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Energy Efficiency Tune-Ups for Mid- to High-Rise Residential Buildings

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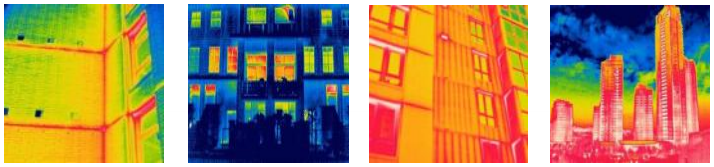

BCBEC Conference and AGM - September 21, 2011

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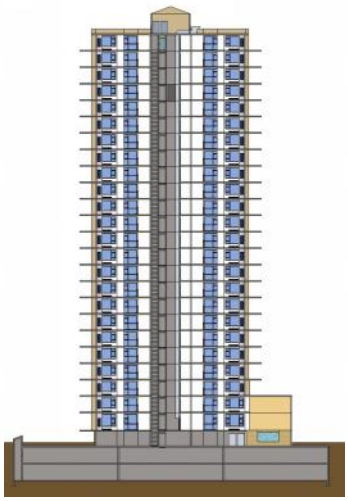
Overview

- Summary of a mid- to high-rise Multi-Unit Residential Building (MURB) energy study
- Measured energy savings from full building enclosure rehabilitations
- Strategies to retrofit and improve the energy efficiency of existing MURBs

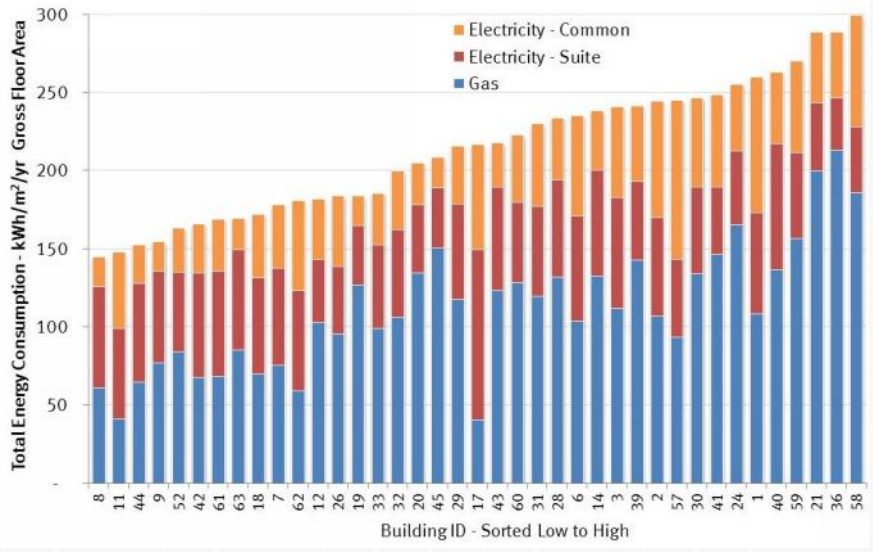


Multi-Unit High-Rise Residential Building Energy Study

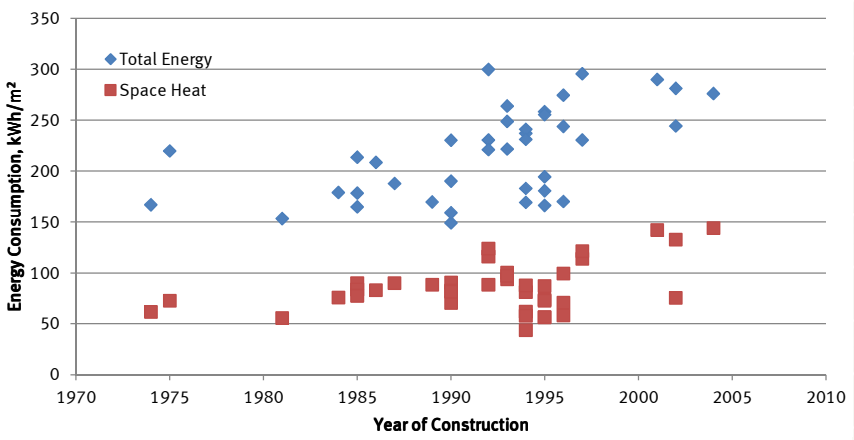
- Energy consumption of over 60 mid- to high-rise Multi-Unit Residential Buildings (MURBs)
  - Constructed between 1974 and 2002
- Half of study buildings underwent a full-scale building enclosure rehabilitation
  - Allows for the assessment of actual energy savings from enclosure performance
- Pre- and post-rehabilitation R-values, air-tightness characteristics analyzed with a decade of daily/month gas & electricity data.
- Other building performance characteristics as the result of the enclosure improvements and other HVAC changes were also assessed.

