, in some cases, lead to additional upgrades being required throughout the building. Although these requirements are often important for the ongoing safety and reliability of the building, they can cause long delays as building owners navigate one or multiple permit applications with long approval timelines.
- **Equitable cost allocation between landlord and tenants (limited by RTA).** Recuperating capital costs associated with electrification is a challenge for landlords as the Residential Tenancy Act (RTA) limits rent increases and the ability to shift utility costs to tenants, without applying for an Additional Rent Increase (ARI) for Capital Expenditures from the Residential Tenancy Branch (RTB) (see box). From the landlord's perspective, the ARI is a time-consuming process that may not result in a sufficient change in rent to cover their costs. Meanwhile, many tenants cannot afford a rent increase and often perceive the eligible expenditures as too vague. For example, as there are no metrics associated with the level of GHG or energy reductions that need to be achieved, any minor improvement resulting in any energy or GHG savings could result in a rent increase.

Text Box 7. Additional Rent Increase

Additional Rent Increase (ARI) for Capital Expenditures allows landlords to apply for an additional rent increase (on top of the allowable annual rent increase) to recoup the costs of necessary capital expenditures in the property. If successful, the RTB's decision will set out the eligible rent increase based on a formula, which factors in the amount of eligible capital expenditures and the number of dwelling units, amortized over a 10-year period. The additional rent increase will be capped at a maximum of 3% per year (plus the annual rent increase) for a maximum of three years. For a capital expenditure to be eligible, it must be made for the purpose of:

- Maintaining, repairing, or replacing a major system or component such as electrical, mechanical, or structural that is necessary or,
- Reduces greenhouse gas emissions or energy use or,
- Improves the security of the rental property.

Ineligible expenditures include:

- Repairs needed as a result of inadequate repair or maintenance by the landlord.
- Expenditures where the landlord has recouped the cost from another source.

3.3.4 Industry and Technology

- **Access to qualified installers.** A lack of qualified heat pump installers and designers with experience working on MURBs and affordable housing throughout the province is leading to poorly designed systems (that may need to be replaced before the end of their lifespan) and increasing costs. This is an issue throughout the province, but can be particularly challenging in northern and rural communities.
- **Technology gaps.** Although there are several technologies available in BC to support electrification, technology gaps that need to be addressed for specific use cases and building types include:
    - Limited availability of cost-effective central hydronic heat pump solutions in the marketplace. This includes the limited capacity of experienced contractors to install the systems and engineers to design the systems.
    - Limited selection of smaller heating capacity in-suite heat pump systems suitable for installation in small apartment suites, small homes, and rooms within homes or apartments.
    - Limited availability of all-in-one heat pump technologies that are high efficiency, cold climate rated (down to -30°C) and operate at a sufficiently low noise rating.

Text Box 8. Portable AC Units

Portable air conditioners are being purchased at a rapid rate by BC residents of all income levels as an emergency measure to improve comfort in warm weather and life-safety in extreme heat events. Although portable air conditioners are lower cost, they are more of a short-term *band-aid* solution to provide temporary air conditioning, rather than a long-term cooling solution. In-suite or centralized heat pump technologies will provide more efficient, effective, consistent, affordable and reliable cooling.[13] The limitations of portable AC units include:

- **Low efficiency.** Portable AC units are low efficiency and will use more electricity than other similar sized AC units. If the hours of use are high, portable AC systems may be expensive to operate.
- **Limited cooling capacity.** Portable AC units have limited effectiveness at providing cooling and in buildings prone to overheating or in extreme heat events may not provide sufficient cooling for vulnerable individuals.
- **Limited cooling coverage.** Due to their size and limited cooling capacity, portable AC units can usually only cool a small area. It may be necessary to use several units to cool a large space or multiple rooms. Multiple portable air conditioners will use more energy and cost more than operating a heat pump system.
- **Noisy operation.** Portable AC units can be very noisy and are not the best option for use in rooms where people are trying to sleep, work, watch TV or enjoy a quiet space.
- **High maintenance.** Portable AC units create condensation. Unless installed with a drain hose, the condensation is directed to a drain pan. If used continuously, the drain pan may need to be emptied as frequently as every few hours or multiple times a day/night.
- **Venting through window.** Portable AC units require exhaust venting through a window. The 'do-it-yourself' installation of the venting is often not well sealed and may result in heat filtering into the home and/or air-conditioned air leaking out of the home.
- **Lifespan.** Portable AC units have the lowest lifespan of all AC types, from 5 to 10 years.[79]

3.4 Addressing Risks to Renters

The barriers outlined above largely capture the building owner's perspective of electrification. However, it is also critical to understand the impacts on tenants and residents. Unlike social housing, market rental buildings do not have a mandate to provide affordable housing, and prices are driven by market forces. This makes low-income tenants in market rentals more vulnerable to potential impacts of renovations. Following engagement with renter organizations, the following concerns with electrification projects were identified:

- **Renoviction and Demoviction.** There have been changes to the RTA in recent years to protect tenants from renovictions and demovictions. Under the current process building owners require RTA approval, all permits to be in place, and 4 months' notice before ending tenancy for renovations. It is also expected that most electrification retrofits, which may also be done in conjunction with other upgrades (e.g. window replacements) can be done without tenant displacement. However, through the engagement, there were reports of ongoing renovictions through alternate mechanisms (i.e. family member moving into the unit) and demovictions. As noted, low-income residents may be more vulnerable to illegal evictions as they may not have the same awareness of rights or access to resources to enter into an arbitration process with the landlord.

[13] FRESCo. (2023, April). *MURB in-suite air-source heat pump.*

- **Incentives to landlords may not result in benefits to tenants.** If incentives are increased for market rental buildings, consideration needs to be made for how these programs can be designed to ensure tenants reap some of these benefits as well.
- **Overheating is an increasing issue for low-income renters**. Overheating is an urgent and critical concern for MURB dwellers, specifically low-income residents and other vulnerable groups.
- **Basic building condition improvements**. Many low-income renters have faced a variety of issues such as vermin and mould that also need to be addressed in conjunction with any upgrade.
- **Power imbalance between landlords and tenants.** Low-income tenants often feel they have little power or ability to request upgrades or improvements for fear of repercussions (e.g. displacement, rent increase, etc.).

Text Box 9. Barriers by Housing Subsector

The following unique barriers also emerged for each of the housing subsectors:

- **BC Housing owned and operated buildings** are required to spend retrofit funding within a limited time frame. These time constraints may not align with timelines for more complex electrification solutions.
- Some **non-profit housing societies** don't have operating agreements with BC Housing and therefore have less access to capital and support when pursuing retrofit projects. These housing societies are generally small and, in many cases, have been deferring routine maintenance, making them in need of significant repairs.
- **Non-profit co-op** retrofit projects can be difficult and time consuming to initiate and approve as the decision-making authority rests with the entire membership, who may have little knowledge or experience with low-carbon retrofits. They are also often restricted from taking on additional debt if they already have a mortgage, even if payback and incentives are generous.
- **LIMR** buildings face the split incentive issue more acutely than the other building types. Traditional leasing agreements create "split incentives" between owner and tenant, in which capital improvements that yield energy savings result in one party paying for improvements while the other party receives the benefits of reduced utility costs. Furthermore, it is assumed that many of the units are in older MURBS with independent (mom-and-pop landlords), and these owners tend to have very low capacity to take on retrofits and are resource intensive to target through outreach and engagement.
- There are also limited electrification incentives available for market rental buildings (compared to social housing). They may qualify for some of the programs targeted at large buildings, however, these tend to be designed for commercial building owners, and smaller residential buildings may not qualify or face a number of barriers to entry. Fortis BC has more generous and easier-to-access gas incentives for market rental buildings, including a free energy audit which has been an effective entry point for gas retrofits.

4 Key Strategies

A comprehensive suite of actions to drive electrification is needed to address the financial, regulatory, technical, and social realities of the affordable housing sector. The following actions are designed to meet the needs of affordable housing residents and owners, and have the potential to create significant co-benefits and drive market transformation, while supporting populations most vulnerable to the impacts of climate change.

The key strategies and objectives outlined below represent the main drivers for equitable electrification for the affordable housing sector. For a list of detailed actions, timelines, and proposed lead and supporting organizations see Section 6.

Key Strategy #1: Create Market Demand

Objectives

1. Create and tailor electrification requirements for affordable housing
2. Raise levels of consumer awareness about the benefits of electrification
3. Increase transparency through energy and GHG benchmarking

The implementation of targets, requirements and information campaigns can create market demand by (1) clearly signaling future requirement to building owners, (2) providing information on the benefits and opportunities of electrification, and (3) informing short- and long-term capital planning decisions.

There are a number of forthcoming local and provincial regulations that are expected to come into effect in the coming years for all building types. Social and LIMR housing should be prioritized for early adoption of these regulation, as opposed to receiving exemptions of extensions.[14] For governments, providing generous funding to support early adoption for the affordable housing can support climate and affordability objectives, while increasing market readiness for other building types. Conversely, exempting affordable housing from regulations (or providing leniency) will exclude low-income residents from the range of benefits that result from electrification. Regulations need to be designed with explicit considerations for the LIMR and social housing sector to ensure they do not result in adverse affordability impacts.

Key Strategy #2: Improve Cost Competitiveness and Affordability

Objectives

1. Increase access to incentives and financing
2. Streamline and simplify retrofit process for building owners and managers
3. Level the playing field between electric and natural gas costs
4. Reduce electricity connection and system upgrade costs, and timeline delays

The upfront cost of electrification projects is often a barrier for building owners, especially if the electrification project triggers the need for an electrical service upgrade or other improvements (e.g. mould or asbestos remediation, or ventilation). Building owners need easy to access and streamlined incentive programs to support electrification retrofits and complementary measures. This includes ensuring that the incentives for electrification

[14] In jurisdictions with existing building decarbonization requirements (i.e. building performance standards) there are two common approaches to mitigate affordability impacts: (1) provide leniency and longer timelines for affordable housing, (2) increasing incentive and support programs to enable affordable housing to meet requirements without adverse equity impacts.

are competitive with equivalent programs for natural gas equipment, and building owners have access to coaching and guidance from a retrofit professional throughout the project.

In some cases, building owners also require support after a retrofit project is complete to address unintended consequences, mainly higher utility costs that can result from poor system design, low quality installations, improperly sized equipment, highly inefficient buildings or ineffective operation and maintenance practices. These issues could be addressed by programs that set standards for system design and quality installations and post retrofit support programs that include resources, incentives for commissioning on ongoing technical support, and emergency funds for repairs or to cover additional utility costs. This support will help ensure positive retrofit outcomes and mitigate potential equity impacts.

Key Strategy #3: Preserve Affordable Housing

Objectives

1. Strengthen affordability and tenant protections through electrification projects
2. Increase data and transparency on low-income housing stock

Carefully designed policies can ensure that affordability and climate action objectives are achieved in concert –and not seen as competing priorities or necessary trade-offs. This lens has been used throughout the Roadmap, however, there are a few key policies that can be used to strengthen the protection of affordable housing and create a stronger foundation for equitable electrification. Policies to protect and restore affordable housing units, include increasing the supply of the non-profit building (e.g. providing financing and incentives for transitioning existing housing units into the non-profit sector), strengthening rent controls, and including anti-displacement measures in incentives and regulations.

For the low-income housing stock, one of the biggest challenges is the lack of data and transparency to identify these units. Monitoring the impacts electrification has on this building stock will require better insights on rental rates, vacancy, and basic building conditions.

Key Strategy #4: Expand Industry Capacity and Technology Availability

Objectives

1. Build industry knowledge, capacity and competence
2. Address equipment and technologies gaps for MURBs

There is a lack of skilled designers and installers, and equipment and technology to support the scale of electrification needed throughout the province. This issue is not isolated to social and low-income housing but applies to the entire MURB sector (and the broader building sector). Increasing training and outreach, standardizing electrification processes, and creating guidelines, templates and datasets targeted at the needs of the low-income and social housing sectors will help expand industry capacity, knowledge and competence.

Increasing access to a range of technologies and products to suit social and low-income buildings will help expedite timelines and improve the quality of installations by ensuring that proper equipment is being used. Existing technology gaps include low Global Warming Potential (GWP) heat pumps, hydronic heat pumps, small capacity in-suite heat pump units, and all-in-one heat pumps capable of operating efficiently in cold climates.

4.1 Sequencing and Prioritizing Actions

Key actions of the Roadmap are sequenced over a 7-year period with incentives and other supports being gradually replaced by regulations. This is an ambitious timeline that will require the rapid ramp up of incentives, support, training and education beginning in the short-term. Figure 7 provides an overview of the sequencing of the key strategies and objectives in the Roadmap, with short-, medium-, and long-term priorities.

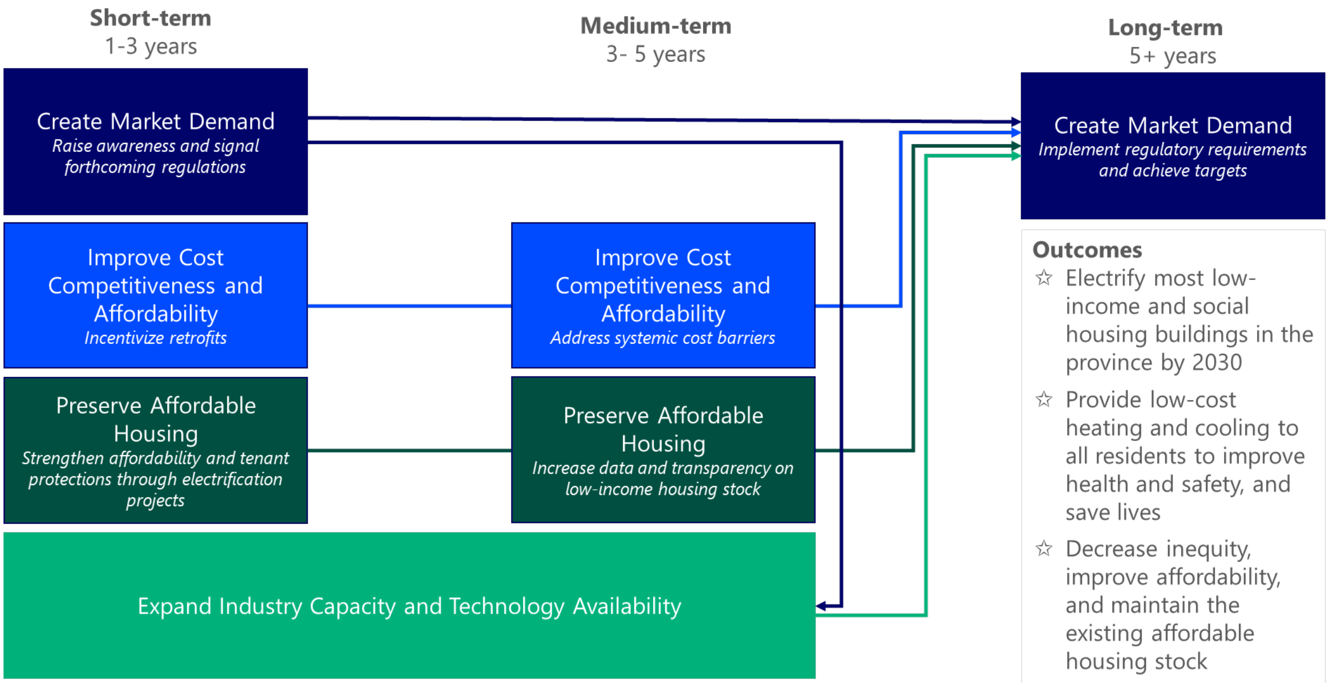


Figure 7. Sequencing of Key Strategies

5 Implementation

The actions in the Roadmap have been developed with significant input from key organizations, which has resulted in general alignment and support. This does not, however, signal a formal commitment to implementation for any of the organizations involved. Ongoing collaboration, partnerships, advocacy, tracking and refinement will be needed to achieve equitable electrification for affordable housing sectors. Initial funding will be provided for the creation of a committee to oversee the coordination and implementation of the Roadmap. Developed through stakeholder engagement, the following recommendations are intended to help guide the development of the implementation committee and other actions to drive and support implementation.

