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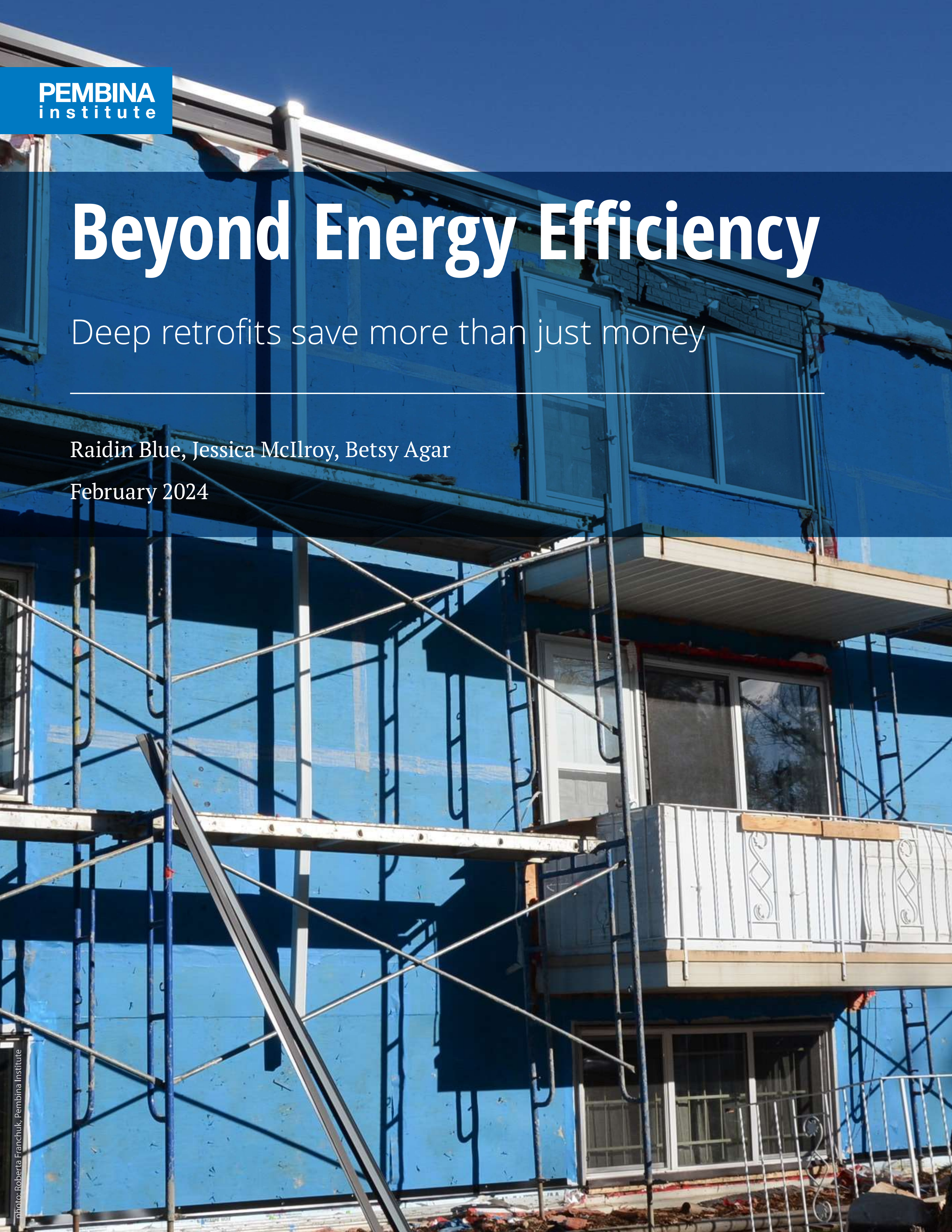
Beyond Energy Efficiency

Deep retrofits save more than just money

Raidin Blue, Jessica McIlroy, Betsy Agar

February 2024



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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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Acknowledgements

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The Pembina Institute acknowledges that the work we steward and those we serve span across many Nations. We respectfully acknowledge the space our organization is headquartered in as the traditional and ancestral territories of the Blackfoot Confederacy, comprised of the bands Siksika, Piikani, and Kainai, the Îyârhe Nakoda Nations, including the bands of Goodstoney, Chiniki, and Bearspaw, and the Tsuut'ina Dené. These Lands are also home to the Métis Nation of Alberta — Region 3 whose Peoples have deep relationships with the Land.

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

Canadian decision-makers must start making the case for deep retrofits of the building stock beyond energy savings and zero in on broader objectives like carbon emissions reductions, health and wellness, affordability, and climate adaptation.

Canada is beginning to recognize the need for deep retrofit of its building stock, but the current paradigm within which retrofits are viewed is focused on near-term return on investment rather than long-term financial and non-monetary benefits. While deep energy retrofits are predominantly valued for their energy savings — which are important — our aging building stock represents a once-in-a-lifetime opportunity to drastically drive down carbon emissions, improve the health and safety of occupants, increase heating and cooling affordability, integrate the building with the grid, and adapt to and mitigate climate change. As Canada decarbonizes its building stock, the deep retrofit paradigm needs to shift beyond cost recovery through energy savings towards capturing the full value of non-energy benefits.

Key components of the proposed paradigm shift include:

Retrofitting for low carbon: Implementing energy efficiency measures and fuel switching to reduce operational carbon, and selecting materials that have low embodied carbon.

Retrofitting for climate resilience: Retrofitting to improve resilience in the face of climate-related risks and protect Canadians, especially vulnerable populations.

Retrofitting for health: Investing in deep retrofits to mitigate climate-related health risks such as by improving indoor air quality and reducing exposure to extreme temperatures.