Summary: MURB Energy Consumption Intensity

Average 39 Buildings = 213 kWh/m²/yr

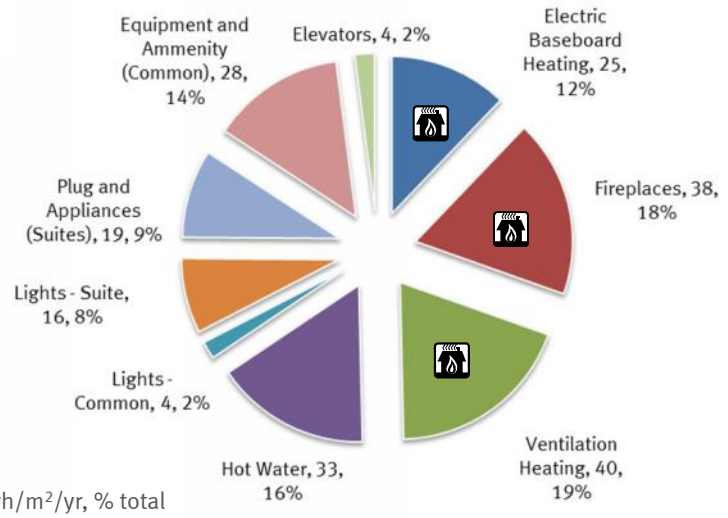


Total Energy Consumption vs Year of Construction



Typical Energy Consumption: 1980s-1990s MURB

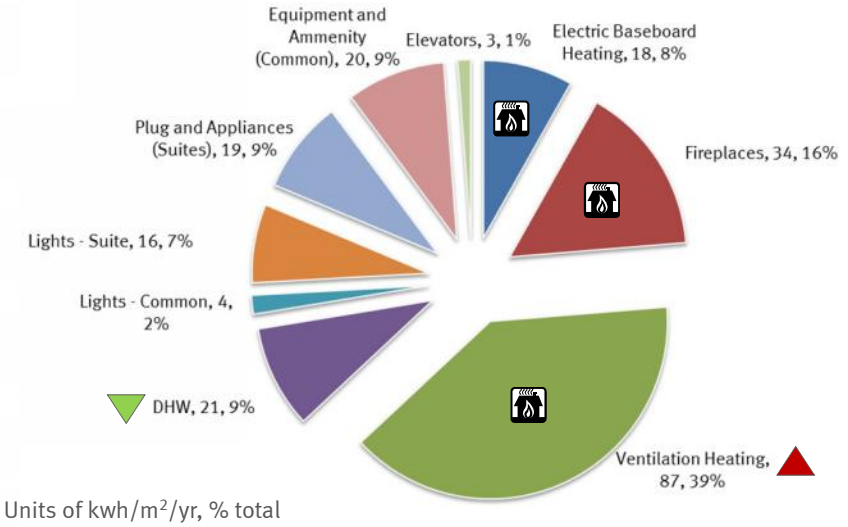
Average of 11 typical study buildings - Total 206 kWh/m²/yr



Units of kwh/m²/yr, % total

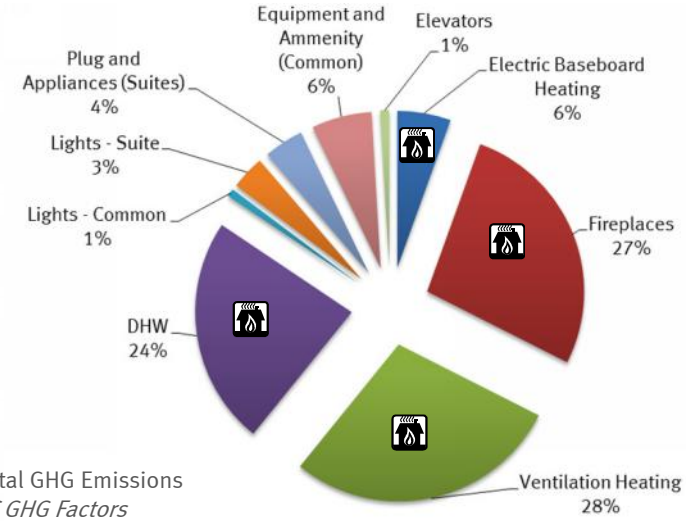
Typical Energy Consumption: Post 2000/Modern MURB

Average of several typical modern MURBs– Total ›222 kWh/m²/yr



Units of kwh/m²/yr, % total

Greenhouse Gas Emissions: Average of Study MURBs



% Total GHG Emissions
– *BC GHG Factors*

Addressing Energy Efficiency in MURBs

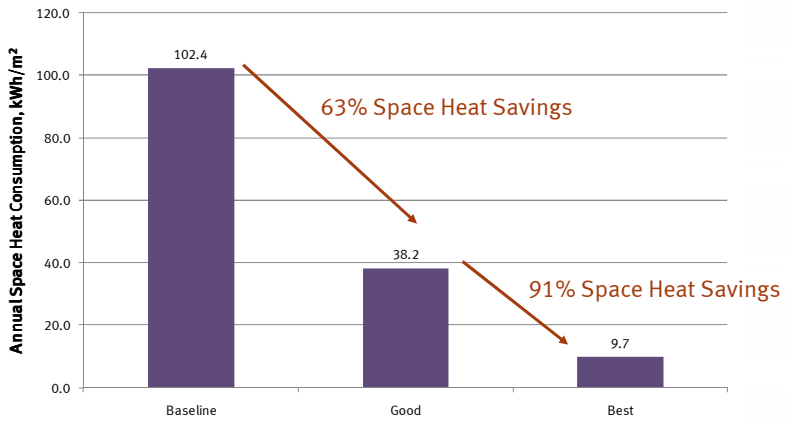
- MURB energy consumption is predominantly influenced by space-heating
  - Building enclosure thermal performance is typically poor (<R-3)
    - Walls have low effective R-values due to thermal bridging, steel framing, exposed concrete slabs etc.
    - Window R-values are very low, and are the largest source of heat loss
    - Air-Leakage through enclosure, and through operable windows is high
  - Make-up air unit gas consumption is high due to pressurized corridor ventilation flow rate and high set-point temperatures – yet very little of this air makes it into the suites
  - Fireplace gas consumption is high as heating efficiency is poor and little incentive to conserve as usage appears "free"

