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Costing Analysis of Window Mounted Heat Pumps

For Vancouver's West End

For:

Brady Faught

City of Vancouver

Prepared by:

FRESCo Building Efficiency

Madi Kennedy

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EXECUTIVE SUMMARY

The West End, one of Vancouver's densest neighbourhoods, has 684 multi-unit residential buildings (MURBs), most built before 1980 and reliant on inefficient windows and fossil fuel heating. Rising energy costs, climate change, and growing demand for cooling are driving the need for retrofit solutions that are scalable and minimally disruptive.

Window-mounted heat pumps (WMHPs) are compact, all-electric systems that provide both heating and cooling. Unlike conventional heat pumps, they plug into standard outlets and avoid refrigerant line sets or exterior compressors—making them particularly suitable for older rental and strata buildings.

Early pilot programs underscore their potential. In New York, WMHPs delivered stable comfort, reduced heating energy use by 86%, and achieved high tenant satisfaction. Vancouver's ongoing demonstration projects are now testing installation logistics and business case viability in the local context.

This study evaluates the feasibility, costs, and scalability of pairing WMHPs with targeted window replacements in the West End, based on:

- Pilots in New York City and Vancouver.
- A scan of 100 representative West End buildings.
- Cost modeling across six retrofit scenarios for both gas- and electrically-heated MURBs.

KEY FINDINGS

TECHNICAL FEASIBILITY

WMHPs are designed for vertically sliding sash windows, which are rare in the West End. However, most buildings can still accommodate WMHPs through one of two retrofit strategies: (1) replacing existing windows with new sash units, or (2) installing fixed glazing with a dedicated slot for the unit.

Estimated compatibility across 684 West End MURBs:

- **8%** have sash windows and could adopt WMHPs without a window replacement
- **58%** could use WMHPs as the primary source of heating and cooling with a window replacement
- **20%** could use WMHPs for partial heating and cooling with a window replacement
- **14%** are considered not compatible

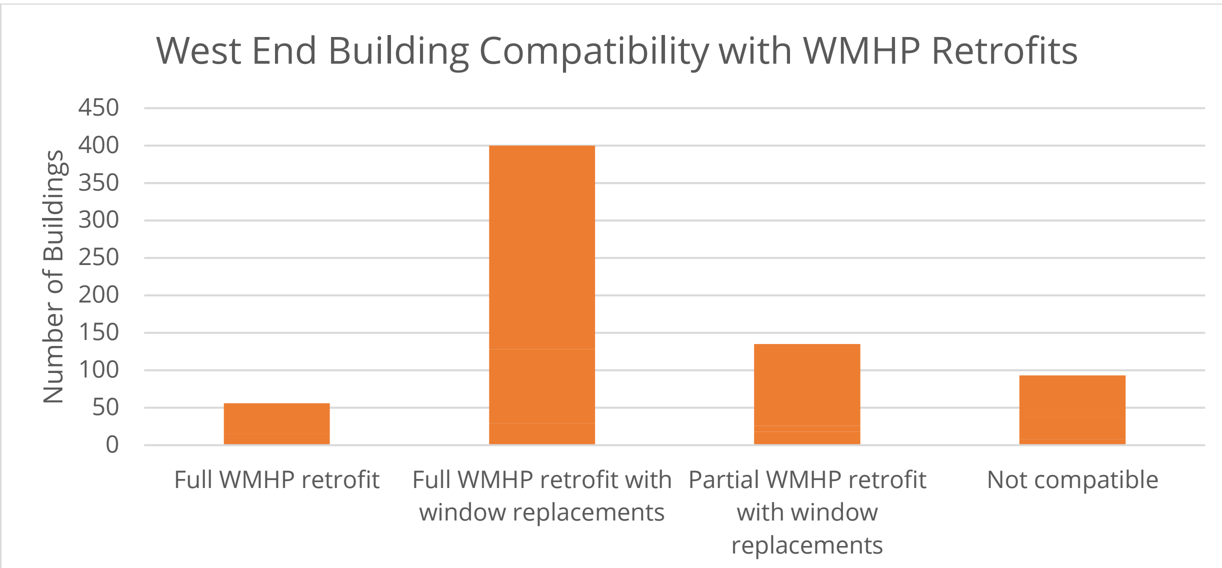

Figure 1. Distribution of 684 West End MURBs by WMHP retrofit feasibility. Most require full window replacements, some allow partial retrofits, and 14% are not compatible.

Common barriers to installation include:

- **Balconies and façade articulation:** Recessed/protruding balconies and angled walls can block safe mounting
- **Insufficient clearance:** Low window heights or deep masonry sills may prevent proper unit placement
- **Incompatible windows:** Sliding glass doors offer no mounting location in main rooms
- **Curtain wall or glass towers:** Provide no mounting location, and typically require alternative HVAC solutions
- **Interior obstructions:** Radiators or cabinetry below windows may block install locations

COST RANGES

Costs vary by building type, heating system, and window condition. Preliminary results show WMHPs are often a cost-effective electrification option, particularly in electrically heated buildings—even when window replacement is required.

In the chart below, the following cost scenarios are included:

- **Full WMHP:** Two window-mounted heat pumps (WMHPs).
- **Full WMHP + Window Replacement:** Two WMHPs plus two new windows.
- **Partial WMHP + Window Replacement:** One WMHP plus one new window.

All scenarios are based on a one-bedroom suite and include in-suite and building-level electrical upgrades for gas-heated suites.

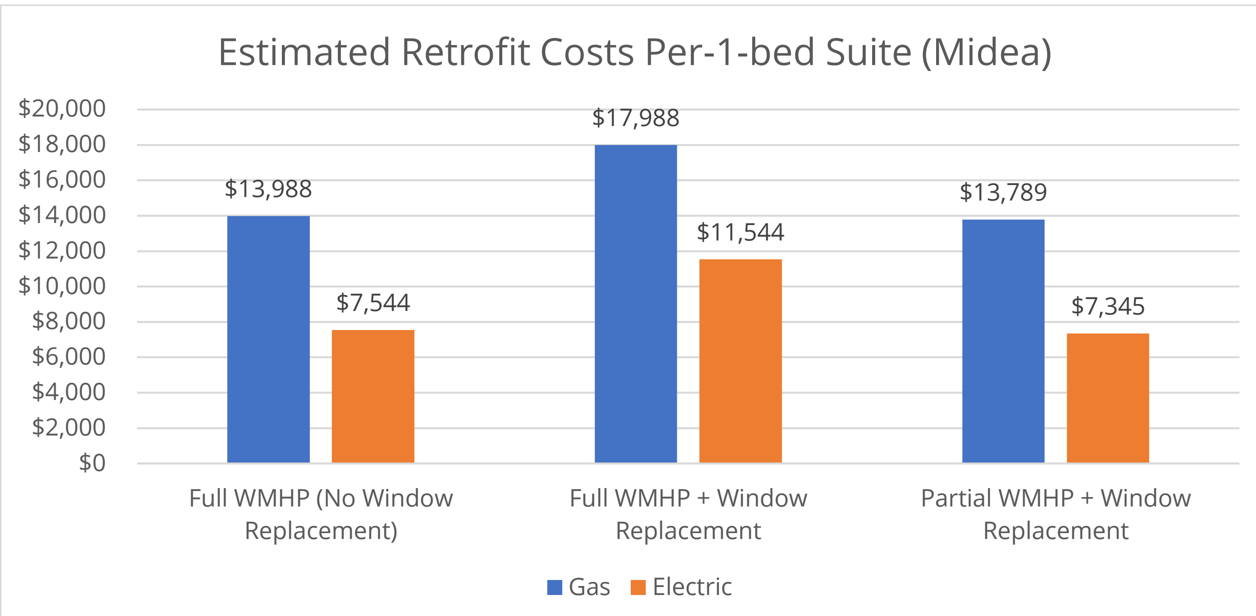

Figure 2. Estimated Costs for WMHP Upgrade in 1-bedroom Gas and Electric Suites

- **Electrically heated buildings present the lowest-cost opportunity.** Even when a full window replacement is required, retrofit costs remain significantly lower than in gas-heated buildings. For example, a 1-bedroom electric unit with new windows is estimated at ~$11,500—roughly 36% less than its gas-heated counterpart.
- **Gas-heated buildings are significantly more expensive to electrify,** primarily due to the need for electrical upgrades at the suite, building, and utility service levels. Service-level upgrades—typically ranging from $500,000 to $1.5 million per building—are not included in the per-suite WMHP cost estimates, but they represent a major project level expense. However, this is not a WMHP-specific challenge; similar

electrical upgrades would be required for most electrification strategies, including central and ductless heat pump systems.