Retrofitting for affordability: Equitable distribution of deep retrofit benefits to overcome the disproportionate impact of climate events and energy poverty on vulnerable communities.

Retrofitting for smart grid integration: Implementing energy efficiency measures, onsite renewable energy generation, and smart controls to transform buildings into grid-integrated energy hubs.

In this report we outline a new paradigm for how we approach and value deep retrofits to help Canada prepare for a net zero future while protecting people in their homes.

1. Introduction

Deep retrofits have been recognized around the world as a critical action in both meeting net-zero emissions reduction commitments and providing climate safe and resilient homes. Done right, deep retrofits go beyond reductions in energy consumption and greenhouse gases, to consider the potential for more affordable heating and cooling, as well as the health, safety and well-being of occupants. As well, these efficiency measures and subsequent energy demand reductions free up clean energy for use in the decarbonization of other sectors, such as transportation and industrial processes.

In Canada, the buildings sector represents the third-largest source of greenhouse gas emissions, and it is estimated that 80% of the buildings that will exist in 2050 have already been built. Pembina Institute modeling shows that to meet Canada's net-zero commitments for the buildings sector, the country must ramp up the rate of retrofits to be upgrading the heating systems, insulation, and ventilation of approximately 600,000 existing homes and 32 million square metres of existing commercial space each year.[1]

Aging buildings represent key opportunities to ensure heating and cooling is affordable, and that homes and buildings are safe, healthy, and resilient for their occupants. Deep retrofits can reduce energy requirements and costs, can include upgrades to address health concerns related to building quality and performance, and can incorporate fuel-switching through heat pumps to reduce emissions while introducing protection against overheating in increasingly hot summers. With many of our homes due for major repairs, we have a once-in-a-lifetime opportunity to make our homes healthier, safer and ready for our new climate reality.

To achieve the level of retrofits required to meet national climate targets, Canada needs a combination of regulations and incentives to drive market uptake. Based on net present value analysis alone, we estimate $10 billion to $15 billion of federal, provincial, and utility investment will be needed per year over the next 20 years, which are daunting costs. For low-income households living with energy poverty, we estimate a federal investment of $24.3 billion over five years[2] is needed to protect vulnerable populations from rising energy costs and increasingly extreme climate events through deep retrofits and fuel-switching. At the same time, we know there are non-energy benefits to retrofits that traditional cost-benefit analyses

[1] Madi Kennedy and Tom-Pierre Frappé-Sénéclauze, *Canada's Renovation Wave: A plan for jobs and climate* (Pembina Institute, 2021), 17. https://www.pembina.org/pub/canadas-renovation-wave

[2] Green Budget Coalition, *Recommendations for Budget 2024* (2023), 17. https://greenbudget.flywheelsites.com/wp-content/uploads/2023/11/Green-Budget-Coalition-Recommendations-for-Budget-2024-November-10-2023.pdf

cannot capture. Investing with expectations of returns beyond simple utility savings and accounting for the broad range of private and public benefits will be critical in rethinking how to make the financial case for future-proofing our homes and buildings. This report outlines aspects of a social cost-benefit framework that recognizes benefits beyond energy efficiency utility savings that is necessary for re-evaluating retrofit policy and asset investment decisions.

2. Transforming the retrofit paradigm

Current government and utility building retrofit policies and programs focus on cutting energy waste but are limited by the focus on short-term financial returns, which are too small to justify deep retrofit investments. In the current paradigm, the business case for retrofit investments precludes opportunities for deep retrofits that require larger capital investments than energy savings alone can return. A new paradigm is needed that frames retrofits as public investment opportunities to reduce climate risk along with emissions and account for non-energy health, safety and resilience benefits. Figure 1 illustrates a model of a paradigm that leverages deep retrofits to improve the lives of Canadians not just to reduce building energy consumption.

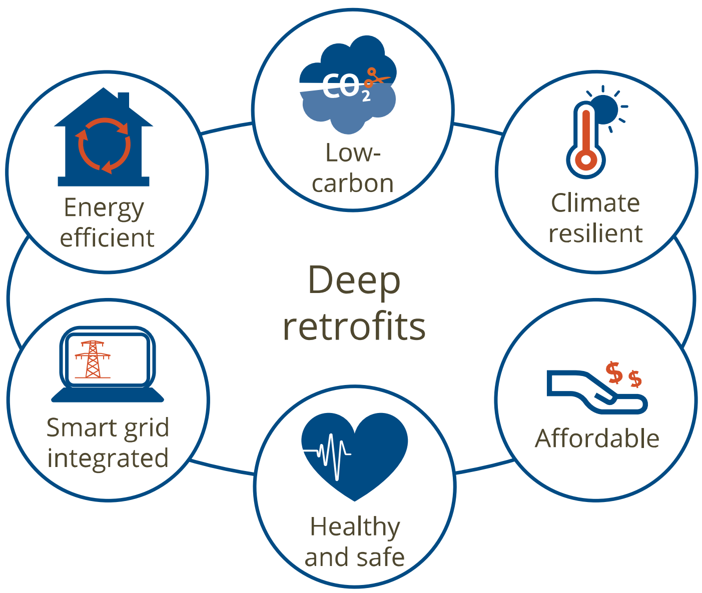

Figure 1. Graphic illustrating aspects of deep retrofit in a new paradigm.

The non-energy benefits illustrated in Figure 1 are seldom included in the valuation of a retrofit and are, as a result, considered side or co-benefits. Ignoring non-energy benefits can create misalignment between the value derived and the value paid for retrofit measures. Furthermore, neglecting to incorporate non-energy benefits through holistic design could miss opportunities offered by synchronistic solutions that provide multiple benefits for similar costs.

