PEMBINA institute

Better Buildings for All

Relieving energy poverty through deep retrofits

Jessica McIlroy, Betsy Agar, Emma Harris

April 2024

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photo: Roberta Franchuk, Pembina Institute

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The Pembina Institute is a national non-partisan think tank that advocates for strong, effective policies to support Canada's clean energy transition. We employ multi-faceted and highly collaborative approaches to change. Producing credible, evidence-based research and analysis, we consult directly with organizations to design and implement clean energy solutions, and convene diverse sets of stakeholders to identify and move toward common solutions.

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These acknowledgements are some of the beginning steps on a journey of several generations. We share them in the spirit of truth, justice, reconciliation, and to contribute to a more equitable and inclusive future for all of society.

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Executive summary

Building retrofit programs have been identified as a key component of emissions reductions strategies, but the broader benefits of high-performance homes are only more recently being discussed. Home upgrades and retrofits are a unique opportunity to improve indoor air quality, thermal comfort and resilience to extreme weather events, while decreasing energy costs and improving overall well-being. However, the financial supports required and made available for retrofits have not been distributed equally or made accessible to all.

In order to look more closely at how public investment in retrofits can achieve cross-cutting climate and affordability goals, we undertook the following:
A literature review of existing low-income focused retrofit programs inside and outside of Canada.

- Interviews with interest holders to gain perspectives on retrofit program success, challenges and gaps.
- Modelling of the retrofit costs and benefits associated with a segment of the Canadian building stock that represents low-income households experiencing energy poverty.

Based on the research and modelling outcomes we recommend:

- A public investment of **$2.8 billion annually from 2025 to 2050** in retrofits for low-income households experiencing energy poverty.
- Retrofit program design that addresses the need for **delivery methods that remove homeowner or resident burdens** and **address retrofit-over-time schedules**.
- **Collaboration and coordination** between all levels of government, with aligned goals and accountability.

1. Introduction

Across Canada, at all levels of government, commitments are being made to reduce greenhouse gas emissions to net-zero levels by 2050 while dramatically increasing clean energy developments. At the same time, the issues of access to affordable housing and overall cost of living have risen to the forefront of political and public interest. Residential building retrofits are one of the few actions that can address climate change mitigation and adaptation goals while improving affordability and well-being. However, the ability to undertake retrofits and home upgrades is not equally accessible to all.

In the 2021 *Canada's Renovation Wave* report, it was acknowledged that fuel-switching and home upgrades are needed to decarbonize buildings, decrease overall energy use, improve air quality, ensure thermal comfort, and increase resilience to extreme weather events and earthquakes.[1] The modelling completed for that report demonstrated that over the next twenty years $10 to 15 billion per year is required to upgrade all residential buildings across the country and meet these goals.

This study takes a closer look at how public investment can be refined to target cross-cutting goals, and in particular addresses the challenges currently experienced by those struggling with affordability. The aim is to understand the investment required to ensure low-income households experiencing energy poverty are able to reduce their energy demands while helping Canada reduce carbon pollution. Our analysis looked for methods to advance building retrofits and support decarbonization for those without access to capital and experiencing barriers to incentive programs. This research builds on the modelling used for the *Renovation Wave* and included:

- Interviewing retrofit program practioners, housing providers, and industry researchers to better understand the level of effectiveness of existing retrofit programs that target low-income and/or non-market housing.
- Modelling residential dwellings in Canada and in each province segmented according to household income level and further broken down by households living with energy poverty.
- Estimating the cost of fully funded retrofits with fuel-switching and mapping an implementation schedule over the next 25 years.
- Proposing policy and program mechanisms and improvements to ensure public funding is efficient and supports households vulnerable to energy cost burdens.

[1] Madi Kennedy and Tom-Pierre Frappé-Sénéclauze, *Canada's Renovation Wave: A plan for jobs and climate*, (Pembina Institute, 2021). https://www.pembina.org/pub/canadas-renovation-wave

2. Retrofit benefits for all

2.1 Retrofitting for affordability

Reducing energy consumption of a building is a primary objective of deep retrofits, and in many jurisdictions decreasing the energy load is also key to addressing heating and cooling costs, reducing carbon emissions, and improving resiliency.[2] However, the level of financial savings associated with reducing energy use depends on the type of energy being used and the utility rate structures in place. Energy efficiency upgrades are known to reduce energy bills and further cost reductions can be gained through fuel switching by removing the fixed cost of maintaining connections to two fuel sources or through the switch to equipment with lower operational costs.

On a global path to net-zero emissions by 2050, building upgrades that retain fossil fuel heating leave future retrofit requirements and their associated costs in place. As more and more Canadians switch to clean electric heat, the customer base supporting natural gas infrastructure will decline leaving fewer Canadians bearing the costs of system maintenance and upgrades. If financial incentives and access to retrofit capital are only accessible to middle- or higher-income households, the burden of maintaining the gas network will fall to lower-income households. The potential impact is analogous to what has started to occur in some parts of the U.S. where solar PV and battery systems are being implemented at a household and distributed level, leaving the fixed connection costs to be borne by the fewer households remaining on the electrical grid.[3]

The scale and pace of fuel-switching looks different province to province, and indeed region to region. The localized electrification of space and water heating will result in different levels of emissions reductions along with different impacts on home energy bills due to the variations in energy systems and grids, utility structures, and building sector capacity. In the long term, the federal government's proposed Clean Electricity Regulations are aiming to both achieve a fully national clean grid by 2035 and increase

[2] Jeff St. John, "Why efficient buildings are key to decarbonizing the power grid," Canary Media, August 22, 2023. https://www.canarymedia.com/articles/energy-efficiency/why-efficient-buildings-are-key-to-decarbonizing-the-power-grid

[3] Aviad Navon et al., "Death spiral of the legacy grid: A game-theoretic analysis of modern grid defection processes," *iScience* 26 (2023). https://www.sciencedirect.com/science/article/pii/S2589004223004923

the supply of electricity to meet future needs.[4] The provincial investments and efforts that are required to decarbonize their respective grids vary, with provinces such as Alberta already making significant strides in shifting away from reliance on coal plants for electricity generation.