- **Window replacements cost approximately $2,000 each.** While this adds to retrofit costs, it is relatively affordable and delivers added value—improving comfort, reducing drafts, and boosting energy efficiency in older buildings.
- **Partial WMHP deployment can lower costs.** Deploying heat pumps only in select rooms (e.g., bedrooms or main living areas) reduces unit and window costs, and can ease electrical constraints.
- **WMHPs remain competitive even with added window costs.** Despite the added cost of window replacement in most West End buildings, WMHPs are still generally less expensive than ductless mini-splits or central heat pump systems, making them a scalable and financially viable solution for many MURBs.

RECOMMENDATIONS

To scale adoption of window-mounted heat pumps in the West End and similar MURB-dense neighbourhoods, strategic coordination is needed across building targeting, product standardization, permitting, and incentives. The following actions are recommended:

- **Target priority buildings** by focusing on electrically heated, window-compatible MURBs and, in gas-heated stock, prioritizing those already scheduled for electrical or window upgrades.
- **Standardize products and installs** through partnerships with window manufacturers and the use of visual mock-ups and installation guidelines to support strata approvals.
- **Streamline permitting and abatement** by clarifying WMHP classification, simplifying approval pathways, and planning early for asbestos management in pre-1980 buildings.
- **Align incentives and scale deployment** by advocating for WMHP eligibility in BC Hydro and CleanBC rebates, providing top-up funding where window replacement is required solely for WMHPs, and leveraging bulk purchasing and pilot projects to reduce costs.

1 INTRODUCTION

Vancouver's West End is one of the city's most densely populated and architecturally varied neighbourhoods — home to hundreds of aging apartment buildings that collectively house thousands of residents. Many of these buildings still rely on outdated windows and inefficient heating systems, contributing to high energy costs, poor indoor comfort, and increasing vulnerability to climate extremes such as heat waves.

As residents face hotter summers, rising utility prices, and shifting expectations for comfort and livability, there is growing demand for retrofit solutions that are scalable, minimally disruptive, and effective in older hard to electrify building stock. In this context, window-mounted heat pumps (WMHPs) offer a promising retrofit option. These compact, all-electric units sit on the windowsill like a portable air conditioner but provide both heating and cooling. WMHPs plug into a standard outlet and do not require refrigerant line sets, exterior compressors, or invasive construction — making them especially well-suited to tenant-occupied buildings and strata properties.

This study explores the feasibility and costs of pairing WMHPs with targeted window replacements to enable broader adoption in the West End. While WMHPs were originally designed for vertically sliding sash windows — a configuration uncommon in British Columbia — this project evaluates two retrofit window strategies that could make these systems viable in a much larger portion of the local building stock.

The assessment includes:

- Desktop research and consultation with industry experts and product manufacturers;
- A scan of 100 representative West End buildings using Google Street View and BC Assessment data to identify typical window types and evaluate WMHP compatibility;
- Cost modeling across multiple retrofit scenarios, considering both gas- and electrically-heated buildings, and full and partial system coverage.

The goal is to estimate how widely this combined retrofit approach could be deployed in the West End — and to identify the major barriers, technical thresholds, and cost drivers. Although this analysis is limited in scope and should be interpreted as an order-of-magnitude costing study (rather than a detailed engineering design), it provides important insights to inform:

- Future pilot projects;
- Incentive program development; and
- Long-term electrification planning for hard to electrify MURBS

Together, WMHPs and compatible window solutions may offer a practical, scalable pathway to decarbonize aging housing stock — while improving tenant comfort, reducing emissions, and strengthening community resilience.

2 INSIGHTS FROM WMHP PILOTS

2.1 Overview

Recent pilot programs in New York City and British Columbia are providing early evidence of how WMHPs can serve as a viable, low-disruption electrification strategy in multi-unit residential buildings (MURBs) — especially older buildings without central HVAC systems.

2.1.1 Product Overview

The Clean Heat for All Challenge — led by the New York City Housing Authority (NYCHA) and the New York State Energy Research and Development Authority (NYSERDA) — catalyzed the development of two cold-climate WMHP models:

- Midea Packaged Window Heat Pump
- Gradient All-Weather 120V™ Window Heat Pump

Both systems are 120V plug-in units that do not require refrigerant line sets, exterior compressors, or wall penetrations. They manage condensate using misting atomizers and can typically be installed in less than a day. Their ease of installation, reversibility, and minimal disruption make them especially well-suited to tenant-occupied buildings and strata properties.

Current product status and pricing:

- The Midea unit is certified and market-ready in Canada and the US, with a current price of approximately $2,000 per unit.
- The Gradient unit is still undergoing testing (expected through winter 2025–26), is not yet certified or available to the Canadian market. The model is currently priced at approximately $5,200.
  (*Note: All prices are approximate and subject to change.*)

Figure 3. Gradient All-Weather 120V™ Window Heat Pump (left) and Midea Packaged Window Heat Pump (right)

Technical Specifications of the Midea and Gradient Units[1]

Specification	Midea Heat Pump	Gradient Heat Pump
Power Requirements	120 VAC / 12 A / 60 Hz	120 VAC / 12 A / 60 Hz
Cooling Capacity @ 95°F	9,100 Btu / 11.81 EER	9,000 Btu / 13.6 EER
Heating Capacity @ 47°F	9,000 Btu / 4.00 COP	9,000 Btu / 4.04 COP
Heating Capacity @ 17°F	9,000 Btu / 2.42 COP	9,000 Btu / 2.37 COP
Heating Capacity @ 5°F	9,000 Btu / 2.00 COP	7,200 Btu / 2.06 COP
HSPF2 (Heating Seasonal Performance)	10.1	9.3
Minimum Operating Temperature	–13°F	–7°F
Compressor Type	Variable speed	Variable speed
Refrigerant Type	R-32	R-32
Maximum Sound Level	51 dB(A)	47 dB(A)
Weight	130 lb	140 lb
Dimensions (W × D × H)	25.5″ × 35″–41″ × 20.5″	25.5″ × 37″–47.4″ × 24″

[1] American Council for an Energy-Efficient Economy (ACEEE). *Decarbonizing Space Heating in Existing Multifamily Buildings*. Report B2506, April 2024. Available at: https://www.aceee.org/sites/default/files/pdfs/b2506.pdf

2.2 New York City Pilot

In June 2024, NYCHA installed 72 WMHP units (36 Midea and 36 Gradient) across 24 apartment units as part of a pilot project. Installations replaced steam heating entirely and ran through the 2023–2024 winter and summer seasons. Results show promising performance:

- **Consistent Comfort in Winter**: Sensor data showed apartments with WMHPs maintained more stable, comfortable temperatures throughout the winter, even during the coldest periods of the heating season
- **Significant Energy and Cost Savings**: WMHP-equipped apartments used 86% less energy for space heating compared to steam-heated control units. Heating energy costs were halved — a 50% reduction — even with higher electricity rates.
- **High Resident Satisfaction**:89% of households with WMHP installations reported being satisfied with their new systems.
- **Scalability and Deployment Strategy**: NYCHA plans full-building WMHP installs at Woodside Houses before the 2025–2026 winter. Longer-term goals include outfitting 30,000 apartments by 2028, and expanding to 50,000 units by 2035, as part of a $250 million program to electrify heating across the NYCHA portfolio.[2]

2.3 Vancouver Demonstration Project

A small-scale demonstration in Vancouver is now underway, involving 6 Midea units across three MURBs (one electric and two gas-heated). Installations are occurring in suites with both existing sash windows and buildings requiring a window replacement for compatibility with WMHP. The demonstration will provide insights on:

- Installation logistics in BC buildings
- Capital cost and business case
- System performance
- Compatibility with local window configurations
- Tenant and landlord experience and satisfaction

[2] New York City Housing Authority. "NYCHA and NYPA Announce Plan to Install 30,000 Electric Heat Pumps in Apartments by 2028." *NYC.gov*, May 8, 2025. https://www.nyc.gov/site/nycha/about/press/pr-2025/pr-20250508.page.