Simple payback and short-term returns on investment fail to recognize the myriad of benefits that are difficult to monetize or include in the bottom line. In a new paradigm, other means of valuation, such as looking at the long-term total cost of building ownership, would better account for the true project value and benefits returned. Table 1 describes some of the critical differences between the existing and proposed paradigms.

Table 1. Retrofit paradigm shift

Characteristic	Existing paradigm	Proposed paradigm
Value of project	Cost savings-driven energy reductions	Deep energy efficiency Climate mitigation Climate and seismic adaptation Health and safety Affordable to heat and to cool Integrated as assets to the electrical grid
Metrics of assessment	Return on investment Simple payback	Total cost of building ownership Cost of carbon abated ($ / GHG) Illness and deaths prevented Units of energy returned to the grid

Source: Adapted from Greenwald, et al.[3]

[3] Robert Greenwald, Iram Green, Sam Thomas, and Craig Edwards, "Deeper Thinking: Changing our mindset with building energy audits to look for deeper carbon reduction strategies," in American Council for Energy Efficient Economy, *2020 Summer Study on Energy Efficiency in Buildings* (2020), 3. https://www.aceee.org/files/proceedings/2020/event-data/pdf/catalyst_activity_10741/catalyst_activity_paper_20200812132344444_1b8b7c74_b214_46f8_8117_63758a5b63ea

3. Benefits beyond energy efficiency

3.1 Low carbon

Building sector operational emissions (categorized as Scope 1 or direct building sector emissions — see Figure 2) account for approximately 13% of Canada's emissions overall,[4] but in urban centres they account for a significantly higher share and reducing building emissions is central to cities' plans for reaching net-zero emissions by 2050. For example, approximately 57% of the City of Calgary's emissions are attributed to buildings, resulting in the plan to have all new buildings built to net-zero standards by 2030 and to achieve an annual conversion rate to net-zero homes of 3% for existing buildings.[5]

Beyond achieving energy savings to lower energy bills, the proposed paradigm expands the objectives to include reducing emissions by lowering energy demand while also fuel-switching. The largest source of Scope 1 building emissions is from fossil fuel combustion for space and water heating and cooking, as such fuel-switching offers a transformational opportunity to drastically cut carbon emissions.

[4] Natural Resources Canada, *The Canada Green Buildings Strategy: Discussion Paper* (2022), 4. https://natural-resources.canada.ca/public-consultations-and-engagements/the-canada-green-buildings-strategy/25009

[5] City of Calgary, "Calgary Climate Strategy – Pathways to 2050. https://www.calgary.ca/environment/climate.html

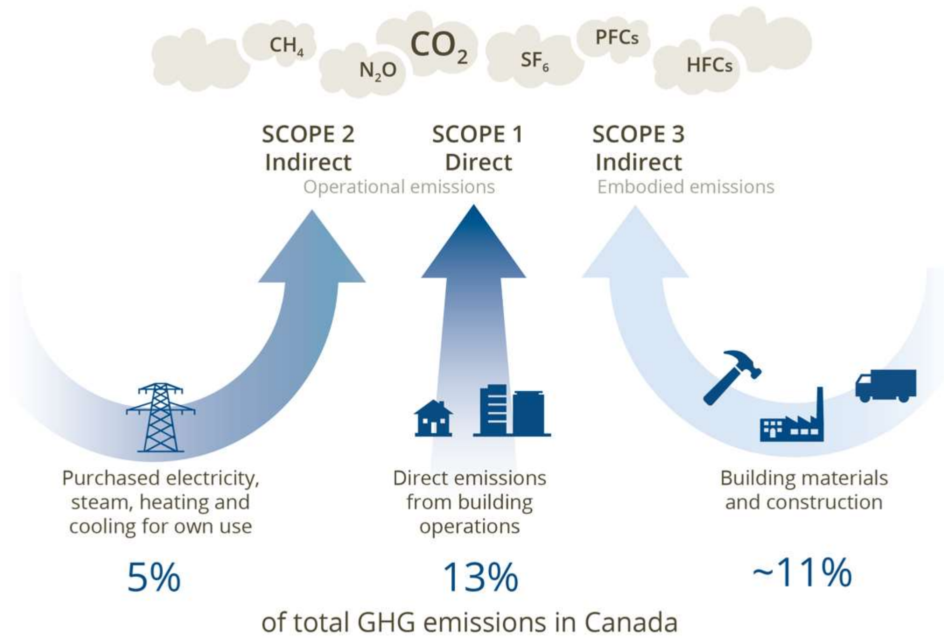

Figure 2. Types of GHG emissions from buildings

Fuel-switching refers to moving away from the use of natural gas or other fossil fuels and to highly efficient equipment such as heat pumps that are powered by clean electricity, which is widely regarded as the lowest-emitting energy source. The emissions factors associated with the electricity supplied to buildings varies by location, but in all grid systems highly efficient electric heat pumps produce lower emissions than furnaces and boilers that burn fossil fuels onsite.[6] Operational emissions associated with electricity supply are categorized as Scope 2 because the emissions are produced during upstream energy production rather than onsite; they make up 5% of Canada's buildings-related greenhouse gas emissions.[7]

The cleaner the electricity grid, the more electric heat pumps can reduce emissions. Currently, replacing a fossil fuel furnace with a cold-climate air-source heat pump results in a net pollution reduction in most provinces and territories. The electrical grids in Alberta, Saskatchewan, and Nunavut have emission factors for which switching from fossil fuel furnaces does not yet result in immediate GHG emissions reductions. However, according to the Evolving Scenario modelled by the Canada Energy Regulator, these emission factors are changing. For example, it is possible for Saskatchewan's electrical grid to be clean enough for heat pumps to be a net-positive (because provinces are moving off coal) by 2026 and Alberta's by 2028, well within a heat pump lifecycle.[6]

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[6] Trevor Billy, Madi Kennedy and Vincent Morales, *Heat pumps in high carbon grids* (Pembina Institute, unpublished).