2.2 Climate action through building retrofits

Meeting Canada's climate commitments will require retrofitting existing buildings. Our homes play a critical role in keeping Canadians healthy and safe and must be equipped with reliable and zero-emission heating and cooling. The climate adaptation opportunities with buildings are less understood but we are starting to recognize the need to prepare them for the increasing threats and impacts of extreme weather events as the climate changes. Existing equipment replacement and building component renewal cycles present once-in-a-lifetime opportunities for future-proofing buildings with adaptation measures and preventing further greenhouse gas emissions; however, the implementation of these improvements at the necessary scale and pace still faces significant challenges.

Deep retrofits are a critical tool in achieving climate mitigation and adaptation targets, and they can also provide numerous benefits to Canadians. Deep retrofits include upgrades to multiple systems of a building utilizing a systems-thinking approach and integrative design process to improve the efficiency of the building,[5] and are generally expected to achieve at least a 50% decrease in energy consumption and an 80% reduction in greenhouse gas emissions.[6]

With a deep retrofit plan that takes a home-as-as-system approach, deep retrofits can be scheduled to align with component replacement cycles — these must not be confused with incremental weatherization and other minor retrofits[7] that take care of 'low-hanging fruit' — and achieve the combined objectives of reducing the energy burdens

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[4] Government of Canada, "Clean Electricity Regulations," updated Feb 16, 2024. https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/clean-electricity-regulation.html

[5] Alexander Zhivov and Rüdiger Lohse, *Deep Energy Retrofit: A Guide To Achieving Significant Energy Use Reduction With Major Renovation Projects* (Switzerland: Springer, Cham., 2021), 7.

[6] Natural Resources Canada, "Deep Retrofit Accelerator Initiative –Application Guide." https://natural-resources.canada.ca/energy-efficiency/buildings/deep-retrofit-accelerator-initiative/deep-retrofit-accelerator-initiative-application-guide/24923

[7] Natural Resources Canada, "Retrofitting," 2018. https://natural-resources.canada.ca/energy-efficiency/buildings/existing-buildings/retrofitting/20707

while improving the ability of the home to address the impacts of climate events such as poor air quality and extreme heat, while decreasing emissions.

2.3 Adapting homes to a changing climate

As Earth's average temperature continues to rise, extreme weather events will increase in frequency and severity; thus, retrofitting homes to ensure they can properly protect occupants is crucial to the health and comfort of Canadians. In the June 2021 heat dome event in western Canada and U.S., B.C. experienced 619 heat-related deaths, with the majority of those occurring in homes without adequate cooling systems.[8] During the summer of 2023, eastern Canada was covered in a level of wildfire smoke that caused the city of Toronto to have the worst air quality rating in the world. In January of 2024, the Alberta Electric Systems Operator issued a grid alert in response to extreme cold, and Albertans were asked to immediately reduce their energy consumption. These events all highlight the importance of having high-performance and climate resilient homes.

We now see terms such as "climate-friendly" or "climate-resilient" describing construction objectives. The City of Victoria defines a climate-friendly home as one that is energy-efficient, all-electric, zero emissions and does not burn fossil fuels.[9] The Climate Resilient Home program in the greater Edmonton region uses the definition of a home that is better able to cope with climate change events, storms, floods, heatwaves, extreme cold, and saves money, reduces damages and keeps the residents comfortable and safe.[10] The understanding and language used to describe resilient retrofits are also evolving to recognize that the retrofits required for resilient buildings must go beyond energy or efficiency retrofits. The Urban Land Institute describes resilient retrofits as any measures that reduce a building's vulnerability to physical climate risks.[11] Efficiency-focused retrofit measures will have resiliency co-benefits;

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[8] B.C. Coroners Service, *Extreme Heat and Human Mortality: A Review of Heat-Related Deaths in B.C. in Summer 2021* (2022). https://www2.gov.bc.ca/assets/gov/birth-adoption-death-marriage-and-divorce/deaths/coroners-service/death-review-panel/extreme_heat_death_review_panel_report.pdf

[9] City of Victoria, "Climate Friendly Homes." https://www.victoria.ca/EN/main/residents/climate-action/climate-friendly-homes.html

[10] Climate Resilient Virtual Home Inc., "Climate Resilient Virtual Home." Lhttps://www.climateresilienthome.ca/

[11] Urban Land Institute, *Resilient Retrofits: Climate Upgrades for Existing Buildings* (2022). https://knowledge.uli.org/-/media/files/research-reports/2022/resilient-retrofits-climate-upgrades-for-existing-buildings.pdf

however, we can optimize the time and effort spent on upgrading a building by deliberately incorporating mitigation, adaptation, and occupant health and wellbeing.

2.4 Energy poverty in Canada

Energy poverty can be generally defined as the inability to adequately meet (through inaccessibility or unaffordability) household energy needs and maintain healthy indoor air temperatures.[12] In trying to determine which households are experiencing energy poverty in Canada, no universal definition is currently in use, which creates a challenge in developing measures to overcome this issue. For this report we have adopted the definition developed by Canadian Urban Sustainability Practitioners (CUSP): Canadian households that spend more than 6% of their total income on energy have high energy costs and are experiencing energy poverty. This was established from the percentage of the total income the average Canadian spends on household energy (3% as of 2015);[13] this 6% threshold therefore captures households that spend at least twice the Canadian average on energy.