2.4 Window Integration: Retrofit Options and Implications

While the New York pilot has already demonstrated strong performance outcomes, the Vancouver demonstration is still in progress. Early installations are taking place across a small number of suites in three multi-unit buildings and are expected to provide valuable insights into local feasibility and occupant experience over time.

One of the key differences between the two contexts is window compatibility. Unlike many New York apartments, most British Columbia buildings — including those in the West End — do not have vertically sliding sash windows, which WMHPs were originally designed to fit. As a result, the Vancouver pilot relies on window replacements to enable WMHP installation.

To support broader adoption, this study evaluated two window integration strategies that allow WMHPs to be used in buildings with fixed-pane, casement, or slider windows. These options are outlined below.

Retrofit Option	Description	Pros	Cons
1. Vertical Slider Replacement	Replace existing window with a new operable sash (vertical slider) window compatible with WMHP mounting.	• Straightforward WMHP installation • Familiar, readily available window form • Maintains window operability if unit is removed	• Lower thermal performance than casement or awning windows
2. Fixed Window with Dedicated WMHP Slot	Replace the entire window with fixed glazing that incorporates a dedicated sill-level slot or insert designed to accommodate a WMHP unit. For larger window openings, the design can include an operable section alongside the WMHP insert to maintain ventilation and egress.	• Enables use of WMHPs in buildings with larger windows that may not be compatible with the sash design • Preserves building layout and exterior appearance • Can be designed to be aesthetic, high-performance, and used with or without the WMHP	• Requires custom fabrication • May involve added coordination, design, or permitting

These integration strategies are most practical in buildings where windows are already due for replacement. In cases where windows are mid-life or recently upgraded, the added cost of replacement can reduce cost-effectiveness — particularly in partial retrofit scenarios — but may still represent the most viable option for adding efficient cooling.

Importantly, any window replacement should follow best practices for building envelope performance and durability. Guidance developed by BC Housing and the Fenestration Association of BC — such as *Best Practices for Window and Door Replacement in Wood-Frame Buildings* — outlines strategies to integrate new windows into existing assemblies while managing moisture, improving air tightness, and extending service life.[3] Following these guidelines is particularly important when window retrofits are combined with mechanical installations like WMHPs, which may require penetrations or changes to window detailing.

As of this study, there are no known WMHP solutions designed for direct integration into existing non-sash windows without full replacement. Continued product development in this area could unlock simpler and more cost-effective options in the future.

2.5 Technical and Permitting Challenges

While WMHPs offer a promising low-disruption retrofit option, several practical and regulatory factors may limit feasibility or increase complexity in some West End buildings.

2.5.1 Architectural & Window Compatibility Constraints

Many buildings — particularly mid-rise strata — feature complex façades that create installation challenges for WMHP installation, even with window replacements. Common issues include:

- **Balconies and articulation**: Recessed or protruding balconies, irregular window placement, and angled walls can prevent safe mounting of WMHP.
- **Insufficient clearance**: In some suites, windows are set too close to the floor, or have sills too deep to support WMHP installation.
- **Incompatible window types**: Buildings with sliding glass doors (instead of operable windows) offer no viable installation point.
- **Curtain wall and glass towers**: These assemblies are generally not compatible with WMHP mounting and would require alternate HVAC solutions.
- **Interior cabinets or fixtures**: If they are situated under windows can limit the ability to install WMHP.

2.5.2 Heating and Electrical System Constraints

- While it is possible to decommission gas heating to an apartment suite, gas-heated buildings with hydronic loops cannot typically be partially decommissioned room-by-room, making it difficult to isolate heating in one zone (e.g., a bedroom).

[3] BC Housing. *Costing Study of In-Suite Mechanical System Upgrades in Multi-Unit Residential Buildings (MURBs)*. 2024. Available at: https://research-library.bchousing.org/Home/ResearchItemDetails/2003

- Partial electrification (e.g., bedrooms only) may also be less attractive to building owners aiming to fully replace their heating systems. That said, this approach can still offer strategic benefits in some contexts — enabling the addition of cooling, lowering GHG emissions in gas-heated buildings, or improving efficiency in electrically heated ones.
- Electrical upgrades are typically required in gas-heated buildings to support WMHPs, including panel upgrades or adding a dedicated circuits for the WMHP. Electrically heated buildings can often repurpose baseboard heater circuits, reducing cost and disruption.

Integration of Load Management Technology

In some cases, load management technologies, such as Evectrix, can be used to manage peak electrical demand and help avoid the need for full electrical service upgrades. However, their applicability in multi-unit residential buildings (MURBs) is limited. For load-shifting strategies to be effective, suites must have sufficient controllable electrical load — typically in the form of in-suite electric hot water heaters and/or electric washers and dryers. In suites with only an electric range, lighting, and standard plug loads, there is insufficient load diversity to enable meaningful demand shifting. Based on typical suite configurations in the West End, we estimate that load management solutions may be viable in approximately 5% of buildings.

2.5.3 Permitting & Code Considerations

Permitting requirements for WMHPs are still evolving. While units are generally classified as plug-in appliances and may not require mechanical permits and the condensate atomizer removes the need for drainage systems that comply with local bylaws, other approvals may still apply:

- Building officials may review installations for compliance with egress, structural, fire safety, visual aesthetics and noise, and weatherproofing requirements.
- Early coordination with permitting authorities is recommended to avoid delays.
- All window retrofits will need to follow standard code and permit requirements. Custom window integrations or first-time installs may require additional testing or compliance documentation, especially where performance or egress is impacted.
- Heritage designation may limit potential to replace windows or impact the heritage aesthetic of the building.

2.5.4 Governance, Aesthetics, and Cost Reallocation Challenges

Strata Constraints

In strata buildings, non-technical concerns can significantly affect retrofit feasibility and uptake:

- **Visual uniformity and precedent-setting**: Many strata corporations require consistent exterior appearances, making it difficult to approve pilot or partial installations.
- **Decision-making timelines**: Strata councils may move slowly or require multiple rounds of approvals, delaying deployment.
- **Solutions**: Early engagement with councils and property managers, along with visual mock-ups or standardized install guidelines, can help address concerns about appearance, noise, and installation consistency.

Rental Housing: Cost Reallocation Barriers

In purpose-built rental buildings, the installation of a heat pump may raise difficult questions around who pays for heating and cooling:

- Gas-heated MURBs often include heating in the rent and are not sub-metered.
- The installation of a heat pump for heating purposes transfers heating costs to tenants via utility bills, requiring rent reductions or other compensation to keep costs neutral.
- While tenants may welcome the addition of cooling, they may not anticipate the additional electric utility costs for accessing cooling.
- This shift is hard to quantify and administer fairly, and can pose financial barriers for landlords and affordability concerns for tenants — especially in buildings with stabilized rents or limited capital reserves.

These barriers highlight the need for clear permitting guidance, coordinated engagement strategies, and policy tools that support equitable cost-sharing in for in-suite heat pump retrofits.

