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UBC Sustainability Scholar Report:

Developing a building energy retrofit toolkit for homeowners in the City of Vernon

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Disclaimer

This report was produced as part of the UBC Sustainability Scholars Program, a partnership between the University of British Columbia and various local governments and organizations in support of providing graduate students with opportunities to do applied research on projects that advance sustainability across the region.

This project was conducted under the mentorship of City of Vernon staff. The opinions and recommendations in this report and any errors are those of the author and do not necessarily reflect the views of the University of British Columbia or the City of Vernon

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Executive summary

Energy retrofits have been identified as key measures to reduce energy consumption and associated greenhouse gas (GHG) emissions from the existing building sector in Canada. In the City of Vernon, the building sector accounts for around 30% of total GHG emissions. As such, the City of Vernon aims to increase the uptake of home energy retrofits to reduce GHG emissions produced from existing buildings. However, homeowners often face challenges of implementing energy retrofits, such us limited energy retrofit knowledge and difficulty to access retrofit financial incentives provided by governments and utility providers. This report provides recommendations for the development of a building energy retrofit toolkit to help homeowners and other interest groups understand various retrofit measures, financial incentives, and retrofit tactics. The following five main recommendations for the toolkit were identified.

Priority solutions to consider for near-term implementation (2024-2025):

1. Fund the CleanBC Municipal Top-ups program to financially support Vernon residents with energy retrofit expenses.
2. Contract a third-party to provide home energy retrofit guidance and support for Vernon homeowners.
3. Develop a series of workshops to educate the building construction industry on home energy retrofits and help remove barriers in the industry.

Additional solutions to consider for later implementation (2025-2026):

4. Consider subsidizing the cost of relatively inexpensive, simple solutions for the greater community to adopt (e.g., smart thermostats, shading curtains, and weather stripping), and possibly provide workshops to teach people how to use these tools
5. Analyze City permitting processes and costs related to energy retrofits to understand if they can be leveraged to enable home energy retrofits.

In summary, this report can serve as a solid foundation for developing energy retrofit programs in the City of Vernon and other local BC governments.

1 Introduction

Extensive use of fossil fuels and associated greenhouse gas (GHG) emissions have been identified as catalysts for climate change and associated environmental impacts [1]. It is suggested that fuel combustion in buildings, transportation, and fugitive sources constitute 82% of the GHG emissions in Canada [3]. In response to the increasing concerns about climate change impacts, the governments of Canada and British Columbia have established ambitious targets to reduce GHG emissions by 80% by 2050, compared to 2005 and 2007 emission levels, respectively [2]. As a result, Canada and the Province aim to reduce energy use in multiple sectors to reduce associated GHG emissions [2].

In recent years, the building sector in Canada has gained attention for the need to reduce GHG emissions. According to the national GHG inventory, Canadian buildings accounted for 12% of the total national GHG emissions. Moreover, the residential building sector accounted for 11% of national energy use in 2017 [2]. Recognizing the importance of reducing energy use and emissions associated with the building sector, all levels of government have introduced policies, standards, and design guidelines to improve building energy performance. For instance, the British Columbia Energy Step Code (BCESC) has been introduced as a tool to enable meeting the provincial target to make all new buildings "net-zero energy ready" by 2032 [4].

In the City of Vernon (COV), annual GHG emissions average 295,235 tonnes of CO_{2e} based on 2017-2021 data. The transportation sector accounts for 63% of the total GHG emissions, followed by the building sector (30%), and organic waste (7%). The COV has set more aggressive GHG reduction targets than BC and Canada, aiming to reduce GHG emissions by 50% by 2023, 75% by 2040, and 100% by 2050 (based on 2017 data). The COV's Building Bylaw includes BCESC and solar ready construction requirements for new building developments and City staff is currently developing a strategy to support the reduction of GHG emissions generated from the existing building stock in the city.

This project aims to research and recommend how best to increase the uptake of energy retrofits in homes in the City of Vernon. The overarching, long-term goal is to create a strong, local culture where citizens understand and believe in the value of building energy retrofits. This project includes researching provincial and local policy and the current financial incentives that support energy retrofits (e.g., rebates and grants). It also includes investigating how other municipalities are influencing residents to retrofit their homes, beyond the policy and financial incentives (e.g., communication materials, website resources, toolkits, or guidelines). To bring in some local context to this research, the City of Vernon staff facilitated interviews with local residences who have retrofitted their homes and have valuable experience and knowledge to share with others. The project identifies successful tactics and resources for increasing the uptake of energy retrofits by homeowners. This work could be actionable immediately, as the City of Vernon intends to use it to develop and deliver a building energy retrofit toolkit in 2024-2025.

2 Literature review

Building energy upgrades can be classified under three categories, including demand side solutions, supply side solutions, and transformation of energy consumption patterns (i.e., human factors) [12,14]. Demand side solutions include upgrading building envelop insulation, airtightness, windows, heating, ventilation, air-conditioning (HVAC) systems, hot-water unit, and appliances to reduce energy consumption [15,16]. Supply side solutions consist of renewable energy technologies such as solar photovoltaics and wind energy, which are recognized as alternative energy systems to generate electricity for buildings [17]. Supply side solutions have received much attention in recent years with the increasing pressures to reduce the environmental impacts associated with energy use [15,16]. Transformation of energy consumption patterns generally applies advanced control techniques or provides homeowners with building operation strategies to facilitate energy efficiency through behavior changes, such as installing smart thermostats.

2.1 Residential energy retrofit measures

Replacing home appliances and thermostats: This includes replacing fossil fuel powered home appliances with electric Energy Star-certified equipment, such as gas range stoves. Installing smart thermostats can also help reduce energy consumption in buildings by providing more strategic control of energy use in buildings. These options are relatively low cost and easy to install, compared to the following measures.

Retrofitting envelope components: Heat loss or gain through building envelopes affects energy consumption and GHG emissions from fossil fuels. [1]. Therefore, upgrading the external walls, ceilings, windows, doors, and airtightness to reduce heat loss and gain can have a considerable impact on energy consumption and also improve the comfort of indoor spaces for occupants. Depending on the upgrade objectives of each project, various energy savings and GHG emission reductions could be achieved. Several factors must be considered in developing retrofit scenarios, including budget and building envelope components [2].