- **Involve relevant stakeholders.** Include broad representation on the implementation committee (e.g. government, utilities, BC Housing, non-profit housing societies, non-profit housing co-ops, landlord and tenant organizations, financial institutions, non-profit and industry organizations, and health authorities). These organizations have deep knowledge and experience, and many are leading initiatives related to action areas in this Roadmap. Broad participation will ensure that past and existing work is being leveraged, and actions are being rolled out in a way that is suitable for building owners, tenants, and residents of LIMR and social housing. Many of these organizations were engaged throughout this project and expressed interest in participating in its implementation.
- **Use short-term sub-committees.** Sub-committees can be used, on an as needed basis, to gain additional insights from technical experts or impacted groups. Sub-committees can ensure the right expertise is being leveraged to address the broad range of actions in the Roadmap and can complement a broader implementation committee focused on higher-level issues.
- **Secure funding.** Ongoing funding will be needed to support the Roadmap implementation. Funding can be sought for overarching coordination, as well as for the development and implementation of specific actions or streams of work. This will help draw on multiple funding sources and enable several organizations to lead discreet pieces of work.
- **Seek government ownership and involvement.** Ensuring government involvement and ownership in the process will support efficient development of achievable policy actions. Provincial participation should include relevant ministries and crown corporations, such as BC Ministry of Energy, Mines, and Low-Carbon Innovation; BC Ministry of Social Development and Poverty Reduction; BC Ministry of Housing; BC Hydro; and BC Housing.
- **Create advocacy campaign.** Ongoing advocacy can help increase awareness, obtain commitments, and ensure accountability. Advocacy, however, may not fit under the broader implementation committee. Instead, it could be included in existing advocacy initiatives, or as its own campaign. Successful advocacy will require a coordinating organization, consistent messaging, and clear accountabilities.
- **Create public communication and outreach material.** Public communication of the Roadmap's objectives and progress will help increase buy-in and transparency. Public facing communications such as op-eds, interviews, annual progress reports, and other materials can be used to reach different audiences. Likewise, communications with other jurisdictions across Canada and North America can help support shared learnings, and innovation.
- **Align with existing initiatives.** As noted, this Roadmap builds off, and aligns with, the Building Electrification Roadmap (BERM). Coordinating the implementation, oversight and tracking of the two roadmaps will help avoid duplication and maintain alignment.
- **Revise and share lessons learned.** The Roadmap should be treated as a living document and receive regular updates and revisions as new information emerges and context continues to evolve.

6 Roadmap Overview

The following section outlines key strategies, objectives and actions that make up this Roadmap. Some of the actions outlined are already underway, whereas others will need to be implemented on a longer timeline. This Roadmap structure is designed to align with the Building Electrification Roadmap. Where it made sense, the same key strategies and objectives have been used, with actions specifically tailored for the low-income and social housing sectors.

Legend

Applicable Buildings

- BCH – BC Housing
- SH –Social Housing
- LIMR –Low-income market rental

Impacts

- Increased rate of electrification
- Improved equity, affordability, and protections for tenants
- Improved climate resilience through access to cooling and ventilation
- Improved business case for landlords, housing providers and co-ops

Timeline

- Short-term – 1-3 years
- Medium-term – 3-5 years
- Long-term – 5+ years

Key Strategy #1: Create Market Demand

Objective	Proposed Actions	Applicable Buildings	Impacts	Proposed Lead/ Supporting Organization	Timeline	Ongoing work
1.1. Create and tailor electrification requirements for affordable housing	**1.1.1.** Set decarbonization targets (tied to accessing funding) for social housing, including: • all new construction social housing to begin installing efficient electric heating and cooling by 2025 • all existing social housing buildings to install efficient electric heating and cooling by 2030	BCH, SH		BC Government, BC Hydro, BC Housing, FCM, CMHC, etc.	Short-term	BC Housing's Design Guidelines and Construction Standards require most new projects to have a lower GHGI limit of 3kgCO2/m2 or fully electric (if possible). BC Housing has committed to all retrofit projects targeting a 50% GHG emissions reduction relative to current emissions levels
	1.1.2. Support social housing and low-income housing in achieving forthcoming regulations (i.e. Carbon Pollution Limits the City of Vancouver and Metro Vancouver, BC's Highest Efficiency Heating Standards) by: • ensuring regulations are designed to address and mitigate equity impacts[i] • earmarking funding to create a dedicated financial hardship fund to support buildings that face financial constraints in achieving compliance[ii]	BCH, SH, LIMR		BC Government, City of Vancouver, Metro Vancouver	Medium-term	
	1.1.3. Explore aligning electrification initiatives with potential "Right to Cool" regulatory / legislative change.	BCH, SH, LIMR		BC Government, Vancouver Coastal Health, BC Housing, BC Hydro	Medium-term	Vancouver Coastal Health released a policy paper in April 2023, "Policy Tools To Create and Support Cooler, Safer Indoor Living Spaces" Metro Vancouver, City of Vancouver, City of North Vancouver and Vancouver Coastal Health are partnering on a project to look at near, medium- and long-term actions to reduce heat-related health harm in MURBs, and the intersection between increasing cooling and decreasing

						overall building emissions. Findings will be available in 2024.
1.2. Raise levels of consumer awareness about the benefits of electrification	**1.2.1**. Create targeted information and outreach campaigns outlining forthcoming regulations,[iii] their implications for LIMR and social housing, and the value proposition for electrification.[iv] Create separate materials for market rental landlords, non-profit housing societies, co-ops, and tenants.	BCH, SH, LIMR		BC Government, BC Hydro and BC Housing, in partnership with member associations (i.e. BCNPHA, AHMA, LandlordBC, CHF BC)	Short-term	Member associations have a number of ongoing initiatives and resources (e.g. LandlordBC MURB electrification retrofit resources, BCNPHA Roundtables, Housing Updates, RENTs, Online Learning Events, Housing Central Conference, etc.)
	1.2.2. Create best practice guidelines for: • landlords and building operators to support tenant engagement and awareness of electrification. • tenants in approaching landlords to discuss energy efficiency, electrification, thermal comfort, and need for cooling.	BCH, SH, LIMR		Member associations (i.e. BCNPHA, AHMA, LandlordBC, CHF BC) and BC Housing with support from BC Hydro and BC Government	Short-term	BC Housing created tenant engagement tools in 2012. BCNPHA is currently working with "Ready to Rent" to update their curriculum.
	1.2.3. Create courses,[v] networks and events for market rental landlords, non-profit housing societies, and co-ops (including those in northern communities) to share lessons learned and best practices on building electrification.	BCH, SH, LIMR		Member associations (i.e. BCNPHA, AHMA, LandlordBC, CHF BC)	Short-term	Member associations have a number of ongoing initiatives (e.g. BCNPHA Roundtables, Housing Updates, RENTs, Online Learning Events, Housing Central Conference, etc.)
1.3. Support transparency through energy and GHG benchmarking	**1.3.1.** Provide benchmarking support for social housing, and low-income market rental buildings for voluntary and mandatory programs (e.g. cohort model, help desk, outreach, webinars, subsidized third-party support, work with utilities to facilitate data access, etc.).[vi]	BCH, SH, LIMR		BCNPHA, AHMA, CHFBC, LandlordBC, BC Hydro, Fortis BC, PNG, BC Government, local/regional governments	Medium-term	CHF BC and BCNPHA are providing benchmarking support for social housing. LandlordBC is providing benchmarking support for rental housing in the City of Vancouver. Vancity provides support to business members.
	1.3.2. Use benchmarking and other data to help identify building owners/operators with heating systems nearing the end of their lifespan, and create a targeted outreach plan to reduce 'like-for-like' emergency replacements.	BCH, SH, LIMR		Member associations (i.e. BCNPHA, AHMA, LandlordBC, CHF BC), BC Housing, BC Government, BC Hydro.	Medium-term	BC Housing, BCNPHA, and AHMA have building-level data that could support this identification and outreach.
	1.3.3. [Broader MURB action] Require utilities to share aggregated whole building energy use data for benchmarking through a simple and streamlined process.	BCH, SH, LIMR		BC Government in partnership with utilities (BC Hydro, FortisBC, PNG, etc.)	Short-term	BC Hydro is currently working to improve this process.

Key Strategy #2: Improve Cost Competitiveness and Affordability

Objective	Proposed Actions	Applicable Buildings	Impacts	Proposed Lead/ Supporting Organization	Timeline	Ongoing work
2.1 Increase incentives and financing	**2.1.1.** Create targeted incentive programs for low-income market rentals delivered through accessible, flexible, timely, and streamlined processes. Explore funding options, including direct install projects prioritized based on the provision of and commitment to long-term affordability; and providing tax incentives.[vii]	LIMR		BC Government, BC Hydro, CMHC, FCM, NRCan,	Medium-term	Clean Buildings Tax Credit provides an income tax credit for energy efficiency improvements. The credit amount is 5 percent of qualifying expenditures paid on the retrofit.
	2.1.2. Offer alternative financing low-interest long-term mechanisms for social and low-income housing.[viii] Financial tools should: • be designed to address constraints of mission-driven, non-profit, and individual and small business building owners • provide flexibility in the range of measures they can support • minimize or prevent first costs from being passed onto tenants and include anti-displacement measures • pool public, private and philanthropic funds • have competitive rates and terms; and be leveraged to increase affordability commitments at a level appropriate for the amount of support received	SH, LIMR		BC Government, FCM, CMHC, and financial institutions with program design/ administration support from member associations (i.e. BCNPHA, AHMA, LandlordBC, CHF BC)	Medium/ long-term	CMHC is currently working on financing program for rental buildings, and has developed a recommendations report. Through the Commercial Retrofit Financing program, Vancity can now provide preferred terms for low-carbon retrofits
	2.1.3. Increase funding for post-retrofit commissioning (e.g. include commissioning support through existing retrofit funding, and/or increase BC Hydro Continuous Optimization Program to include more social and LIMR).	BCH, SH, LIMR		BC Hydro, BC Government, BC Housing	Short-term	BC Hydro currently provides support through the Continuous Optimization Program
	2.1.4. Provide post-retrofit funding and support to social housing that experience increased utility bills or additional operations and maintenance costs as a result of electrifying their buildings.	BCH, SH, LIMR		BC Government, BC Housing, BC Hydro member associations (i.e. BCNPHA, AHMA, LandlordBC, CHF BC)	Short-term	

	2.1.5. [Broader MURB action] Explore opportunities for using a carbon credit scheme for social housing and low-income market rental buildings.	BCH, SH, LIMR		BC Government, BC Housing, BC Hydro, BCNPHA	Long-term	BCNPHA is exploring the application of a carbon credit scheme for social housing.
2.2. Streamline and simplify the retrofit process for building owners	**2.2.1.** Create a concierge program to support building owners and industry.[ix] The program should support building owners in assessing building performance, identifying and selecting retrofit measures, accessing financing and incentives, selecting contractors, and measuring impacts.	BCH, SH, LIMR		BCNPHA and LandlordBC with government funding partners (i.e. BC Government, BC Hydro, local governments, etc.), Vancity	Medium-term	City of Vancouver, CleanBC and BC Hydro have partnered with LandlordBC to deliver the Rental Apartment Retrofit Accelerator (RARA) Pilot for market rental housing. The City of Vancouver has also partnered with BCNPHA to deliver the Non-Profit Resilient Retrofit Grant program for non-profit housing. ZEBx/ZEIC is requesting NRCan funding to expand concierge service offerings across all building types.
	2.2.2. Explore opportunities to bundle retrofit projects to leverage economies of scale for social housing and LIMR. This could include aggregating buildings that are similar buildings within a region, and sharing one dedicated project manager who can align project procurement.	BCH, SH, LIMR		BCNPHA and LandlordBC with government funding partners (i.e. BC Government, BC Hydro, local governments, etc.), Vancity	Medium-term	
	2.2.3. Work with funders to better align grants, incentives and financing.[x] Ensure access to wholistic funding is available to address issues that may arise when electrifying (i.e. mould or asbestos remediation, or adding ventilation).[xi]	BCH, SH, LIMR		Funders (i.e. BC Hydro, BC Government, CMHC, FCM, Vancity, Local Governments, etc.)	Medium-term	CleanBC Better Homes and Better Buildings provides a centralized location to access provincial funding information.
	2.2.4. [Broader MURB action] Establish guidelines for common heat pump applications in MURBS and streamline the permitting processes and other bylaws that can impact heat pump applications accordingly.	BCH, SH, LIMR		BC Hydro, EGBC, HC Housing, Local Governments/AHJs	Medium-term	
2.3. Reduce electricity connection and system upgrade costs and timeline delays	**2.3.1.** Reduce the cost of electrical capacity upgrades in the short-term by: • creating incentives for electrical capacity upgrades in social and low-income buildings • streamlining access to historical utility data (min 1 year) to complete electrical load capacity calculation	BCH, SH, LIMR		BC Hydro, BC Government	Short-term	

	2.3.2. [Broader MURB action] Reduce costs of electrical capacity upgrades in the medium-term by: • changing cost structure for upgrades • assessing load reduction and management opportunities that mitigate the need for capacity upgrades. • exploring alternative methodologies for calculating electrical service • Identifying and proactively investing in upgrades in capacity constrained areas	BCH, SH, LIMR		BC Hydro, Technical Safety BC (TSBC), BC Government	Medium-term	Upgrades to BC Hydro's Distribution Extension Policy are underway. TSBC is also reviewing electrical load calculations, and load management programs and pilots are underway
2.4. Level the playing field between electric and natural gas costs	**2.4.1.** Ensure that electrification incentives and retrofit implementation support are more attractive than for natural gas equipment for affordable housing.	BCH, SH, LIMR		BC Government, BC Hydro, BC Housing	Short-term	Updates that are underway for DSM regulations is addressing the role of natural gas incentives.
	2.4.3. For BC Housing funded projects, require an independent 3rd party review for projects pursuing gas incentives to demonstrate they cannot feasibly electrify.	BCH, SH		BC Housing	Short-term	
	2.4.2. [Broader MURB action] Increase potential retrofit funding by standardizing the practice of quantifying the life safety and other non-energy benefits of electrification in utility regulatory filings and other funding programs (e.g., the value of cooling, and improved health and wellbeing).	BCH, SH, LIMR		BC Government, BC Hydro	Long-term	

Key Strategy #3: Preserve Affordable Housing

Objective	Proposed Actions	Applicable Buildings	Impacts	Proposed Lead/ Supporting Organization	Timeline	Ongoing work
3.1. Strengthen affordability and tenant protections in retrofit projects	**3.1.1.** Embed tenant protections into building decarbonization programs (e.g. affordability covenants, structures that allow owners to exit the market by selling to community supporting entities, include strong anti-displacement measures in any mandates, focus programs on stabilizing communities and keeping people in their homes).	LIMR		BC Government, local government in consultation with member associations (i.e. BCNPHA, AHMA, LandlordBC, CHF BC), TRAC, Poverty Reduction Coalition	Short-term	The BC Government established a $500 million Rental Protection Fund to convert market rental buildings into social housing. Efficiency Canada's recent report explores policy mixes that address the tension between energy efficiency and tenant rights.
	3.1.2. Explore methods for collecting information on rental rates, vacancy, and basic building conditions and components to enable the identification of affordable market rental buildings, compliance with health and safety standards, and monitoring of the affordability/equity impacts of electrification.[xii]	LIMR		BC Government, and local government in consultation with LandlordBC, TRAC, Poverty Reduction Coalition	Medium-term	

Key Strategy #4: Expand Industry Capacity and Technology Availability

Objective	Proposed Actions	Applicable Buildings	Impacts	Proposed Lead/ Supporting Organization	Timeline	Ongoing work
4.1. Build industry knowledge and competence	**4.1.1.** Support demonstration projects & develop case studies with costing data for social and LIMR throughout the province, including northern communities.	BCH, SH, LIMR		Member associations (i.e. BCNPHA, AHMA, LandlordBC, CHF BC) to lead targeted case studies with ZEBx, BC Hydro, BC Government support with funding and alignment with broader case study work	Medium-term	Reframed Initiative is working on deep retrofit demonstration projects for social housing. BCNPHA has created numerous case studies based on the over 1,000 retrofit projects that have been supported over the past 11 years. The Vancity Non-Profit Housing Retrofit Program's net-zero pilot is seeding case studies.
	4.1.2. Create a public template and dataset with a standard set of data points to support reporting on installation and operational costs associated with building electrification.[xiii,xiv]	BCH, SH, LIMR		Member associations (i.e. BCNPHA, AHMA, LandlordBC, CHF BC) with support from BC Hydro, BC Government	Short-term	BCNPHA has a dataset created over the course of 11 years of retrofit support work. There may be opportunities to share aggregate information.
	4.1.3. [Broader MURB action] Provide targeted training for contractors and engineers for working on low-income market rental and social housing.	BCH, SH, LIMR		BC Housing, and BC Hydro (Trade Alliance), EGBC, MCABC, in partnership with existing training providers	Medium-term	
	4.1.4. [Broader MURB action] Identify and promote best practices in heat pump design and installation for MURBs, such as establishing best practices criteria for selecting heat pumps for central systems and apartment suites - sizing, heating/cooling load size, selection of equipment (i.e., good turn down, low decibel rating, cold climate, etc.), and establishing guidelines for heat pump installations in cold climates, including identifying where and when hybrid systems may be necessary to provide back-up heating.	BCH, SH, LIMR		BC Housing, EGBC, MCABC, BC Hydro, Member associations (i.e. BCNPHA, AHMA, LandlordBC, CHF BC). Industry Associations	Short-term	BC Housing has created a number of design guidelines for industry members.
	4.1.5. [Broader MURB action] Create a pre-qualified list of contractors and engineers to work on social and LIMR projects to simplify	BCH, SH, LIMR		BC Housing, BC Hydro Trade Alliance) and BCNPHA with HPSC to	Medium-term	BCNPHA has an existing list of engineers, and contractors that

	the procurement process and improve QA/QC. Ensure contractors and engineers area available throughout the province including northern communities.			expand the existing registered contractor list.		they are continuing to work with to develop skills and expertise.
4.2. Identify equipment and technologies gaps for MURBs	**4.2.1**. Create a social and LIMR electrification alliance/network across North America.	BCH, SH, LIMR		BC Hydro, BC Housing, BC Government, and member associations (i.e. BCNPHA, AHMA, LandlordBC, CHF BC)	Medium-term	
	4.2.2. [Broader MURB action] Support the use of low GWP, and sealed refrigerant, heat pumps in low-income and affordable housing.	BCH, SH, LIMR		BC Hydro, BC Government, FCM, CMHC	Medium-term	
	4.2.3. [Broader MURB action] Increase the supply of smaller, lower-cost heat pumps suitable for suites, and bedrooms within MURBs.	BCH, SH, LIMR		BC Hydro and BC Government	Medium-term	The BC Heat Pump Attraction Strategy, commissioned by Vancouver Economic Commission and B2E looks at some barriers and possible solutions.