[7] Natural Resources Canada, *The Canada Green Buildings Strategy: Discussion Paper* (2022), 4. https://natural-resources.canada.ca/public-consultations-and-engagements/the-canada-green-buildings-strategy/25009

In addition to operational emissions, the materials used in building components have embodied carbon introduced through the material extraction, transportation, and manufacturing associated with their production. Embodied carbon emissions are considered indirect Scope 3 emissions, and account for 11% of emissions globally.[8] Unlike operational carbon emissions, which can be reduced over time through retrofits, embodied carbon emissions are locked in at the time a building is constructed or retrofit. For example, the carbon emitted in the process of producing cement that is used in constructing a building's foundations are counted as Scope 3 for the building. Embodied carbon emissions should be factored into material selection decisions but also as part of decisions on whether to demolish and replace a building rather than retrofitting and wasting carbon already embodied within the existing building materials. Governments are starting to understand the necessity of tracking embodied carbon: the City of Vancouver now requires embodied carbon reporting and has plans to set embodied carbon caps.[9]

3.2 Climate resilient

Canada is already experiencing the effects of climate change, including frequent extreme temperatures, increased occurrence and intensity of wildfires combined with expanded locations, erratic precipitation patterns leading to unpredictable cycles of droughts and floods, shorter winters, thawing permafrost and glaciers, and diminishing protective ice and snow cover. Homes and buildings are critical lines of defense to protect people in Canada against extreme weather, and deep retrofits are the only climate action that both lowers emissions and increases resiliency.

In addition to human risks, the Insurance Institute of Canada reported that severe weather claims paid by Canada's insurance industry have doubled every five to 10 years. Climate change has also been cited as the reason that Canadian home insurance rates increased by 5% to 10% on top of inflation in 2019.[10] At the same time, premiums and deductibles for sewer backup and overland flood insurance have increased. Insurers around the world are warning that climate

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[8] American Institute of Architects, "ROI: Designing for reduced embodied carbon," 2023. https://www.aia.org/resource-center/roi-designing-reduced-embodied-carbon

[9] City of Vancouver, *Embodied Carbon Guidelines Version 1.0* (2023). https://vancouver.ca/files/cov/embodied-carbon-guidelines.pdf

[10] Federation of Canadian Municipalities, *Investing In Canada's Future: The Cost of Climate Adaptation at the Local Level* (2020), 12. https://data.fcm.ca/documents/reports/investing-in-canadas-future-the-cost-of-climate-adaptation.pdf

change may make insurance coverage unaffordable for most people[11] and several companies are no longer providing insurance in areas where natural disasters made worse by climate change are happening more often.[12]

Seismic resilience

In 2013, the Insurance Bureau of Canada (IBC) estimated the economic losses of major earthquakes affecting B.C. and the Ontario/Québec region based on historical data, including direct property and infrastructure losses and indirect losses from supply chain interruptions, infrastructure network disruptions, and other interconnectivity problems between economic sectors.[13]

For the B.C. scenario, IBC modeled a magnitude 9.0 earthquake which resulted in an estimated **$58.6 billion in direct losses from properties** and $12.7 billion in Indirect infrastructure and asset losses. The Ontario/Quebec scenario was modeled on a magnitude 7.1 earthquake, resulting in **$45.9 billion in direct property losses** and $11.3 billion in indirect property, infrastructure and public asset losses.

Deep retrofits can also capitalize on synergistic interventions, such as improving seismic resilience while increasing structural capacity during envelope upgrades. Seismic upgrades to an existing wood-framed multi-unit residential building (MURB), for example, might include adding supporting walls or columns that can resist seismic and severe weather forces and prevent collapse. The National Institute of Building Sciences and Natural Resources Canada estimate that for every **$1 spent on seismic upgrades, $4 are saved in recovery costs.**[14, 15]

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[11] Marketplace, "Insurance increasingly unaffordable as climate change brings more disaster." https://www.marketplace.org/2020/08/31/insurance-increasingly-unaffordable-as-climate-change-brings-more-disasters/

[12] Christoper Flavelle, Jill Cowan, and Ivan Penn, "Climate shocks are making parts of America uninsurable. It just got worse." *The New York Times*, May 31, 2023. https://www.nytimes.com/2023/05/31/climate/climate-change-insurance-wildfires-california.html

[13] Air Worldwide, *Study of Impact and the Insurance and Economic Cost of a Major Earthquake in British Columbia and Ontario/Québec* (Insurance Bureau of Canada, 2013), 11. https://www.multivu.com/players/English/7765151-insurance-bureau-canada-disaster/docs/2013-study-of-impact-and-the-insurance-and-economic-cost-of-a-major-earthquake-335090927.pdf

[14] National Institute of Building Sciences, *Natural Hazard Mitigation Saves 2019 Report* (2019), 658. https://www.nibs.org/projects/natural-hazard-mitigation-saves-2019-report

[15] Natural Resources Canada, *Earthquake Hazards and Risks*. https://earthquakescanada.nrcan.gc.ca/hazard-alea/earthquake_hazards_risks.pdf

3.3 Healthy and safe

The occupant health benefits of building upgrades have largely been missing from opportunities deep retrofits present beyond energy efficiency. The COVID-19 pandemic and recent heatwaves and forest fires have brought indoor air quality and heat safety concerns into public dialogue. Consideration of both positive and negative health outcomes should be key in decisions when setting performance objectives for both new construction and deep retrofit projects.