Retrofitting mechanical systems: Research has shown that substantial energy savings can be achieved by improving the building heating and cooling systems and the energy source [3]. Building mechanical systems include HVAC (heating, ventilation, and air conditioning) and water heating systems. In recent years, heat pumps for space heating and water heating have garnered greater attention to reduce building energy use and associated emissions because of their high coefficient of performance (COP) [4]. Heat pumps use electricity to transfer heat from a cool space to a warm space, making the cool space cooler and the warm space warmer. As heat pumps transfer heat rather than generate heat, heat pumps can efficiently provide comfortable temperatures for buildings. In Canada, there are two main types of heat pumps: air source heat pumps (ASHP) and geothermal heat pumps (GHP). ASHPs transfer heat between a house and the outside air. During the heating season, ASHPs move heat from the outside air into your warm house. During the cooling season, ASHPs move heat from your house to the outside air. It should be noted that ASHPs may need to be installed with back-up natural gas furnaces in case ASHPs fail during extreme situations. To deal with this issue, homeowners may select cold-climate heat pumps that perform well in extreme. Different from ASHPs, GHPs transfer heat between a house and the ground. Although GHPs are more expensive than ASHPs, GHPs have low operating costs because they take advantage of relatively constant ground temperatures. In addition, GHPs can be used in more extreme climates than ASHPs [5].

Installing solar photovoltaic panels: Rooftop solar photovoltaic (PV) panels utilize solar energy to produce electricity. Solar PV panels are limited in their GHG emissions reduction benefits in BC, as the grid is already ‘‘low-emission and renewable” due to high levels of hydro power. and the production of PV panels generate GHG emissions. However, solar PV could deliver financial benefits for homeowners by generating electricity for the BC Hydro grid. BC Hydro provides financial credits to homeowners for solar energy production, which can be leveraged to offset the cost of other energy retrofits.

2.2 Classification of energy retrofit measures

Minor retrofit measures:

Minor retrofit measures are low-cost, easy to implement and offer good value for the money and effort invested. Measures could include:

- Installing smart thermostats
- Air sealing with caulking or spray foam
- Weatherstripping for doors and windows
- Installing shading curtains
  Upgrading lighting systems

Although they are relatively simple, these projects can make a big difference to building energy consumption, as discussed further in Section 2.3. Upgrading lighting systems have limited impacts on GHG emissions, as electricity in BC is relatively clean, but nonetheless efficient lighting will reduce the overall energy demand in a building.

Major retrofit measures:

Major retrofit measures can reduce a significant amount of GHG emissions from buildings, but they require a higher-level of effort and are costlier than the minor retrofits. Major retrofit measures could include:

- Replacing energy-efficient windows and exterior doors
- Updating inefficient heating and cooling systems
- Updating inefficient water heaters

Deep retrofit measures:

Deep retrofits are the most robust option, combining minor and major retrofit measures with renewable energy generation. Deep retrofits provide the greatest potential for overall GHG emission reductions, but they are more complex, costly, and can be disruptive to occupants, so it’s best to time them with tenant turnover or other major changes to occupancy. Measures could include:

- Retrofitting envelope components, such as adding wall and ceiling insulation
- Replacing energy-efficient mechanical systems, such as air-source or ground-source heat pumps,
- Installing renewable energy generation systems, such as solar panels.

2.3 Primary results from the scholar’s prior publications

This section presents the primary results from the scholar's previous publications. This research conducted building energy simulation analysis of different retrofit measures for a case study single house located in Vancouver. The annual energy, cost, and emission performance of different retrofit measures are summarized in the following figures.

As presented in Figure 1, energy savings is greatest from air source heat pumps, which can deliver around 29 GJ annual energy savings per house. Solar PV panels have similar potential to deliver approximately 27.5 GJ per house. Furthermore, smart thermostats, combined with high energy-efficient gas furnace (98% AFUE NGF), can also produce considerable energy savings (around 10 GJ) by providing greater energy analysis and control measures for occupants.

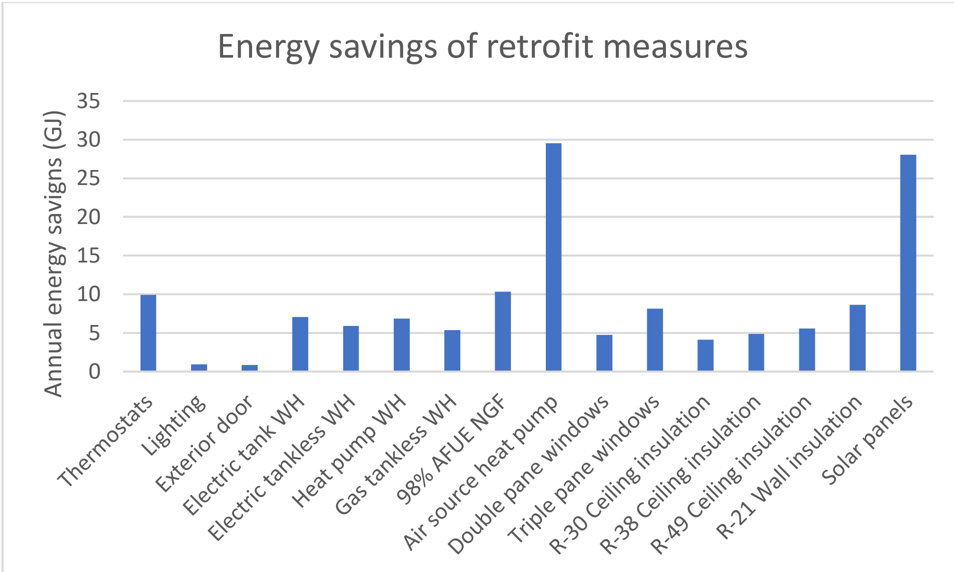


Figure 1. Annual energy savings of energy retrofit measures

The annual energy cost savings of different retrofit measures are depicted in Figure 2. Solar panels can produce more than $800 CAD energy cost savings annually by generating on-site electricity and getting credits from utility providers. In addition, upgrades in smart thermostats, lighting systems, high energy efficient gas furnace, and triple-pane windows can individually produce around $100 CAD of annual energy cost savings. It should be noted that installing heat pumps can increase annual energy costs by $400 CAD because the heating source will switch from natural gas to electricity, but this may vary in practice, as the Vernon homeowner interviews revealed this transition can be cost neutral in some scenarios.

