ACHIEVING HIGH-PERFORMANCE MULTI-UNIT RESIDENTIAL BUILDINGS: THE OPPORTUNITIES

OVERVIEW

CHALLENGES OF MURB PERFORMANCE
Energy intensity of multi-unit residential buildings (MURBs) has been marginally increasing since the 1970s, despite an increased awareness of and attention to energy efficiency.

AVERAGE ENERGY INTENSITY (ekWh/m²)

DATE OF CONSTRUCTION


MURB UNITS ARE LESS ENERGY EFFICIENT THAN SINGLE-DETACHED HOUSES.

It is a common misconception that multi-unit residential buildings are necessarily more energy efficient than single-detached homes.

ENERGY CONSUMPTION BY DWELLING TYPE

SINGLE-DETACHED HOUSE 258
DOUBLE ROW HOUSE 203
MULTI-UNIT RESIDENTIAL BUILDING 292
BEST-IN-CLASS MURB 120

KEY FACTORS:
• Building envelope
• Mechanical systems
• Controllability and accountability of the systems by the building operator and occupants
• Lighting
• Plug loads
• Water consumption
This series of infographics will highlight the opportunities in achieving high performance in multi-unit residential buildings (MURBs) under key performance categories.

**THEME 1: SPACE AND WATER HEATING**
Space and water heating typically accounts for 80% of all energy consumed.

**THEME 2: VENTILATION AND AIR QUALITY**
Type of ventilation system, air leakage patterns and the occupants’ use of their windows and doors all impact the quality of air getting into the suites.

**THEME 3: BUILDING ENVELOPE**
Despite advances in building envelope materials and systems, the benefits of these assemblies are often negated by thermal bridges and increased window-to-wall ratio.

**THEME 4: MEASUREMENT, CONTROL AND ACCOUNTABILITY**
Individual suites and occupant behaviour can affect energy and water consumption in MURBs so there is a large opportunity for savings.

**THEME 5: LIGHTING AND PLUG LOADS**
Lighting, plug loads and appliances represent approximately 18% of the total energy end use for a typical MURB.

**THEME 6: WATER CONSUMPTION**
On average, Canadians use an average of 251L of freshwater per capita per day, which is the fourth highest average consumption globally.
**THEME 1: SPACE HEATING AND WATER HEATING**

Space and water heating consume 80% of the overall energy consumed.

- **OVERALL ENERGY SAVINGS**
  - 13% can be achieved with **HEAT RECOVERY VENTILATION SYSTEMS.**
  - The heat recovery system also improves the indoor air quality while achieving energy savings.

- **INCREASE IN TOTAL SPACE HEATING**
  - 48% increase in total space heating in suites with decorative gas fireplaces.

- **80% OF THE OVERALL ENERGY IS USED FOR SPACE AND WATER HEATING.**

**EXPLORE OTHER THEMES:**

- **OVERVIEW**
- **1 SPACE HEATING AND WATER HEATING**
- **2 VENTILATION AND AIR QUALITY**
- **3 BUILDING ENVELOPE**
- **4 MEASUREMENT, CONTROL AND ACCOUNTABILITY**
- **5 LIGHTING AND PLUG LOADS**
- **6 WATER CONSUMPTION**

**ENERGY SAVINGS**

- 21% can be achieved with **HIGH-EFFICIENCY CONDENSING BOILERS**
  - Using a high-efficiency condensing boiler (93% efficient) rather than a standard efficiency boiler (80% efficient) can reduce space heating energy consumption by 21%.

**ANNUAL SPACE HEAT CONSUMPTION (kWh/m²):**

- **SUITES WITHOUT FIREPLACES**
  - **29.1**
  - **39.9**

- **SUITES WITH FIREPLACES**
  - **25.1**
  - **39.9**

**SPACE HEATING**

- **GAS FIREPLACE**
  - **37.5**

- **SUITE ELECTRIC SPACE**
  - **25.1**

- **MAKEUP AIR UNIT GAS**
  - **29.1**

**CANADA MORTGAGE AND HOUSING CORPORATION**
THEME 1: SPACE HEATING AND WATER HEATING (CONT.)

Space and water heating consume 80% of the overall energy consumed.

IN THE INDIVIDUAL SUITES

11% ELECTRICAL SAVINGS IN SPACE COOLING DURING THE SUMMER when the thermostat setpoint is increased by 3°C during the day.

6.5% SAVINGS IN SPACE HEATING DURING THE WINTER when the thermostat setpoint is decreased by 4°C overnight.

Simple actions by the occupant, such as ADJUSTING THE THERMOSTAT, have an impact on the energy consumption.

IN THE CORRIDORS

9% SAVINGS IN SPACE HEATING WHEN THE THERMOSTAT SETPOINT IS DECREASED BY 5°C.

Simple actions by the building operator, such as ADJUSTING THE THERMOSTAT from 21°C to 16°C, have an impact on the energy consumption.