While often associated with low-income households, energy poverty is not only a factor of income level. Other factors such as inefficiency of a home, the type of energy used to heat it, and local energy rates are major contributors to energy poverty.[14] In fact, it is estimated that less than half of Canadian households experiencing energy poverty are also classified as low-income.[15] Energy poverty also takes place in every jurisdiction and is a complex issue impacted by technical, social and economic factors.[16]

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[12] Mylène Riva et al., "Energy poverty: an overlooked determinant of health and climate resilience in Canada," *Canadian Journal of Public Health* 114 (2023). https://doi.org/10.17269/s41997-023-00741-0

[13] Canada Energy Regulator, "Market Snapshot: Fuel poverty across Canada – lower energy efficiency in lower income households," August 30, 2018. https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/market-snapshots/2017/market-snapshot-fuel-poverty-across-canada-lower-energy-efficiency-in-lower-income-households.html

[14] Mylene Riva et al. "Energy poverty in Canada: Prevalence, social and spatial distribution, and implications for research and policy," *Energy Research & Social Science* 81 (2021). https://doi.org/10.1016/j.erss.2021.102237

[15] Canadian Urban Sustainability Practitioners, *Energy Poverty in Canada: a CUSP Backgrounder* (2019), 7. https://energypoverty.ca/backgrounder.pdf

[16] Runa R. Das and Mari Martiskainen, *Keeping the Lights On: Ensuring energy affordability, equity, and access in the transition to clean electricity in Canada* (David Suzuki Foundation, 2022). https://davidsuzuki.wpenginepowered.com/wp-content/uploads/2022/10/DSF_Keeping-Lights-On_Das-Martiskainen_Oct2022_Final.pdf

Energy and climate justice

Energy poverty and climate impacts are interconnected, and energy justice is inextricably linked to climate justice. Like climate change, the development of energy systems and supply and energy decision-making impact people unequally.[17] Indeed, those least responsible for energy systems and climate change are disproportionately impacted and are already experiencing social and economic inequities.[18]

Approximately 20% of Canadian households spend more than 6% of their after-tax income on energy and are experiencing energy poverty, as noted in Table 1, which outlines the percentages of households in Canada and by province that are experiencing energy poverty, and the percentages of households classified as low-income from the 2016 census. Combining the two measures to get the percentage of households that are both low-income and experiencing energy poverty allows us to understand the portion and number of homes most in need of energy upgrades. The calculation of the combined percentage of housing stock of those experiencing energy poverty and are classified as low-income can be found in Appendix B.

[17] University of Sussex, "What is energy justice," 2023. https://study-online.sussex.ac.uk/news-and-events/what-is-energy-justice

[18] University of California, Centre for Climate Justice, "What is climate justice?" 2024. https://centerclimatejustice.universityofcalifornia.edu/what-is-climate-justice/

Table 1. Estimated proportion of low-income households also living with energy poverty

Province	Low-income households	Households experiencing energy poverty	Estimated low-income households also living with energy poverty[1]
Canada	18%	20%	8%
Newfoundland and Labrador	20%	38%	15%
Prince Edward Island	21%	40%	16%
Nova Scotia	21%	37%	15%
New Brunswick	21%	36%	14%
Quebec	20%	18%	7%
Ontario	17%	22%	9%
Manitoba	17%	15%	6%
Saskatchewan	15%	19%	8%
Alberta	11%	16%	6%
British Columbia	19%	15%	6%

1 See detailed calculation in Appendix B

3. Income-qualified retrofit programs: Challenges and solutions

To better understand the strengths and shortcomings of existing income-qualified retrofit programs, we reviewed the design and implementation of income-qualified programs in Canada, the U.S. and other countries to identify opportunities to improve retrofit support programs that target low-income households and those experiencing energy poverty. We also conducted interviews with program practitioners, academics, and analysts to identify gaps amongst current retrofit programming in Canada.

The programs reviewed targeted a range of building types, multi-unit buildings and single-family homes, as well as publicly subsidized and affordable housing developments operated by different types of owners. The key factor in deciding to review a program was the resident income level and the eligibility targeting low-income households. The income level considered to be "low income" is different in each country, province and state, and in Canada is defined as a household with income below 50% of median household incomes.[19]

3.1 Key challenges

There have been small-scale successes in the rollout of income-qualified retrofit and energy upgrade programs, and reviews and program results show that there is overall low uptake among the targeted households. According to Efficiency Canada, average rates of eligible household participation in provincial and territorial low-income programs in Canada were only around 1-2%.[20] This low level of program uptake is due to

[19] Government of Canada. Towards a Poverty Reduction Strategy – A backgrounder on poverty in Canada. Last updated April 20, 2022. https://www.canada.ca/en/employment-social-development/programs/poverty-reduction/backgrounder.html

[20] Abhilash Kantamneni and Brendan Haley, *Efficiency for All: A review of provincial/territorial low-income energy efficiency programs with lessons for federal policy* (Efficiency Canada, 2022), 6. https://www.efficiencycanada.org/wp-content/uploads/2022/03/Low-Income-Energy-Efficiency-Programs-Final-Report-REVISED-with-COVER.pdf

a number of factors, and four primary issues surfaced through our interviews and research.

One of the main barriers to existing low-income and income-qualified retrofit programs is the lack of awareness of how to access the program and the complexity of the applications. Navigating the programs can be a daunting and time-consuming task, and for vulnerable households, spending hours researching and applying for programs is a costly use of time. Housing providers expressed concern that low-income program applicants are required to undertake extensive work to understand how to apply for and participate in a program while moderate- and high-income households go through a quick and simple process. For immigrants and new Canadians, the requirements for proof of income and application information are a further challenge when language supports are not made available.

Lack of full financial coverage was also identified as a barrier to uptake and participation. In the development of some utility and government rebate programs, there has been a prevailing opinion that there would be a higher level of success if applicants have a level of their own money invested to not take advantage of the program. The vast majority of retrofit programs targeting low-income households thus provide rebates for only 80-90% of the costs. It was clear from research that full, 100% coverage is needed.

Every retrofit must have mitigation plans to address any potential unintended consequences. For lower-income households, these possible issues include the risk of uncovering deeper problems with the building and the fear of eviction resulting from the renovation process (known as renoviction). When issues unrelated to the retrofit occur (e.g., finding asbestos during demolition, ensuring the building meets accessibility requirements, etc.), it can put an end to the entire retrofit as low- and medium- income households often cannot afford the time or money to further invest in the project. Agreeing to a retrofit before knowing what is behind walls can be nerve-wracking, especially for residents who already lack financial security and become responsible for a portion of the bill.