Climate change is increasing health risks in a myriad of ways: wildfires spread smoke and particulate pollution that impact air quality; changes in local weather, such as longer and more frequent heat waves, increase overheating risks and help spread infectious diseases. In 2021, 619 deaths in B.C. were attributed to a single heat wave event, with 98% occurring indoors and most in homes without adequate air conditioning.[16] Climate change made the record-breaking 2023 wildfire season in Eastern Canada, which resulted in extensive air quality warnings, twice as likely than under historic conditions.[17] The COVID-19 pandemic has also made Canadians acutely aware of the quality of the air they breathe. Whereas our homes were once presumed to be safe, these events are (at times tragic) harbingers signalling the need for upgrades to ensure our ability to stay safe in our homes and buildings.

Poor building conditions increase health vulnerabilities, especially for people living with existing health conditions, and at greater levels in MURBs compared to single-family homes. Table 2 outlines common health issues associated with poor indoor air quality.

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[16] Report to the Chief Coroner of British Columbia, *Extreme Heat and Human Mortality: A Review of Heat-Related Deaths in B.C. in Summer 2021* (2022), 3. 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

[17] Clair Barnes et al., *Climate change more than doubled the likelihood of extreme fire weather conditions in Eastern Canada* (World Weather Attribution, 2023). https://spiral.imperial.ac.uk/bitstream/10044/1/105981/17/scientific%20report%20-%20Canada%20wildfires.pdf

Table 2. Common health issues in buildings with poor indoor air quality

Health Issue	Description
Sick building syndrome	Sick building syndrome is a condition that is thought to be caused by spending prolonged time in a building with poor air quality. Symptoms include headache, fatigue, dizziness, irritation of the skin, eyes and nose, and difficulty breathing, which are made worse by low ventilation rates.[18]
Allergies and asthma	Building conditions such as excess moisture and the presence of mould and dust mites are strongly associated with asthma and allergy symptoms.[19]
Infectious disease transmission	Infectious diseases can be transmitted by airborne microbes (viruses and bacteria). The COVID-19 pandemic has brought a significant amount of attention to the role of buildings in mitigating transmission risk.[20]
Adverse brain development	There is evidence linking air pollution with adverse brain development in children.[21] Infant exposure to indoor air pollution is related to impaired cognitive function, mental and motor development.[22]

One-quarter to one-third of Canadian adults living in MURBs suffer from health conditions that are exacerbated by the impacts of climate change (see Table 3). These vulnerabilities jump considerably for seniors living in long-term care facilities as chronic illness and age-related health conditions increase. This is due to their high sensitivity and low adaptive capacity. Adaptive capacity depends on several factors including access to financial and community resources, and the quality of the built environment. Because of this, populations who live in poor conditions or poor-quality housing, and those who are low income, are inherently more vulnerable to the impacts of climate change.

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[18] William Fisk, et al., "Quantitative relationship of sick building syndrome symptoms with ventilation rates," *Indoor Air,* 19, no. 2 (2009), 1. DOI: 10.1111/j.1600-0668.2008.00575.x

[19] William Fisk, "How IEQ Affects Health, Productivity," *ASHRAE Journal* 44, no. 5 (2002), 57. https://escholarship.org/uc/item/2dq7g159

[20] Canadian Centre for Occupational Health and Safety, "Indoor Ventilation for Respiratory Infectious Diseases," October 17, 2023. https://www.ccohs.ca/infectious-diseases/indoor-ventilation/

[21] Devon C. Payne-Sturges et al., "Healthy Air, Healthy Brains: Advancing Air Pollution Policy to Protect Children's Health," *American Journal of Public Health* 109 (2019). DOI: 10.2105/AJPH.2018.304902

[22] Eva Morales et al., "Association of early-life exposure to household gas appliances and indoor nitrogen dioxide with cognition and attention behavior in preschoolers," *American Journal of Epidemiology* 169 (2009). DOI: 10.1093/aje/kwp067

Table 3. MURB residents living with health conditions aggravated by climate impacts

Health condition	Rate among adult MURB residents	Aggravating climate impacts			
		Extreme heat	Flooding and reduced water quality	Changes in infectious agents	Wildfire smoke and reduced air quality
One or more chronic illness[23,24]	30%	✓		✓	✓
Allergies[25]	25%	✓	✓		✓
Hypertension[26,27,28]	22%	✓			✓
Mood or anxiety disorders[29]	12-31%	✓	✓	✓	✓

A growing body of scientific evidence indicates that the air within homes and other buildings — where we spend 90% of our lives — can be more polluted than the outdoor air, even in the largest, most industrialized cities.[30, 31] Common indoor pollutants include toxic gases such as carbon monoxide, nitrogen oxides and radon, volatile organic compounds, particulates, pathogens such as bacteria and viruses, and allergens. Figure 3 shows the common sources and locations of indoor air pollutants.

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[23] Jennifer F. Bobb et al., "Cause-specific risk of hospital admission related to extreme heat in older adults," *Journal of the American Medical Association*, 312, no. 24 (2014). DOI: doi.org/10.1001/jama.2014.15715

[24] J. Z. K. Yip and A. Woo, *Extreme Heat Risks and Impacts on B.C.'s Health Facilities: A background report,* (Lower Mainland Facilities Management, (2018).

[25] Gennaro D'Amato et al., "Meteorological conditions, climate change, new emerging factors, and asthma and related allergic disorders. A statement of the World Allergy Organization," *The World Allergy Organization Journal*, *8*(1), (2015). https://doi.org/10.1186/s40413-015-0073-0

[26] Cheryl D Fryar, Te-Ching Chen, Xianfen Li, "Prevalence of Uncontrolled Risk Factors for Cardiovascular Disease: United States, 1999–2010," *NCHS Data Brief,* 103 (2012). https://www.cdc.gov/nchs/data/databriefs/db103.pdf

[27] Li-Yuan Sun et al., "Risk Factors of Cardiovascular Disease and Their Related Socio-Economical, Environmental and Health Behavioral Factors: Focused on Low-Middle Income Countries- A Narrative Review Article," *Iranian Journal of Public Health*, 44 no.4 (2015). https://pubmed.ncbi.nlm.nih.gov/26056662/

[28] Rachel Hajar, "Risk Factors for Coronary Artery Disease: Historical Perspectives," *Heart Views : The Official Journal of the Gulf Heart Association*, 18, no. 3, (2017). https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5686931/

[29] Extreme heat: (Cusack et al., 2011) as cited in (Yip & Woo, 2018).