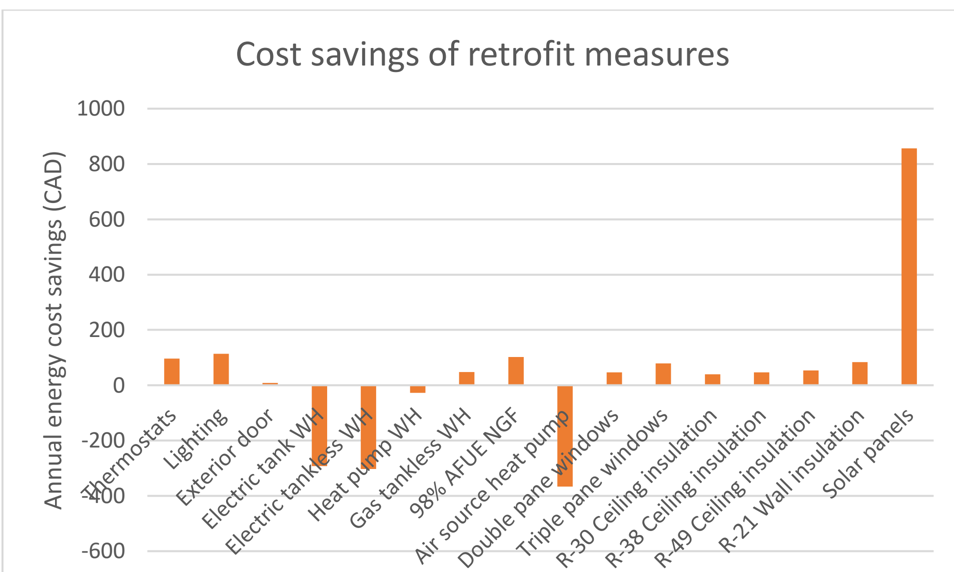


Figure 2. Annual energy cost savings of energy retrofit measures

Figure 3 depicts the emission reduction potential of the retrofit measures. Heat pumps can produce the highest annual emission savings (more than 2.5 ton CO_2 per house), followed by electric water heaters (around 1 ton CO_2 per house). In addition, smart thermostats, heat pump water heaters, and high energy-efficient gas furnace can also deliver around 0.5 ton of annual emission reductions individually.

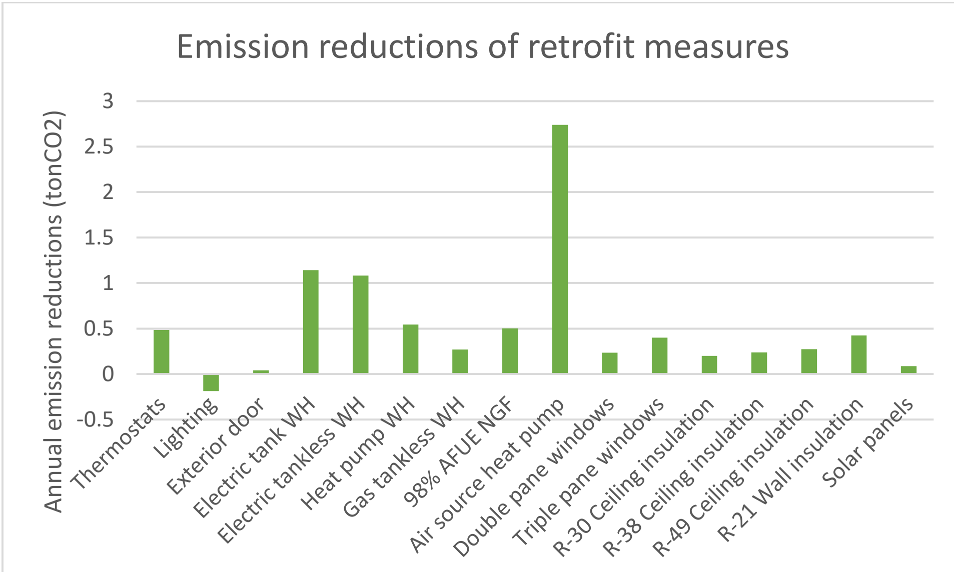


Figure 3. Annual carbon emission reductions of energy retrofit measures

3 Retrofit policy instruments and tactics for residential buildings

This section develops a classification framework to characterize various retrofit policy instruments and tactics in Canada and BC. Energy retrofit policy instruments can be distributed into four categories: financial incentives (FI), research and service (RS), direction and command (DC) and assessment and disclosure (AD). The descriptions of these instruments are shown in Table 1. Overall, the interplay between different retrofit policy instruments (RPIs) and stakeholders are depicted in Figure 4. The details of the four kinds of RPIs are discussed in the following sections. The provided Excel file is an appendix to the report.