WEST END BUILDING TYPOLOGIES & COMPATIBILITY

2.6 Methodology and Data Sources

This analysis draws on multiple sources to build a high-level profile of the West End's MURB stock. Core data was provided by the City of Vancouver and supplemented through a visual scan using Google Street View, BC Assessment records, and select real estate listings. A representative sample of 100 buildings was reviewed in detail to assess window configurations and heating systems. Figure 2 depicts the grid that was used to select the sample of buildings. The findings from this assessment were then extrapolated to the broader inventory of 684 MURBs to estimate retrofit potential across the neighbourhood.

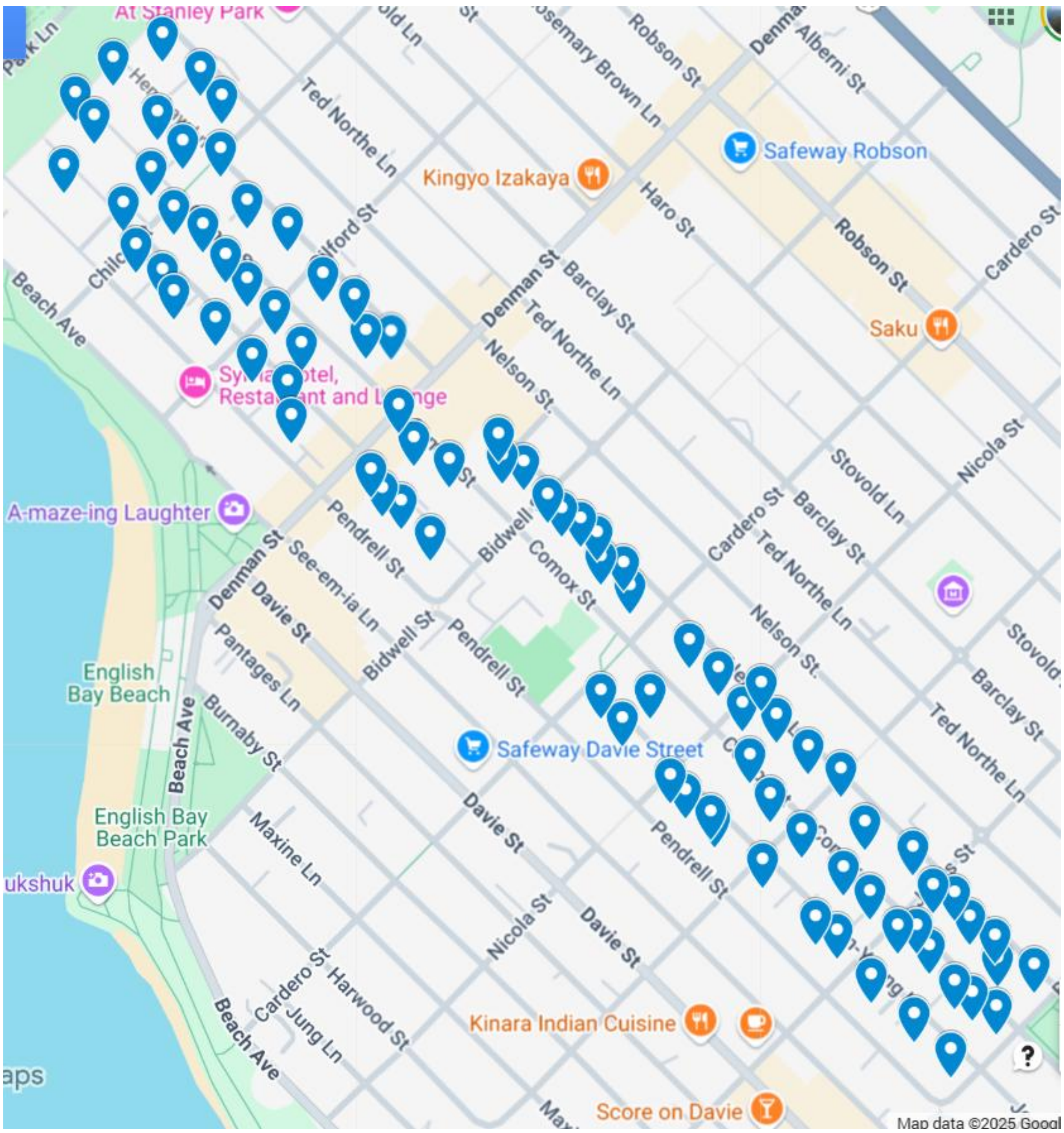

Figure 4. Map of Buildings Assessed in this Analysis

2.7 Key Characteristics of the West End Building Stock

The building stock in the West End reflects decades of layered development and presents a wide range of retrofit conditions. Understanding the mix of heating systems, building forms, construction eras, and window types is essential for identifying where and how WMHP retrofits can be successfully deployed.

- **Heating systems:** 85% of buildings use natural gas, 1% are connected to district energy, and just 14% are electrically heated — a higher share of gas-heated buildings than in most Vancouver neighbourhoods, presenting a key challenge for electrification.[4]
- **Building typologies:** The stock is mostly low-rise (70%), followed by mid-rise (22%) and high-rise (8%). However, unit distribution is nearly even — with 34% of units in low-rise buildings, 35% in mid-rise, and 31% in high-rise — highlighting the need to include all building forms in retrofit planning.
- **Building age and asbestos:** More than 80% of buildings were constructed before 1980, increasing the likelihood of asbestos-containing materials (ACMs). Abatement may be required for panel upgrades, dedicated electrical outlet installations, or window replacement — adding cost and complexity, and in some cases requiring temporary tenant relocation.
- **Window Condition:** Based on the visual scan, approximately 50% of buildings appeared to have windows that could be classified as inefficient or in poor condition (e.g., single-pane or visibly deteriorated), 40% in fair condition (mid-lifespan), and 10% with newer high-performance glazing. This variation has implications for both the cost and urgency of window replacement in a WMHP retrofit.

[4] Based on data provided by the City of Vancouver

2.8 Typology of WMHP Compatibility

All buildings were categorized into four groups based on their compatibility with WMHP installation. This typology informed the retrofit feasibility analysis and market-wide cost modeling.

1. Full WMHP Upgrade (F)

Existing windows are directly compatible with WMHPs — no replacement or major modifications needed.

- **Windows**: vertically sliding sash with appropriate sill depth
- **Retrofit:** simple, low-cost install
- **Example:** Heritage mid-rise with wood sash windows

2. Full WMHP Upgrade with Window Replacement (WF)

Existing windows must be fully replaced to support WMHPs, but suite layouts are otherwise compatible.

- **Typical windows:** horizontal sliders, casement or awning
- **Retrofit:** full window replacement using WMHP-compatible design
- **Example:** low-rise walk up with aging aluminum sliders

3. Partial WMHP Upgrade with Partial Window Replacement (WP)

Only some suites or exposures are compatible, even with a targeted window replacement.

- **Constraints:** Balconies, articulation, or sliding doors limit installation in key spaces (e.g., living rooms).
- **Retrofit:** partial suite coverage (e.g., bedrooms only).
- **Example:** Mid-rise with balconies in every unit or strata buildings with mixed glazing and variable façade features

4. Not Compatible (NC)

WMHPs cannot be installed, even with window replacement.

- **Barriers:** curtain wall glazing, no operable windows, insufficient clearance
- **Retrofit:** alternate HVAC solutions required
- **Example**: Modern high-rises with full-height glass

3 WHOLE-BUILDING COST SCENARIOS

Retrofitting MURBs with WMHP can significantly improve thermal comfort, enable cooling, reduce electrical costs for heating (in electrically heated suites) and reduce greenhouse gas emissions (in gas heated suites). However, retrofit will costs vary widely depending on building type, existing infrastructure, and window configuration.

This section illustrates the capital costs associated with different building typologies and retrofit scenarios. It draws on real-world examples from Vancouver's West End to highlight how heating systems, window conditions, and electrical capacity shape retrofit feasibility and cost.