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THEME 2: VENTILATION AND AIR QUALITY

The type of ventilation system, air leakage and occupant actions all impact the quality of fresh air getting into the suites.

Windows, air leakage and ventilation make up the three biggest energy loss categories: 75% combined.

Fresh air is not equal across the floors. Fresh air provided by corridor ventilation mechanical systems often does not make its way into the suites as a result of stack and wind effect and air leakage.

On average, MURBs have been found to be more leaky than the values set by ASHRAE fundamentals.

<table>
<thead>
<tr>
<th>LEAKY PER ASHRAE FUNDAMENTALS</th>
<th>AVERAGE</th>
<th>TIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.0</td>
<td>1.5</td>
<td>0.5</td>
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Measured (mean) MURB 3.66 L/s-m² at 75 Pa

Compartmentalization aims to provide controlled ventilation rates in all suites by a combination of airtight suites, corridors, etc., resistance to stack and wind effects, and independent ventilation provided directly to each suite via in-suite heat recovery ventilators. It also provides additional benefits to:

- Moisture control;
- Odour control;
- Fresh air control;
- Pressure control;
- Sound/Acoustical control;
- Fire/Smoke control; and
- Heat loss and comfort.

Explore other themes:

- Overview
- 1. Space heating and water heating
- 2. Ventilation and air quality
- 3. Building envelope
- 4. Measurement, control and accountability
- 5. Lighting and plug loads
- 6. Water consumption

Fresh air provided by corridor ventilation mechanical systems often does not make its way into the suites as a result of stack and wind effect and air leakage.

Fresh air is not equal across the floors.

| SUITE 1203 | 57 |
| SUITE 1103 | 91 |
| SUITE 1102 | 73 |
| SUITE 1101 | 27 |
| SUITE 1003 | 40 |
| SUITE 402  | 23 |
| SUITE 303  | 12 |
| SUITE 302  | 5  |
| SUITE 301  | 13 |
| SUITE 202  | 5  |

Total airflow from all sources into each of the measured suites (L/s):

| SUITE 1203 | 57 |
| SUITE 1103 | 91 |
| SUITE 1102 | 73 |
| SUITE 1101 | 27 |
| SUITE 1003 | 40 |
| SUITE 402  | 23 |
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| SUITE 202  | 5  |

40 L/s ASHRAE 62.1-2010

Upper suites are overventilated.

Lower suites are under-ventilated.
THEME 3: BUILDING ENVELOPE

Despite advances in building envelope materials and systems, the benefits of these assemblies are often negated by thermal bridges and increased window-to-wall ratio.

40% is the optimal window-to-wall ratio as recommended by recent building codes. Placement of this available glazing is also important, as upward of 80% of the annual available interior daylighting can still be achieved with this fenestration ratio.

Depending on the assembly, thermal bridges reduce the thermal performance of the overall envelope by as much as 70%.

The window-to-wall ratio is increasing in the current design trend.

THE WINDOW-TO-WALL RATIO DRAMATICALLY INFLUENCES THE THERMAL PERFORMANCE OF THE OVERALL ENCLOSURE. The higher the window-to-wall ratio is, the lower the effective overall wall R-value becomes.

R-22 vs. R-15.4 vs. R-5.5

The nominal (design) performance of a sample brick veneer wall.

30% Reduction
The effective (true) performance when the conductive loss of the veneer wall is taken into account.

70% Reduction
The effective (true) performance when the conductive losses of the entire building are taken into account.

The effective overall wall R-value, when the conductive losses of the entire building are taken into account.

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THEME 4: MEASUREMENT, CONTROL AND ACCOUNTABILITY

Individual suites and occupant behaviour can affect energy and water consumption in MURBs so there is a large opportunity for savings.

**+12% MORE ELECTRICITY**

**+15% MORE WATER**

**CONSUMPTION INCREASES WHEN UNITS ARE NOT SUB-METERED AND BILLED INDIVIDUALLY.**

Sub-metering provides feedback on energy and water consumption to occupants, which can alter their habits and ultimately reduce energy and water end use.

**30% ELECTRICAL HEATING ENERGY SAVINGS**

can be achieved with

**HEATING MANAGEMENT SYSTEMS,** which adjust the available heat output from boiler systems based on:
- exterior temperature;
- floor level; and
- suite orientation.

This can reduce electricity consumption for space heating while still maintaining a comfortable indoor space temperature.

**YOU CAN'T IMPROVE WHAT YOU DON'T MEASURE.**

**REAL-TIME METERING** of building equipment and consumption allows building operators and residents to identify when equipment isn't operating properly.

**+2°C WARMER**

On average, occupants living in the bulk metered apartments keep their units about 2°C warmer than occupants living in units where they pay for the heat they use.
THEME 5: LIGHTING AND PLUG LOADS

Lighting, plug loads and appliances represent approximately 18% of the total energy end use for a typical MURB.

50% input power savings with LED

LED (light emitting diode) technology can reduce the input power without compromising lighting levels in the space.