[ii] NEEP. Centring Equity in the Rules and Regulations of a Building Performance Standard. https://neep.org/sites/default/files/media-files/bps_and_equity_brief.pdf

[ii] In the US, many building performance standards requirements provide alternative compliance pathways, exemptions, extensions and additional supports for affordable housing. These include Washington DC, where affordable housing buildings can receive an extension for meeting BPS and are provided additional support through the Affordable Housing Retrofit Accelerator; and Boston where there is an equitable Emissions Investment Fund designed to help environmental justice populations in upgrading relevant buildings to improve energy performance.

[iii] i.e. Carbon Pollution Limits the City of Vancouver and Metro Vancouver, BC Highest Efficiency Heating Standards, and the Zero Carbon Step Code

[iv] Explore partnerships with public health organizations to promote using heat pumps to address overheating in low-income and affordable housing.

[v] Examples of topics: understanding your energy profile and carbon footprint, energy studies and assessments, how to compare electric and gas options, life cycle analysis (total cost of ownership), planning in advance of mechanical equipment failure, incentives and financing, developing a portfolio-level decarbonization roadmap, etc.

[vi] Example: The City of Edmonton provides technical support to buildings for participation in their voluntary benchmarking program. This includes, technical support and education on program participation, tenant energy literacy and energy management, and support accessing provincial efficiency incentive programs.

[vii] Minneapolis 4D program takes advantage of the state's 4d 40% property tax reduction for low-income properties as an incentive for market-rate building owners to keep rents affordable. In exchange for committing to maintain affordable rents, the city helps property owners apply for the 40% tax abatement. Properties qualify for this program if at least 20% of units have current rents that are affordable (30% of gross income) to households earning at or below 60% of Area Median Income (AMI) and the property owners agree to keep these rents affordable for a period of 10 years.

[viii] Many non-profit housing societies can't take on debt because they don't generate income to pay off the interest.

[ix] Example: Energy Savers Retrofits in Chicago is a collaboration between the non-profit Elevate Energy and Community Investment Corporation (CIC), a community development financial institution. The program provides a one-stop-shop for technical support, financial information, and underwriting for retrofit projects. The program combines public, private, and philanthropic dollars with the goal of preserving affordable housing.

[x] Example: New York City Affordable Housing Decarbonization Pilot Program will fund electrification activities in affordable housing, and will provide a streamlined funding process, by which affordable housing owners can access all NYSERDA incentives without additional administrative work.

[xi] Example: New York's Green Housing Preservation Program provides low and no-interest loans to conduct energy and water retrofits and lead and other rehabilitation. The program can provide up to $80,000 for retrofits per unit and can assist in securing additional funds and in contract management. In exchange, participants enter into an affordability agreement with the Housing Preservation Program.

[xii] Proactive rental inspections and rent registries are becoming increasingly popular across North America to ensure renters can access safe, healthy, and affordable homes. These proactive inspections also remove the onus from the tenant to monitor compliance and submit complaints. https://www.tenants-rights.org/wp-content/uploads/2022/03/PASH-Healthy-Homes-Pilot-Proposal-whitepaper.pdf

[xiii] Aggregated information from this reporting should be made publicly available to support stakeholder awareness on installation costs and operation costs

[xiv] In February 2022, Montreal implemented a mandatory housing registry for landlords with more than eight units, which includes a requirement to submit information on rental rates and vacancy, as well as prove that their building is in good condition and has had required inspections. The latter regulations was designed to help improve rental housing and shift the burden of proof of unit quality to landlords.

Appendix A: Summary of Best Technical Opportunities and Technology Gaps for Low-Income Electrification

Introduction

The electrification of affordable housing holds tremendous potential for promoting energy efficiency, reducing greenhouse gas emissions, and improving the quality of life of residents by providing cooling and improved ventilation. This summary identifies that there are viable building electrification opportunities available for domestic hot water, make up air ventilation and space heating and cooling. Key technology gaps are also identified including the need for advancements in central hydronic heat pump system technology, the need for more smaller sized in-suite heat pump technologies for small suites and homes and rooms within homes, and the need for advancements in all-in-one heat pump technologies (improved efficiency, improved cold climate rating, and lower noise).

Best Technical Opportunities

Domestic Hot Water Electrification

CO2 Heat Pump Hot Water Heater systems are emerging as the most viable solution for electrifying central natural gas domestic hot water heating systems. Electrifying central domestic hot water with CO2 heat pump hot water system retrofits retrofit has proven successful in BC and other locations like New York City and California.

There are two types of CO2 heat pump hot water systems:

- **Large Modular Array CO2 Air Source Heat Pump Water Heater:** Modular systems have many outdoor units mounted together, each of which looks superficially like a mini-split outdoor “fan box”. All refrigerant is contained inside each outdoor unit. Due to the unique characteristics of CO2 as a refrigerant they are effective at heating up cold water without auxiliary heating down to -25C.
    - For central systems, arrays of CO2 modular HPWH units are the most efficient option for providing hot water for multiple suites. The available product size range allows selection of the right capacity and flexible physical configuration to meet location constraints.
    - Pre-plumbed skid mounted systems are more expensive but avoid typical problems from unfamiliar mechanical designers and plumbers. If the units are not purchased in a pre-plumbed array, extreme caution needs to be taken to get proper design and connections; typical engineer and plumber experience with gas systems leads to problematic installations.
    - System benefits include high-efficiency and low-carbon, low-global warming potential refrigerants, cold climate, flexible placement of outdoor units, scalability, light weight, low noise, and simple field service.
    - Key limiting factors include availability of space for mounting arrays of the outdoor unit(s), and location for the storage tanks. Since the storage for heat pump DHW systems is much larger than typical gas DHW systems, space in existing mechanical rooms and roof structural capacity can be a limitation.

- **Large Central CO2 Air Source Heat Pump Water Heater:** Central domestic hot water (DHW) systems are electrified by replacing a central natural gas boiler central natural gas domestic hot water heater (typically a direct fired storage water heater or water heater and separate storage tank) with a large central heat pump and separate storage tanks.
    - Central DHW heat pump retrofits are more viable in buildings that already have a central hot water system, as adding a new central piping loop would be a disruptive and expensive retrofit.
    - Two large size CO2 DHW heat pump options are available now in the BC market. Although these are typically louder, heavier, more difficult to place and more expensive than CO2 modular systems, many designers prefer them due to their larger size.
    - With proper design and installation, its relatively straight forward to retrofit if there is an adequate location for the required storage tanks and enough electrical capacity.
    - System benefits include large size/capacity, high efficiency and low carbon, cold climate performance.

Make Up Air (MUA) Electrification

Heat Pump Make Up Air (MUA) systems are a viable solution for electrifying make up air units and are increasingly being installed in BC. MUA systems deliver tempered (heated) outdoor air to the hallways and other common areas of the building to "make up" for local exhaust in the suites.

- **Heat Pump Make Up Air (MUA):** Standard gas MUA systems are rated 80% efficiency and are often very oversized. Heat pump MUA systems are two to three times more efficient than standard gas MUA systems (or electric resistance systems), can provide cooling as well as heating and are one of the most cost-effective ways to reduce building greenhouse gas emissions. When a heat pump MUA retrofit is well-designed, more efficient equipment can be installed and the system can be down-sized to reduce capital costs, operational costs, and excess heated air. .
    - Since MUA systems are common in MURBs from the late 80's onwards, heat pump central MUA system can be installed in a wide variety of MURBs.
    - Key technical considerations that can be used to determine if a heat pump MUA system is the best option for building electrification retrofit include a) Is there sufficient electrical capacity for the electrification of the MUA system, and b) Is the building structure strong enough for the heavier ASHP MUA to be installed on the roof.
    - Heat pump MUA system benefits include strong economics, maximum efficiency, GHG reduction, no tenant disruption, and the ability to provide some central cooling.

In-Suite Space Heating

Electrification with **decentralized or "in-suite" heat pump technologies**, rather than central solutions, is emerging as an increasingly viable solution for both homes and multi-unit residential buildings.

- **Mini-Split Air Source Heat Pump:** This technology features an outdoor heat pump unit and one or more indoor units (indoor heads) that are connected by refrigerant lines. Each indoor mini-split unit has its own fan and evaporator coil and will independently service a single room or zone. Both ductless and ducted versions of multi-split systems are available to provide conditioned air to multiple rooms/zones by providing an indoor unit in each zone. Typically, two to four indoor units are installed on each outdoor unit split system.

- Mini-split air sources systems are very versatile and can be installed in a wide variety of low-income homes and buildings. In 2023, they are considered the most viable in-suite solution. Compared to other in-suite technologies, mini-split systems provide a broader heating and cooling capacity range, lower operating temperatures, lower sound ratings, and better performance compared to other technologies currently in the market. Mini-splits also have the best market availability, with a large number of brands and models available. Due to the large number of systems installed in the single-family residential market broad there is moderately high contractor capacity in with mini-split heat pump installations in BC (compared to other technologies currently in the market).
- Mini-Split system benefits include highest efficiency, cold climate models available to operate to -30 °C, ability to provide zonal heating and cooling, flexible installation options for indoor and outdoor units, and low electrical capacity model availability.
- Key technical considerations that can be used to determine if mini-split systems are the best option for a suite or for a whole building electrification retrofit include electrical capacity, placement options for indoor and outdoor unit, appropriately sized systems (small enough) for small suites and bedroom, placement of refrigerant lines, and addressing condensation disposal.

Other emerging in-suite heat pump options include:

- **All-in-One (AIO) Air Source Heat Pump:** AIO are high efficiency air-source heat pumps in a single-package design with no outdoor unit. The indoor unit is mounted on an interior wall and sealed to two small vents that pass-through penetrations in an exterior wall. Each indoor unit directly distributes heat into the room/zone where it is placed. AIO systems can meet the heating and cooling needs of an office, hotel room, apartment, or small dwelling, and they are ideal for smaller sized open space areas. Multiple systems can be installed for full suite or home heating and cooling.
  - System benefits include no outdoor unit, simple installation, low risk of refrigerant leakage, aesthetics and choice of models, cold climate models available and multiple functions.
  - System challenges include only two brands available in BC, limited contactor experience with installation, limited cold climate capacity (only to -15 degrees) and they emit higher noise levels than mini-split systems.
  - More products in this niche are anticipated in the future.
- **Ducted All-in-One Heat Pump.** Ducted All-in-One (Ducted AOI) systems are high efficiency air-source heat pumps with no outdoor unit and attached to an interior ducting system to distribute heat through multiple diffusers in multiple rooms. The indoor unit is attached to two external vents and is typically ceiling mounted.
  - Can meet the heating and cooling needs of multiple rooms or zones within an office, hotel room, or apartment. This technology is best suited for retrofit applications where there is sufficient ceiling high for framed-in ducting or where exposed ducting is aesthetically acceptable (i.e., loft apartments).
  - System benefits include no outdoor unit, ducted full-suite solution, low risk of refrigerant leakage, cold climate models available (to -15 degrees), multiple functions.
- **Central Hydronic Systems:** Central hydronic heating systems, fueled by gas or oil, are found in many BC MURBS built prior to the 1990s. Theoretically, electrifying a gas or oil boiler could be done simply by replacing the heating source with a central heat pump. However, many existing gas hydronic systems are

1) very old, past end of life, prone to hydronic pipe leaks (behind drywall), may have internal pipe blockages and have may have damaged emitters, 2) are high temperature systems which can be extremely difficult to provide with central heat pump systems.

- System benefits of central heat pump hydronic systems include the ability to avoid or limit work in the suites, they provide radiant heat rather than forced air, there is no need for new enclosure penetration, and they can provide central hydronic heating to all room within a suite with heat emitters.
- The system challenges of central heat pump hydronic systems include they are only feasible where the hydronic piping is in good condition, cooling through central hydronic is not recommended as 'chilled floors' are not comfortable, and cooling in uninsulated hydronic pipes could cause condensation and mould growth.
- As of 2022, only one example of a MURB retrofit with central hydronic heat pump, with the capacity to meet full heating loads, has been identified.

Technology-Specific Gaps

The key technology specific gaps for low-income building electrification identified are:

1. The current limited availability of cost-effective central hydronic heat pump solutions in the marketplace. This includes the limited capacity of experienced contractors to install the systems and engineers to design the systems.
2. The limited selection of in-suite heat pump systems suitable for installation in small apartment suites, small homes, and rooms within homes.
3. The limited availability of all-in-one heat pump technologies that are high efficiency, cold climate rated (down to -30°C) and operate at a sufficiently low noise rating.

2023 Summary Electrification Technology Solutions in BC

The table below presents an overview of the status of various heat pump technologies that can be used to electrify residential buildings, including affordable housing. The table assesses each technology's feasibility, prevalence of installation in BC, main hurdles and risks, and product availability, providing valuable insights into the current state of electrification efforts in the region.

Electrification Technology	Feasibility (Varies)	Prevalence Installations in BC	Hurdles and Risks	Product Availability
CO2 Heat Pump Domestic Hot Water	Very feasible	Several	• Dependent on site conditions (e.g., space, location of outdoor units relative to storage). • Electrical capacity. • Gas backup overuse risk if hybrid solutions are used.	• Only 3 best class products (CO2 domestic heat pump hot water systems) in the market in spring 2023. • Many new products will be on the market in the near future.
Heat Pump Make Up Air	Very feasible	Many	• Electrical capacity • Structural capacity • Gas backup overuse common with hybrid solutions	• Many products available.
Space Heating: In-Suite Heat Pump	Feasible	Few	• Regulatory (switching utility costs onto tenant meter) • Electrical capacity • Will gas backup be eliminated? • Heat load/sizing	• Many products available. • Smaller apartment sized units needed.
Space Heating: Central Hydronic Heat Pump	Difficult	One building	• Existing hydronic pipe leaks and incompatibility • High complexity, design risk, maintenance costs • High potential for gas backup overuse risk	• Small selection for central outdoor heat pump. • Potential products for in-suite

Appendix B: Case Studies

Completed Low-income Building Electrification Projects

Examining electrification projects in low-income buildings that were completed provides valuable insights into understanding the factors that contribute to their the project being realized. By analyzing these projects, we can identify some of key drivers overcoming barriers to electrification and to further identify how future projects can be more successful.

In this study, we profiled and analyzed three cases of low-income buildings that completed electrification retrofits. The objective was to determine the reasons behind their implementation.