3.1 Overview of Retrofit Scenarios

To reflect the diversity of MURBs in the West End, we modeled three common retrofit configurations:

1. **Full WMHP Upgrade (F):** Heat pump installation with no window replacement
2. **Full WMHP + Window Replacement (WF):** Heat pump installation with full suite window replacement
3. **Partial WMHP + Window Replacement (WP):** Partial-suite WMHP installs (e.g., bedrooms only) with selective window replacement

Each configuration is modeled for both gas- and electric-heated buildings. Cost estimates include heat pump units, electrical work, window replacement (as needed), labor, permitting, and taxes. The scenarios are based on 2024–2025 equipment pricing and contractor rates in British Columbia and are intended to support early-stage planning and budgeting.

3.2 Core Retrofit Assumptions

While WMHPs are generally simpler to install than conventional HVAC systems, several variables drive cost and complexity — including building age, existing electrical infrastructure, and presence of asbestos-containing materials (ACMs). The table below outlines key assumptions for different building types:

Item	Details
Window mounted heat pump	• Midea: ~$2,000 per unit • Gradient: ~$5,200 per unit • Installation: 1–2 hours per unit @$150 / hour
Dedicated circuit and receptacle	• ~$3,000 / suite including new copper wiring
Electric panel upgrade	• Electrical panel upgrade ~$2,000 / suite
Building electrical infrastructure	• Panel feeder upgrades ~$4,000 / suite

Window replacement costs	• ~$1,300 - $2,100 per window depending on performance and window type
Asbestos abatement	• ~$500 - $4,000 per suite depending on whether ACMs are encountered around electrical panels, outlets, or window assemblies
Electrical service upgrade	• ~$500,000 - $1.5 million[5]

Cost Comparison with Mini-Split Heat Pumps – 2 Units Per Suite

In a recent FRESCo implemented pilot project, mini-split heat pumps were installed in four one-bedroom units — each equipped with two indoor heads (one in the living room and one in the bedroom). Installation costs ranged from $9,200 to $14,105 per suite, covering only the heat pump equipment and installation. These figures do not include required electrical work, asbestos abatement, or permitting.

By comparison, the estimated cost of installing window-mounted heat pumps (WMHPs) in a similar configuration (two units per one-bedroom suite) is:

- Midea WMHPs: Approximately $4,600 per suite (equipment + installation)
- Gradient WMHPs: Approximately $11,000 per suite (equipment + installation)

If paired with a window replacement, the total estimated cost rises to:

- Midea WMHPs + Window Replacement: Approximately $8,600 per suite (equipment + installation)
- Gradient WMHPs + Window Replacement: Approximately $15,000 per suite (equipment + installation)

At the lower end of the cost range, WMHP are substantially cheaper than mini-split heat pumps. At the upper end the costs are comparable.

[5] **Note:** BC Hydro's new Distribution Extension Policy, which came into effect on July 5, 2025, changes how costs are shared between customers and BC Hydro for new service connections and electrical capacity upgrades. At the time of writing, the implications for retrofit projects remain unclear — including how upgrade costs will be calculated and allocated. As such, the cost assumptions in this report may change as the policy is more fully implemented and interpreted.

3.3 Scenario Assumptions by Heating Type

Parameter	Gas-Heated Building	Electric-Heated Building
Window mounted heat pump	Required	Required
Dedicated circuit and receptacle	Required	Required
Electric panel upgrade	Required	Not required (reuse baseboard circuit)
Building electrical infrastructure	Required	Not required
Window replacement	Only for: Full WMHP + Window Replacement (WF) Partial WMHP + Replacement (WP)	
Asbestos Abatement	Where applicable	Where applicable
Electrical Service Upgrade	Required	Not Required

3.4 Representative Cost Scenarios

To illustrate real-world cost implications, we present three building archetypes from the West End. Each example highlights a distinct retrofit type, showing how building characteristics influence upgrade feasibility and capital cost.

3.4.1 Full WMHP Upgrade – Electric Building

Example: 1601 Comox Street
Year Built: 1912
Building Form: 6-storey walk-up with 36 residential units
Unit Mix: 20 one-bedroom suites and 16 two-bedroom suites
Heating System: Electric[6]
Asbestos Abatement: Not anticipated

This heritage-era apartment building is fully electric and well-suited to WMHP installation. Most suites feature compatible sash windows that do not require replacement, allowing for straightforward integration of Midea WMHPs. Each one-bedroom suite would receive two units (typically one in the living area and one in the bedroom), while two-bedroom suites would receive three units to ensure full space conditioning. Each unit would be connected to a dedicated outlet and receptacle. Some basement units may be excluded due to limited clearance or atypical layouts, but the majority of suites can be retrofitted with minimal disruption. Asbestos abatement is not anticipated, as asbestos-containing materials were less commonly used in buildings constructed in the early 1900s.

- **Estimated retrofit cost per suite:**
    - One-bedroom: $7,544
        - Electrical infrastructure upgrade (dedicated receptables): $3,146
        - Midea WMHP (x2) and installation $4,398
    - Two-bedroom: $9,743 including three heat pumps, and three dedicated outlets and receptacles.
        - Electrical infrastructure upgrade (dedicated receptables): $3,146
        - Midea WMHP (x3) and installation $6,597
- **Estimated total building cost:** $306,768

This archetype represents an ideal early adopter: an electrically heated, window-compatible low-rise with no abatement barriers — offering low-cost, low-complexity installation potential for full-building electrification.

[6] Note: this is assumed to be electrically heated for the purposes of this study, but may in reality be gas heated

3.4.2 Full WMHP + Window Replacement – Gas Heated Building

Example: 1721 Comox Street
Year Built: 1956
Building Form: 3-storey walk-up with 23 suites
Unit Mix: 23 bachelor units (approximately 425 sq ft each)
Heating System: Gas
Asbestos Abatement: Anticipated
Tenure: Market rental — units renting for approximately $2,000/month

This three-storey walk-up rental building requires several upgrades to enable installation of Midea WMHPs. Each of the 23 bachelor suites would receive one WMHP and one new window, as the existing glazing is not compatible. To support the added electrical load, the retrofit scope includes panel and circuit upgrades along with dedicated receptacles in each suite. Because the building is gas-heated, a full electrical service upgrade is assumed. Given the small size of the building, this cost is estimated at the lower end of the expected range.

Constructed in 1956, the building predates modern asbestos regulations, so abatement is assumed to be necessary in all suites — particularly around electrical panels and window areas. This adds cost and coordination complexity, especially in a fully occupied rental building where tenant relocation may be required for safe access.

- **Estimated retrofit cost per suite:**
  - Base retrofit per suite: $15,789
    - Electrical infrastructure upgrade (including panel feeders, suite panels, breakers and dedicated receptables): $9,590

    - Midea WMHP and installation: $2,199
    - Window replacement: $2,000
    - Asbestos abatement: $2,000
- **Electrical service upgrade*:*** $500,000
- **Estimated total building cost:** $863,147 ($363,147 for heat pumps and $500,000 for electric service upgrade)

Despite the higher per-suite cost due to electrical and abatement requirements, this building represents a strong candidate for WMHP retrofits due to its compact form, standardized suite layouts, and high potential for year-round comfort and cooling benefits.

3.4.3 Partial WMHP + Partial Window – Gas Heated Building

Example: 1869 Comox Street
Year Built: 1964
Building Form: 12-storey concrete tower with 86 rental units
Unit Mix: 82 one-bedroom units, 2 one-bedroom + den units, and 2 two-bedroom units.
Heating System: Gas
Asbestos Abatement: Completed
Tenure: rents average $1,326 for one-bedrooms, with higher rates for larger suites

This 12-storey concrete high-rise is a mid-century purpose-built rental building with gas heating. The recent completion of asbestos abatement eliminates cost and logistical barrier often encountered in retrofitting buildings of this era.