Experiences from existing and past retrofit programs has highlighted the importance of recognizing significant regional differences across Canada and therefore the collaboration between all levels of government. The cost of retrofits, the potential energy savings, the greenhouse gas emissions reduction potentials, and the industry capacity and market readiness levels vary greatly province to province and region to region. Broad, national level home retrofit programs will have uptake and delivery challenges if these local needs are not taken into consideration.

3.2 Key solutions

To overcome the challenges related to program complexity, many jurisdictions included a "concierge service" approach, which facilitates access to all available rebates and financial incentives through application support and education. The service is delivered through local agencies who understand local demographics and conditions. Some of the most successful retrofit efforts recognized that only a small percentage of people will search out retrofit supports and have included an element of door-to-door outreach to overcome the limitations of typical communications channels. In Efficiency Canada's review of low-income retrofit programs, it was noted that leveraging local knowledge and relationships is important for successful delivery of federal programs.[21]

To overcome low participation rates while ensuring retrofit programs are aligned with net-zero emission targets, a number of advocacy organizations are calling for deeper investments and household energy savings achievements substantially above current program levels.[22] To achieve overlapping targets on household affordability and improved cost of living, efficiency upgrades and improved climate resilience, low-income households will need access to free, fully funded retrofit rebates.

A successful program must take the customer journey into account. This recognizes the timing of heating and cooling equipment purchase decisions and the service providers homeowners are most likely to reach out to first. The requirement to undergo a home energy audit prior to accessing funding support risks a potentially lengthy delay between the new heating and/or cooling equipment decision point and when financial support is available. This can result in less efficient, like-for-like equipment replacement.

[21] *Efficiency for All,* 45.

[22] *Efficiency for All,* 47; and Affordability Action Council, *Retrofit Reset: Prioritize Low-Income Households* (2023), 9. https://irpp.org/research-studies/prioritize-low-income-households/

4. Investing to relieve energy poverty among low-income households

The objectives of this project were to understand the investment required to ensure low-income households experiencing energy poverty would be able to reduce their energy demands while helping Canada reduce carbon pollution. Effective deep retrofit programs simultaneously help households reduce energy costs and ensure health and safety within the home; reduce government cost and risk related to increasing extreme weather events and housing affordability; support emission reduction goals; and stimulate market growth to deliver local economic development and jobs. Financial subsidies will remain a powerful tool in creating market pull for net-zero carbon buildings in parallel with governments introducing regulations to push the building sector towards favouring low-carbon, energy efficient, safe, healthy, climate resilient homes.

The following details modelling conducted to establish a recommended investment level and timeframe for residential energy efficiency and resiliency targeting low-income households.

4.1 Methodology and assumptions

For this study, we adopted the modelling approach developed to produce *Canada's Renovation Wave* which analyzed the cost and benefit of subsidizing up to 50% of the total cost of deep retrofits and fuel-switching for heating for households across Canada. In this iteration, we zeroed in on the proportion of Canadian households that are classified as low-income and experiencing energy poverty, approximately 8% of Canadian households. The following analysis projects the level of investment governments would need in order to provide zero-cost deep retrofits and fuel-switching for low-income households living with energy poverty.

The range of upgrades modelled was selected to reduce existing and future operating costs, while improving the quality and resiliency of the home. We propose:

- Vintage (built before 1996) homes heated by fuels other than electricity undergo deep retrofits and fuel-switch with an electric heat pump.

- Newer (built after 1995) homes heated by fuels other than electricity fuel-switch with an electric heat pump.
- Vintage (built before 1996) homes heated by electricity undergo deep retrofits and switch to an electric heat pump.
- Newer (built after 1995) homes heated by electricity switch to an electric heat pump.

The model recognizes an observed change in housing performance and building codes in 1996, resulting in the distinction in building vintage at that time.[23]

For this analysis, we have not proposed changes to the domestic water heating.

The retrofit implementation schedule modelled follows a similar trajectory to the one modelled in the Renovation Wave report in 2021 and ramps retrofits up to a rate of 6% per year to 2036 and stabilizes at that rate for seven years, before ramping down until the stock meets the 2050 net-zero emissions target (Figure 1). Please refer to *Canada's Renovation Wave* for methodological details, and Appendix A for input assumptions specific to this work.

