Identification of Best Practices in Northern MURBs

INTRODUCTION

The availability of quality, affordable housing can be one of the more pressing issues facing Canadians living in the North. It can be undermined by the harsh climate, long winters, short construction season, lack of skilled tradespeople, inappropriate design, extended supply chains, remote locations, dependence on costly site-generated electricity and imported fuel oil, and high material and labour costs. Faced with these challenges, affordable housing providers across the northern regions of Canada, the United States, Greenland and Scandinavia have developed innovative approaches to better meeting the housing needs of their populations. To capitalize on the knowledge gained, lessons learned and results achieved by these prototypical demonstration projects, Canada Mortgage and Housing Corporation (CMHC) commissioned a literature search and review to compile available information on innovative northern housing projects and to share their best practices.

PROJECT OVERVIEW

This project involved a literature search and review that focused on multi-unit residential buildings (MURBs) that have been designed to significantly exceed local building code requirements in northern climates primarily above 60°N latitude. A variety of literature was examined for best practices and examples of high-performing buildings as documented in research journal articles, publications from government organizations and energy efficiency agencies, as well as available information from building developers, owners and architects. Typical dwelling types examined include multi-story MURBs, low-rise apartment complexes and semi-detached duplex houses. Both new construction and retrofit examples were documented.

Figure 1: Four-unit townhouse in Kuujjuaq (Nunavik, Quebec)

Source: EVOQ Architecture

KEY FINDINGS

The literature review found many strategies, technologies and practices employed by northern housing providers to significantly reduce energy consumption while addressing a range of other priorities, including healthy indoor environments, cutting greenhouse gas emissions, reducing dependence on site-generated electricity, increasing resiliency, and affordability. Key features and the projects that included them are profiled below.

Passive solar design elements

- **Orientation:** Positioning of the building to maximize winter solar heat gains. The Plateau subdivision of Iqaluit set the goal of orienting 70% of windows in a southern direction, an effort that was estimated to reduce energy costs by 1% at no incremental increase in construction costs.
- **Window sizing and placement:** Minimizing the sizing and quantity of windows in northern elevations. All of the seven units in the Storelva passive house in Tromsø, Norway, have almost windowless facades to the north, with the exception of a narrow window running down the entire facade to allow more daylight in and to minimize heat loss.
- **Shading:** Optimization of shading devices, such as eave overhangs or external shading devices, to permit low winter sun to enter the building and keep high summer sun out. The roof overhang and balconies of the Lindås passive house in Gothenburg, Sweden, prevent the rooms from overheating during the summer period, but do not reduce the incident radiation during the winter, when the sun is lower.

Well-insulated, airtight building envelope

- Typical U-values ranged between 0.09 W/m^{2}K (R63) and 0.22 W/m^{2}K (R26) for floors, 0.07 W/m^{2}K (R81) and 0.14 W/m^{2}K (R41) for roofs, 0.08 W/m^{2}K (R71) and 0.20 W/m^{2}K (R28) for external walls, and, 0.7 W/m^{2}K (R8) and 1.4 W/m^{2}K (R4) for windows.
- Efforts to minimize air leakage were apparent in many of the identified buildings; the Oxtorget passive house in Värnamo, Sweden, met its target of 0.2 l/s/m^2 at a pressure of 50 Pa based on measurements, and the Nunavik Pilot House in Nunavik, Quebec, was designed to meet an airtightness requirement of less than 0.6 air changes per hour (ACH) at 50 Pa.

- Minimizing the occurrence of thermal bridges was emphasized; examples include the replacement of concrete slabs with steel-frame balconies, thermal breaks for cladding attachments, and minimizing envelope penetrations.
- High-performance glazing is typically specified, such as triple-pane glazing with inert gas fill and low emissivity coatings, insulating spacer and insulated fiber glass frames.