Table 1. Clusters of retrofit policy instruments and tactics

Instruments	**Descriptions**	**References**
FI	Economic supports for retrofit activities including grants: direct subsidies from governments; rebates: partial amount returned on applied retrofit measures; tax credits: deduction on the tax required to be paid; loans: purchase of retrofit materials or equipment at a low-interest rate.	[6–15]
RS	Innovative research: well-designed retrofit programs, new retrofit technologies, auxiliary tools; government public service: technical supports, increase of retrofit related institutions and departments, education and training programs.	[16–20]
DC	Overall direction: overall strategy, action plan; retrofit directives: environmental requirements, standards, regulations, and retrofit guidelines for existing residential buildings.	[18,20–23]

AD	Building energy performance assessment: energy auditing, rating, labeling, benchmarking, post-retrofit evaluation; disclosure of building energy consumption.	[17–19,24,25]

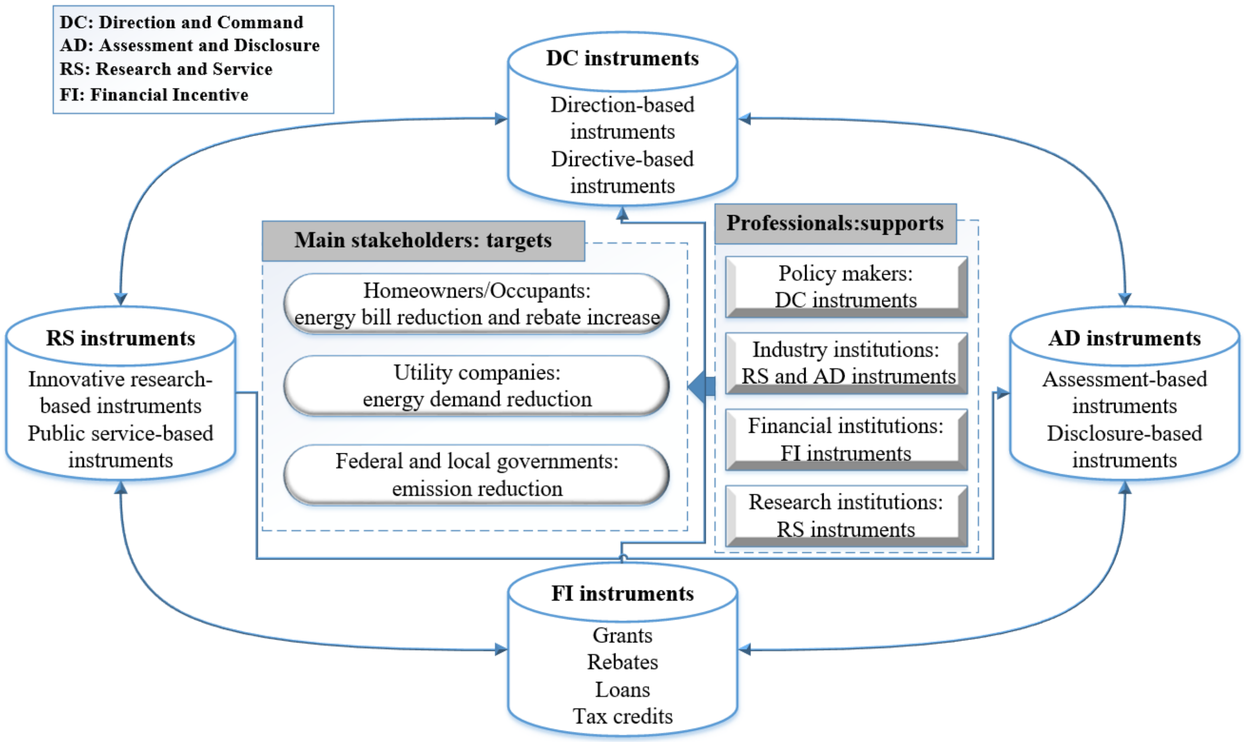


Figure 4. The interplay between different retrofit policy instruments and stakeholders

3.1 Financial incentive (FI) instruments

As most retrofit activities require financial supports, FI instruments have garnered much attention. These financial supports mainly come from utility provider and government rebates, tax credits, bank loans, and third-party grants. These instruments can address stakeholders' main concerns on financial issues related to retrofit projects, such as high initial cost, long payback period, and uncertainty of return on investment, and thus, improve their willingness and aspiration to upgrade buildings. In Canada, FI instruments are mainly provided by utility providers and local governments. A multitude of financial incentives can be distributed into four groups: rebates, tax credits, loans, and grants.

A number of rebate programs have been launched in BC to encourage homeowners to purchase energy-efficient HVAC and water heater equipment to replace older, less efficient models, such as the **Clean BC Better Homes Program** or **the Energy Saving Program**. The Clean BC Better Homes Program is coordinated by the Province of BC, BC Hydro, and Fortis BC, and the Energy Saving Program is coordinated by the Government of Canada, Province of BC, and BC Hydro. These two programs provide rebates for retrofitting home envelope insulation, windows, doors, heat pumps, and water heaters (details and rebate amounts for each retrofit measure can be found in the Excel file delivered with this report to the COV). It should be noted that homeowners can only select one program between the **Clean BC Better Homes Program** and **the Energy Saving Program** when they apply for retrofit rebates.

In addition, municipalities have funded "top-up" rebates for their residents through the **Clean BC Municipal Top-ups Program**. This program enables homeowners to automatically receive additional rebate amounts from their municipality via the Clean BC Better Homes Program or the Energy Saving Program**.** Residents only have to apply once to the Clean BC Better Homes Program and, if they qualify for a Clean BC rebate, the municipal funding is automatically provided as a top-up to the Clean BC rebate. Clean BC Better Homes coordinate the rebate top-up program on behalf of the municipalities, which can assist municipalities in reducing human resource needs. The top-up rebate amounts vary from $350 to $2000, depending on the retrofit measure and the municipality's budget. Currently, 19 municipalities provide top-up rebates for retrofitting electric heat pump space heating, electric service upgrade, and electric heat pump water heaters, including the City of Kelowna and City of Kamloops in the Thompson-Okanagan region. The City of Kelowna provides up to $2000 and the City of Kamloops provides up to $500, depending on the retrofit measure. The next intake for the Clean BC Municipal Top-ups Program is January 2025. It is important to consider this option as a local tool to alleviate homeowners' concerns about high upfront costs of retrofits [26,27]. The details and rebate amounts for each municipality are summarized in the Appendix.