[30] U.S. Environmental Protection Agency, *The total exposure assessment methodology (TEAM) study: Summary and analysis* (1987), 369. https://www.aivc.org/sites/default/files/airbase_11604.pdf

[31] U.S. Environmental Protection Agency, "The Inside Story: A Guide to Indoor Air Quality." https://www.epa.gov/indoor-air-quality-iaq/inside-story-guide-indoor-air-quality

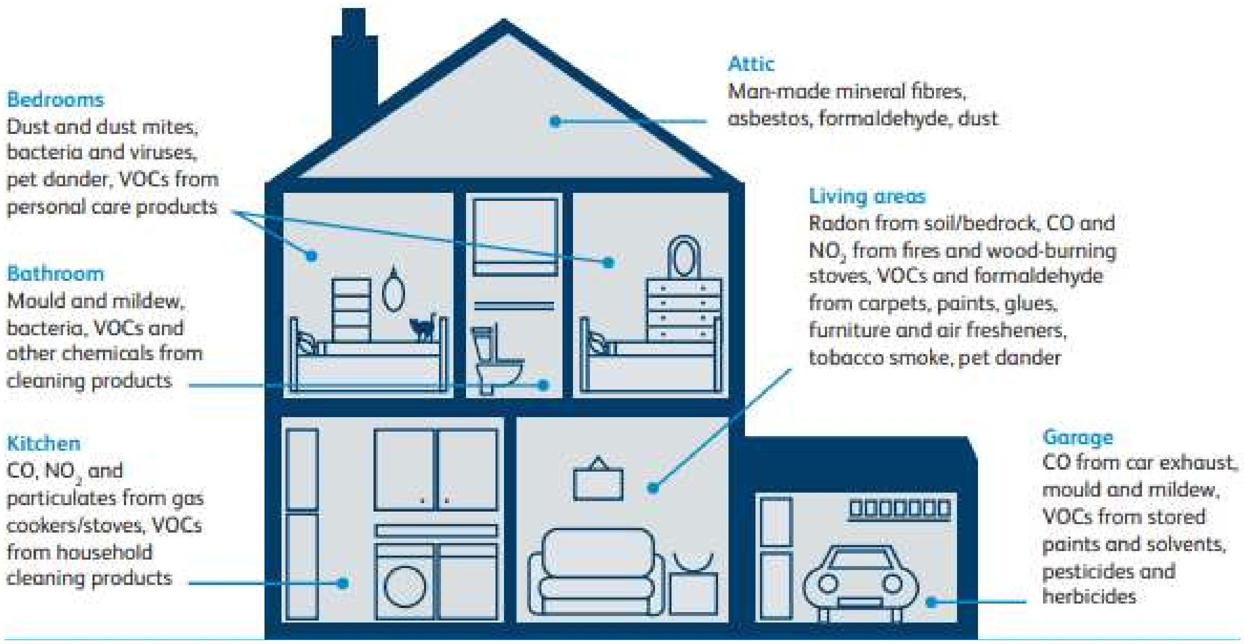

Figure 3. Common sources of indoor air pollution

Source: The Royal College of Physicians[32]

Health Canada is raising concerns about the risks of trapping radon during energy retrofits if ventilation and air exchanges are not properly considered.[33] Radon gas can accumulate in the home and cause significant health issues, including lung cancer. Radon exposure risk varies by location and even building type and should be considered when assessing building level risks and vulnerabilities.[34]

The risk of trapping air pollutants within homes and buildings underscores the importance of taking a systems approach to new construction and deep retrofit design. Tightening up leaky homes and buildings can inadvertently increase exposure to indoor air pollutants. Air sealing must be paired with commensurate mechanical equipment upgrades, such as heat or energy recovery ventilators, that bring sufficient fresh, filtered air inside and exhausts stale, potentially polluted air.

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[32] The Royal College of Physicians, *Every breath we take: the lifelong impact of air pollution* (2016). https://asbp.org.uk/wp-content/uploads/2016/08/Every-breath-we-take.-Full-Report-Low-res.4.pdf

[33] Health Canada, "Radon and energy retrofits," October 23, 2023. https://www.canada.ca/en/health-canada/services/publications/health-risks-safety/radon-energy-retrofits.html

[34] Anne-Marie Nicol, "Focus on health in the balance of energy retrofits and indoor air quality," *National Collaboration Centre for Environmental Health*, November 23, 2022. https://ncceh.ca/resources/evidence-briefs/focus-health-balance-energy-retrofits-and-indoor-air-quality

3.4 Affordable

Climate events carry greater impacts for populations living with health vulnerabilities and other social injustices, which can exacerbate and be exacerbated by the rising cost of living; deep retrofitting can be a means to alleviate these burdens and correct these injustices. Vulnerable populations can include those living with high environmental sensitivities, mental and physical health conditions or chronic health issues, as well as children, the elderly, low-income households, and people with disabilities. Because deep retrofitting is a once-in-a-lifetime opportunity, it must also be utilized to address energy poverty by lowering utility bills and improving living conditions. Approximately 20% of households in Canada are experiencing energy poverty and struggle to pay their utility bills and meet their energy needs.[35] Retrofits can reduce energy bills and improve living conditions, but the majority of financing tools and grants currently available for retrofits require upfront capital investments and/or significant administrative burdens that create access barriers for low-income people in Canada. Policies and programs to accelerate deep retrofits must be developed and implemented with a social justice lens that equitably distributes benefits of healthier, safer homes that are more affordable to heat and to cool.