Building A

- **Building Location:** Vernon, BC
- **Climate Zone:** 5 (3,000 to 3,999 HDD)
- **Building Type:** Low-rise building, 75 units
- **Sector:** Senior housing for seniors over 55 years old or under 55 with disability
- **Rent Type:** 30% of tenants' monthly gross income, fixed low rate
- **Retrofit:**
  - **Year of Completion:** 2021
  - **Electrified Building Systems:** This retrofit project was designed with the **"**building-as-a-system" approach and included addition of heat recovery ventilation (HRV). Space heating was retrofitted from the original gas fired hydronic system to in-suite single-head cold-climate heat pumps. It was decided not to add electric baseboards for back up heating, primarily to minimize resident disruption and work in the suites**.**
  - **Electrical Service Upgrade:** Required as the original space heating was by gas. Electrical work included upgrading the main service and distribution from the main service directly to the mini-splits. Connecting to the suite meters would have been more expensive and would have resulted in heating costs being transferred to the low-income residents.
  - **Trigger To Explore Electrification:** Retrofit was motivated by a) faulty and leaky hydronic piping that would have been very costly and disruptive to tenants to fix, b) inadequate heating in some rooms and overheating in other rooms, and c) clogging of hydronic valves.
  - **Project Cost:** $24,336 per suite (including electrical service upgrade and distribution)
  - **Issues:** In December of 2022 temperatures dropped to -32C and some of the heat pumps stopped working. When the temperatures increased to -26C the heat pumps started working again. The contractor proposed to install wind screens to prevent this issue, which were installed in Summer 2023.

Building B

- **Location:** Clinton, BC
- **Climate Zone:** 6 (4,000 to 4,999 HDD)
- **Building Type:** Low-rise building, 14 units
- **Sector:** Senior housing
- **Rent Type:** 30% of tenants' monthly gross income
- **Retrofit:**
  - **Year of Completion:** 2020

    - **Electrified Building Systems:** From gas space heating and domestic hot water heating to in-suite heat pump, with no back up heating, and electric resistance domestic hot water. No ventilation upgrades (windows and bathroom fans).
    - **Electrical Service Upgrade:** Required as the original space heating and domestic hot water heating was by gas.
    - **Trigger To Explore Electrification:** The condition of the mechanical systems was not ideal and nearing end of life. Project Costs: $33,621 per suite (including electrical service upgrade).

Building C

- **Location:** Surrey, BC
- **Climate Zone:** 4 (<3,000 HDD)
- **Building Type:** Townhouse complex, 30 townhomes over 8 buildings with common office and daycare facility
- **Sector:** Housing for families and 2 accessible units for people with disabilities
- **Retrofit:**
    - **Year of completion:** 2022
    - **Electrified Building Systems:** This project was designed with the "building-as-a-system" approach and included addition of heat recovery ventilation (HRV). Space heating was retrofitted from in-suite ducted gas furnace to in-suite central ducted air source heat pump. Domestic hot water heating was retrofitted from gas fired tank to tank style air source heat pump.
    - **Electrical Service Upgrade:** Required as the original space heating and domestic hot water heating was by gas.
    - **Trigger To Explore Electrification:** The mechanical system, particularly the heating systems, were near end of life and requiring frequent maintenance.
    - **Project Cost:** $16,161 per suite, as follows:
        - Air source heat pump space heating: $8,032 per suite
        - Air source heat pump water heating: $1,935 per suite
        - Electrical Upgrades: $6,194 per suite

Summary of Reasons Electrification Projects Did Not Proceed

Understanding why electrification projects that were planned to proceed, but did not successfully reach completion, is an important step to identifying, and finding solutions to, the barriers to electrification projects.

Six common examples of why buildings did not proceed with the electrification retrofits are profiled and analyzed to determine the reasons behind the retrofit projects not being completed.

The findings demonstrate that the technical challenges faced by these six projects are common among other building sectors and are not exclusive to social and LIMR. Five out of the six identified challenges are related to project costs.

The challenges are summarized as follows:

- **Time Restrictions:** At the point of failure of the mechanical system, there is generally not sufficient time for electrification planning, design, and installation.
- **Electrical Capacity Assessments**: The time and costs associated with electrical capacity assessments can delay projects or result in stakeholders selecting other retrofit options.
- **Capital Costs of Electrification Projects:**
    - Cost of electrical capacity upgrades (i.e., panel or transformer upgrade)
    - Cost of mechanical upgrades (i.e., heat pump system)

- Few contractor bids, resulting in higher bids due to less competition, and limited options.
- **Building modifications and structural upgrades:** Requirement for building modification and structural upgrades to accommodate high-efficiency electric systems, resulting in higher costs and project complexity.

Key Examples

Point of Failure of Mechanical System – Not Sufficient Time for Electrification Planning, Design and Installation

- **Location:** Interior BC
- **Building Type:** Mid-Rise, Social Housing
- **Trigger To Explore Electrification:** Domestic hot water tank systems were failing and needed replacing as soon as possible. .
- **Why Project Did Not Proceed:**
  - Emergency replacement did not allow for enough time to evaluate and implement the electrification alternative. Planning tasks for electrification projects can take a year or more to complete. Planning tasks may include electrical capacity assessment, system design, tendering, contract with mechanical contractor, equipment order and installation.
- **Proposed action(s) to address this barrier:**
  - **1.3.2.** Use benchmarking and other data to help identify building owners/operators with heating systems nearing the end of their lifespan and create a targeted outreach plan to reduce 'like-for-like' emergency replacements.

Costs of Electrical Capacity Upgrades

- **Location:** Lower Mainland
- **Building Type:** Low-Rise, Social Housing
- **Trigger To Explore Electrification:** Nearing end of life for mechanical systems and exploring electrification for greenhouse gas emission reductions.
- **Why Project Did Not Proceed:**
  - Cost of electrical capacity upgrades were cost prohibitive, estimated to be between $400,000 and $500,000.
  - The project did not explore electrical load reduction or load management measures that could reduce the cost of the electrical capacity upgrades.
- **Proposed action(s) to address this barrier:**
  - **2.3.1.** Reduce the cost of electrical capacity upgrades in the short-term by:
    - creating incentives for electrical capacity upgrades in social and low-income buildings
    - streamlining access to historical utility data (min 1 year) to complete electrical load capacity calculation
  - **2.3.2. [Broader MURB action]** Reduce costs of electrical capacity upgrades in the short-term by:
    - changing cost structure for upgrades
    - assessing load reduction and management opportunities that mitigate the need for capacity upgrades
    - exploring alternative methodologies for calculating electrical service
    - Identifying and proactively investing in upgrades in capacity constrained areas

High Upgrade Costs of Mechanical System

- **Location:** Lower Mainland
- **Building Type:** High-Rise, retirement home with lots of amenities
- **Trigger To Explore Electrification:** Upgrade from building boiler to central heat pump system.
- **Why Project Did Not Proceed:**
  - Tenders on mechanical design resulted in costs 40% higher than expected. High costs were likely due to inflated post-pandemic construction costs and possibly the lack of experience from contactors adding costs to cover risks and a learning curve.
  - The project was put on hold.
- **Proposed action(s) to address this barrier:**
  - **2.1.1.** Create targeted incentive programs for low-income market rentals delivered through accessible, flexible, timely, and streamlined processes. Explore funding options, including direct install projects prioritized based on the provision of and commitment to long-term affordability; and providing tax incentives.
  - **4.1.3**. Provide targeted training for contractors and engineers for working on low-income and social housing.
  - **4.1.5. [Broader MURB action]** Create a pre-qualified list of contractors and engineers to work on social and LIMR projects to simplify the procurement process and improve QA/QC.
  - **4.2.3. [Broader MURB action]** Increase the supply of smaller, lower-cost heat pumps suitable for suites, and bedrooms within MURBs.

High Upgrade Costs and Few Competitive Bids

- **Location:** Lower Mainland – Various locations
- **Building Type:** Across all building types, low-rise to high-rise
- **Trigger To Explore Electrification:** Upgrading make-up air ventilation to hybrid heat pump system.
- **Why Project Did Not Proceed:**
  - Tenders on mechanical design resulted in costs double than expected. High costs were likely due to inflated post-pandemic price increases and contractors being exceptionally busy and unable to keep up with demand.
  - Six contractors invited to bid, only two responded.
  - The projects were put on hold.
- **Proposed action(s) to address this barrier:**
  - **2.1.1.** Create targeted incentive programs for low-income market rentals delivered through accessible, flexible, timely, and streamlined processes. Explore funding options, including direct install projects prioritized based on the provision of and commitment to long-term affordability; and providing tax incentives.
  - **2.1.2.** Offer alternative financing low-interest long-term mechanisms for social and LIMR.
  - **4.1.3**. Provide targeted training for contractors and engineers for working on low-income and social housing.
  - **4.1.5. [Broader MURB action]** Create a pre-qualified list of contractors and engineers to work on social and LIMR projects to simplify the procurement process and improve QA/QC.
  - **4.2.3. [Broader MURB action]** Increase the supply of smaller, lower-cost heat pumps suitable for suites, and bedrooms within MURBs.

Requirement for Building Modification and Structural Upgrades Resulting in Higher Costs

- **Location:** Fraser Valley
- **Building Type:** Low-rise, rental building
- **Trigger To Explore Electrification:** Upgrading make-up air ventilation to hybrid heat pump system.

- **Why Project Did Not Proceed:**
    - Building has a gable roof structure. The installation of a packaged heat pump make-up air system required a modification to the roof structure and structural upgrades to accommodate the system.
- **Proposed action(s) to address this barrier:**
    - **2.1.1.** Create targeted incentive programs for low-income market rentals delivered through accessible, flexible, timely, and streamlined processes. Explore funding options, including direct install projects prioritized based on the provision of and commitment to long-term affordability; and providing tax incentives.
    - **2.2.1.** Create a concierge program to support building owners and industry. The program should support building owners in assessing building performance, identifying and selecting retrofit measures, accessing financing and incentives, selecting contractors, and measuring impacts.

2.2.3. Work with funders to better align grants, incentives and financing. Ensure access to wholistic funding is available to address issues that may arise when electrifying.

Time and Costs Associated with Electrical Capacity Assessments

This is not an individual case study but is based on information received about multiple prospective projects in social housing buildings in BC that did not proceed.

- **Triggers to Explore Electrification:** Various, including incentivized energy audits, failed equipment, ESG impetus, desire for cooling, etc.
- **Why Projects do Not Proceed:**
    - Energy Audits, historically defined as "ASHRAE Level 2", traditionally did not consider fuel switching. Even when electrification measures were added, the necessary analysis of electrical capacity to support these measures was neglected, and left to a later separate assessment, rather than being integrated.
    - Electrical capacity assessments can take between 2 months to 1 year or more due to the challenges of accessing energy consumption data from utilities and the complex requirements that have been established for calculating electrical capacity. For many retrofit projects, these long delays lead to lost opportunities due to replacement of failed equipment.
    - The cost of an electrical capacity assessment for a typical MURB ranges from $3,000 to $7,000. The cost can vary based on complexity, number of meters, and the methodology. Interconnected buildings or loads on common meters, such as central kitchens or laundries, can increase loads.
    - For a typical MURB with common and suite electrical meters, accessing peak demand data can be costly and time consuming. BC Hydro provides peak building demand data, but it was taking at least one month to fulfil requests, although this has recently been reduced by BC Housing and BC Hydro to less than a month. Often additional time is required to allow for questions about the data provided. Other utilities, such as New Westminster, Penticton, Nelson and FortisBC electric, do not provide peak building demand data as it is not metered. If peak demand data cannot be accessed, the Canadian Electrical Code requires either one year's worth of metered data (which may require submetering that can cost approximately $30,000), or a calculated method (which will result in an overestimation of required capacity and may increase project electrical capacity upgrade costs).
- **Proposed action(s) to address this barrier:**
    - **2.3.1.** Reduce the cost of electrical capacity upgrades in the short-term by:
        - creating incentives for electrical capacity upgrades in social and low-income buildings
        - streamlining access to historical utility data (min 1 year) to complete electrical load capacity calculation

- **2.3.2. [Broader MURB action]** Reduce costs of electrical capacity upgrades in the short-term by:
    - changing cost structure for upgrades
    - assessing load reduction and management opportunities that mitigate the need for capacity upgrades
    - exploring alternative methodologies for calculating electrical service
    - Identifying and proactively investing in upgrades in capacity constrained areas

Appendix C: Characterization of the Social Housing Building Stock

1 Method

1.1 Data Sources

The data analysis incorporates multiple datasets that contribute to a more comprehensive analysis of the BC social housing building stock. Each datasets includes a different housing association, as well as the details on the building stock, such as the archetype, vintage, floor area, number of units, and fuels used for both space heating and DHW. The four data sources considered for the analysis are the following:

1. **BC Housing:** The first block, comprising approximately 50% of the dataset, consists of buildings that are not owned nor managed by BCH (British Columbia Housing), but have received funding from BCH at some point. The second block, representing around 25% of the dataset, includes buildings that are owned by BCH but not managed by the organization. Lastly, the third block, also comprising approximately 25% of the dataset, consists of buildings that are both owned and managed by BCH.
2. **BC Non-Profit Housing Association (BCNPHA):** These are buildings that are funded by a non-profit organization, other than indigenous.
3. **Aboriginal Housing Management Association (AHMA):** These are buildings that are funded by BC Housing and managed by an aboriginal non-profit.
4. **Non-Profit Co-ops:** These are co-op buildings that are funded by a non-profit organization.

1.1.1 Data Availability

In terms of data availability, Introba received the first three datasets and a high-level estimate of the Non-Profit Co-op buildings. The compiled dataset encompasses a total of 4,935 distinct buildings. It should be noted that within this dataset, there are 389 buildings without vintage information, 112 buildings without floor area data, 82 buildings without units information, 356 buildings without space heating fuel type, and 1,682 buildings without DHW fuel type.

On the other hand, the inclusion of the Non-Profit Co-op buildings introduces an additional 270 buildings to the social housing building stock. Despite the limited information available, Introba has made informed assignments for these buildings based on the data shared by BCH. Archetype, vintage, floor area, number of units, as well as fuels used for both space heating and DHW have been attributed to these buildings to the best extent possible.

1.2 Datasets Consolidation

Combining the four datasets yields a total of 5,982 entries with building information. To ensure data accuracy, we identified and removed duplicate buildings based on their individual building identifiers. As a result, the dataset now consists of 4,935 unique buildings.

Notably, not all buildings in each dataset possess a unique building individual ID. However, both the BC Housing and AHMA datasets are equipped with individual building identifiers, enabling us to identify and eliminate duplicate entries within these datasets. Conversely, the BCNPHA dataset includes some buildings with an Estate ID. In such cases, we were able to identify and remove duplicates by cross-referencing against the other two data sources. As for the non-profit co-op buildings, being part of a high-level estimate without detailed granularity, it becomes challenging to determine whether these buildings have already been accounted for in another data source or not.

Furthermore, in instances where duplicates were identified and conflicting building information was present across the various data sources, we prioritized the BC Housing data as the most reliable source of information.

1.3 Buildings Classifications

To enable a thorough examination of the results, the dataset was organized by classifying the data according to the building's archetype, vintage, type of ownership, and space heating and DHW fuel types. Such classification and building portfolio characterization allows for a more comprehensive exploration of the data, and a more in-depth understanding of the social housing building stock.

The dataset encompasses a range of 32 distinct building types, which were subsequently grouped into 8 final archetypes as outlined in Table 1. It is worth mentioning that out of the total building types in the dataset, 17 were categorized as non-typical residential structures and were considered irrelevant for the analysis. The remaining 15 building types were assigned to specific archetypes to ensure analysis simplicity and clarity (see Table 2).

Table 2. *Archetypes considered in the analysis.*

Dataset Building Type	Archetype Assignation
Apartment 8-24 Storey	HR MURB
Multi Unit Residential Building	HR MURB
Apartment 4-7 Storey	MR MURB
Apartment 1-3 Storey	LR MURB
Single detached	SFD
Single Detached	SFD
Single Family Dwelling 1 Storey	SFD
Single Family Dwelling 2 Storey	SFD
Row House	Row House
Townhouses/Rowhouses	Row House
Modular Housing	Modular Housing
Duplex	Duplex
Duplex/Triplex	Duplex
Hotel	Hotel
Hotel-SRO	Hotel

1.4 Energy and GHG assessment Methodology

This section presents the approach employed by Introba to estimate the environmental impact of the building portfolio by utilizing the social building stock data discussed in the preceding sections and incorporating insights from previous studies. By combining these key elements, Introba derived calculations that provide an estimation of the environmental footprint associated with the building portfolio under consideration.

To approximate the average Energy Use Intensity (EUI) per building, Introba utilized data from a previous study that incorporates multiple sources. The study calculates the average EUI per building type by following the methodology outlined below:

For SFD, the average EUI was calculated based on pre-retrofit EUIs from EnerGuide data for a sample comprising data for over 13,000 homes collected between 2007 and 2021.

