HOUSING OBSERVER 2017
Passive Approaches to Low-Energy Affordable Housing

Credit: Karen’s Place - CSV Architects and Gordon King Photography

ARTICLE 2—OCTOBER 2017
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1. Passive approaches to low-energy affordable housing

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

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-residential buildings, 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 multi-residential buildings;
- 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.

2. 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 airtight 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.
3. 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 United States 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 Canadian Home Builders’ Association’s Net Zero Energy Housing Labelling Program, the U.S. Department of Energy’s Zero Energy Ready Home program and CMHC’s EQuilibrium™ Housing Demonstration Initiative; and
- **Living Building Challenge** by the International Living Future Institute (ILFI).

![Figure 1 The Heights – Vancouver, B.C.](image)

Credit: Image courtesy of Cornerstone Architecture
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 the following:

**Figure 2** Canadian and U.S. construction and retrofit projects outlined in CMHC report: Passive Approaches to Low-Energy Affordable Housing

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Location</th>
<th>Building Type</th>
<th>Performance Target</th>
<th>Completed</th>
<th>Affordable Housing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southeast False Creek Net Zero Building</td>
<td>Vancouver, BC</td>
<td>8-storey</td>
<td>Net-zero</td>
<td>2010</td>
<td>Yes</td>
</tr>
<tr>
<td>Chapelview Apartments</td>
<td>Brampton, ON</td>
<td>16-storey</td>
<td>LEED platinum</td>
<td>2010</td>
<td>Yes</td>
</tr>
<tr>
<td>Bedford Roadhouse</td>
<td>Nelson, BC</td>
<td>Triplex</td>
<td>Passive House</td>
<td>2013</td>
<td>No</td>
</tr>
<tr>
<td>North Park Passive House</td>
<td>Victoria, BC</td>
<td>6-unit multi</td>
<td>Passive House</td>
<td>2014</td>
<td>No</td>
</tr>
<tr>
<td>HNS Passive House Pilot Project</td>
<td>Truro, NS</td>
<td>Duplex</td>
<td>Passive House</td>
<td>2015</td>
<td>Yes</td>
</tr>
<tr>
<td>Vancouver Coastal Health Staff Housing</td>
<td>Bella Bella, BC</td>
<td>6-unit townhouse</td>
<td>Passive House</td>
<td>2015</td>
<td>No</td>
</tr>
<tr>
<td>Social Housing Duplex</td>
<td>Quaqtaq, Nunavik</td>
<td>Duplex</td>
<td>Passive House</td>
<td>2015</td>
<td>Yes</td>
</tr>
<tr>
<td>Salus Clementine</td>
<td>Ottawa, ON</td>
<td>4-storey</td>
<td>Passive House</td>
<td>2016</td>
<td>Yes</td>
</tr>
<tr>
<td>Marken Design+Consulting</td>
<td>Vancouver, ON</td>
<td>10-storey</td>
<td>Passive House</td>
<td>Design</td>
<td>n/a</td>
</tr>
<tr>
<td>Internet Housing Society</td>
<td>Edmonton, AB</td>
<td>16-unit townhouse</td>
<td>Passive House</td>
<td>Planned</td>
<td>Yes</td>
</tr>
<tr>
<td>Cordage Green</td>
<td>Welland, ON</td>
<td>44-unit townhouse</td>
<td>Passive House</td>
<td>Planned</td>
<td>Partial</td>
</tr>
<tr>
<td>Station Point Greens</td>
<td>Edmonton, AB</td>
<td>16-storey</td>
<td>Passive House</td>
<td>Planned</td>
<td>No</td>
</tr>
<tr>
<td>Cornerstone Architecture</td>
<td>Vancouver, BC</td>
<td>6-storey</td>
<td>Passive House</td>
<td>Planned</td>
<td>No</td>
</tr>
<tr>
<td>Project Name</td>
<td>Location</td>
<td>Building Type</td>
<td>Performance Target</td>
<td>Completed</td>
<td>Affordable Housing</td>
</tr>
<tr>
<td>------------------------------</td>
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<td>--------------------</td>
</tr>
<tr>
<td>Place of Hidden Waters</td>
<td>Tacoma, Washington</td>
<td>20-unit townhouse</td>
<td>LEED Platinum</td>
<td>2012</td>
<td>First Nations</td>
</tr>
<tr>
<td>zHome</td>
<td>Issaquah, Washington</td>
<td>10-unit townhouse</td>
<td>Net-zero</td>
<td>2012</td>
<td>Partial</td>
</tr>
<tr>
<td>Bellfield Townhomes</td>
<td>Philadelphia, Pennsylvania</td>
<td>3-unit townhouse</td>
<td>Passive House</td>
<td>2013</td>
<td>Yes</td>
</tr>
<tr>
<td>The Mennonite</td>
<td>Brooklyn, New York</td>
<td>24-unit, 4-storey</td>
<td>Passive House</td>
<td>2014</td>
<td>Yes</td>
</tr>
<tr>
<td>Knickerbocker Commons</td>
<td>Brooklyn, New York</td>
<td>24-unit, 4-storey</td>
<td>Passive House</td>
<td>2014</td>
<td>Yes</td>
</tr>
<tr>
<td>Stellar Apartments</td>
<td>Eugene, Oregon</td>
<td>6-unit, 3-storey</td>
<td>Passive House</td>
<td>2014</td>
<td>Yes</td>
</tr>
<tr>
<td>Uptown Lofts</td>
<td>Pittsburgh, Pennsylvania</td>
<td>3-storey</td>
<td>Passive House</td>
<td>2015</td>
<td>Yes</td>
</tr>
<tr>
<td>Orchards at Orenco</td>
<td>Hillsboro, Oregon</td>
<td>57-unit, 3-storey</td>
<td>Passive House</td>
<td>2015</td>
<td>Yes</td>
</tr>
<tr>
<td>Ankeny Row</td>
<td>Portland, Oregon</td>
<td>5-unit townhouse</td>
<td>Passive House</td>
<td>2015</td>
<td>Partial</td>
</tr>
<tr>
<td>River Market</td>
<td>Kansas City, Missouri</td>
<td>276-unit, 6-storey</td>
<td>Passive House</td>
<td>Under construction</td>
<td>Yes</td>
</tr>
<tr>
<td>Cornell Student Housing</td>
<td>New York, New York</td>
<td>352-unit, 26-storey</td>
<td>Passive House</td>
<td>Under construction</td>
<td>Student housing</td>
</tr>
</tbody>
</table>
4. 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; 38x89-mm (2x4-inch) or 38x140-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 or ERVs) to improve indoor air quality while saving energy and lowering costs.

