Multi-unit Residential Buildings in BC

A Vision for Energy Efficiency

Andrew Pape-Salmon PEng MRM
Jordan Fisher LEED AP
Warren Knowles PEng BEP
Jennifer Sanguinetti PEng LEED AP

Top left: High performance fibreglass windows.

Above: Renovations to the Greenbrook housing site saw a 45% decrease in actual measured energy consumption below 2005 values.

Introduction

In a time of unprecedented financial pressures for families in British Columbia, the engineering community has an opportunity to facilitate significant utility bill savings through building energy efficiency upgrades. Furthermore, these measures can improve comfort, reduce greenhouse gas emissions and lower building maintenance costs, and are also synergistic with long-term capital asset renewal.

A 40% reduction in energy demand is achievable for many of the over 12,000 existing multi-unit residential buildings (MURBs) across the province. Over the life of every building, owners are required to periodically make decisions and take action, to maintain and renew the various components of their buildings. Ideally, energy efficiency upgrades of existing MURBs can be coupled with these normal renewal projects where components have reached the end of their service life, and require replacement in order to maintain the building value. These projects could include improvements to the building enclosure (roofs, walls, windows, etc), heating, ventilation and cooling systems, domestic water heating and lighting. Water efficiency measures can also provide energy savings to local government infrastructure.

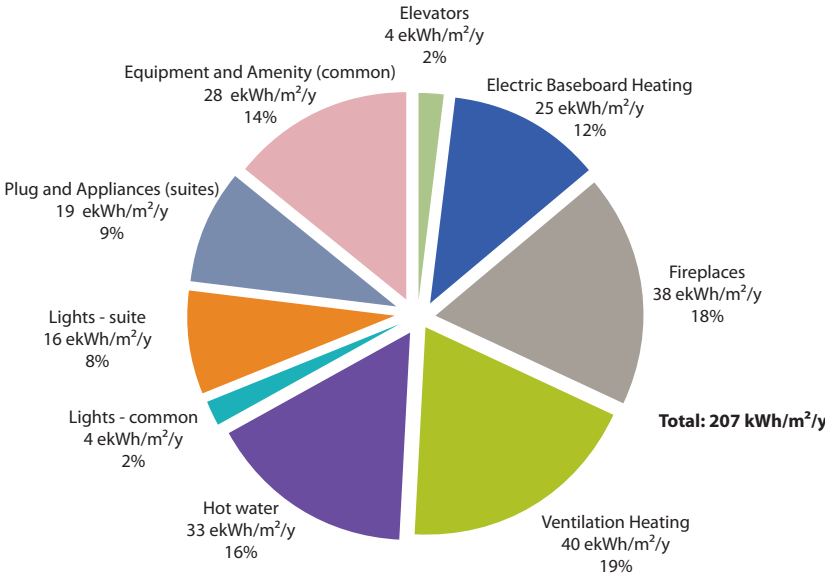
This article provides an overview of energy efficiency opportunities for existing MURBs, a review of market mechanisms and government measures to support an ambitious vision of a 40% reduction in energy demand across the sector and a description of a case study where such measures have been undertaken.

The Case for Energy Efficiency

The MURBs sector represents about 31% of BC's housing stock of about 1.8 million households. A BC Hydro study published in 2011 ("BC Hydro Apartments Report") illustrated that 63% of 384,000 MURBs surveyed were "low-rise," the remaining being "high-rise" over 4 stories, and that 64% of all MURBs have electric space heating in the units. Compared to 1996 consumption data, the high-rise, electrically heated buildings used 22% more electricity in 2010, and the low-rise buildings used 4% less electricity.

This is consistent with the RDH study ("Energy Consumption and Conservation in Mid- and High-Rise Residential Buildings in British Columbia," 2011) that found the total natural gas and electricity consumption of MURBs in BC varies between 144 and 299 ekWh/m^2/y, with an average consumption of 213 ekWh/m^2/y among 39 study buildings. The

Fig. 1.1 Distribution of annual energy consumption in the simulated typical MURB developed. Units shown in ekWh/m²/y and percentage of total.



study found that modern buildings (constructed from the 1990s to present) typically consumed more than those constructed in the 1970s and 1980s. Thirteen of the study buildings were examined in detail in order to develop a calibrated model of a typical high-rise MURB. Figure 1.1 presents the energy distribution for a typical MURB, based on this model.

Potential energy-efficiency measures that could be coupled with building renewals work were identified using the calibrated model, including:

- Exterior wall insulation improvement
- Window replacement
- Building enclosure air tightness improvement
- Hallway make-up air temperature reduction (16°C)
- Heat recovery on ventilation
- Fireplace removal or conversion to high efficiency appliances.

Based on the above energy efficiency measures, significant reductions in space-conditioning loads could be realized. For example, annual heating energy could potentially be reduced from over 100 ekWh/m²/y to less than 10 ekWh/m²/y, as illustrated in Figure 1.2 .

