



Passive approaches to low-energy affordable housing

An introduction to the benefits, technologies, costs and best practices

Submitted by Canada Mortgage and Housing Corporation (CMHC)

Affordable housing providers are increasingly interested in energy-efficient housing models that can achieve improved levels of building performance in support of lower cost housing and better quality living environments. For many, the rising cost of utilities can make even the lowest-cost housing unaffordable, or force them to make hard choices between utilities, groceries and other basic needs. For housing providers, high energy bills or operating and maintenance costs can significantly reduce the money they

have available for other much-needed expenses, like repairs or client services. Fortunately, in recent years, innovations and experience in more sustainable affordable housing development have made it more accessible and financially viable.

One of the most promising ways to meet both affordability and environmental goals is through a better building strategy that uses ‘passive’ approaches to design and construction to significantly reduce energy consumption, while creating a

comfortable, attractive and healthy living environment. To help affordable housing providers explore this new approach in affordable multi-unit residential buildings (MURBs), Canada Mortgage and Housing Corporation (CMHC) carried out a comprehensive literature review of existing research and projects in the field.

The goal of the review was to:

- Identify promising passive design strategies and technologies for low-energy and affordable MURBs;
- Identify real-world projects that have successfully implemented passive low-energy approaches in their design and construction; and
- Identify some of the challenges, costs and benefits associated with passive low-energy affordable homes.

What is ‘passive design?’

‘Passive design’ refers to any technologies, construction methods or other strategies that increase energy-efficiency, reduce operating costs and improve indoor environmental quality, without the need for expensive and overly complex mechanical or energy systems.

This includes relatively simple and inexpensive improvements like increasing the amount or performance of a building’s insulation, reducing thermal bridges, creating air-tight building envelopes, using high-efficiency space conditioning (heating and cooling) systems and incorporating Heat Recovery Ventilators (HRVs) to maintain comfort, provide good indoor air quality and control moisture.

Existing high-performance labels, programs and standards

There are a number of high-performance and energy-efficiency labels, programs and standards in use today, which incorporate passive low-energy design features and technologies. These include such industry-leading initiatives as:

- Leadership in Energy and Environmental Design (LEED) certification programs developed and delivered by the U.S. Green Building Council (USGBC) and Canada Green Building Council (CaGBC);
- Passive House Standard by the international Passive House Institute;

- Net-Zero Energy Home initiatives like the CHBA's Net Zero Energy Housing Labelling program, the US DOE Zero Energy Ready Home program and CMHC's Equilibrium™ Housing Demonstration Initiative; and
- Living Building Challenge by the International Living Future Institute (ILFI).

Numerous affordable housing projects across Canada and the U.S. are using these programs to achieve extremely high levels of energy performance at a minimal additional cost. Some of the examples outlined in the report included:

Passive design technologies and design practices

As the project examples show, passive low-energy design principles can be used with a wide range of construction practices, methods and materials. The 'best' choices often depend on where a project is located, the building type and design, current material prices as well

as the experience and preferences of the builder or developer.

In general, however, many of the passive, low-energy affordable housing projects tended to feature common design elements and attributes, such as:

- High-performance wall systems with high levels of blown or sprayed insulation; 38 x 89 mm (2x4-inch) or 38 x 140 mm (2x6-inch) wood-frame construction with significant exterior rigid foam insulation; or Structural insulated panels (SIPs);
- A focus on eliminating thermal bridges through the building envelope to minimize heat loss;
- Strategically-placed, high-performance triple-glazed windows with inert gas fill, thermally-broken and insulated frames, warm edge spacers, low-emissivity coatings, multiple airtight seals and external shading;
- An airtight building envelope with a minimum airtightness of 0.6 ACH50; and

- Heat Recovery or Energy Recovery Ventilators (HRVs and ERVs) to improve indoor air quality while saving energy and lowering costs.

The costs and benefits of passive design

The incremental cost of integrating passive low-energy design practices can vary considerably from one project to the next. For the projects reviewed in the study, the additional cost was found to be from 5-10% of the total cost of construction.

Affordable housing projects tended to have a slightly higher incremental cost, since they often have a lower base cost to begin with. Instead of focusing solely on incremental costs, however, the projects identified tended to look at how the costs and benefits of the affordable passive low-energy design projects compared to the cost of similar projects that don't have these features.