Energy poverty

Energy poverty is experienced by households that are unable to access and to afford adequate energy for basic needs, such as heating and cooling. Any household that spends more than 6% of their after-tax income on home energy services (or roughly twice the national median) is considered to be experiencing energy poverty.[36]

Whereas Canada's Atlantic provinces have the highest rates of energy poverty in Canada, for example, 41% of the households in Prince Edward Island face high home energy cost burdens, approximately 20% of households across Canada experience energy poverty.[37]

Energy poverty impacts both low- and moderate-income households, and rural households are more likely to experience energy poverty than their urban counterparts (typically because rural homes are larger and rural utility transmission charges are higher). Those living in older homes

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

[36] This is one of the commonly used metrics used to measure energy poverty; however, there is no formal definition. CUSP, *Energy Poverty in Canada: A CUSP Backgrounder* (2019), 3. https://energypoverty.ca/backgrounder.pdf

[37] *Energy Poverty in Canada,* 4.

are disproportionately impacted by energy poverty; while they typically have lower rents, older homes tend to be less energy efficient and cost more to heat and to cool.

Creating targeted policies and support for fuel switching and efficiency improvements for those who are currently facing, or at risk of, energy poverty will help ensure equitable access to the benefits of healthier, safer, resilient homes that are affordable to heat.[38,39] Addressing energy poverty will require utility bill assistance programs to backstop immediate needs but also long-term energy efficiency improvements to help permanently reduce energy use and lower utility bills.[40]

A large part of protecting affordability is preventing tenant displacement as it is personally and financially expensive for those living in the building. Two growing concerns among tenants are the threats of being evicted in the retrofitting process or having their rents increased above guidelines. Affordability covenants and renovation bylaws are possible methods of ensuring deep retrofits can occur without increasing living expenses. The City of Hamilton is passing a bylaw attempting to prevent "renovictions."[41] Landlords will be required to apply to the city for a licence, obtain a building permit, and provide evidence from a qualified expert that eviction is required to complete the work. If so, the landlord must then provide alternative accommodation or financial compensation between what the tenant pays in rent and the average market rent of a similar unit. Regardless of these external programs and regulations, to identify and address tenant concerns, MURB retrofits need robust tenant engagement strategies that inform design and process decisions. Best practice recommendations include allocating a tenant liaison throughout the duration of the project whose job is to facilitate communication of retrofit plans, advocate for solutions to occupant concerns, and minimize disruption, especially for sensitive or vulnerable tenants.[42]

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[38] Greenlining, *Equitable Building Electrification: A Framework for Powering Resilient Communities*, (2019), 6. https://greenlining.org/wp-content/uploads/2019/10/Greenlining_EquitableElectrification_Report_2019_WEB.pdf

[39] Ecotrust Canada, *Moving Toward Energy Security in British Columbia's Rural, Remote and Indigenous Communities,* (2020), 4. https://ecotrust.ca/wp-content/uploads/2020/03/2019-Policy-Report_EC_lowres.pdf

[40] Rachel Cluett, Jennifer Amann, and Sodavy Ou, *Building Better Energy Efficiency Programs for Low-Income Households,* (ACEEE, 2016), 8. https://www.aceee.org/sites/default/files/publications/researchreports/a1601.pdf

[41] Brian Doucet, "Hamilton council passes a bylaw to end renovictions, helping to address housing affordability," The Conversation, January 18, 2024. https://theconversation.com/hamilton-council-passes-a-bylaw-to-end-renovictions-helping-to-address-housing-affordability-220807

[42] Madi Kennedy, *Retrofitting with tenants in place* (Pembina Institute, 2020). https://www.pembina.org/reports/retrofit-tenants-case-study-2020.pdf

3.5 Smart grid-integrated

Achieving a zero-carbon building sector by 2050 relies primarily on fuel-switching the 63% of Canadian buildings still heated with natural gas or oil alongside the rapid decarbonization of the electricity grid. As heating electrification increases winter electricity demand and hotter summers increase demand for cooling, governments and utilities are necessarily pursuing new sources of low-carbon energy and developing strategies to manage seasonal and daily electricity demand peaks. Deep retrofits and other major building system renewal projects represent opportunities to transform buildings into energy hubs that contribute to electrical grid services.

Energy efficiency measures that cut heating and cooling requirements can help flatten load profiles, and deep retrofits that include on-site renewable energy generation can facilitate flexible response to demand spikes. Vehicle-to-grid-capable electric vehicles can also be integrated through smart charging infrastructure that the utility can direct to moderate the flow of electricity to and from the grid. Figure 4 illustrates how grid-integrated buildings can combine energy efficiency, on-site energy generation, energy storage, and smart controls to transform buildings into energy hubs integrated into the electricity system. Furthermore, when combined with on-site energy storage, grid-integrated on-site renewables can also help accelerate grid decarbonization and provide building-level resilience during extreme climate events that cause power outages by way of providing building-scale backup power.