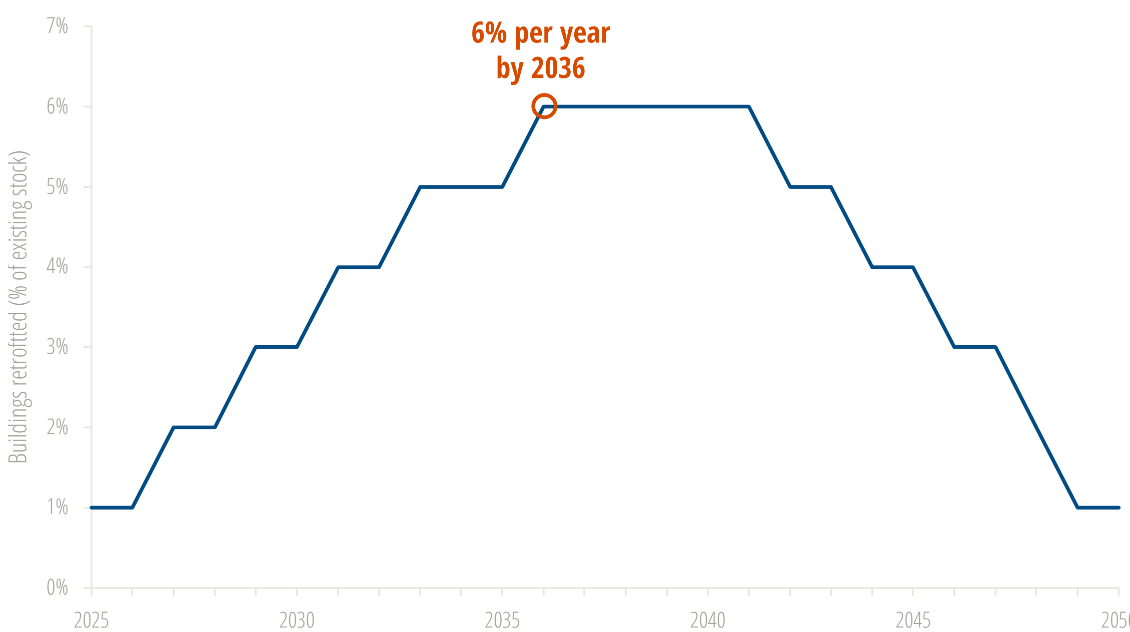

Figure 1. Proposed implementation schedule for retrofits

As summarized in Table 1 above, we approximated the proportion of Canadian households that qualify as low-income and that are living with energy poverty based on

[23] Ralph Torrie (2024), personal communication.

the number of low-income households reported by 2016 Statistics Canada and data from the Canadian Urban Sustainability Partnership backgrounder on energy poverty in Canada (details can be found in Appendix B).

4.2 Results and analysis

Residential deep energy retrofits have historically struggled to secure a financial return on investment based solely on energy cost savings. However, as we continue to experience the impacts of climate change more frequently and with more intensity, proactively adapting our homes and buildings to be more resilient and keep occupants healthy and safe inside is changing the calculus. It is estimated that every $1 invested in adaptation measures can save $15 of recovery costs,[24] and we continue to understand the value of saving lives during heat waves, sealing out pollution from wildfires, and staying warm or cool during extreme temperatures. Below we outline the utility savings deep retrofits can provide for low-income households as well as the expected public return on investment.

4.2.1 Household cost savings

Under the proposed scenario, zero-cost retrofits and fuel-switching would be provided for 8% of Canadian households (totalling 1.1 million). The participating low-income Canadians living with energy poverty would save an estimated $1.7 billion in annual utility costs as of 2050, an average between $280 to $2,450 per household, depending on the type and location of the home. The model projects gross thermal energy savings of 34%-57%, depending on the vintage of the home. With appliance and lighting upgrades, these retrofits would go a long way in relieving energy poverty for low-income Canadians.

[24] Government of Canada, "Funding climate change adaptation," June 27, 2023. https://www.canada.ca/en/environment-climate-change/news/2023/06/funding-climate-change-adaptation.html

Table 2. Annual dwellings retrofitted and economic impact

	Number of dwellings retrofit per year			Energy bill savings per year ($ millions)
	Detached homes	Attached homes	Apartments	
Canada	17,226	3,012	8,725	1,700
NL	635	80	120	75
PE	164	11	49	15
NS	946	78	291	100
NB	758	43	174	85
QC	3,206	509	3,206	325
ON	7,657	1,759	3,679	870
MB	485	38	169	30
SK	538	32	112	15
AB	1,357	194	405	55
BC	1,481	270	788	130

The average utility bill savings per household type are summarized in Table 3.

Table 3. Estimated average annual utility savings by housing type

	Average annual utility bill savings by housing types		
	Detached homes	Attached homes	Apartments
Canada	$1,850	$1,285	$805
NL	$2,455	$2,000	$1,280
PE	$1,685	$1,040	$780
NS	$2,100	$1,720	$935
NB	$2,135	$1,415	$1,015
QC	$1,680	$1,180	$905
ON	$2,175	$1,520	$950
MB	$1,135	$785	$595
SK	$670	$310	$300
AB	$725	$280	$305
BC	$1,610	$905	$500

4.2.2 Public benefits

As shown in Table 4, a total of $70 billion invested over the next 25 years could ultimately save 8,100 TJ of electricity and reduce building emissions by 2.4 million tonnes CO_2e in that time period, which is the equivalent of taking over 500,000 gas-powered vehicles off the road.[25] This investment is also projected to create 16,300 long-term good jobs distributed locally and grow the annual GDP by $6.7 billion. Not captured here are the additional returns through tax revenues and local economic growth.

Table 4. Results of proposed retrofit scenario until 2050

	Attached Homes	Detached Homes	Apartments
Retrofits (per year)	17,000	3,000	9,000
Heat pump conversions (per year)	5,700	24,400	15,300
Investment needed (over 25 years)	$70 billion		
Electricity savings (per year)	8,100 TJ		
Emissions reductions (per year)	2,500 kt CO_2e		
GDP growth[26] (per year)	$6.7 billion		
Jobs created (FTE years)[27]	16,300		

[25] Calculated using U.S. Environmental Protection Agency, "Greenhouse Gas Equivalencies Calculator." https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

[26] Using the estimate of $4 in GDP growth for every dollar spent based on 2018 modelling by Dunsky and the Center for Spatial Economics and referenced in: Efficiency Canada, *Less is More* (2018). https://www.efficiencycanada.org/less-is-more/

[27] Simple multiplier for repair construction in 2016 from: Statistics Canada, "Table 36-10-0594-01 Input-output multipliers, detail level." https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3610059401&pickMembers%5B0%5D=2.3&pickMembers%5B1%5D=4.34&cubeTimeFrame.startYear=2016&cubeTimeFrame.endYear=2016&referencePeriods=20160101%2C20160101

5. Recommendations

In *Beyond Energy Efficiency*, the Pembina Institute outlines the once-in-a-lifetime opportunity deep retrofits present and the societal value of making sure all Canadians have equitable access to these benefits.[28] While much work remains to accelerate the implementation of deep retrofits in all types of buildings, governments are able to advance market mechanisms such as utility demand-side management and low-cost financing to support most housing models. These options are not feasible for low-income households, therefore direct public funding is needed.

Below we outline recommendations on how to effectively target and deliver public funds for deep retrofits in low-income homes.