Due to glazing configurations and layout constraints, Midea WMHPs are assumed to be installed only in the bedrooms. Living rooms are not suitable for installation due to sliding balcony doors, making this a partial retrofit scenario. Window replacements are limited to the rooms receiving WMHPs.

While the building is gas-heated, the smaller load associated with bedroom-only WMHPs means a full electrical service upgrade is not assumed (although a detailed electrical assessment would still be needed to confirm service capacity). Each suite would require panel upgrades along with dedicated circuits and receptacles to power the units.

- **Estimated retrofit cost per suite:**
    - One-bedroom: ~$13,789
        - Electrical infrastructure upgrade (including panel feeders, suite panels, breakers and dedicated receptables): $9,590
        - Midea WMHP and installation: $2,199
        - Window replacement: $2,000
    - Two-bedroom: ~$17,988
        - Electrical infrastructure upgrade (including panel feeders, suite panels, breakers and dedicated receptables): $9,590
        - Midea WMHP (x2) and installation $4,398
        - Window replacement (x2): $4,000
- **Estimated total building cost:** $1.2 million

This scenario highlights the potential for partial WMHP deployment in buildings with mixed glazing types and sliding balcony doors. However, partial electrification at this scale may not be feasible or the best option in all gas heated buildings. Feasibility will depend on the existing heating system configuration — for example, buildings with centralized hydronic loops are often not compatible with room-by-room decommissioning, limiting the ability to electrify a single room.

In these cases, alternative technologies should be explored for full electrification, such as mini-split heat pumps, which may be better suited for these suites with balconies. A comprehensive assessment of the existing heating system, combined with a clear understanding of project goals (e.g., cooling, full electrification, cost control), is essential to determine the most practical and cost-effective retrofit pathway.

Load Management: Evectrix System Summary

Load management technologies like Evectrix can help reduce or eliminate the need for full electrical service upgrades by intelligently managing in-suite electrical loads. This solution is particularly valuable in buildings where electrical infrastructure is near capacity but can be rebalanced instead of expanded.

Manufacturer Estimate

Item	Pre-Tax Cost (Per Suite)
Evectrix Panel + Cables	$4,500- $5,500
Installation Labor	$1,500 - $2,500
Total	$6,000- $8,000

Criteria for Viable Load Management Installations

Load management may be suitable if the following apply:

1. Electrical service upgrades can be avoided through managed loads
2. Suites contain significant controllable electric loads, such as:
    - Electric ranges
    - In-suite electric dryers
    - Electric domestic hot water heaters
3. Installed heat pumps can be integrated via IR control or third-party thermostats
4. Spare electrical capacity exists for active load balancing (TBD by Evectrix per site)
5. Ongoing system monitoring is supported by on-site staff (ideal but not mandatory)

Key Takeaway

Load management with Evectrix offers a potential pathway to enable WMHP retrofits in electrically constrained buildings. However, it is only suitable for a limited subset of buildings — specifically those with:

- In-suite controllable loads
- Minimal shared electrical infrastructure
- Clear avoidance of costly service upgrades

4 MARKET SIZING AND SENSITIVITY ANALYSIS

This section estimates the potential scale and capital cost of window-mounted heat pump (WMHP) retrofits across the West End based on building compatibility, heating type, and suite characteristics. The objective is to understand what full implementation could look like — both in terms of investment requirements and variation by building type and retrofit scenario.

4.1 Methodology and Assumptions

The analysis combines available building data (number of buildings, suite counts, and energy source) with key assumptions about:

- **Suite mix** by bedroom type (bachelor to four-bedroom) was estimated using a representative building sample.
- Buildings were categorized by **retrofit typology**:
    - Full WMHP only
    - Full WMHP + Window Replacement
    - Partial WMHP + Partial Window Replacement
- **Heating source** was identified as either gas or electric
- **Window replacement** was assumed only in rooms receiving WMHPs, not full suite coverage. That said, some buildings may opt for full window replacement depending on window condition or design considerations.

The estimated distribution of buildings by compatibility type is summarized in the following table.

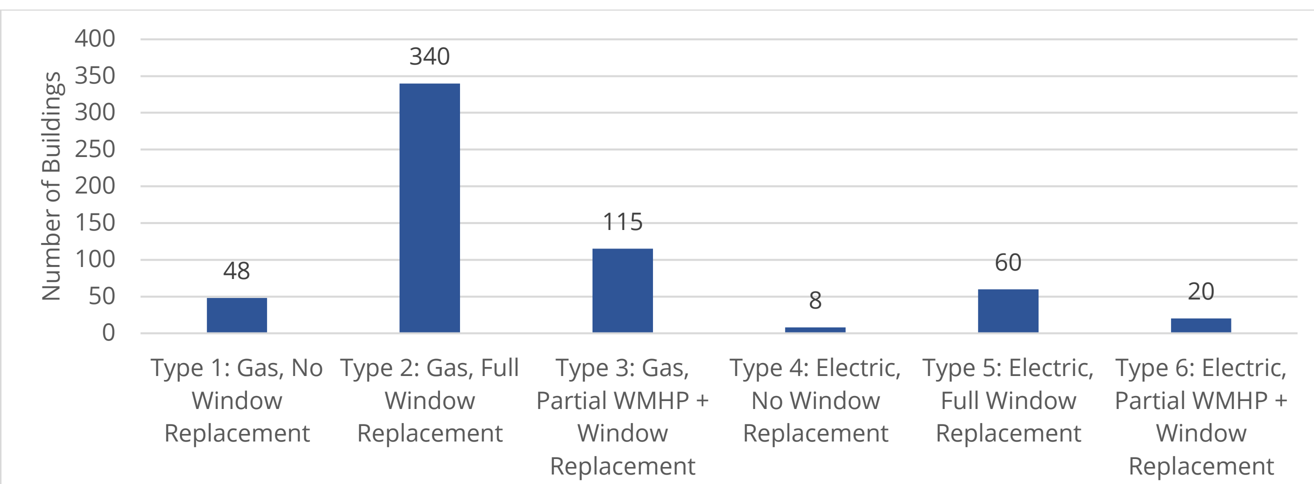

Figure 5. Estimated distribution of buildings by retrofit type

4.2 Per-Suite Retrofit Cost Estimates

Cost estimates were developed for six retrofit scenarios, each modeled across five suite types. These reflect the most likely retrofit configurations given existing window and heating system conditions. Costs include WMHP units (Midea), window replacements (as applicable), electrical upgrades, labor, permitting, and contractor markup.

Midea WMHP – Estimated Per-Suite Retrofit Costs

Scenario	Bachelor	1-Bed	2-Bed	3-Bed	4-Bed
Type 1: Gas, No Window Replacement	$ 11,789	$ 13,988	$ 16,187	$ 18,386	$ 20,585
Type 2: Gas, Full Window Replacement	$ 13,789	$ 17,988	$ 22,187	$ 26,386	$ 30,585
Type 3: Gas, Partial WMHP + Window Replacement	n/a*	$ 13,789	$ 17,988	$ 22,187	$ 26,686
Type 4: Electric, No Window Replacement	$ 5,345	$ 7,544	$ 9,743	$ 11,942	$ 14,141
Type 5: Electric, Full Window Replacement	$ 7,345	$ 11,544	$ 15,743	$ 19,942	$ 24,141
Type 6: Electric, Partial WMHP + Window Replacement	n/a*	$ 7,345	$ 11,544	$ 15,743	$ 19,942

Gradient WMHP – Estimated Per-Suite Retrofit Costs

Scenario	Bachelor	1-Bed	2-Bed	3-Bed	4-Bed
Type 1: Gas, No Window Replacement	$ 15,123	$ 20,656	$ 26,189	$ 31,722	$ 37,255
Type 2: Gas, Full Window Replacement	$ 17,123	$ 24,656	$ 32,189	$ 39,722	$ 47,255
Type 3: Gas, Partial WMHP + Window Replacement	n/a*	$ 17,123	$ 24,656	$ 32,189	$ 40,022
Type 4: Electric, No Window Replacement	$8,679	$ 14,213	$ 19,746	$ 25,279	$ 30,812
Type 5: Electric, Full Window Replacement	$ 10,679	$ 18,213	$ 25,746	$ 33,279	$ 40,812
Type 6: Electric, Partial WMHP + Window Replacement	n/a*	$ 10,679	$ 18,213	$ 25,746	$ 33,279

Notes:

- *Partial retrofit of bachelor suites is not possible.*
- *Costs reflect average assumptions by bedroom count; individual suite conditions may differ.*

- *Electric service upgrade costs are excluded from this table.*

4.3 Full Implementation Cost

To estimate the total cost of a full WMHP retrofit program in the West End, per-suite costs were extrapolated to the estimated number of suites in each retrofit scenario. This analysis reflects 100% participation among technically compatible buildings using Midea units.