The average EUI of gas and electricity for each commercial and industrial building type is an average of the EUIs found for that building type in the following studies:

- 2022 Building Benchmark BC Data for Saanich, Victoria and Esquimalt (2022)
- PUMA Utility Monitoring Inc's 2021 Benchmarking Reports (2022)
- RDH's Commercial Electrification Study (2020)
- RDH's Commercial Retrofit Energy Modelling Report (2019)
- U.S. EIA's Commercial Buildings Energy Consumption Survey (CBECS) for the West Region (2018)
- Stantec Consulting's Commercial Building Energy Modeling Study (2014)

The average EUIs for gas and electricity for both MURB rental and MURB condo buildings have been determined using an average of the EUIs found in the following studies:

- RDH's Phase 2 Strata Energy Study (2019)
- RDH's Market Rental Revitalization Study (2018)
- RDH's Deep Condo Retrofit - Context and Analysis Report (2016)
- RDH's Summary Report of MURB Emission Reduction Potential (2015)
- U.S. EIA's Residential Energy Consumption Survey (RECS) for the West Region (2014)

Consequently, the existing 8 distinct archetypes were consolidated into 5 archetypes to align with the classifications utilized in the previous study. This grouping was necessary to ensure consistency and comparability between the current analysis and the referenced study. Table 3 outlines the average EUIs by building type retrieved from the previous analysis, while

Table 4 shows how Introba matched the archetypes considered in this analysis against the building types considered in the previous study.

Additionally, as illustrated in Table 4**,** the EUI values encompass two categories for multi-unit residential buildings: electric heated and gas heated. therefore, the selection of the appropriate EUI value was determined by the primary heating fuel type employed by each building. For instance, if a high-rise MURB is predominantly heated using electricity, the EUI value for MURB electric was assigned to that particular building. This same principle was applied to the low-rise MURB, high-rise (HR) MURB, and mid-rise MURB archetypes.

Table 3. *Average EUIs by Building Type*

Building Type Match	Total	Electricity (kWh/m2-yr)	Gas (kWh/m2-yr)
MURB Electric	199.9	148.1	51.8
MURB Gas	229.7	65.9	163.8
Other Commercial	607.2	325.3	281.8
Single Family Detached	98.8	48.4	50.4
Single Family Attached	182.6	88.8	93.8

Table 4. *Building Type Match*

BCH Building Type	Avg EUI Building Type
SFD	Single Family Detached
Duplex	Single Family Attached
Modular Housing	Single Family Attached
Row House	Single Family Attached
Hotel	Other Commercial
HR MURB	MURB Electric or Gas
LR MURB	MURB Electric or Gas
MR MURB	MURB Electric or Gas

Regarding the greenhouse gas (GHG) emissions intensity for the different fuel types considered in this analysis, the corresponding values were obtained from the Best Practices Methodology for Quantifying Greenhouse Gas Emissions, as provided by the BC Ministry of Environment and Climate Change Strategy[xv] (See Table 5).

Table 5. *GHG Emissions Intensity values for Gas and Electricity*

Emissions Intensity	Gas (gCO2e/kwh)	Electricity (gCO2e/kwh)
GHGi	180	11.5

After assigning each building type to an average Energy Use Intensity (EUI), the average EUI was subsequently multiplied by the total floor area of each building type. This calculation yielded the total energy consumption per year for each specific building type.

Once the total energy consumption results were obtained, they were multiplied by the corresponding Greenhouse Gas (GHG) emissions intensity of each fuel type. This step enabled the calculation of the total greenhouse gases emitted over the course of a year for the entire building stock.

2 Results

The main goal of this analysis is to evaluate the size of the social housing sector and estimate the associated greenhouse gas (GHG) emissions from the building stock. It is important to emphasize that this analysis offers a general estimation of the environmental impact of the building portfolio. While diligent efforts have been made to capture and quantify GHG emissions, it is important to acknowledge the limitations in accuracy of the results.

As further discussed in the main report, the available data on LIMR is insufficient to allow for a detailed characterization of the stock. This technical appendix focuses on the characterization of the social housing stock only (for which higher quality data is available), however, Section 2.3 compares the relative size of social housing and LIMR.

2.1 Building stock characterization

2.1.1 Building Archetype and Vintage

For analysis purposes, we have grouped the data into four buildings ownership categories: 1) BC Housing (owned and operated); 2) non-profit; 3) indigenous non-profit; and 4) co-op. Most of the buildings (3,091) fall within the Non-profit ownership, followed by Indigenous non-profit (1,092 buildings), BC Housing owned and operated (482 buildings), and finally co-ops (270 buildings) (see Table 6).

Table 6. *Number of Building by Ownership*

Ownership	Number of Buildings
Non-Profit	3,091
Indigenous non-profit	1,092
BC Housing (Owned and Operated)	482
Co-op	270

In terms of the heating and DHW fuel type, the compiled dataset comprises a total of 5 distinct space heating fuel types and 6 distinct DHW fuel types. To simplify the analysis, these fuel types were consolidated into 3 primary categories: natural gas, electricity, and other. Additionally, a separate category was designated for cases where the fuel type was unknown.

Regarding the vintage of the building stock, the majority of buildings were constructed between the 1970s and the 1990s, with a peak occurring during the period of 1990-1999 (see Table 7). This categorization provides a valuable foundation for conducting a comprehensive analysis of the heating and DHW fuel usage based on the era of construction. However, it is important to note that this analysis does not delve into specific details regarding the heating and DHW systems employed in these buildings.

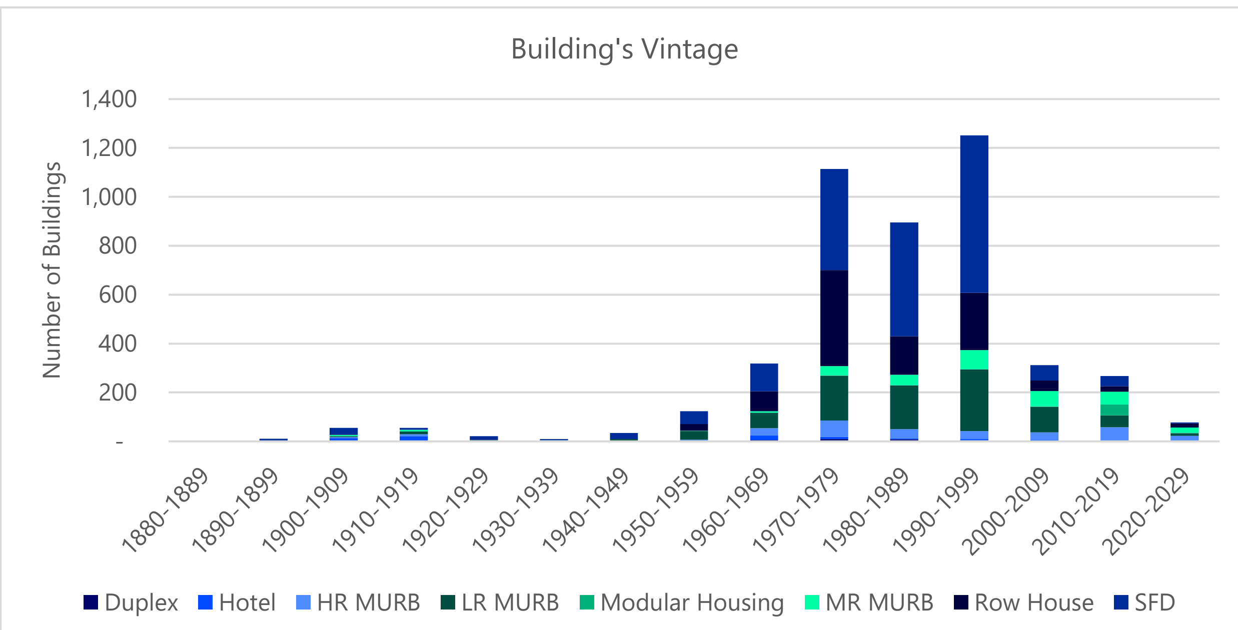


Figure 8. *Building Stock Vintage by Archetype*

Lastly, the compiled data sources are summarized in Table 7, which provides an overview of the number of buildings, total floor area, and total units categorized by archetype. Additionally, Table 8 illustrates the geographic distribution of the building stock across the British Columbia province, providing insights into the regional representation of social housing.

__Table 7.__ Size and number of buildings per archetype

Archetype	Buildings	Total GFA (m2)	Units
HR MURB	507	2,249,200	28,323
Row House	1,035	1,976,300	18,171
LR MURB	904	1,931,600	27,182
MR MURB	315	1,321,300	16,904
SFD	1,989	482,500	6,163
Hotel	79	150,200	3,236
Modular Housing	51	72,500	1,456
Duplex	56	26,400	261

Table 8. Size and number of buildings by geographic location

Region	Buildings	Total GFA (m2)	Units
Lower Mainland	2,041	4,790,800	60,346
Vancouver Island	824	1,389,600	17,498
Interior Region	907	987,500	11,703
Northern Region	892	497,400	5,823
Unknown	1	330	6

2.1.2 Heating and DHW systems

Overall, the results reveal that the majority of buildings examined in this analysis rely on NG as the primary fuel source for both space heating and domestic hot water DHW provision. However, it is important to note that there is a considerable number of buildings (1,682) with an 'unknown' fuel type for DHW, creating a gap in our understanding of the fuel consumption between NG and electricity for this specific end use. Table 9 and Table 10 provide a comparison between the fuel types used for each end use. This comparison sheds light on the distribution of fuel choices within the building portfolio.

__Table 9.__ Number of Buildings and Total Floor Area by Space Heating Fuel Type

Space Heating Fuel	Buildings	Total GFA (m2)
NG	3,321	4,896,800
Electricity	1,252	2,696,800
Unknown	356	613,400
Other	6	3,100

__Table 10.__ Number of Buildings and Total Floor Area by DHW Fuel Type

DHW Fuel	Buildings	Total GFA (m2)
NG	1,919	3,668,100
Unknown	1,682	2,359,300
Electricity	1,304	2,093,200
Other	30	89,400

As anticipated, an examination of the number of buildings by fuel type (See Figure 8) reveals that NG is the predominant choice across most archetypes, with the exception of modular houses, where electricity holds a slightly larger share. In contrast, when considering the perspective of floor area (See Figure 9), electricity surpasses NG as the primary fuel type in smaller building types, with the exception of SFD homes. Conversely, NG maintains its status as the most commonly used fuel type in MURBs.

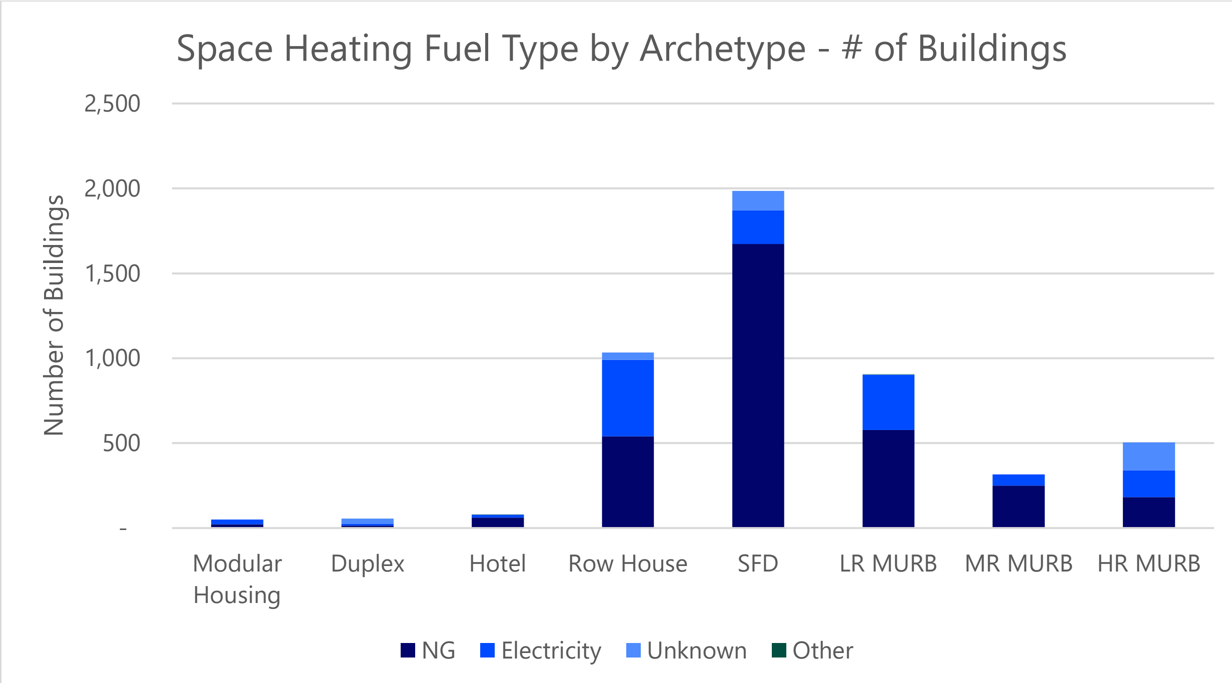


Figure 9. *Space Heating Fuel Type by Number of Buildings*

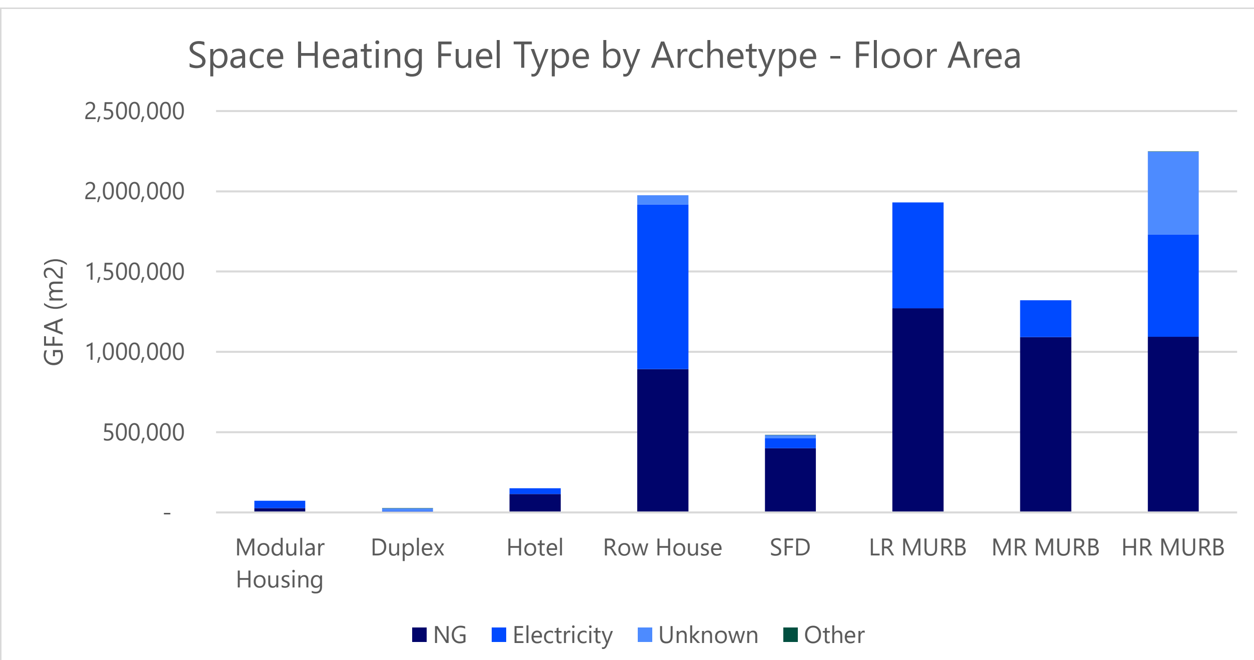


Figure 10. *Space Heating Fuel Type by Floor Area*

When analyzing the DHW fuel type based on the number of buildings, electricity surpasses NG in three archetypes: modular housing, duplex, and SFD (See Figure 10). Conversely, NG remains the predominant fuel choice for DHW in the remaining archetypes. However, it is worth noting that these results may be influenced by the presence of an unknown portion within the fuel type data for each archetype. Moreover, a similar pattern to the space heating fuel type can be observed when examining the DHW fuel type by archetype in relation to the floor area. In smaller building types, electricity appears to be more commonly used, except for SFD homes (See Figure 11).