Other than rebates, municipalities can utilize tax credits to incentivize the uptake of energy retrofits. For example, the Government of Canada has introduced the **Clean Technology (CT) Investment Tax Credit (ITC)**. The CT ITC rate can be up to 30% of the capital cost of CT properties (e.g., solar panels and heat pumps) that is acquired and that becomes available for use from March 28, 2023, to December 31, 2033 (details are illustrated in the Excel file delivered with this report to the COV). The Canada Revenue Agency will provide ability to claim the credit on a corporate income tax return, while the Natural Resources Canada will provide engineering guidance on CT property. The COV should consider promoting these tax incentives to residents and also consider if and how municipal tax incentives could be leveraged to motivate home energy retrofits.

In addition to aforementioned financial support, loans and third-party grants can also be used to incentivize homeowners to upgrade their homes. For example, the Government of Canada has introduced the **Canada Greener Homes Loan Program.** This program provides interest-free loans (up to $40,000) for eligible retrofits, and the repayment term is 10 years. Furthermore, third-party grants are also important. For example, the HomeZero Collective Society has provided **HomeZero Pilot Grants** for 11 pilot retrofit projects. This program provides $10,000 for Air Source Heat Pump (ASHP) retrofit package (includes Energuide assessment, detailed design, ASHP, solar panels, heat pump water heater, and EV charging outlets) and $30,000 for Geothermal Heat pump (GHP) retrofit package (includes Energuide assessment, detailed design GHP, solar panels, heat pump water heater, and EV charging outlets).

3.2 Research and service (RS) instruments

RS instruments include innovative research programs, public service, and auxiliary tools provide by local governments or third-parties. These instruments also help stakeholders to explore new retrofit technologies and more easily access retrofit information and technical support to address practical retrofit problems. In this sense, this type of tactic can provide reliable support for DC and AD instruments and disseminate the benefits brought by FI instruments, and thus, arouse stakeholders' awareness and improve their work efficiency. Nevertheless, a lack of practitioners with rich retrofit knowledge and skills is a challenge that hinders the implementation of RS instruments in many municipalities [27,28].

For example, the City of Vernon staff and the UBC Sustainability Scholar will help to identify services for the Vernon residents to help them conduct home energy retrofits. Furthermore, the City of Kelowna offers the **Home Energy Navigator Program** to engage and support homeowners throughout their retrofit journey. This program provides access to dedicated and customized supports when upgrading the energy performance of homes, including one-on-one guidance, help deciding what upgrades to pursue, and assistance navigating rebate programs (details of this program are illustrated in the Appendix). This program can help homeowners easily access various retrofit information and rebates on governmental websites. In addition, the City of Kelowna host Heat Pump Focus Groups and collects feedback from homeowners who have experience with heat pump installation and usage to better support community climate action. All participants (maximum of 20 participants) will receive a $50 gift certificate for their contribution. Similarly, the City of Kamloops have published post-retrofit surveys of heat pumps case studies on its website. This can provide a digital platform to assist homeowners in understanding the benefits and challenges of installing heat pumps and other retrofit measures (details of the studies are summarized in Appendix). The local homeowner case study results were summarized on information sheets, which were shared online to help other residents in Kamloops better understand the benefits and processes involved through the lens of others in the city who with recent experience with this work. The COV could consider developing similar case study information sheets from the homeowner interviews that were conducted for this study.

3.3 Direction and command (DC) instruments

DC instruments can play an important role in promoting energy retrofits by providing an overall development direction, requirements, regulations, and recommendations at the early stage of a retrofit project. With this kind of instrument, the stakeholders can be aware of long-term retrofit strategies, retrofit benefits, minimal retrofit requirements, and applicable retrofit measures. However, the compliance of DC instruments might be difficult to achieve. For example, this kind of instrument cannot be implemented effectively if mandated by governments without adequate implementation guidelines and supports. In this regard, DC instruments should be combined with FI and RS instruments to improve the effectiveness of policy implementation.

For example, the City of Vernon has introduced the Vernon’s **Climate Action Plan**, which sets directions for emission reduction targets, goals, and actions. In addition, the City also enforced Vernon’s Building Bylaw that set requirements for energy efficiency and solar readiness in new buildings. However, no specific DC instruments have been established by the COV for energy efficiency in existing buildings, but this can be a future instrument to enable energy retrofits in existing buildings.

3.4 Assessment and disclosure (AD) instruments

AD instruments can provide pre- and post-retrofit building energy performance assessment through energy auditing, rating, labeling, and benchmarking. Practice has substantiated that AD instruments can deliver both environmental and economic benefits [60]. For example, the **EnerGuide Home Evaluation Program** is commonly applied in Canada to help homeowners understand how buildings consume energy and identify retrofits to help improve energy efficiency. An energy advisor can assess homes from basement to attic. This will give homeowners an EnerGuide rating for their homes and an energy efficiency report to help homeowners make decisions about possible energy upgrades. A challenge with building assessments is that many retrofit practitioners only focus on pre-retrofit assessment and neglect the importance of post-retrofit evaluation. Thus, the effectiveness of retrofit measures is difficult to verify [29]. Other challenges facing AD instruments consist of the organization of complicated energy data, the development of evaluation software, and a lack of professional assessors [22].