In all cases, the impacts of these energy efficiency improvements onto the other building functions and systems must be considered. For example, improvements to wall and window assemblies will reduce the amount of air infiltration and exfiltration through the building; therefore, upgrades to (or replacement of) the ventilation equipment should also be considered.

The opportunities for reduced energy consumption translate to financial reductions of:

- Electricity costs, for individual and common spaces
- Natural gas and other fuel costs
- Revenue-neutral carbon tax on natural gas and other fuel bills
- Offset charges for provincial public sector buildings (eg, BC Housing), and, after 2012, offset prices for buildings of local governments that have signed the Climate Action Charter.

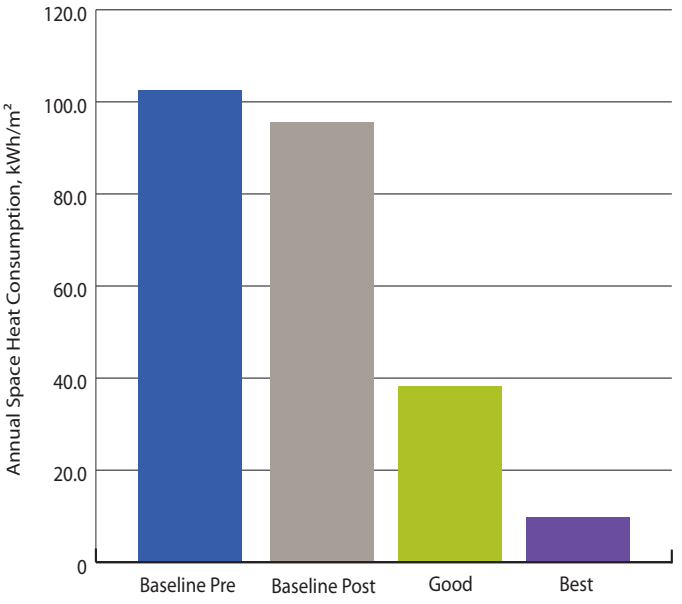
Legislated targets and incentive programs designed to prioritize carbon emission reductions and increase efficiency can provide additional financial benefits. When combined with the carbon tax and likely maintenance savings associated with retrofits of aging equipment, the financial justification for deeper energy retrofits is significant.

Benefits beyond those directly associated with reduced energy costs or addressing envelope issues (eg, moisture ingress) can include:

- Improved occupant thermal comfort
- Reduced infiltration of street noise
- Improved indoor air quality
- Lower maintenance costs
- Potential for better insurance rates following upgrades.

These non-energy benefits can strengthen the business case for building retrofits.

Fig. 1.2 Potential energy saving opportunities in typical MURB.



Market Mechanisms and Government Policies

In British Columbia there are a number of initiatives that create an opportunity for accelerated market uptake of energy efficiency measures.

An important new measure to promote building renewal in MURBS is legislated mandatory depreciation reports. They are a planning tool used by strata corporations to clearly understand what the strata is responsible to renew as part of their building system (ie, generate a physical component inventory), the age of the building system, its projected life expectancy, when it should be planned for renewal, what it will cost when renewal is required, and how the strata will pay for it. This planning tool can also be used to identify ideal opportunities to incorporate energy efficiency measures as part of the normal maintenance and renewals program.

BC's three major energy utilities invested $211 million in energy efficiency measures for the residential, commercial and industrial sectors in 2011. For example, BC Hydro's Power Smart program offers a number of product incentives and information available to strata corporations and residential homeowners. FortisBC Energy gas programs applicable to MURBs include the energy assessment, commercial boiler, and water heater programs (all for common spaces). Additional natural gas efficiency rebates (eg, EnerChoice® gas fireplaces, clothes washers, ENERGY STAR® water heaters) are available for individually metered units. The government's demand-side regulation defines how such programs are evaluated for cost-effectiveness.

Government regulations can have a significant impact on energy savings and affordability of homes. For example, in 2008, the BC Building Code set energy and water efficiency standards for new buildings and major renovation projects, including a reference to the ASHRAE 90.1–2004 energy standard, relevant for mid- and high-rise MURBs. Furthermore, the *Energy Efficiency Act* standards for glazing assemblies apply to installations in new and existing buildings (see the Homeowner Protection Office publication: "Fenestration Energy Performance: A Roadmap for Understanding Requirements for Residential Buildings in British Columbia," 2011).

While many energy efficiency opportunities have a good business case and can receive utility incentives, building owners may not implement them due to complications and time constraints. For incentives, owners must undertake technical assessments of their buildings, secure funding and financing, weigh the business case against other priorities, procure the relevant products and services, coordinate implementation and verify performance. As a result, they frequently pursue only one or a few simple measures.