5.1 Fund for impact

There is increasing support for publicly fully funded retrofits for those experiencing energy poverty as we collectively build our understanding about both the impacts of climate change and the intersections with social justice. Public funding should be directed to those least able to access the programming and capital required for costly home energy upgrades. [29]

Public funding from all levels of government is needed to achieve the levels of retrofits required to reach emission reductions targets and address energy poverty. These funds may come from a combination of new funding and redirecting existing program funding toward low-income households.

As provided in Table 4, the full investment needed to provide upgrades to the identified segment of households would create $6.7 billion in GDP growth annually.

We recommend that between 2025 and 2050 an average of $2.8 billion per year of public funding be allocated to deep retrofits and electrification upgrades for low-income households (as defined by Statistics Canada) also experiencing energy poverty.

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[28] Raidin Blue, Jessica McIlroy, and Betsy Agar, *Beyond Energy Efficiency: Deep retrofits save more than just money* (Pembina Institute, 2024). https://www.pembina.org/reports/beyond-energy-efficiency.pdf

[29] Green Budget Coalition, *Recommendations for Budget 2024* (2023), 14. https://greenbudget.ca/recommendations/

5.2 Remove barriers

Existing low-income or income-qualified retrofit programs are seeing different levels of success, but overall are not resulting in the depth and pace of retrofits that are required. As stated, the level of funding made available, both in total value and amount per home, needs to be significantly higher. To ensure the implementation of retrofit strategies and plans are effective, program navigation needs to be improved.

We recommend that a retrofit program geared towards low-income households also experiencing energy poverty include the following:

- **A single point of entry, no-cost application process with facilitated support from a local agency such as a concierge service or door-to-door program agents.**
- **Supply-side program delivery and payment processing where home contractors or equipment providers complete application approvals and receive program funds.**
- **Flexible implementation steps that address the fast and efficient replacement of equipment at the time of failure and retrofits-over-time asset management.**

5.3 Coordinate across governments, utilities and industry

Elements of the responsibility to ensure all homes in Canada are climate resilient and affordable to operate lie with each level of government. For retrofit efforts to be effective, there must be alignment of emission reduction and resilience targets within and across levels of government, coordinated and streamlined through development of an accountable body.

Provincial coordination is required to ensure investments in decarbonizing the grid and electricity supply, the increased electrification of other sectors, jobs and skills training efforts, and the design and implementation of demand-side management programs and utility rate structures are aligned to a net-zero by 2050 goal.

We recommend federal and provincial governments and utilities partner to fund zero-cost residential retrofits for low-income households living with energy poverty. (in a suggested 50-25-25 cost-sharing split)

We recommend deep retrofit programs be carried out in collaboration with local governments, utilities and industry to leverage their regular contact points with home and building owners.

Appendix A. Model assumptions

The model used for this analysis is the same model used for the *Canada's Renovation Wave* report. The model was developed by Ralph Torrie for Corporate Knights' Build Back Better project in 2020, and subsequently expanded for Efficiency Canada's report *Canada's Retrofit Mission*. The Excel-based model provides a high-level assessment of the impacts of retrofitting the residential building stock including the costs, energy impacts, and GHG impacts. The following outlines key data sources and assumptions.

Building stock

National energy use database results from 2020 were used for building stock characteristics (such as heating source, building type and vintage), energy use and GHG emissions.

The model does not account for growth of the building stock, or demolition of existing buildings. We estimated the impact of demolition rates by assuming demolished stock was replaced with an electrically heated building with equivalent total energy use (with the simplifying assumption that the increase in square footage is offset by an increase in efficiency). The costs from these projects are not included in the total investment. It does represent (although imperfectly) the energy use and resulting carbon reductions from these replacements. Greenfield developments are not represented.

Grid factors

The model used projections of electricity generation broken down by fuel source for every province and territory for 2021-2050 based on Canada Energy Regulator's evolving scenario from their 2020 *Canada's Energy Future* report. The emissions intensity of the electricity grid was then calculated by applying the emissions intensity of each generation source, using historical data from Canada's National Inventory Report, to its proportion of total generation in a given year.

Carbon pricing

The Canada Energy Regulator evolving scenario was used to project utility rates to 2050 for this analysis. This includes increase in carbon pricing using the assumption that carbon prices continue to rise to $60/t in 2030 and $125/t by 2050 (in 2019 real terms).[30] This rate is below the federal government's recent commitment to a $170/t carbon tax by 2030. Future analysis will include the impact on cost of a $170/t carbon tax in 2030.

Air conditioning

The analysis does not include any projections or considerations for the installation of air conditioning units and their impact on building performance. The installation of heat pumps will eliminate the need for separate air conditioning equipment as they can provide both heating and cooling.

Lights and appliances

The modelling does not include lighting and appliance retrofits.

Electricity pricing

Default energy price data from Canada Energy Regulator, *Canada's Energy Future 2020*, 2020$/GJ, residential, end use prices.

Retrofit costs

Heat pump prices have been concluded from the ICF Costing Data.

The analysis does not account for any decreasing market prices in equipment, labour, or capital costs over time.

The total cost of retrofit applied to the model includes the heat pump price combined with a retrofit cost based on a literature review completed for *Canada's Renovation Wave*. The capital costs applied to the model are provided in Table 5. The amount allocated to a "retrofit" provides an allowance for envelope, insulation and window improvements.

Costs do not take into account any rebates or financial incentives currently available to home or building owners.

[30] Canada Energy Regulator, *Canada's Energy Future 2020* (2020), 27. https://www.cer-rec.gc.ca/en/data-analysis/canada-energy-future/2020/

Table 5. Retrofit costs assumptions

Housing Type	Heat Pump Costs	Retrofit Cost	Total Cost
Single family detached dwellings	$16,000	$80,000	$96,000
Single family attached dwellings (ex. townhouses)	$16,000	$80,000	$96,000
Apartments (per unit costs)	$16,000	$90,000	$106,000

Schedule

The model schedule is based on the net-zero emissions target of 2050 and begins in 2025, ramping up of the volume of retrofits to 2036 and then ramping down in 2042. (Figure 1).