80% input power savings with LED + sensors

Occupancy sensor placement can further save electricity in common areas by approximately 30% by shutting off non-essential lighting when not in use.

9-25% ELECTRICITY SAVINGS

can be achieved with ENERGY-EFFICIENT IN-SUITE APPLIANCES rather than standard appliances.

2% OF OVERALL ENERGY CONSUMPTION

The size of a household’s ‘phantom load’ will depend on the number of electronic devices and their design but can account for up to 2% of overall energy consumption for MURBs.

In North America, the average home has 25 OR MORE PRODUCTS THAT CONSUME ELECTRICITY 24 HOURS A DAY.

CONSIDER UNPLUGGING PRODUCTS WHEN NOT IN USE OR PLUGGING THESE ITEMS INTO A TIMED POWER SWITCH.

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**THEME 6: WATER CONSUMPTION**

On average, Canadians use an average of 251L of freshwater per capita per day, which is the fourth highest average consumption globally.

**FOURTH HIGHEST AVERAGE CONSUMPTION GLOBALLY**

These high water demands put a strain on both upstream and downstream facilities, including municipal water supply, wastewater and stormwater infrastructure.

**CANADIAN AVERAGE USE OF FRESHWATER PER CAPITA PER DAY**

251L

**17% of a MURB’s annual utility costs**

**WATER SAVINGS**

were achieved with

A PLUMBING RETROFIT of low-flow toilets and shower heads, which was recently conducted by Ottawa Community Housing across its portfolio. Indoor water consumption can be reduced in multi-unit residential buildings through the use of low-flow plumbing fixtures for faucets, water closets and shower heads.

**EXPLORING OTHER THEMES: OVERVIEW**

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**RECOMMENDED FLOW AND FLUSH RATES FOR**

- **SHOWER HEAD**
  - 5.7 L/min
- **TOILET**
  - 3.8 L/flush
- **LAVATORY FAUCET**
  - 3.8 L/min
- **KITCHEN FAUCET**
  - 5.7 L/min

Building and site design can also REDUCE IMPACT ON DOWNSTREAM STORMWATER FACILITIES by reducing the extent of impermeable surfaces on site through:

- **GREEN ROOFS**;
- **AT-GRADE VEGETATION**; and
- **PERMEABLE PAVEMENT**.

Low-impact development maximizes the amount of water infiltrated on site to reduce stormwater runoff.

Native and adaptive planting species also reduce the amount of water required for irrigation while providing vegetation that is suitable to the microclimate.
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Energy Consumption Trends of Multi-Unit Residential Buildings in the City of Toronto, University of Toronto

Energy Benchmarking and Energy Saving Assessment in High-Rise MURB, Yirong Huang, Ryerson University, 2012

THEME 1

Energy Consumption and Conservation in Mid- and High-Rise Residential Buildings in British Columbia, RDH

Energy Benchmarking and Energy Saving Assessment in High-Rise Multi-Unit Residential Buildings, Yirong Huang, Ryerson University – NRCan data


Condensing Boilers Evaluation, National Renewable Energy Laboratory, p. 47

Energy Consumption and Conservation in Mid- and High-Rise Residential Buildings in British Columbia, RDH, p. 190

“Effects of Thermostat Setting on Energy Consumption,” CMHC Research Highlight, 2005

Controlling the Temperature in Canadian Homes, Statistics Canada, 2008
http://www.statcan.gc.ca/pub/16-001-m/2008006/5212652-eng.htm

Energy Consumption and Conservation in Mid- and High-Rise Residential Buildings in British Columbia, RDH, p. 111-112

THEME 2


WSP/MMM database, ASHRAE Fundamentals

Air Leakage Control in Multi-Unit Residential Buildings: Development of Testing and Measurement Strategies to Quantify Air Leakage in MURBs, CMHC/RDH, 2013

WSP/MMM database

THEME 3

“Integrated Thermal and Daylighting Analysis for Design of Office Buildings,” ASHRAE Transactions, 2005

High Performance Enclosures, John Straube, 2012

WSP/MMM project database

THEME 4

Energy Benchmarking and Energy Saving Assessment in High-Rise MURB, Yirong Huang, Ryerson University, 2012

WSP/MMM project database

“On the Behavioral Effects of Residential Electricity Submetering in a Heating Season,” Building and Environment, November 2014


THEME 5

WSP/MMM project database

https://www.energystar.gov/products/appliances/clothes-washers

“Electrical Energy Efficiency and Phantom Load Reduction Strategies,” EQuilibrium™ Housing InSight, 2014

THEME 6

Residential Water Use in Canada
https://www.ec.gc.ca/indicateurs-indicators/default.asp?lang=en&n=7E808512-1

Ottawa Community Housing Case Study, Plumbing Retrofits, http://www.och-lco.ca/green-plan/

EQuilibrium™ Communities Insight: Green Infrastructure and Low-Impact Development, CMHC, 2013
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