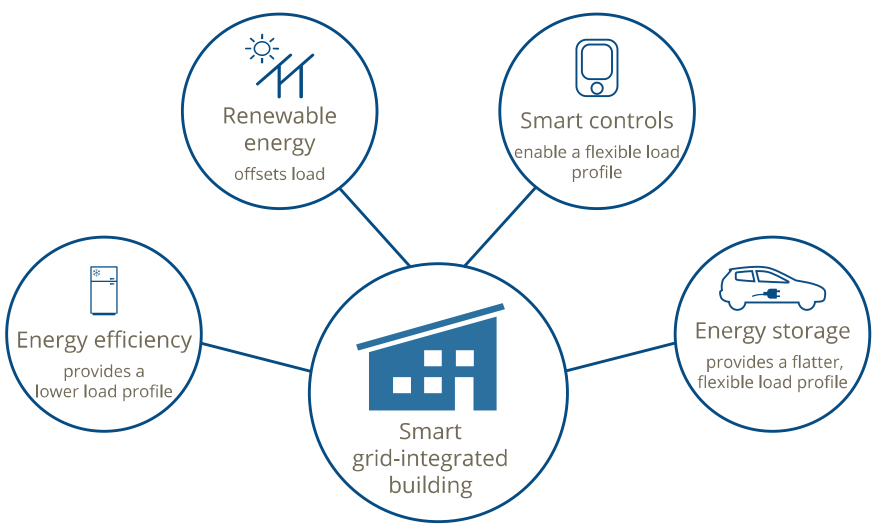

Figure 4. Features of a smart grid-integrated efficient building

Source: Adapted from RMI[43]

[43] Cara Carmichael, "Grid-Integrated Buildings: A Profitable Linchpin to Decarbonization." *RMI*, November 15, 2018. https://rmi.org/grid-integrated-buildings/

Furthermore, grid-integrated, efficient buildings with on-site renewable energy generation that helps grid operators reduce demand have been shown to cost less than increasing utility-scale production. Specifically, the American Council for an Energy-Efficient Economy (ACEEE) estimates that funding building efficiency upgrades and the integration of demand-response measures paid over five years would be a 39% lower capital investment than building new natural gas peaker plants. This does not include the avoided fuel, maintenance and energy transmission infrastructure construction costs.[44] By integrating on-site energy generation and storage, existing building retrofits can help utilities manage load, moderate electrical flow and stabilize line voltage.

Where time of use pricing is in place, grid-integrated buildings can also help lower operating costs for the building owners by decreasing and time-shifting demand to less expensive off-peak hours and, in some jurisdictions, building owners can sell electricity back to the grid to generate revenue. Failing to prioritize grid-integration as part of a new deep retrofit paradigm shift could lock home and building owners out of financially beneficial opportunities and impede capacity of the grid to support electrification of the broader economy.

[44] Steve Nadel, Christine Gerbode, and Jennifer Amann, *Energy Efficiency and Demand Response: Tools to Address Texas's Reliability Challenges* (ACEEE, 2021) https://www.aceee.org/white-paper/2021/10/energy-efficiency-and-demand-response-tools-address-texas-reliability

Recommendations

Canada's building stock is aging and reaching natural periods for renewal. Deep retrofitting a building is a once-in-a-lifetime opportunity to make these upgrades and improve the lives of people and conditions of our buildings, which is why this paradigm shift is crucial to the success of decarbonization efforts in Canada. If these values are not incorporated now, people in Canada will miss out on a remarkable opportunity — and even an essential requirement — to improve where and how we live.

Deep retrofits are the only climate policy to advance both climate mitigation and adaptation while also ensuring homes and buildings are healthy, safe, and affordable to heat and to cool. Policies, programs and regulations must be designed to recognize the relationship between homes and buildings and climate adaptation, health, safety and affordability, such as by executing government strategies such as through:

Policies and programs:
Set targets and timelines for home and building adaptation upgrades, such as a minimum number of safe temperature hours during a power outage during extreme weather events.

- Design incentive and other support programs to favour retrofit designs that address multiple objectives and capture synchronistic design strategies (e.g., a retrofit to improve seismic resilience could include increasing insulation and air-sealing to improve climate resilience).
- Create targeted policies and support for fuel switching and efficiency improvements for households currently facing, or at risk of, energy poverty to help ensure equitable access to the benefits of healthier, safer, resilient homes that are affordable to heat and cool.
- Tie affordability covenants to deep retrofit incentive programs to prevent renovictions so that deep retrofits can benefit tenants not displace them.
- Incorporate embodied carbon reporting requirements into public procurement policies, such as through Greening Government and Buy Clean policies.

Regulation:

- Phase out sale of conventional space and water heating systems through regulatory tools such as federal or provincial energy efficiency acts.
- Direct utility planning to support homes and buildings becoming low-carbon energy hubs that contribute to a reliable, resilient energy system.
- Mandate utility bill assistance programs to backstop immediate energy poverty burdens.
- Create municipal bylaws and regulatory tools that decarbonize buildings while protecting tenants against rent hikes and renovictions.

- Develop and facilitate implementation of low-embodied carbon and climate-secure building codes, including the coming alterations to existing code.

Capacity building:
Map climate risks (in addition to flood mapping underway) that communities face throughout Canada and co-develop pre-emptive strategies to enable rapid recovery from extreme weather events by provinces and regional governments.
Support industry capacity growth, training and up-skilling to implement new standards for low-carbon, climate-secure buildings and retrofits.

- Grow the construction and retrofit workforce by removing barriers and providing supports for increasing participation by equity-deserving populations.

These are once-in-a-lifetime opportunities. Traditional retrofits fall short of the requirements for climate change adaptation and mitigation and leave out considerations of health and well-being, seismic upgrades, equity and grid integration. This is why there is an urgent need for a paradigm shift in Canada's approach to building retrofits to one that emphasizes deep retrofits as a linchpin for achieving net-zero emissions and climate resilience.

The proposed paradigm shift challenges the prevailing retrofit paradigm, advocating for a more comprehensive valuation framework that considers the non-energy benefits of retrofits. By emphasizing the importance of addressing climate mitigation and adaptation, health impacts, equity considerations, and grid optimization, deep retrofits present an opportunity for a resilient, sustainable, and more equitable future.