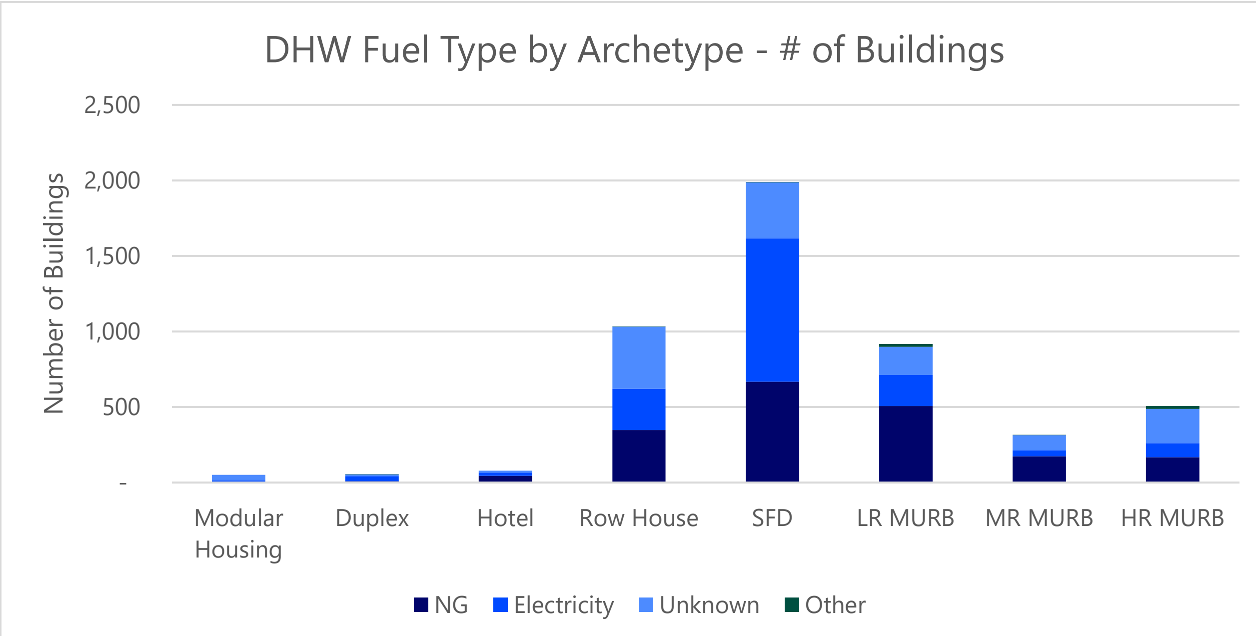


Figure 11. *DHW Fuel Type by Number of Buildings*

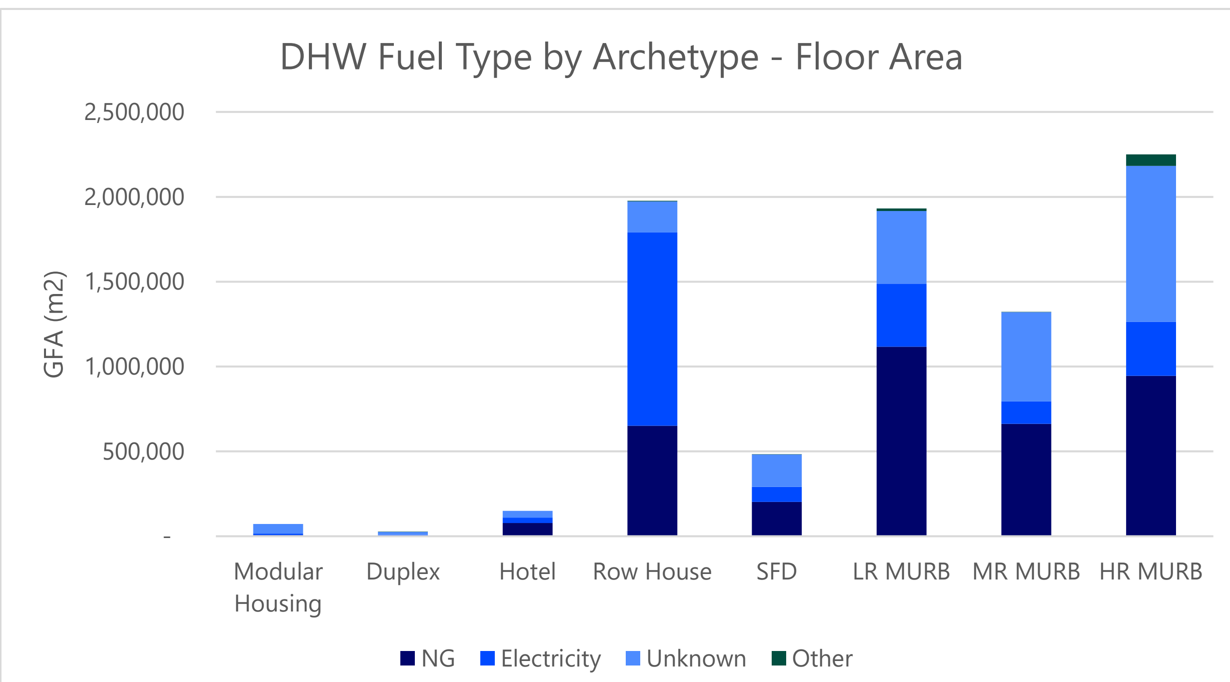


***Figure 12**. DHW Fuel Type by Floor Area*

When considering ownership, NG remains the dominant fuel type for both space heating and DHW purposes (See Figure 12 and Figure 13). However, there are notable exceptions. Electricity surpasses NG as the primary fuel type for DHW in Indigenous non-profit buildings, and it also emerges as the primary fuel type for both space heating and DHW in co-op buildings. This same pattern occurs when looking at it from a total floor area perspective (See Figure 14 and Figure 15).

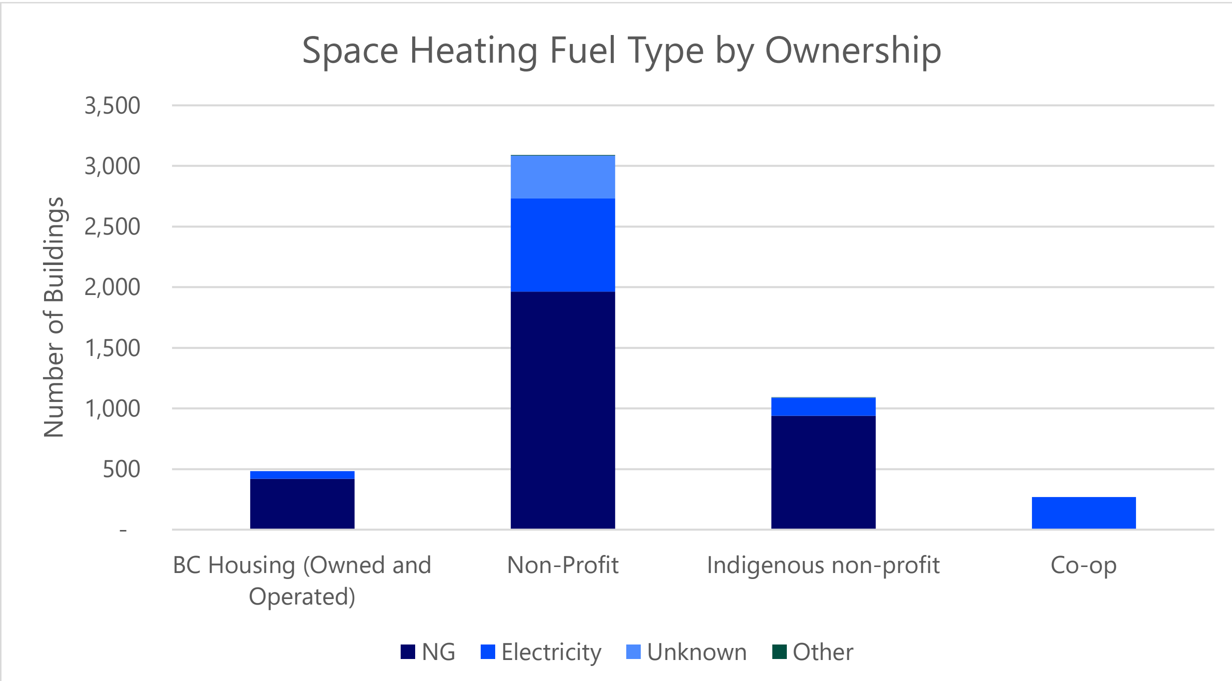


Figure 13. *Space Heating Fuel Type by Building Ownership and number of Buildings*

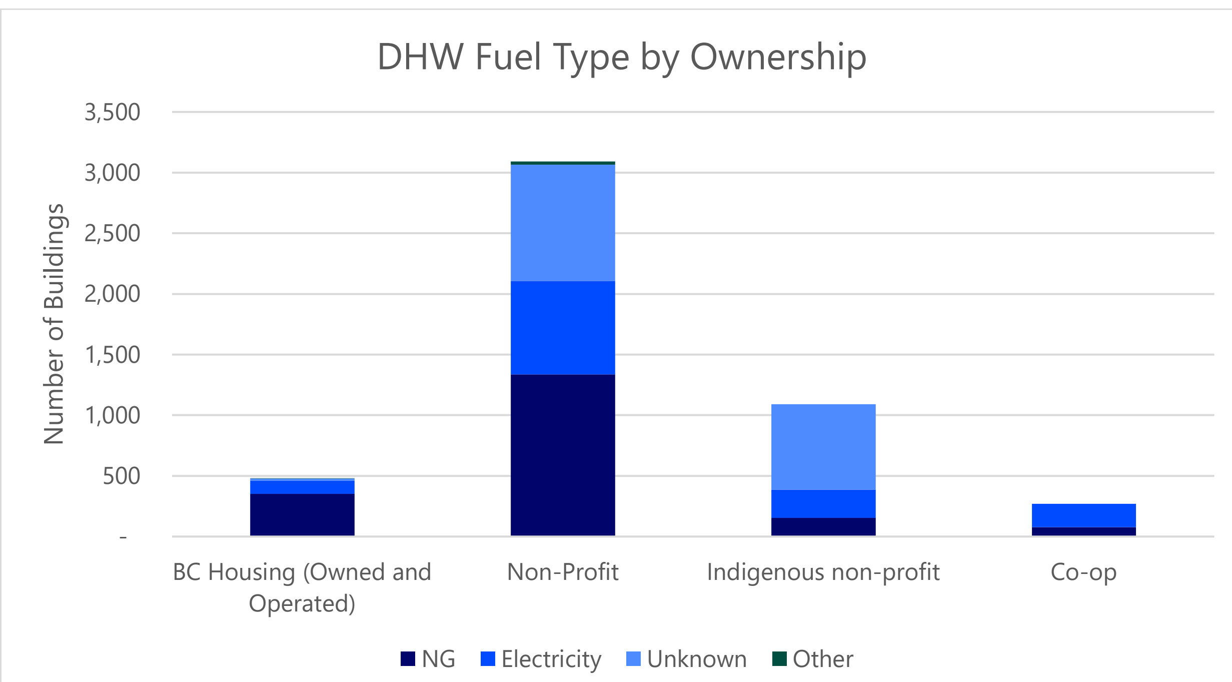


Figure 14. *DHW Fuel Type by Building Ownership and Number of Buildings*

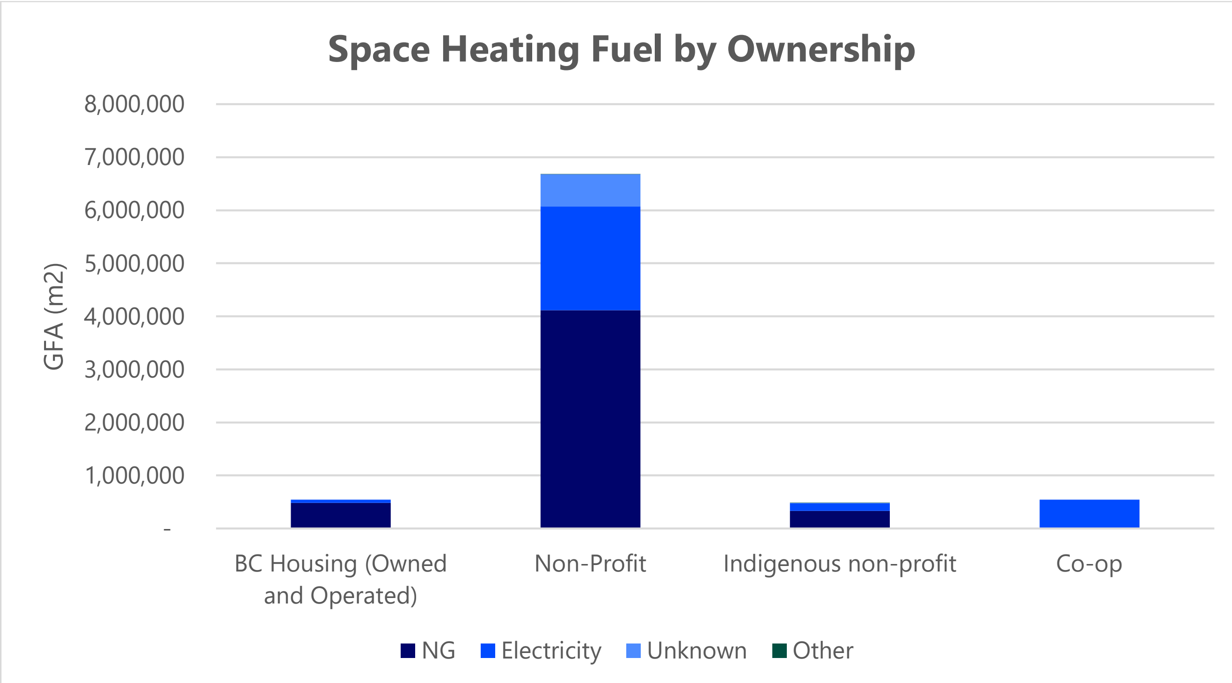


Figure 15. *Space Heating Fuel Type by Building Ownership and Floor Area*

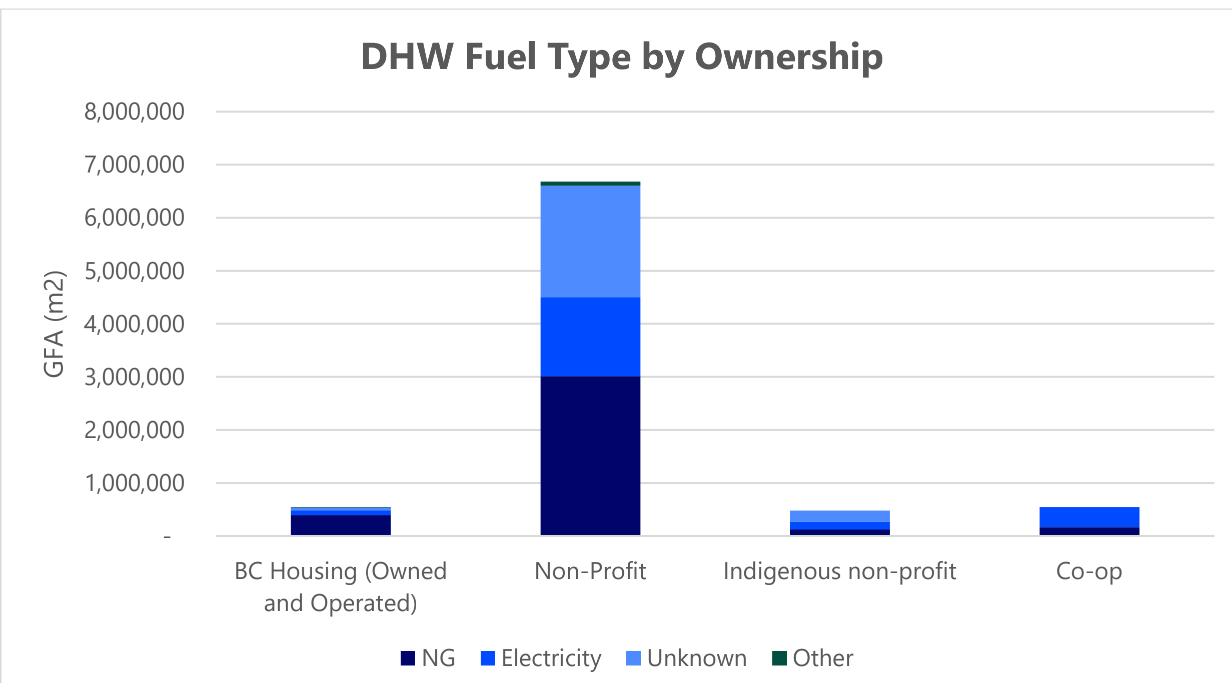


Figure 16*. DHW Fuel Type by Building Ownership and Floor Area*

2.2 Energy and GHG performance

In terms of energy use intensity (EUI) and GHG emissions, by using the method described in the previous section, Introba was able to calculate an approximate energy use and environmental impact of the social housing building stock. Table 11 presents the aggregated data on total energy use and GHG emissions across different building archetypes.