4 Summary of interviews with homeowners

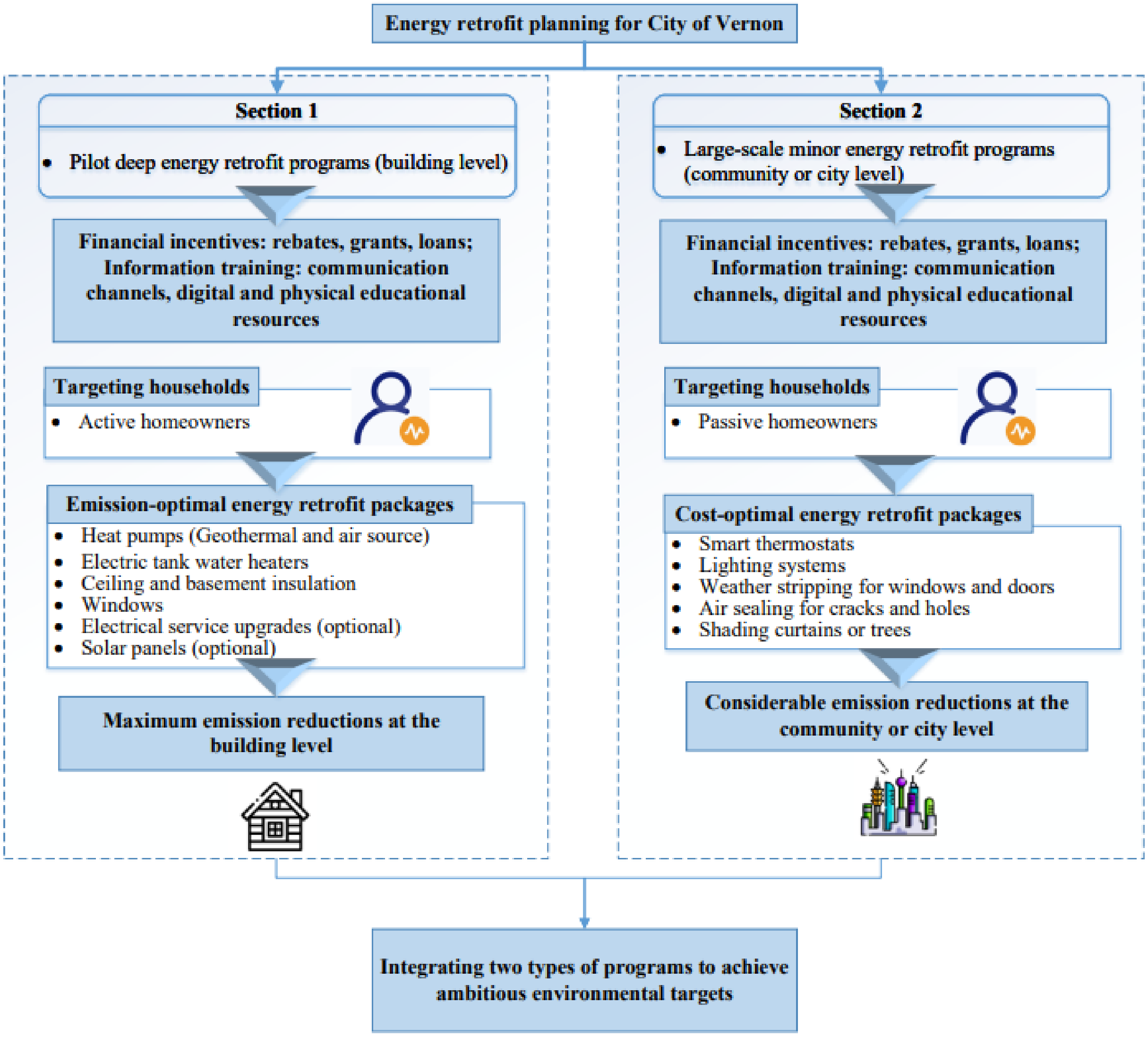
To learn about retrofit benefits and potential challenges and solutions, the scholar and the COV staff conducted interviews with homeowners in the COV. Six homeowners in the COV were interviewed via Zoom between July-August 2024. A summary of individual interviews is provided in the Appendix (Table A2-A7). In general, interviewees experienced the following challenges and recommended a set of solutions to help others overcome these challenges.

Table 2. Retrofit challenges and recommended solutions

Challenges	**Solutions**
The costs of energy retrofits can be a barrier.	Offer financial support to reduce the cost.
Difficulty navigating the complex processes involved with energy retrofits.	Provide a service to guide people through the retrofit process and reduce the complexities.
Local contractors have limited knowledge and experience with home energy retrofit measures.	Support industry education to enhance local contractors’ skills and knowledge so that they are better prepared to support residents.
Lack of relatively simple, inexpensive solutions that are easy to adopt.	Identify and consider subsidizing solutions that can be easily and quickly adopted by the greater community.
Challenging to navigate the City permitting for energy retrofits.	Analyze if City permitting impacts energy retrofits and how permitting processes and costs can be used to simplify the process.

5 A roadmap and recommendations for retrofit planning in the City of Vernon

This section provides a comprehensive roadmap for retrofit planning in the City of Vernon, as depicted in Figure 5. The proposed roadmap mainly consists of two sections. In addition, this study also provides six recommendations for retrofit policy development in the City.



5.1 Conducting pilot deep energy retrofit programs

Retrofitting households with active retrofit personas can deliver substantial emission reductions at a building level since the occupants are inclined to try more sophisticated retrofit measures even if the measures require more investment costs and human efforts. Emission-optimal retrofit measures, including upgrades in heat pumps, electric tank water heaters, ceiling and basement insulation, and windows, should be adopted by active personas to achieve more ambitious environmental targets. Heat pumps, including Geothermal heat pumps and air source heat pumps, can deliver the highest emission savings. Geothermal heat pumps (GHPs) can take advantage of the constant temperature of the shallow earth to efficiently exchange temperatures, heating homes in the winter and cooling homes in the summer, while air source heat pumps (ASHPs) can transfer the heat from the air to homes in the winter and transfer the heat from homes to the air in the summer. Compared to ASHPs (may need back-up heating sources), GHPs are more reliable in winter times especially during extreme cold climates. However, GHPs are more expensive than ASHPs and require more space for installations.

Implementing the emission-optimal retrofit measures may impose economic burdens on homeowners. Therefore, municipalities should provide financial incentives, such as grants, rebates, interest-free loans, and tax credits for active personas to release economic burdens from homeowners. In addition, post-retrofit surveys and evaluations should be performed to collect feedback from occupants and validate the effectiveness of deep energy retrofits. Information training programs can be provided to help homeowners share successful retrofit information with others. The programs can include communication channels (e.g., public workshops and live media), educational digital resources (e.g., a comprehensive retrofit information and rebate website), and physical assets (e.g., successful retrofitted homes). To conclude, conducting pilot energy retrofit programs by engaging with high-interest occupants is helpful for exploring the maximum emission reduction potential at a building level but may impose a heavy financial burden on local governments.