Total Capital Cost by Retrofit Type

Retrofit Type	# of buildings	Estimated Total Cost Midea	Estimated Total Cost Gradient
Type 1: Gas, No Window Replacement + *electric service upgrade*[7]	48	$15.6 million + *$33.1 million*	$28.2 million + *$33.1 million*
Type 2: Gas, Full Window Replacement + *electric service upgrade*	340	$224.1 million + *$251.6 million*	$306.2 million + *$251.6 million*
Type 3: Gas, Partial WMHP + Window Replacement	115	$49.3 million	$79.0 million
Type 4: Electric, No Window Replacement	8	$1.8 million	$3.4 million
Type 5: Electric, Full Window Replacement	60	$25.2 million	$39.7 million
Type 6: Electric, Partial WMHP + Window Replacement	20	$4.3 million	$9.1 million
Total	**591**	**$320.4 million**	**$465.6 million**
Total *with Electrical Service Upgrade*	**591**	**$605.1 million**	**$750.3 million**

Note: These values include all construction and installation costs, and assume no government incentives, financing programs, or bulk purchasing discounts.

[7] Electrical service upgrade costs are estimated by building size: $500,000 for low-rise, $1,000,000 for mid-rise, and $1,500,000 for high-rise buildings. These figures are intended as rough order-of-magnitude estimates only. Actual costs vary significantly depending on existing electrical infrastructure, service configuration, and utility coordination requirements.

4.4 Sensitivity Analysis

The capital costs estimated in this study are based on average unit pricing and standard retrofit assumptions. However, several key variables could significantly increase or decrease the total cost of a window-mounted heat pump (WMHP) retrofit program across the West End. This section outlines those sensitivities to help contextualize the findings and inform future planning.

Window Replacement Scope

While this study assumes window replacement only in rooms receiving a WMHP, some buildings may choose full-suite or full-building replacements — either to improve overall envelope performance or maintain aesthetic uniformity. This could double or triple window-related costs, particularly in larger units or high-rise buildings with extensive glazing.

Asbestos Abatement

Asbestos abatement was excluded from the core per-suite cost estimates but could represent a major cost driver — particularly given that more than 80% of West End MURBs were built before 1980, when asbestos-containing materials (ACMs) were commonly used in drywall, sealants, and other building components.

While actual costs will vary depending on the scope of work, even conservative estimates suggest significant implications for retrofit budgets. If 25% of suites require abatement at an average cost of ~$3,000 per suite, the added cost across the West End retrofit program could exceed $67 million. This figure could be substantially higher depending on:

- The proportion of affected buildings and suites (50% or more may be a more realistic estimate),
- The specific materials and locations where ACMs are present,
- The scale of renovation required (e.g., full window replacement vs. outlet installation).

Estimated Abatement Cost Ranges by Scope of Work:

Scope of Work	Estimated Cost per Suite
Electrical outlet or panel upgrade (localized wall cut)	$500 – $1,500
Window removal (asbestos in sealants/drywall)	$2,000 – $4,000
Full suite abatement (walls, ceilings, windows, etc.)	$5,000 – $10,000+

Note: Full suite abatement is rare and generally only triggered by major renovations beyond the scope of WMHP retrofits. Most WMHP-related abatement would involve localized removal near electrical panels or window frames.

Electrical Service Upgrade Costs

Electrical service upgrades are one of the most significant and uncertain cost drivers for WMHP retrofits, with estimates ranging from $500,000 to over $1.5 million per building. Costs vary based on building size (e.g., low-rise vs. high-rise), whether new infrastructure must be installed above or below ground, and site-specific requirements such as space for transformers and coordination with BC Hydro.

As of July 5, 2025, BC Hydro's new *Distribution Extension Policy* has changed how upgrade costs are shared between customers and the utility. However, its implications for retrofit projects — including how costs will be calculated and allocated — remain unclear. All upgrade costs continue to be determined on a case-by-case basis, depending on local system capacity, project scope, and electrical demand.

The cost assumptions in this report reflect current practices and may change as the new policy is fully implemented and interpreted.

Load Management

In a small subset of buildings, load management technologies may offer a cost-effective alternative to full electrical service upgrades. These systems coordinate and stagger high-demand loads within a building to stay within the limits of existing electrical capacity — avoiding or deferring costly service upgrades.

- Estimated cost: $6,000–$8,000 per suite
- For a 20-unit building, this equates to roughly $140,000, compared to $500,000+ for a full-service upgrade.

We estimate that approximately 5% of West End buildings may be suitable candidates for this approach. Load management is most viable in gas-heated buildings where significant in-suite electrical loads — such as electric water heaters or in-suite laundry — already exist. In these cases, enough load diversity may be available to enable control strategies that shift or cycle demand, making the most of the building's existing electrical infrastructure.

Suite Mix and Bedroom Distribution

Cost estimates assume average suite mixes by building form. In reality, actual bedroom counts and layouts vary — particularly in mixed-use, stratified, or co-op buildings.

- Higher ratios of larger suites (e.g., 2- or 3-bedroom) will increase per-building costs.
- Atypical layouts (e.g., corner units, double balconies) may increase installation complexity.

Market Variables

Equipment and labor pricing are subject to change:

- **Economies of scale**: Larger or coordinated procurement may reduce equipment and install costs over time.
- **Supply chain volatility**: Inflation, shipping delays, or contractor shortages may increase costs during implementation.
- **Technological change**: New models or installation methods may improve performance or reduce cost.

Policy and Incentives

No incentives or subsidies were included in this analysis. However, future programs could significantly alter cost dynamics:

- **Rebates** (e.g., for WMHPs, window replacement, or electrical work) could lower upfront cost barriers.
- **Regulatory shifts** (e.g., mandatory carbon limits, cooling requirements) could accelerate adoption even at higher cost.

5 FINDINGS & CONSTRAINTS

This analysis confirms that a significant share of MURBs in Vancouver's West End are technically compatible with window-mounted heat pump (WMHP) retrofits. Of the 684 buildings, an estimated 8% of buildings could adopt WMHP as a primary source of heating and cooling without a window replacement, 58% could adopt WMHPs as their primary source of heating and cooling with a window replacement. 20% of buildings could use WMHP for partial in-suite heating and cooling (with a window replacement)— leaving just 14% of buildings classified as not compatible.

This represents a substantial retrofit opportunity, particularly for buildings with aging windows, electric heating systems, or simpler architectural forms that enable lower-cost installations.