Energy poverty methodology

B.1 Proportion of low-income households living with energy poverty

The model requires the input of the percentages of households in each province that are being targeted for retrofit supports. The result of this breakdown is summarized in Table 1.

B.1.1 Canadian data summary

	Households with high home energy cost burdens	Households with low to moderate home energy cost burdens	Total
Low-income households (by LIM-AT)	1,143,275	1,257,470	2,400,745
Not low-income households	1,667,630	9,716,765	11,384,395
Total	2,810,905	10,974,235	13,785,140

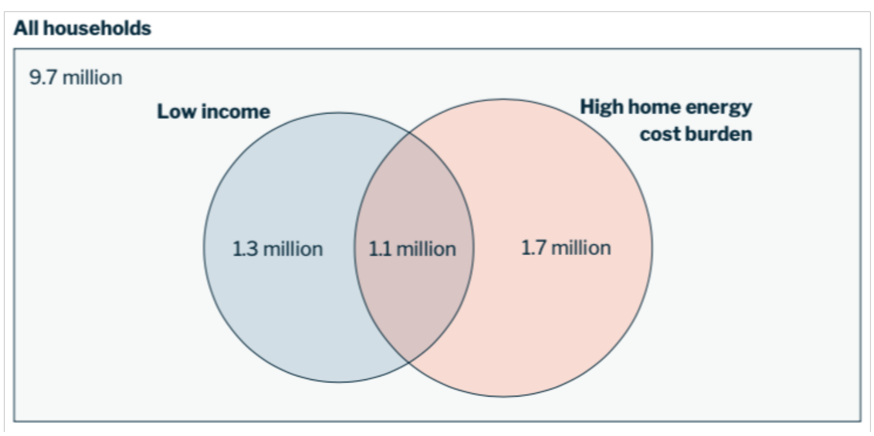

Figure 2. Intersection of low-income households living with energy poverty

Source: CUSP[31]

[31] *Energy Poverty in Canada: a CUSP Backgrounder*, 7.

In Canada, low-income households living with energy poverty (have high energy cost burdens) is estimated at 1,143,275 as reported by CUSP and illustrated in Figure 2; this is 8% of all Canadian households or approximately 48% of all low-income households.

Since we are seeking the subset of low-income households also living with energy poverty, we express the relationship between households living with energy poverty and low-income households as a ratio, as summarized in Table 6.

Table 6. Summary of national energy poverty data

Description	Amount	Percentage
Canadian households	13,785,140	--
Low-income Canadian households	2,400,725	17%
Canadian households experiencing energy poverty	2,810,905	20%
Canadian households that are low-income and living with energy poverty	1,143,275	8%
Ratio of energy poverty households to low-income households	1.19	
Percentage of low-income Canadian households living with energy poverty	48%	

B.1.2 Calculating provincial breakdown

To calculate provincial data, we used data on *households experiencing energy poverty* from the Canadian Urban Sustainability Practitioners, presented in total number of households (Figure 3).

Using the 2016 data for total dwellings from the Stats Can census,[32] we can create an estimate of the percentage of homes that are experiencing energy poverty in each province and territory by calculating:

(#homes experiencing energy poverty/#total occupied dwellings) *100

[32] Statistics Canada, "Data tables, 2016 Census." https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/dt-td/Rp-eng.cfm?LANG=E&APATH=3&DETAIL=0&DIM=0&FL=A&FREE=0&GC=0&GID=0&GK=0&GRP=1&PID=111829&PRID=10&PTYPE=109445&S=0&SHOWALL=0&SUB=0&Temporal=2017&THEME=121&VID=0&VNAMEE=&VNAMEF=

Note: using the 2016 census gives us an accurate estimate of the percentage of households experiencing energy poverty in 2016. For the purposes of this report, we are assuming that the percentage will be relatively the same in 2023.

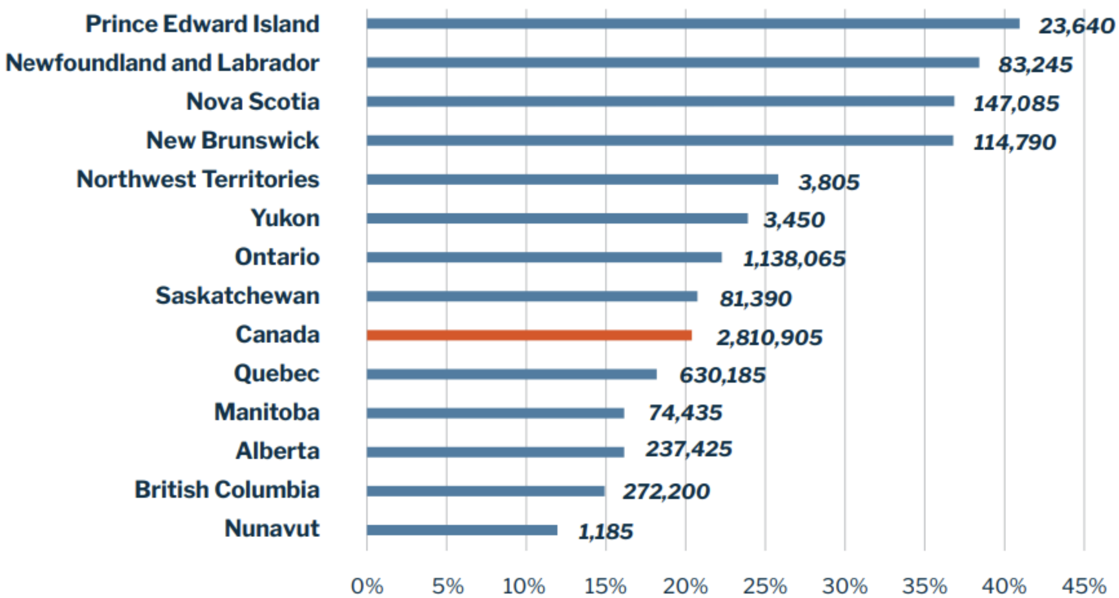

Figure 3. Households experiencing energy poverty in Canada

Source: CUSP[33]

Data on the *percentage of low-income households* came from the same 2016 StatsCan census data.