5.2 Promoting large-scale minor energy retrofit programs

Large-scale minor energy retrofit programs targeting passive and neutral personas should be promoted. While retrofitting households with passive personas may not produce noticeable environmental benefits at the building level due to limited retrofit opportunities, the minor retrofit packages can be easily applied to a community or even a city to obtain environmental benefits. Cost-optimal retrofit measures can produce both emission and cost savings. For example, a smart thermostat is an internet-connected device that controls home HVAC systems and can automatically adjust temperature setpoints to optimize performance and achieve energy savings. Smart thermostat features often include two-way communication, occupancy detection (such as geofencing and occupancy sensors), schedule learning, and seasonal optimization algorithms. Smart thermostats can control most conventional HVAC systems, including heat pumps and gas furnaces.

Other recommended minor retrofit measures include upgrades in shading curtains, air sealing for cracks and holes, and lighting systems. Shading curtains are energy-efficient window attachments. In heating seasons, around 30% of a home's heating energy can be lost through windows. In cooling seasons, approximately 76% of sunlight that falls on standard double-pane windows enters to become heat. Shading curtains can mitigate the loss of heating energy in winter and cooling energy in summer. In addition, conducting airtightness assessment is beneficial for finding air leakage areas around envelopes. To improve home airtightness, weatherstripping can be used to block air leakage around doors and windows. Similarly, air sealing for cracks and holes on the inside surface of exterior walls, ceilings, and floors can help to prevent air from escaping into walls and ceilings.

In summary, municipalities may provide limited financial incentives or information training programs to assist occupants in understanding the benefits of energy retrofits. Promoting the penetration of minor energy retrofit programs at a large scale can also deliver significant environmental benefits without imposing a heavy financial burden on occupants and municipalities.

5.3 Prioritization of toolkit recommendations for 2024-2026

Based on the research results, the following 5 tools have been identified and prioritized for near-term and longer-term considerations.

Near-term priorities (2024-2025):

1. Fund the CleanBC Municipal Top-ups program to financially support Vernon residents with energy retrofit expenses.
2. Contract a third-party to provide home energy retrofit guidance and support for Vernon homeowners.
3. Develop a series of workshops to educate the building construction industry on home energy retrofits and help remove barriers in the industry.

Longer-term priorities (2025-2026):

4. Consider funding and educational resources for low-cost, simple solutions for the greater community to adopt, such as smart thermostats, shade curtains, and weather stripping.
5. Analyze City permitting and taxes related to energy retrofits to understand how these can be leveraged to make it easier to tackle home energy retrofits.

6 Conclusion

Building energy retrofits have garnered greater attention for its need to improve building energy efficiency and reduce associated GHG emissions. This research develops an energy retrofit toolkit for the City of Vernon to increase the uptake of home energy retrofits. As outlined in Section 5, this research provided a roadmap and 5 main recommendations for a toolkit to support home energy retrofits in the City of Vernon.

This project initially conducts a comprehensive review of possible retrofit measures. These retrofit measures can be mainly categorized into three clusters: minor, major, and deep retrofits. In addition, this report summarizes available financial incentives provided by municipalities, utility companies, and third parties for different retrofit measures. These financial incentives include rebates, loans, grants, and tax credits. The details are illustrated in the Excel file delivered with this report to the COV, which can help homeowners easily access various retrofit financial incentives. Furthermore, this report develops a classification framework to characterize other energy retrofit tactics, including research and service, direction and command, and assessment and disclosure. In addition, a summary of interviews with other municipalities and homeowners who have retrofitted their homes is provided to help homeowners and other stakeholders understand successful retrofit experience, benefits, and lessons learned. Finally, this report provides a roadmap and recommendations for energy retrofit planning in the City of Vernon. The proposed recommendations can be used to increase the uptake of home energy retrofits.

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Appendix

Table A1. Clean BC Municipal top-ups program

Municipalities	Electric Heat Pump Space Heating	Electric Service Upgrade	Electric Heat Pump Water Heater
City of Vancouver	Must be converting from fossil fuel space heating system to qualify, see below for details.		Must be converting from a fossil fuel water heating system to qualify
City of Vancouver		$1,500	$1,000
District of North Vancouver	$2,000		
District of West Vancouver	$2,000		
City of New Westminster	$2,000	$500	
City of Kamloops	$350	$500	$350
Resort Municipality of Whistler	$350	$500	$1,000
City of Kelowna	$2,000	$1,500	$1,000
District of Saanich	$350	$500	$350
District of Central Saanich	$350		$350
District of North Saanich	$350		
Town of Sidney	$350	$500	$350
Town of View Royal	$350		
City of Nanaimo	$350	$500	$350
City of Powell River	$350	$500	$350
City of Campbell River	$350		
District of North Cowichan	$350	$500	$350
City of Duncan	$350	$500	$350
District of Squamish	$350		
City of Chilliwack	$2,000	$1,500	$1,000

Home Energy Navigator Program

The Home Energy Navigator Program is a free program funded by local governments in BC to engage and support homeowners throughout their retrofit journey. Participants are connected with an Energy Concierge (provided by Green City Solutions), who will be available throughout their retrofit project to answer questions, provide support, and give local, expert advice and guidance to navigate the complex world of home energy retrofits. This program provides access to dedicated and customized supports when upgrading the energy performance of homes, including one-on-one guidance, help deciding what upgrades to pursue, and assistance navigating rebate programs. The resources provided by the program include: (1) A virtual home energy consultation; (2) A dedicated Energy Concierge for ongoing support; (3) Understanding contractor quotes; (4) Helps for understanding EnerGuide home evaluation reports; (5) Personalized rebate guidance documents; (6) Online resources. This program is run by a third party, which can help municipalities reduce the human resources needs to manage this service.

This program provides a five-step strategy to support homeowners through the whole implementation process of home energy retrofits. Whether homeowners are just starting, or halfway through, the program can assist homeowners in accessing various retrofit resources and financial supports. The five-step strategy is illustrated as follows.

Step 1: Sign-up to connect with Energy Concierge

Homeowners can be connected with an Energy Concierge who will discuss the retrofit project in a free virtual consultation, advise on next steps, and provide support throughout the retrofit implementation process. Homeowners need to complete a program intake form to outline key energy efficiency concerns as well as retrofit objectives.