Figure 3  The Heights – Vancouver, B.C.

Credit: Images courtesy of Cornerstone Architecture
5. 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 between 5 to 10% of the total cost of construction.

Affordable housing projects tend 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’s important to remember that passive low-energy design features can achieve significant long-term energy and operating savings throughout the entire life cycle 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 arrears;
- fewer notices and customer calls;
- fewer shut-offs and reconnections due to delinquencies; and
- an increase in overall property values.

Figure 4  Cote Bungalow – East River, Nova Scotia
Credit: Photographs by Elemental Photography. All images courtesy of Passive Design Solutions
6. Interviews with key experts

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

Figure 5  Stakeholders interviewed by CMHC about passive low-energy housing

<table>
<thead>
<tr>
<th>Organization</th>
<th>Project</th>
<th>Project Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>BC Housing</td>
<td>Numerous projects, British Columbia</td>
<td>LEED Gold requirement</td>
</tr>
<tr>
<td>City of Vancouver</td>
<td>SEFC Net Zero, Vancouver, BC</td>
<td>67-units, 8-storey, built in 2010, 68% energy savings</td>
</tr>
<tr>
<td>Centretown Citizens Ottawa Corporation</td>
<td>Beaver Barracks, Ottawa, ON</td>
<td>250-unit mid-rise, 2012, GSHP + energy efficiency</td>
</tr>
<tr>
<td>County of Dufferin</td>
<td>40 Lawrence Avenue, Orangeville, ON</td>
<td>30-unit, 3-storey, GSHP + ICF construction</td>
</tr>
<tr>
<td>Wood Buffalo Housing and Development Corporation</td>
<td>Stony Mountain Plaza, Fort McMurray, AB</td>
<td>125-unit, 4-storey, prefab, GSHP + energy efficiency</td>
</tr>
<tr>
<td>Ottawa Community Immigrant Services Organization</td>
<td>140 Den Haag, Ottawa, ON</td>
<td>64-unit, 8-storey, LEED Silver, R-38 walls</td>
</tr>
<tr>
<td>Stellar Apartments, St. Vincent de Paul Society</td>
<td>Stellar Apartments, Eugene, Oregon</td>
<td>6-unit, 3-storey, Passive House</td>
</tr>
<tr>
<td>Onion Flats Architecture</td>
<td>Belfield Townhomes, Philadelphia, PA</td>
<td>3-unit, Passive House townhouse</td>
</tr>
<tr>
<td>Habitat for Humanity Canada</td>
<td>Various projects in Canada</td>
<td>Requirements vary by project</td>
</tr>
</tbody>
</table>
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.
   - Ensure measures are 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 multi-residential buildings to demonstrate lower construction costs, lower utility and operations and maintenance costs, and tenant feedback.
   - Management commitment to other rating systems that 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 turnaround 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.
   - Frequent reluctance of developers 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 related to 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 entitled Passive Approaches to Low-energy Affordable Housing Projects – Literature Review and Annotated Bibliography at www.cmhc.ca or call 1-800-668-2642.

Further reading

Visit www.cmhc.ca/Observer to get the latest information.

Project Manager: Sandra Baynes, Knowledge Transfer and Outreach, Canada Mortgage and Housing Corporation

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