While the proportion of low-income households is fairly similar across provinces, some provinces have significantly higher proportions of households experiencing energy poverty (Table 7). We therefore assumed that the share of households that are both low-income and experiencing energy poverty would be proportionately affected by this difference. We calculated a correction factor as a ratio of the provincial proportion of households living with energy poverty compared to low-income households, against the equivalent proportion for Canadian households. (See the column "Correction factor" in Table 7; this is calculated from the value of the column "Ratio of energy poverty to low-income households" for each province compared to the Canadian value of 1.19.)

From there, we first assumed that the relationship between low-income households and households experiencing energy poverty would be broadly similar to the relationship found nationally; that is, around 48% of all low-income households live with energy

[33] *Energy Poverty in Canada: a CUSP Backgrounder*, 4.

poverty. We multiplied this value by the correction factor to estimate the *share of low-income households in each province that would be affected by energy poverty*; multiplying this result by the share of low-income households gave us the *share of all households in each province that are both low-income and living with energy poverty*.

Table 7. Calculating energy poverty combined with low-income households

Province	Share of all households that are:		Ratio of energy poverty to low-income	Correction factor	Low-income households living with energy poverty	
	Low-income	Experiencing energy poverty			Share of low-income households	Share of all households
Canada	17%	20%	1.19		47%	8%
NL	15%	38%	2.60	2.19	102%	15%
PEI	16%	40%	2.45	2.06	96%	16%
NS	19%	37%	1.98	1.66	77%	14%
NB	17%	36%	2.10	1.76	82%	14%
QC	16%	18%	1.11	0.93	43%	7%
ON	17%	22%	1.29	1.09	51%	9%
MB	21%	15%	0.73	0.62	29%	6%
SK	18%	19%	1.04	0.87	41%	7%
AB	14%	16%	1.14	0.96	45%	6%
BC	19%	15%	0.78	0.65	30%	6%

B.2 Breakdown by dwelling type

The model also takes into account the type of dwelling, so the percentages of households experiencing energy poverty by housing type must be input.

The CUSP energy poverty data provide a breakdown of the number of homes experiencing energy poverty by dwelling type (Figure 4).

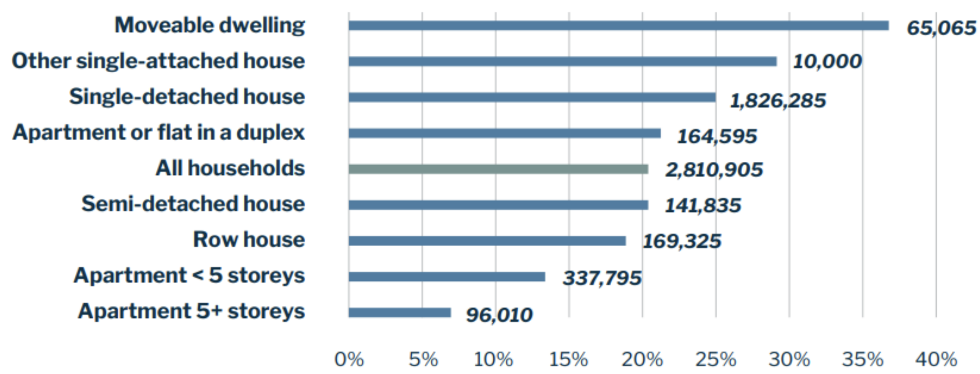

Figure 4. Number of homes by dwelling type experiencing energy poverty

Source: CUSP[34]

Again cross-referencing with the 2016 census, we determined the percentages of households experiencing energy poverty by housing type.

The model uses different dwelling categories from the CUSP backgrounder and census data and therefore the dwelling types have been recategorized to fit model categories of single family detached, single family attached and apartments. As the model is unable to account for them, moveable dwellings have been excluded; the total of the three categories of building types thus sums to 97.7% not 100%.

We assume the distribution of poverty by dwelling type is distributed the same way in each province and apply it accordingly. The percentage of each type of housing dwelling experiencing energy poverty in Canada and by province is provided in Table 8.

[34] *Energy Poverty in Canada: a CUSP Backgrounder*, 8.

Table 8. Percentage of each dwelling type experiencing energy poverty

Province	Single family detached	Single family attached	Apartments
NL	24.7%	4.3%	8.1%
PEI	25.8%	4.5%	8.5%
NS	23.8%	4.2%	7.8%
NB	23.3%	4.1%	7.6%
QC	11.6%	2.0%	3.8%
ON	14.3%	2.5%	4.7%
MB	9.9%	1.7%	3.2%
SK	12.2%	2.1%	4.0%
AB	10.1%	1.8%	3.3%
BC	9.4%	1.7%	3.1%
YK	14.8%	2.6%	4.8%
NWT	16.5%	2.9%	5.4%
NU	7.9%	1.4%	2.6%

Appendix B. Retrofit outcomes and costs

Table 9. Retrofit outcomes and costs projected for zero-cost retrofit of low-income households living with energy poverty

	Total number of deep retrofits (to 2050)	Total number of heat pump installations (to 2050)	Total capital expenditures to 2050 (millions)
Canada	724,000	1,135,000	$70,000
NL	21,000	45,000	$2,104
PE	6,000	24,000	$569
NS	33,000	62,000	$3,271
NB	24,000	53,000	$2,508
QC	166,000	228,000	$15,083
ON	327,000	435,000	$31,286
MB	17,000	40,000	$1,706
SK	17,000	41,000	$1,746
AB	49,000	94,000	$5,059
BC	63,000	113,000	$6,323