Step 2: Planning and choosing energy retrofit measures

Homeowners can connect with the Energy Concierge for support in choosing contractors and quotes that fit goals. The Energy Concierge will review homeowners' quotes, intake form, and chat with them to provide a Contractor Selection Report and Quote Comparison Report to help them make informed choices for homes.

Step 3: Implementing energy retrofits

This phase is all about retrofits implementation. Homeowners need to complete planned energy retrofit measures with selected contractors with the knowledge and confidence that Energy Concierge is available to answer energy retrofit questions throughout.

Step 4: Applying financial rebates

After completing upgrades, homeowners can connect with the Energy Concierge who will put together a Rebate Application Guide customized to the project. The Energy Concierge will also check eligibility requirements against energy upgrades and help homeowners address any issues.

Step 5: Finishing retrofit project

The Energy Concierge will send homeowners a commemorative package to mark completion of the program and celebrate new upgrades.

Kamloops published Heat Pump Case Studies

Kamloops introduced a pilot retrofit program, which assist homeowners in upgrading heat pumps and other retrofits for six homes. The municipality also conducted a post-retrofit survey on the case studies and identified energy retrofit benefits and key strategies. The main benefits of installing heat pumps include: (1) Reduced carbon footprint; (2) Improved thermal comfort and indoor air quality; (3) On-site solar panels can offset increased electricity use from charging electric vehicles and using heat pumps; (4) Energy cost savings. The lessons learned from these case studies are summarized as follows: (1) Leaves and snow can accumulate around the heat pump outdoor unit (it can be addressed by raising the outdoor unit higher); (2) Heat pumps might be undersized, resulting in more reliance on the natural gas furnace; (3) The heat pump model recommended by the installer had been on the rebate list, but no longer was at time of purchasing, highlighting the importance of having up-to-date program details; (4) In a home with some insulation and draft issues, having a back-up furnace can decrease utility bills in extreme cold temperatures; (5) Maintaining a consistent temperature is key to using the heat pump most effectively.

Summary of Homeowner Interviews

Table A2. Summary of the first interview

Homeowner 1 interview	
Home information	1940s, no insulation in basement and exterior walls, low-efficient windows
Retrofit measures	Geothermal heat pumps, back-up gas furnace, triple-pane windows, on-demand water heaters, basement and wall insulation, weather stripping, and air sealing
Benefits realized	• Enhanced indoor thermal comfort in both winter and summer • Decreased heating and cooling load • Enhanced airtightness of the house • A large amount of retrofit rebates • Less noise than former air condition unit
Lesson learned	Recommended minor retrofits: • Weather stripping for windows and doors • Air sealing for cracks and holes around windows, basement, and pipes • Water reclamation: converting municipal wastewater or sewage wastewater into water that can be reused for a variety of purposes • Grey water recycling

Table A3. Summary of the second interview

Homeowner 2 interview	
Home information	1960s, low-efficient heating systems
Retrofit measures	Air source heat pumps, weather stripping for windows and doors
Benefits realized	• Rebates for heat pumps • Quieter than former HVAC systems
Lesson learned	• Heat pumps were broken sometimes, but no one checks if it works well or not • Not effective for heating in winter sometimes, using natural gas furnace for heating • It is complicated to reset heat pump temperatures • Battery banks can be used to improve energy security and avoid power outrage due to wildfires

Table A4. Summary of the third interview

Homeowner 3 interview	
Home information	1950s, low-efficient heating systems
Retrofit measures	High energy-efficient gas furnace, heat recovery ventilator, electric baseboard, wall insulation, air sealing, weather stripping for windows and doors
Benefits realized	• Decreased energy use by around 30% • Better indoor thermal comfort
Lesson learned	• Cost was the main barrier, priorities were given to cost-effective retrofit measures • Difficulty to access a mix of rebate information • Complicated retrofit permitting process • Solar panels, heat pumps, and heat pump water heaters are attractive to the homeowner

Table A5. Summary of the fourth interview

Homeowner 4 interview	
Home information	1960s, low-efficient heating systems
Retrofit measures	Air source heat pumps
Benefits realized	• Decreased carbon footprint

	• Enhanced cooling effect and indoor thermal comfort during summer
Lesson learned	• Heat pumps may be undersized by the installers, and homeowners have more reliance on back-up natural gas furnace for heating • It's better to keep a consistent indoor temperature using heat pumps

Table A6. Summary of the fifth interview

Homeowner 5 interview	
Home information	1950s, low-efficient gas furnace
Retrofit measures	Air source heat pumps, backup energy-efficient gas furnace, shading curtains
Benefits realized	• More comfortable indoor environment in summer • Decreased natural gas use and GHG emissions • The transition to heat pump was cost neutral • The homeowner received a substantial rebate to cover the retrofit cost • Appropriate occupant behaviors are beneficial for improving thermal comfort in summer
Lesson learned	• Heat pumps are big, need space to install • Cost is the main barrier to installing a heat pump • Homeowners need to accommodate indoor dark mode due to shading curtains • Retrofit permitting paperwork is complicated, and homeowners need support to simplify this process

Table A7. Summary of the sixth interview

Homeowner 6 interview	
Home information	1980s, natural gas furnace, medium level of envelope insulation
Retrofit measures	Double pane, low E, Argon filled windows; Basement exterior wall insulation and attic insulation; EnerGuide assessment; Electrical service upgrade; Solar roof panels; Air sealing; Colde-climate air source heat pump (ccASHP); Electric domestic hot water heater and back up electric duct heater

Benefits realized	• Utility bills are much lower by selling on-site electricity to utility providers (BC Hydro bill is only $ 7.00 per month while net positive) • ccASHP works well and keeps house at +20C when outside air rempterature at -28C • Decreased energy use by 32 GJ/year • Decreased GHG emissions by 2.7 ton/year
Lesson learned	• Long-term payback period of solar panels (around 12 years) • Not using hot water heat pumps and tankless hot water heaters • Complicated retrofit permitting process