To offset the upfront investment, it is important to remember that passive

Project Name	Location	Building Type	Performance Target	Completed	Affordable Housing
Southeast False Creek Net Zero Building	Vancouver, BC	8-storey	Net-zero	2010	Yes
Chapelview Apartments	Brampton, ON	16-storey	LEED platinum	2010	Yes
Bedford Roadhouse	Nelson, BC	Triplex	Passive House	2013	No
North Park Passive House	Victoria, BC	6-unit multi	Passive House	2014	No
HNS Passive House Pilot Project	Truro, NS	Duplex	Passive House	2015	Yes
Vancouver Coastal Health Staff Housing	Bella Bella, BC	6-unit townhouse	Passive House	2015	No
Social Housing Duplex	Quaqtaq, Nunavik	Duplex	Passive House inspired	2015	Yes
Salus Clementine	Ottawa, ON	4-storey	Passive House	2016	Yes
Marken Design+Consulting	Vancouver, ON	10-storey	Passive House	Design	n/a
Internet Housing Society	Edmonton, AB	16-unit townhouse	Passive House	Planned	Yes
Cordage Green	Welland, ON	44-unit townhouse	Passive House	Planned	Partial
Station Point Greens	Edmonton, AB	16-storey	Passive House	Planned	No
Cornerstone Architecture	Vancouver, BC	6-storey	Passive House	Planned	No
Place of Hidden Waters	Tacoma, Washington	20-unit townhouse	LEED Platinum	2012	First Nations
zHome	Issaquah, Washington	10-unit townhouse	Net-zero	2012	Partial
Bellfield Townhomes	Philadelphia, Pennsylvania	3-unit townhouse	Passive House	2013	Yes
The Mennonite	Brooklyn, New York	24-unit, 4 storeys	Passive House	2014	Yes
Knickerbocker Commons	Brooklyn, New York	24-unit, 4 storeys	Passive House	2014	Yes
Stellar Apartments	Eugene, Oregon	6-unit, 3 storeys	Passive House	2014	Yes
Uptown Lofts	Pittsburgh, Pennsylvania	3-storey	Passive House	2015	Yes
Orchards at Orenco	Hillsboro, Oregon	57 unit, 3 storeys	Passive House	2015	Yes
Ankeny Row	Portland, Oregon	5-unit townhouse	Passive House	2015	Partial
River Market	Kansas City, Missouri	276-unit, 6 storeys	Passive House	Under construction	Yes
Cornell Student Housing	New York, New York	352-unit, 26 storeys	Passive House	Under construction	Student housing

Table 1: Canadian and U.S. construction and retrofit projects outlined in CMHC report: Passive Approaches to Low-Energy Affordable Housing.

low-energy design features can achieve significant long-term energy and operating savings throughout the entire lifecycle of a building. This includes both reduced energy consumption and lower utility bills, as well as a variety of non-energy-related benefits to affordable housing providers, such as:

- the avoidance of rate subsidies;
- lower bad-debt write-offs;
- reduced carrying costs for arrearages;
- fewer notices and customer calls;
- fewer shutoffs and reconnections due to delinquencies; and
- an increase in overall property values.

Interviews with key experts

As part of the study, a series of interviews about passive low-energy design approaches were conducted with leading affordable housing providers, experts and stakeholders from across Canada and in the U.S.

As a result of those interviews, the study was able to identify some of the main needs, challenges, benefits and trends of passive low-energy housing approaches from some of the foremost experts in the field. Their responses were then grouped into five key categories:

1. Reasons to pursue low-energy affordable housing:

- Meet the requirements imposed on affordable housing providers.
- Achieve higher levels of

performance to meet future Code requirements.

- Lower utility bills for tenants and/or affordable housing providers.
- Reduce maintenance and replacement costs.

2. Requirements to implement successful passive design measures:

- Have few or no occupant controls.
- Address the lack of trained building operators and high turnover.
- Accommodate occupants who open windows in winter.
- Be simple to design, commission and operate.

3. Tenant education initiatives Introduced after project completion:

- How to reduce overall energy consumption.
- How to operate an HRV/ERV.
- How and when to open windows for passive cooling.
- How to adjust to the slower response time of ground-source heat pumps.

4. Benefits of low-energy passive design:

- Lower utility costs.
- Better indoor air quality.
- More comfortable and quieter living environments.
- Lower tenant turnover.


5. Barriers to adoption of passive low-energy design principles:

- Lack of examples of larger passive low-energy MURBs to demonstrate lower construction costs, lower utility and O&M costs, and tenant feedback.

- Management commitment to other rating systems which may make it difficult to adopt different approaches.
- Lack of awareness of innovative technologies and practices by authorities having jurisdiction over building design approvals.
- Short turn-around time from when projects are awarded funding to when finished designs are required (approx. three months on average), which doesn't leave enough time to support new design approaches, conduct performance modelling, or try new things.
- Developers are often reluctant to build passive low-energy housing if they have limited availability of key components and need to sole-source products such as high-performance windows or HRVs.

Find out more

For more information about the benefits, features, costs and best practices of incorporating passive low-energy design principles into your next affordable housing project – including an in-depth look at the leading techniques and technologies, interviews with affordable housing providers and other stakeholders, as well as dozens of real-world case studies from across North America – download your free copy of the CMHC Research Report:

Passive Approaches to Low-energy Affordable Housing Projects – Literature Review and Annotated Bibliography at www.cmhc.ca or call 1-800-668-2642. 

Organisation	Project	Project Details
BC Housing	Numerous projects, British Columbia	LEED Gold requirement
Housing Nova Scotia	HNS Passive House pilot, Truro, NS	Passive House duplex built in 2015
City of Vancouver	SEFC Net Zero, Vancouver, BC	8-storey, 67 units, built in 2010, 68% energy savings
Centretown Citizens Ottawa Corporation	Beaver Barracks, Ottawa, ON	250-unit mid-rise, 2012, GSHP + energy efficiency
County of Dufferin	40 Lawrence Avenue, Orangeville, ON	30-unit, 3 storeys, GSHP + ICF construction
Wood Buffalo Housing & Development Corp.	Stony Mountain Plaza, Fort McMurray, AB	125 units, 4 storeys, prefab, GSHP + energy efficiency
Ottawa Community Immigrant Services Organisation	140 Den Haag, Ottawa, ON	64 units, 8 storeys, LEED Silver, R-38 walls
Stellar Apartments, St. Vincent de Paul Society	Stellar Apartments, Eugene, Oregon	6-unit, 3-storey Passive House
Onion Flats Architecture	Belfield Townhomes, Philadelphia, PA	3-unit Passive House townhouse
Habitat for Humanity Canada	Various projects in Canada	Requirements vary by project

Table 2: Stakeholders interviewed by CMHC about Passive Low-energy Housing.