Energy-efficient building service systems (mechanical, electrical and lighting)

- Heat recovery ventilators: a heat recovery effectiveness of at least 75% was noted, with several projects being designed for heat recovery in the range of 85% to 90%.
- With the exception of one project, all of the MURBs reviewed used a hydronic system for space heating, with the majority consisting of baseboard and localized convectors as opposed to central forced-air heating. Additionally, 23% also included underfloor radiant heating.
- Four projects in Northern Europe utilized air-source or ground-source heat pumps for heating, which can be more energy-efficient than electric baseboard heaters and fuel-fired boilers.
- Water-efficient showerheads, dishwashers and washing machines were commonly used to reduce domestic hot water loads by 30–70%.
- White or light-colored reflective interior walls reduce the demand for artificial lighting; this practice was applied in the Løvåshagen co-operative housing project in Bergen, Norway.
- Energy-efficient electric appliances (such as those that are ENERGY STAR®-rated) consume 20% to 40% less energy than standard models and were included in many of the identified low-energy MURBs.

Renewable energy systems

- 53% of the MURBs studied utilized solar thermal collectors to generate hot water for domestic uses as well as space heating. They were often supplemented with electric heaters, oil furnaces or wood-fired heaters during the winter months. 13% of the projects implemented photovoltaic (PV) arrays.
- A strategy to compensate for low solar availability in the North was included in the design of the Storelva passive house in Tromsø, Norway. The units have thermal collectors in the ground, for pre-heating/cooling of ventilation air, combined with a backup air-to-water heat pump for heating during winter.
- A combined heat and power (CHP) system powered from biofuels simultaneously generates electricity and hot water in the Schiestlhaus high-altitude refuge in Hochschwab, Austria.

Community engagement

For several of the identified projects, future occupants were engaged and consulted during the design process through community consultations and design charrettes. In the case of the Northern Sustainable House located in Dawson City, Yukon, the community engagement highlighted several issues that needed to be addressed with the existing plans. This included the possibility of using alternative materials, improved mechanical heating and ventilation, the need for more storage space, shading and windbreaks, and consideration of changing family sizes, evolving family dynamics, and affordability.

Cost and energy-performance metrics

In the case of the Klosterenga Ecological Housing project in Oslo, Norway, the project cost was approximately 15% to 20% higher than a reference building at a nearby site, with payback for individual components ranging between 15 and 20 years. The cost of the Oxtorget passive house in Värnamo, Sweden, was 19% higher than that of a reference building. The incremental cost associated with the energy efficiency measures implemented in the Oxtorget passive house was about $440/m^2, which was 16% of the total project costs. This is also in line with the Zero Energy House in Järvenpää, Finland, which indicated a 15% cost premium. In terms of operating costs, the projects typically resulted in a 30% to 60% reduction in annualized energy usage and, therefore, similar levels of energy cost reductions can be expected. Overall, the combination of various energy efficiency measures in the identified MURBs result in total energy use intensity that is between 54% and 89% below the baseline level.

IMPLICATIONS FOR THE HOUSING INDUSTRY

The documented examples of housing projects illustrate various strategies that northern housing providers have used to achieve low-energy, healthy, culturally appropriate multi-unit residential buildings in harsh northern climates. The technologies and practices implemented can yield significant energy cost savings, resulting in more affordable housing, while providing more comfortable and healthier living environments. While the higher-performance buildings reviewed tended to have greater upfront capital costs, multiple benefits were also noted that should be taken into account during the planning and design stages. Further research on the lifecycle costs and benefits of innovative northern housing is necessary to support the development of a more complete understanding of the economic and non-financial merits of higher-performing housing to inform decision-making processes. Detailed case studies of successful Canadian projects can shed further light on best practices and lessons learned within the local context.

FURTHER READING

Full report – *Identification of Best Practices in Northern MURBs* (https://eppdscrmssa01.blob.core.windows.net/cmhcprodcontainer/sf/project/archive/research_2/identification_of_best_practices_northern-murbs.pdf)

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