Table 11. *Total Energy Use and GHG Emissions by Archetype*

Archetype	Number of Buildings	Electricity Use (MWh)	NG Use (MWh)	Total (MWh)	GHGe (tCO2e)
HR MURB	507	200,419	297,180	497,599	55,797
LR MURB	904	181,249	242,777	424,027	45,784
MR MURB	315	105,866	190,745	296,611	35,552
Row House	1,034	175,520	185,374	360,894	35,386
Hotel	79	48,856	42,321	91,178	8,180
SFD	1,989	23,365	24,306	47,670	4,644
Modular Housing	51	6,436	6,797	13,234	1,298
Duplex	56	2,347	2,479	4,826	473

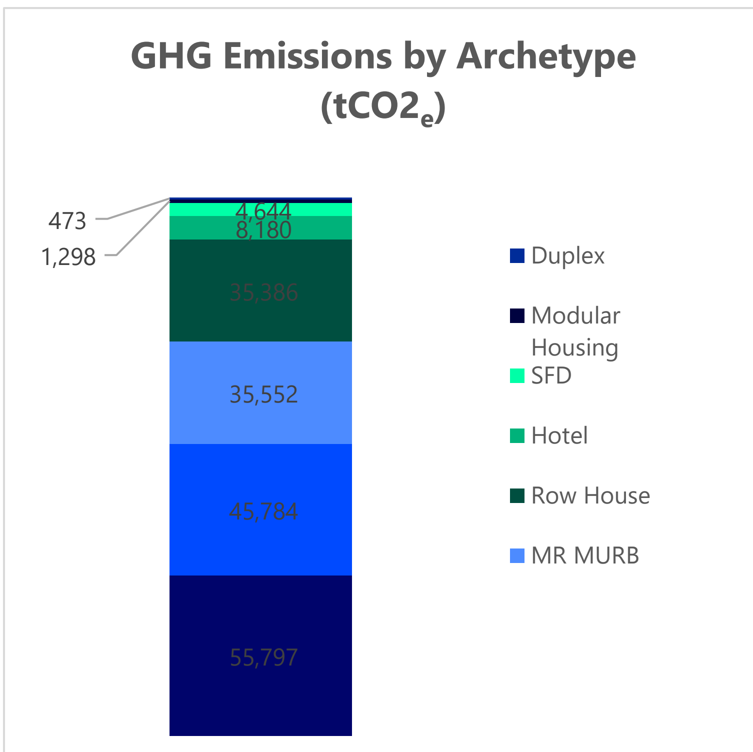


Figure 17. *GHG Emissions by Archetype*

Table 12 provides an overview of GHG emissions categorized by building ownership. The analysis reveals that buildings owned and operated by BC Housing contribute only 7% of the total emissions. In contrast, the majority of emissions, accounting for 84%, are attributed to non-profit buildings. The contrast of GHG emissions share by building ownership can be seen in Figure 17.

Table 12. *GHG emissions by Building Ownership*

Archetype	BC Housing (Owned and Operated)	Non-Profit	Indigenous non-profit	Co-op
HR MURB	2,041	53,164	592	-
LR MURB	5,059	35,109	2,649	2,967
MR MURB	1,460	32,483	1,609	-
Row House	3,608	23,918	2,932	4,928
Hotel	275	7,597	308	-
SFD	307	2,962	1,375	-
Modular Housing	8	1,284	5	-
Duplex	-	473	-	-

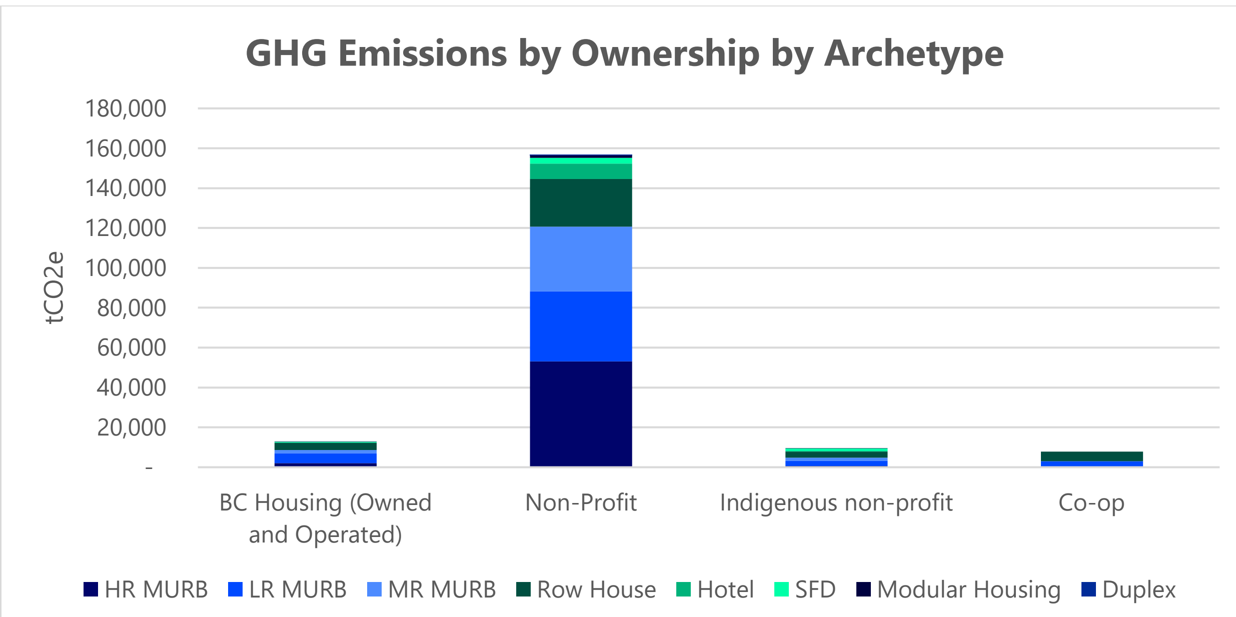


Figure 18. *GHG Emissions by Ownership by Archetype*

2.3 Social Housing and Low-income Market Rental

The following figure compares the relative size of the Social Housing market and the LIMR. The number of LIMR units has been approximated based on data from the Canadian Rental Housing Index[xvi], which in turn is based on census data.

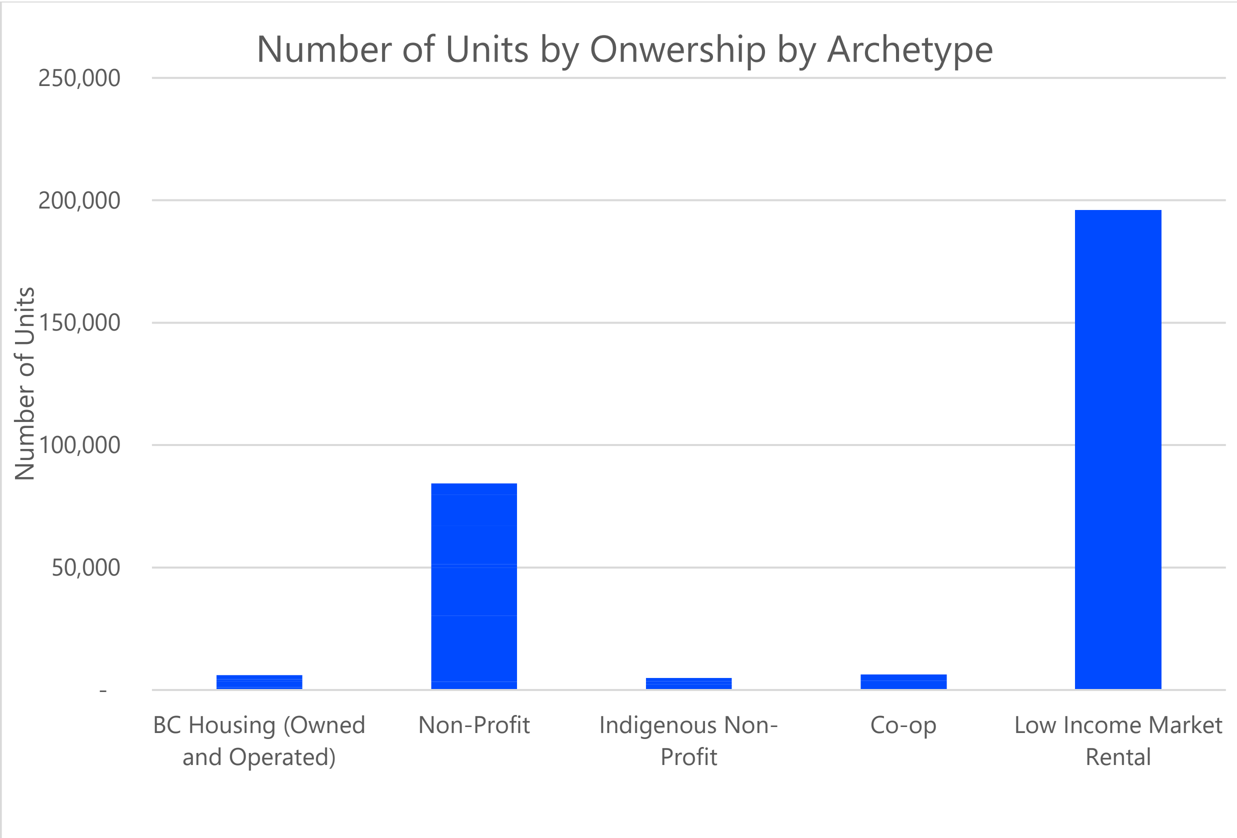


Figure 19. *LIMR size relative to Social Housing*

The figure shows that out of the approximately 300,000 low-income households that are renting, approximately one third live in social housing units, while the remaining two thirds live in market rental units. It must be stressed that the figure above combines data from different sources with very different quality levels. The estimate of the LIMRLIMR size should be used as a first approximation.

[xv] 2021 B.C. Best Practices Methodology for Quantifying Greenhouse Gas Emissions. Ministry of Environment and Climate Change Strategy. May 2022. 17145 - Appendix 1 Best Practices Methodology for Quantifying Greenhouse Gas Emissions (gov.bc.ca)
[xvi] Canadian Rental Housing Index. Renter Households. https://rentalhousingindex.ca/en/#renter_prov

Appendix D: Review of (Technical) Challenges and Opportunities: Low-Income Building Electrification

Introduction

The majority of the of the barriers and challenges related to electrification of existing buildings are similar regardless of the income level of the occupants of a building. However, there are some specific barriers and challenges associated with advancing electrification in buildings that house low-income households.

- **Targeting electrification for low-income households:** Low-income people live in a wide range of building types with different ownership structures, making it difficult to identify and target low-income households with electrification programs.
- **Potential for disproportionate financial burden from energy bill Increases:** Uncertainty whether building electrification will increase utility costs for low-income households **and** become a disproportionate financial burden.
- **Financial barriers for housing providers:** There are a range of financial barriers that can function as a disincentive for building electrification. These barriers may be more pronounced and complicated for providers of LIMR.

Similarly, most of the opportunities for electrification of buildings are comparable regardless of the income level of residents. Some of the specific opportunities that can maximize the benefits and accelerate electrification of LIMR include:

- **Improving comfort and ensuring life safety of vulnerable people during hot weather:** Building electrification projects that provide space cooling represent an opportunity to both decarbonize buildings and address life-safety risks of vulnerable low-income population.
- **Addressing energy poverty by improving building efficiency:** Building electrification, combined with efficiency retrofits that reduce energy consumption levels, has the potential to reduce the operational costs for low-income households, thereby reducing energy poverty.
- **Introducing an Income-Qualified (Lifeline) Electrification Rate:** Explore the introduction of a reduced electricity rate for low-income households in buildings that have electrified. This can ensure that energy bills for low-income households remain affordable and mitigate uncertainty of the impact of electrification on operating costs, as well as future electricity price increases. It is worth noting that the current framework under the Utilities Commission Act doesn't permit rate adjustments based on income levels, and the likelihood of regulatory changes enabling such adjustments is not anticipated.

Specific Barriers and Challenges: Low-Income Building Electrification

The following is an overview of the specific challenges associated with electrification of low-income housing.

1. Challenges Targeting Low-Income Households:

- Most low-income people live in a wide range of building types with different ownership structures, not only in dedicated low-income housing or in social housing. This range includes mixed-income buildings, such as purpose-built market rental housing, rented privately-owned condominium strata housing, co-operative housing and other forms of privately-owned housing.
- Low-income households may not self-identify as such and the owner of the building may not know the income level of the household.

Impact on Electrification:

- Given that low-income people live in a wide range of building types with different ownership structures, it can be difficult to identify and target low-income households with electrification programs. For example, in BC there are currently no targeted electrification programs for strata housing, and only one pilot program for market rental building electrification. As a result, the low-income households (rental housing or owners) within rental or strata buildings in the province do not have access to building electrification programs.
- Electrification and retrofit programs may have criteria that limit their ability to benefit low-income households. For example, Natural Resources Canada's Deep Energy Retrofit Acceleration Funding identifies low-income buildings as those with at least 50% of the building to be low-income residents. This 50% threshold may be challenging to identify and validate and will exclude the many buildings in the province where less than 50% of residents are low-income.[xvii]
- There are no electrification programs available to assist many of the low-income households that are most in need, most vulnerable and potentially most at risk of homelessness (I.e., living in purpose-built market rental housing and rental housing in-strata housing).

2. Energy Affordability/Energy Poverty[xviii]

- There is limited data available on whether the electrification of buildings will result in a reduction or increase in energy affordability.
- Because electricity is more expensive than natural gas, electrification of a building (fuel switching from natural gas to electricity) *may* result in higher utility bills. Although not all low-income households pay for their energy bills separately from their rent, for those that do, even small increases in energy bills can be a disproportionate financial burden that limits their ability to pay for rent, food or other necessities. For buildings where energy costs are paid for by landlords, potential increases in electricity costs will inevitably filter down to increases in strata fees or rent.
- There is further uncertainty about the future electricity cost increases in BC and how this will impact the long-term affordability of living in electrically heated buildings.
- Adding cooling systems to an apartment represents a new electrical load that will increase energy bills in the cooling season. For example, a single portable air conditioner moderately used in warmer weather can result in cost increases between $26 to $115 per unit per year and put fiscal burden on housing providers or tenants who pay their energy bills.

Impact on Electrification:

- The high level of uncertainty about whether building electrification will increase utility costs for low-income individuals and become a disproportionate financial burden can become a barrier which may limit or discourage some housing providers from actively pursuing building electrification.

3. **Barriers for Low-Income Housing Providers:** There are a range of financial barriers affecting all types of housing providers considering building electrification. However, low-income housing providers and operators face specific considerations and complexities that can significantly impact their electrification opportunities. We have identified financial barriers specific to the low-income housing sector.

- **Financial Barriers: Business Case:** Rental building owners have limited options for how to recuperate capital costs associated with electrification since they cannot increase rent for existing tenants due to Residential Tenancy Act (RTA) limits in rent increases.[xix]
- **Regulatory Barriers: Residential Tenancy Act (RTA):** The RTA also limits the ability of landlords from shifting utility costs to tenants, which may create challenges for some retrofitting options. For example, building electrification projects that involve the replacement of a natural gas boiler on a central utility meter with in-suite heat pumps on an individual apartment suite meter, may result in a shift in utility costs from the landlord to the tenant. [xx]

- If the landlord (profit or non-profit) is going to transfer utility bills to tenants, they have to ask the tenants to agree and change the rental agreement and reduce the rent by the same amount of the expected increase.

- **Program Barriers: Complexity and Timeline Constraints for Accessing Incentives:** Building electrification incentives, grants and financing available to low-income housing providers may be complex to navigate and time consuming to access. [xxi]

Impact on Electrification:

- Financial barriers that limit a building owner's ability to justify a capital expenditure with either increased revenues or decreased operating costs can function as a disincentive to building electrification.
- Without clear guidelines on how and when utility costs can be shifted to be paid by tenants, most landlords may be hesitant to undertaking building electrification retrofits that would complicate their ability to comply with Residential Tenancy Act requirements or introduce issues for tenant/landlord relations

General Barriers and Challenges: Building Electrification for All Income Levels

The 2019 Building Electrification Roadmap (BERM) highlighted some of the primary barriers facing BC's building sector. The barriers identified in the 2021 BERM remain in 2023. Slightly modified, those barriers were identified as:[xxii]

1. A low level of awareness by consumers and industry alike of the benefits and opportunities of building electrification in BC.
2. The low cost of natural gas compared to BC's low-carbon electricity.
3. The relatively high capital cost of replacing natural gas equipment with high efficiency electric equipment.
4. The perception among tradespeople and building professionals that installing high-efficiency electric systems brings higher risk and lower return than conventional gas-powered systems.