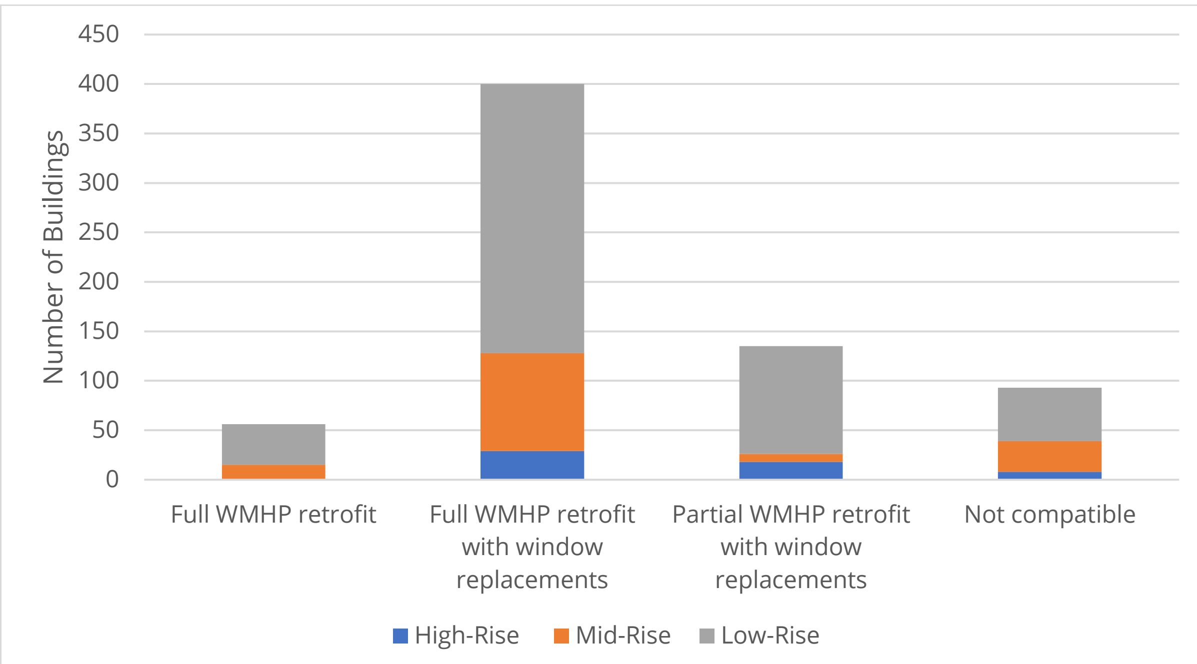

Figure 6. Number of buildings compatible with each retrofit type

5.1 Key Constraints

While feasibility is high, several common barriers and cost drivers must be considered:

- **Architectural features** such as balconies, overhangs, and recessed or angled façades limit external clearance and may reduce the number of installable suites.
- **Large or floor-to-ceiling windows** may not provide sufficient interior sill height or depth to securely mount a WMHP unit.

- **Sliding glass doors without adjacent windows** (common in living rooms) eliminate viable mounting locations in some suites.
- **Hydronic heating systems** in gas-heated buildings cannot typically be decommissioned room-by-room, limiting the effectiveness of partial electrification.

5.2 Cost Implications

Two key cost drivers emerged across the building stock:

- **Electrical upgrades** are required in most gas-heated buildings to support WMHP installation — including panel upgrades, circuit work, and sometimes service upgrades at the building level.
- **Asbestos abatement** is likely in buildings constructed before 1980 (over 80% of West End MURBs), particularly for window and electrical retrofits. This adds both cost and logistical complexity, and may require tenant relocation.

While these costs are not insignificant, it's important to note that they would be required for nearly any building electrification strategy — including central systems or mini-splits. In this context, the low unit cost and ease of installation of Midea's WMHPs may still make them one of the most cost-effective options, especially in buildings that don't require full mechanical upgrades.

5.3 Window Replacement Trade-offs

Window compatibility is a key constraint — and cost driver — for WMHP deployment. While many buildings have aging, single-pane windows that already warrant replacement, others have newer glazing systems that complicate the retrofit decision.

- In buildings with older windows, replacement can improve comfort, air sealing, and envelope performance alongside WMHP installation.
- In buildings with new or mid-life windows, however, replacement may add significant cost without delivering proportional benefits — raising questions of cost-effectiveness and material waste.
- In strata settings, early window replacement may also raise concerns about asset depreciation and owner buy-in — requiring programs and policies to consider how to balance technical feasibility with ownership structure and timing of capital upgrades.
- There are currently no tested retrofit solutions to integrate WMHPs into existing non-sash windows without full replacement. Advancements in this area could significantly reduce costs and expand the applicability of this approach.

Tenant Billing & Rent Reallocation Challenges

In addition, electrifying gas-heated buildings presents a persistent challenge around cost reallocation between landlords and tenants. In most gas-heated MURBs, the landlord pays for heating as part of the rent, and suites are not individually metered. With electrification, however, tenants are typically billed directly through their own utility accounts — meaning they assume responsibility for heating costs that were previously included in rent. To maintain fairness, landlords are expected to reduce rent by an equivalent amount.

In practice, this is difficult to structure in a consistent and equitable way. The lack of a standardized framework can create financial uncertainty for landlords and affordability concerns for tenants — especially in older rental buildings where rents are stabilized, but the cost of electrification is high.

Note: FRESCo has submitted a proposal to undertake a research project focused on addressing this issue. If accepted, the project is expected to run from fall 2025 through spring 2026.

6 RECOMMENDATIONS

WMHPs offer a rare combination of scalability, simplicity, and tenant-friendly installation, making them a compelling option for decarbonizing older apartment buildings — particularly in dense neighbourhoods like Vancouver's West End. However, to enable broader uptake, a coordinated approach is required that aligns retrofit conditions, manages logistical barriers, and supports market readiness.

1. Prioritize the Right Buildings

Early implementation should focus on buildings where retrofits are most cost-effective and least complex:

- Electrically heated MURBs with operable windows and minimal façade articulation offer the lowest barriers to installation.
- In gas-heated buildings, prioritize those where electrical upgrades and window replacements are already planned or needed for other reasons.
- Use the compatibility typology developed in this study (Full, WF, WP, NC) to identify and rank buildings by retrofit feasibility and expected cost.

2. Coordinate Product and Installation Pathways

Successful scaling will require closer coordination with manufacturers, contractors, and permitting authorities:

- Work with window manufacturers to develop standardized WMHP-compatible configurations (e.g., custom inserts, integrated slots, or vertical sash retrofits).
- Explore retrofitting options for existing windows to reduce replacement costs in newer buildings.
- Consider options to propose the installation of one WMHP unit per suite to enable access to efficient cooling in at least one room. In electrically heated buildings this one WMHP unit can also offset more expensive, and less efficient, electric baseboards.

3. Streamline Permitting and Abatement

Permitting, safety, and asbestos considerations can delay or limit adoption if not addressed proactively:

- Clarify WMHP classification (e.g., plug-in appliance vs. mechanical equipment) and streamline approval pathways.
- Develop standardized installation guidelines that address egress, weather sealing, and fire safety — particularly for strata settings.
- Plan for asbestos abatement early, especially in buildings constructed before 1980, where ACMs are likely to be encountered during electrical or window work.

4. Align Incentives and Build for Scale

To drive adoption, cost barriers must be reduced through funding, policy alignment, and demonstration:

- Leverage all available programs for the combined retrofit package — for example, as of summer 2025, the CleanBC MURB Retrofit Program offers $100/m² for eligible window replacements.
- Advocate for inclusion of WMHPs under BC Hydro's in-suite rebate program and other municipal/provincial incentive streams.
- Where window replacement is required solely to enable WMHP installation, consider top-up funding or bundled rebates.
- Support bulk purchasing and coordinated deployment models to reduce per-unit and installation costs.
- Pilot a variety of building types — including gas- and electrically-heated MURBs with full and partial retrofits — to generate real-world data on costs, comfort, and performance.
- Develop a long-term retrofit roadmap that integrates WMHPs with electrification upgrades, load management, and envelope improvements.

WMHP Rebate Eligibility

As of July 2025, the WMHPs will not be eligible under the BC Hydro in-suite rebate program. Future eligibility may depend on unit certification, energy performance, and alignment with program priorities. We recommend advocating for the inclusion of WMHPs — particularly for electric buildings — due to their scalability, cost-effectiveness, and tenant benefits.