One solution is through turnkey programs that assist building owners in managing the retrofit process. The program provides a project manager who gives building owners support and a credible perspective on the technical, financial, and practical aspects of implementing a building retrofit. While incentives may address a financial barrier for an individual retrofit, the existence of turnkey programs can be the difference between whether a retrofit is undertaken or not. A pilot MURB turnkey program is underway in the City of Vancouver targeting retrofits that could save between

15–40% of energy use and offering low-interest financing, aligned with utility bill savings. Upgrades to MURBs can be more challenging to coordinate than investor-owned commercial buildings or privately owned homes because of the combination of private and common spaces. The turnkey program manager is therefore a valuable contributor to the project.

Providing consistent energy performance measurement is another key issue. As a building's energy and water consumption represent significant ongoing costs, building energy labels (such as those available for appliances like refrigerators) have the potential to provide valuable information to current or prospective building owners and tenants. Natural Resources Canada (NRCan) is currently working on the development of an energy benchmarking system for commercial and institutional buildings, however, a program has not yet been developed for MURBs.

Challenges with labelling and benchmarking MURBs are as follows:

- Some MURBs include multiple buildings and commercial space
- Benchmarking must account for amenity spaces and parking garages
- Unit-level metering of thermal energy (eg, shared hot water) or natural gas (eg, for gas fireplaces) requires certification by independent standards organizations
- Without sub-metering, occupants have less incentive to reduce consumption, despite paying for the costs through strata fees.

An energy labelling pilot project for the MURB sector is currently being undertaken in BC to explore the process of energy labelling and identify challenges and potential solutions. Future work may include a benchmarking component where performance is compared against a statistically significant data set of similar buildings, normalized for differences in outdoor climate and building occupancy.

Insulation upgrade to the Belmont Building in Vancouver.

Case Study – BC Housing

BC Housing has undertaken significant capital renewal projects on a number of buildings with a focus on prolonging the life of these public assets, increasing the energy efficiency, decreasing the operating costs and liabilities and improving the comfort of the residents. An example is Greenbrook, a public housing site in Surrey, BC that is owned and operated by BC Housing.

Before renovation, residents were experiencing high heating bills not conducive to their low income. There were also some health concerns related to poor humidity control and inadequate air flow.

The renewal project included features such as:

- Installing high-efficiency, air source heat pumps and heat recovery ventilation systems
- Replacing the building envelope
- Upgrading the lighting to more efficient fixtures
- Providing new interior finishes to improve indoor air quality
- Upgrading water fixtures to low-flow models
- Installing photovoltaic solar modules to provide an alternative source of electricity under a net metering agreement with BC Hydro
- Sustainability education sessions communicating how to use new equipment correctly and how behaviour can impact energy bills.

The much-needed renovations at Greenbrook reduced the site's energy costs and provided a public asset that is more energy efficient, healthier and aesthetically pleasing. In 2011 the actual measured energy consumption decreased by 45% (92.1 ekWh/m^2) below 2005 values (167.2 ekWh/m^2) and greenhouse gas emissions were reduced by 90%. The changes at the site also created opportunities for new partnerships and a better understanding of the need for more sustainability education.

Conclusions

Multi-unit residential buildings (MURBs) represent a large proportion of the province's housing stock and a potential for significant energy efficiency improvements. A targeted 40% reduction in demand can be achieved through a combination of building envelope upgrades, replacement and tuning of mechanical systems and lighting. This target is easier to achieve when efficiency is coupled with building renewal projects where components have reached the end of their service life, and require replacement in order to keep-up the asset. Energy savings can be enhanced by occupant education efforts, as evidenced by the Greenbrook project in Surrey where energy consumption decreased by 45%. While the benefits are large, a number of barriers prevent strata corporations and individual homeowners from implementing energy efficiency as part of building renewal. A pilot turnkey energy efficiency program is underway in Vancouver to address a number of barriers, including a financing program that is aligned with energy bill savings. Furthermore, a number of other market mechanisms including strata corporation depreciation reports and government policies, such as fenestration efficiency standards, are helping to advance building renewals that improve energy efficiency.

Acknowledgements and Note

The authors would like to acknowledge the input of Brittany Hanam and review of the article by Susan Hayes, both with RDH Building Engineering. In addition, several BC Hydro and FortisBC personnel provided data and input. ⊠

Andrew Pape-Salmon PEng MRM is Director of Energy Efficiency with the Electricity and Alternative Energy Division in the Ministry of Energy and Mines. Jordan Fisher LEED AP is the program director for FRESCo Building Efficiency.Warren Knowles PEng BEP is a Principal and Senior Building Science Specialist with RDH Building Engineering in Vancouver. Jennifer Sanguinetti PEng LEED AP is Director, Smart Buildings and Energy Management with BC Housing.

This article will be presented at the APEGBC Annual Conference session "Multi-unit Residential Buildings in BC – A Vision for Energy Efficiency" in October and a longer paper will be distributed as a handout.