5. Whole building energy efficiency upgrades *may be needed* in some buildings to allow for the cost-effective deployment of high-efficiency electric space heating equipment.

There is a wide range of other barriers for electrification that may apply to of all types of residential buildings, including low-income housing buildings in BC. Those barriers can be summarized as: [xxiii]

- **Access to Utility Data and Determining Electrical Capacity:** The time and costs associated with accessing utility data and upgrading a building's electrical capacity can introduce both timeline and financial challenges.
- **Time of Replacement:** Mechanical systems reaching their end of life are often replaced at time of, or near, failure. Building electrification is typically not possible on an emergency replacement timeline.
- **Limited Awareness of Successful Examples:** There are limited publicly available examples or case studies of successful building electrification projects that were cost-effective to install and operate that can be used to help explain, and socially normalize, building electrification. [xxiv]
- **Limited Capacity of Organizations/Owners to Drive Retrofit:** Building retrofits can be complex and time consuming and there may be limitations to the time, knowledge, experience and motivation within the organization/company required to start a retrofit project.
- **Competing Building Upgrade Demands:** Many buildings in BC have competing building upgrade needs that may take priority over building electrification. Examples of other competing upgrades include elevator upgrades, basic maintenance, seismic upgrades, aesthetic upgrades, etc.
- **Building Retrofits Reveal Cascade of Other Issues:** Starting a retrofit may reveal other building issues that may escalate costs, create time delays, inconvenience occupants or otherwise complicate the project. These can include identification of asbestos, mould, wood rot or moisture, structural, electrical or plumbing issues or a wide range of other complications.
- **Complex Decision-Making Structures:** Decision-making of building upgrade investments can be complicated for strata corporations and co-op housing that have complex decision-making structures, with multiple owners and approval processes. This can make it difficult to implement electrification projects.[xxv]
- **Need for Other Building Upgrades and/or Auxiliary Heating in Cold Climates:** In cold climates, the electrification of buildings may require other building upgrades and or auxiliary heating to ensure the heating system can maintain comfortable temperatures in the coldest weather.[xxvi]
- **Limited Supply of Experienced Consultants and Contractors for Part 3 Building Electrification:** There is a limited supply of experience consultants and contractors for providing building electrification planning and construction services for Part 3 buildings. Further, there is limited training or established best practices to inform training.[xxvii]
- **Higher Levels of Support Available for Gas System Upgrades:** Stakeholders identify that programs for upgrading gas systems offer more support and are easier to access than programs for building electrification. In many cases this high level of support for gas system upgrades makes it easier and more financially attractive to not fuel switch and instead replace the existing systems with a newer gas system.
- **Potential for Tenant Disruptions:** Upgrading a building from a central natural gas heating system to an electric in –suite heat pump system, for example, requires access to suites, which may result in tenant disruption. For some retrofit projects, it can also be challenging to retrofit with tenants in place.[xxviii]
- **Other Technical Barriers:** There are a wide range of specific technical barriers that can either limit acceptance of building electrification or increase the cost. Examples include:
    - Requirement for suite and/or building level electrical upgrades.

- Building envelope penetrations can void the developer/contractor warranty on exterior.
- Noise issues created by in-suite outdoor units or central systems.
- Lack of space in some buildings to install equipment, e.g., the space requirements for outdoor unit of mini-split heat pumps systems.
- Requirement for a structural assessment and structural upgrades for rooftop units.
- Addressing where to direct condensate from in-suite heat pump systems.
- Providing full suite (all room) heating and cooling solutions.
- Appropriately sizing in-suite heat pumps systems for bedrooms and small apartment suites.
- High risk of GHG savings persistence for hybrid-electrification solutions.

- **Demographics and Acceptance of New Technologies:** Some demographics, such as older residents who may live in social housing, may not understand how to use heat pump heating system controls, may lose remote controls or set them incorrectly. Some tenants are resistant to electrification (wall mounted indoor units of mini-split heat pumps in kitchen or living room or outdoor units on balconies or decks) for aesthetic reasons.[xxix]
- **Split Incentives:** Split incentives occur when one party is responsible for an energy efficiency measure's cost, while the savings resulting from that measure will benefit another party. For example, in apartment buildings, the property owner is responsible for paying for upgrades, while the residents are the primary beneficiaries of these energy savings through reduced utility bills.[xxx]
- **Permitting Can Delay Projects:** The process of accessing permits and the different permit requirements in different jurisdictions can delay and increase costs of projects.
- **Lack of Awareness of Pending Regulations Related to Electrification:** Most stakeholders are not aware of pending regulations related to building electrification and, as a result, have not taken into consideration how those regulations will impact their planning for building maintenance and investments in building retrofits.

Specific Opportunities for Electrification of Low-Income Housing

The majority of the opportunities for electrification of buildings are also similar regardless of the income level of the building occupants. However, there are specific opportunities that should be explored that can maximize the benefits and accelerate the electrification of low-income housing.

Enhancing Comfort and Ensuring Life Safety of Low-Income Households During Extreme Heat Events[xxxi]

An equity-based approach to building electrification means that all people have affordable access to the health, comfort, economic and resilience benefits of building electrification. However, low-income, marginalized communities and vulnerable individuals that may be the most impacted by the impacts of climate change should be prioritized.

Beyond maintaining comfortable temperatures in apartments, for vulnerable individuals, access to conditioned or safe-temperature spaces during extreme heat events may be a life-safety measure. Homes with temperatures that rise above 31 degrees Celsius can become unsafe for inhabitants. Low-income, vulnerable and at-risk population may not be able to make alternative arrangements or have limited options of places where they can be other than where they live, making them more vulnerable to these events.

While there are no clear statistics available, a higher percentage of low-income individuals may fall into the category of people that are vulnerable or at-risk in extreme heat events. The province of BC has identified that the following types of people are especially at-risk if they do not have access to air conditioning and need to be prepared or supported:

- Seniors aged 65 years or older, infants and young children
- People who live alone and people who are pregnant
- People who are marginally housed
- People with limited mobility or pre-existing health conditions
- People with mental illness or substance use disorders
- People who work in hot environments

The BC Coroners Service (BCCS) confirmed that the one-week extreme heat event, June 25 to July 1, 2021, resulted in 619 heat related deaths. Key recommendations of the BCCS include the implementation of extreme heat prevention and long-term risk mitigation strategies that include improving access to active cooling measures (like installing heat pumps) and passive cooling measures (like improving building efficiency through other retrofits).

Building electrification projects that provide space cooling represents an opportunity to both decarbonize buildings and address a life-safety risk.

Due to the limitations of portable air conditioner operating capacity (ability to cool a room) in extreme heat,[xxxii] it is anticipated that heat pumps will increasingly be identified as a solution to improve the life-safety of the province's most vulnerable populations. Subsidies should be provided, especially for low-income residents, to encourage the purchase of more efficient and capable portable heat pumps as an alternative to portable air conditioners.

Addressing Energy Poverty by Improving Building Efficiency and Electrification[xxxiii]

Energy poverty is defined as "the experience of households and communities that struggle with meeting their home energy needs." Households that spend more than 6% of their after-tax household income on home energy services (or roughly twice the national median) have high home energy cost burdens and are said to be experiencing energy poverty.

Building electrification, combined with efficiency retrofits that reduce energy consumption levels, has the potential to reduce the operational costs for low-income households, thereby reducing energy poverty.

While building electrification offers the potential to reduce energy costs, more research is needed on how this can be successfully achieved.

General Opportunities for Building Electrification for All Income Levels

There are also a wide range of other opportunities for building electrification that can support the acceleration of electrification for all types of buildings, including low-income housing.[xxxiv]

- **Strong Financial Incentives:** As has been demonstrated in the single-family residential homes market, the presence of incentives has been a key market driver to accelerate consumer adoption of home electrification. It is anticipated that offering financial incentives for electrification of multi-unit residential buildings, including low-income housing, will be essential in promoting building electrification. These incentives should be easier to access and of higher value than those for installing gas systems.
- **Process for Transferring Utility Costs (Residential Tenancy Act):** In rental buildings (or rental suites) with central natural gas heating systems, landlords typically cover the utility costs, with a portion of the rent allocated to cover these expenses. Switching from central gas systems to in-suite air source heat pumps may be the most practical and cost-effective option for many retrofits. Switching to in-suite systems would result in tenants having control and accountability for their own energy consumption. To

enable this type of building electrification, the provincial government needs to establish a well-defined, transparent, and fair process for shifting responsibility for utility costs between landlords and tenants.

- **Promote Portable Heat Pumps as an Energy-Efficient Alternative to Portable Air Conditioners:** Portable air conditioners are being purchased at a rapid rate by BC residents of all income levels as an emergency measure. Subsidies should be provided to encourage the purchase of more efficient and capable portable heat pumps as an alternative to portable air conditioners.[xxxv]
- **In-Suite Electrification:** The increasing availability of in-suite heat pump technologies offers a more cost-effective approach to building electrification. With the development of appropriate technical guidelines, suites can be electrified on a unit-by-unit basis during resident turnover or as funding becomes available.
- **Streamlining Access to Utility Data and Standardizing Electrical Capacity Assessment Process:** Simplifying the process of accessing utility data and standardizing electrical capacity assessments will reduce the time and costs involved. This will ensure more efficient, cost-effective assessments.
- **Stakeholder Awareness:** To address the lack of stakeholder awareness about the benefits of building electrification, a wide range of efforts will be required. This includes developing peer learning opportunities, case studies, demonstration projects, and promoting positive examples of building electrification projects in low-income housing. The focus of these awareness building efforts should be on effectively communicating the benefits, roadmap, and costs associated with installing and operating all-electric buildings.
- **Accelerating Adoption of New Technologies:** To increase awareness and market adoption of newer and potentially more cost-effective heat pump technologies, there needs to be a dedicated plan and process for accelerating the market adoption of promising new technologies.
- **Proactive Capital and Electrification Planning Roadmap:** It is recommended to proactively plan for building electrification, as waiting for mechanical system end-of-life upgrades may not allow sufficient time for a timely transition. Initiatives should be launched to motivate and support low-income housing providers in planning ahead for building electrification. This can be achieved through an Electrification Capital Planning process, which includes identifying equipment lifespan, understanding energy consumption, assessing electrical capacity, and exploring potential electrification options.
- **Industry Capacity Building:** The capacity of the industry in British Columbia to design and implement electrification retrofits in apartments is relatively low. Opportunities exist to improve industry capacity by offering technical training and incentives to designers, mechanical engineers, and contractors working on low-income housing.
- **A Variety of Electrification Implementation Support Services:** The electrification of the wide range of different types of low-income housing (building types and ownership structures) calls for the development of a range of electrification implementation support programs and services.
- **Awareness Building and Engagement on Pending Regulations:** More outreach and engagement with stakeholders are needed regarding regulations related to building electrification. This will build support and enhance implementation plans, encouraging early adopters who will electrify their buildings prior to the introduction of the regulations.

Appendix E: Jurisdictional Review of Affordable Housing Electrification Plans

Plans and Reports Reviewed

- Los Angeles - CEMO Report on Equitable Building Decarbonization (2022)
- Oregon Ten-Year Plan: Reducing the Energy Burden In Oregon Affordable Housing (2018)
- Los Angeles Affordable Housing Decarbonization Study Phase 2 (2021)
- California Building Decarbonization Summit Report 2021
- Developing An Equitable Building Decarbonization Strategy Chicago (2022)
- Federal Reserve Bank Of New York – Sustainable Affordable Housing Strategies for Financing An Inclusive Energy Transition (2022)

Key Recommendation Themes

1. **Engagement:** Include frontline communities in the design, implementation, and evaluation of all building decarbonization policies and programs.
2. **Tenant protection and housing preservation:** Embed tenant protections and affordable housing preservation into building decarbonization policies and programs.*
3. **Funding quantity:** Increase the level of funding for social and low-income housing.
4. **Funding structure** Simplify the administration and improve alignment to increase the accessibility of funding.
5. **Data collection**: Gather data to track and measure progress*
6. **Education:** Expand education, outreach and technical assistance related to building decarbonization.
7. **Policy tools:** A wide range of technical, financial, regulatory, and administrative tools must be customized to address the specific challenges and vulnerabilities of the sector.
8. **Co-benefits:** Leverage building decarbonization to improve public health and habitability

*actions specifically targeted at market rental buildings.

Appendix F: Engagement Summary – Final Workshop

A workshop was hosted in September 2023 to solicit feedback final feedback on the Roadmap actions and discuss next steps for implementation. Over 30 participants attended from a broad range of organizations including: government, utilities, non-profit housing societies, ENGOs, local governments, industry associations, tenants' organizations, landlord associations, co-op housing providers, and financial institutions.

The following provides a summary of key feedback.

Q1: What are your general impressions of the Roadmap?

- Decarbonizing the LIMR and social housing stock by 2030 is a very ambitious objective
- Ensure differentiation in actions for LIMR and non-profit housing
- Include more consideration for northern communities
- Ensure energy efficiency is part of the solution and don't exclude baseboard heating as a viable electrification solution
- Industry capacity is a significant barrier to electrification
- Benefits of cooling are very important for these housing subsectors
- Maintaining affordability is critical
- Consider alignment with BC BERM
- Industry capacity continues to be a significant barrier to electrification

Q2: What do you think are the priority actions?

Through the prioritization activity, actions related to regulatory and systemic changes emerged as the top priorities. These included:

- 1.1.1 Set decarbonization targets (tied to accessing funding) for social housing
- 1.1.3. Explore aligning electrification initiatives with potential "Right to Cool" regulatory / legislative change.
- 2.2.1. Create a concierge program to support building owners and industry.
- 2.2.3. Work with funders to better align grants, incentives and financing
- 2.3.1/2.3.2. Reduce costs of electrical capacity upgrades
- 3.1.1. Embed tenant protection into building decarbonization programs

Q3: What are some recommendations for structuring implementation actions?

- **Involve relevant stakeholders.** Include broad representation on the implementation committee (e.g. government, utilities, BC Housing, non-profit housing societies, non-profit housing co-ops, landlord and tenant organizations, financial institutions, non-profit and industry organizations, and health authorities). These organizations have deep knowledge and experience, and many are leading initiatives related to action areas in this Roadmap. Broad participation will ensure that past and existing work is being leveraged, and actions are being rolled out in a way that is suitable for building owners, tenants, and residents of LIMR and social housing. Many of these organizations were engaged throughout this project and expressed interest in participating in the implementation committee.

- **Use short-term sub-committees.** Sub-committees can be used, on an as needed basis, to gain additional insights from technical experts or impacted groups. Sub-committees can ensure the right expertise is being leveraged to address the broad range of actions in the Roadmap and can complement a broader implementation committee focused on higher-level issues.

- **Secure funding.** Ongoing funding will be needed to support the Roadmap implementation. Funding can be sought for overarching coordination, as well as for the development and implementation of specific actions or streams of work. This will help draw on multiple funding sources and enable several organizations to lead discreet pieces of work.
- **Seek government ownership and involvement.** Ensuring government involvement and ownership in the process will support efficient development of achievable policy actions. Provincial participation should include relevant ministries and crown corporations such as BC Ministry of Energy, Mines, and Low-Carbon Innovation; BC Ministry of Social Development and Poverty Reduction; BC Ministry of Housing; BC Hydro; and BC Housing.
- **Create advocacy campaign.** Ongoing advocacy can help increase awareness, obtain commitments, and ensure accountability. Advocacy, however, may not fit under the broader implementation committee. Instead, it could be included in existing advocacy initiatives, or as its own campaign. Successful advocacy will require a coordinating organization, consistent messaging, and clear accountabilities.
- **Create public communication and outreach material.** Public communication of the Roadmap's objectives and progress will help increase buy-in and transparency. Public facing communications such as op-eds, interviews, annual progress reports, and other materials can be used to reach different audiences. Likewise, communications with other jurisdictions across Canada and North America can help support shared learnings, and innovation.
- **Align with existing initiatives.** As noted, this Roadmap builds off, and aligns with, the Building Electrification Roadmap (BERM). Coordinating the implementation, oversight and tracking of the two roadmaps will help avoid duplication and maintain alignment.
- **Revise and share lessons learned.** The Roadmap should be treated as a living document and receive regular updates and revisions as new information emerges and context continues to evolve.

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