MURB Energy Simulations : The Potential

Energy Model Calibrated with Billing Data and Building Enclosure and HVAC Characteristics

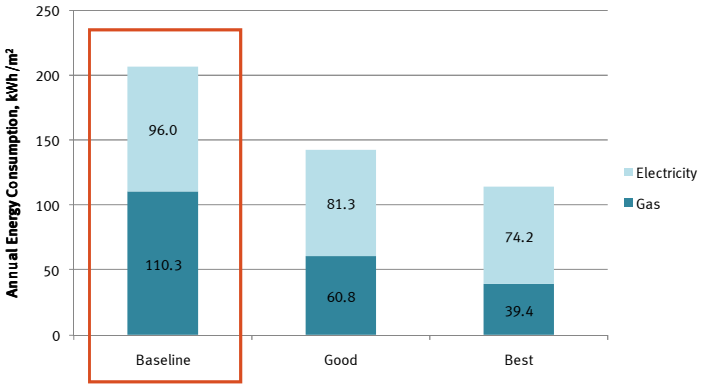
Scenario	Simulation Inputs
Baseline: Pre-Rehab	• Walls effective R-3.6 • Windows single glazed U = 0.7, SC = 0.67 • Air tightness "Tight – High Average", 0.15 cfm/ft² • Make-up air temperature set-point 68° F • No heat recovery
Good: Target Performance	• Walls effective R-10 • Windows double glazed, argon fill, low-e, low conductive frame; U = 0.27, SC = 0.35 • Air tightness "Tight – Low Average", 0.05 cfm/ft² • Make-up air temperature set-point 64° F • No heat recovery • No Fireplaces
Best: Green Design Performance	• Walls effective R-18.2 • Windows triple glazed, argon fill, low-e, low conductive frame; U = 0.17, SC = 0.23 • Air tightness "Very Tight", 0.02 cfm/ft² • Make-up air temperature set-point 60° F • 80% Heat Recovery • No Fireplaces

Potential for MURB Space Heat Consumption in Vancouver



Impact of Space Heat Energy on Total Energy Consumption

- Can reduce energy by almost half with ventilation and enclosure upgrades only
- Further improvements from DHW, Lighting, Appliances, Controls etc.



Current Levels ~ 200 kWh/m²/yr

We can get to ~100 kWh/m²/yr

Energy Savings from Building Enclosure Rehabilitations

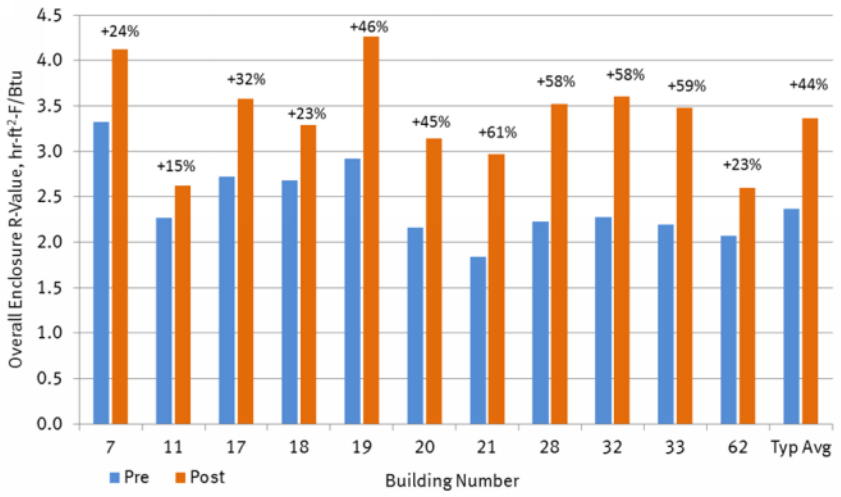
- Enclosure rehabilitations performed at study MURBs primarily to address moisture ingress damage
- Little incentive for owners to perform energy upgrades due to increased cost – a huge missed opportunity
- Full 100% re-cladding, insulating and new windows at all study MURBs
- Thermal improvements from: exterior insulation assemblies, improved detailing (i.e. cladding attachments), better windows (thermally broken, low-e etc.)
- Improved air-tightness characteristics during rehabilitation

Typical Rehabilitation Thermal Detailing

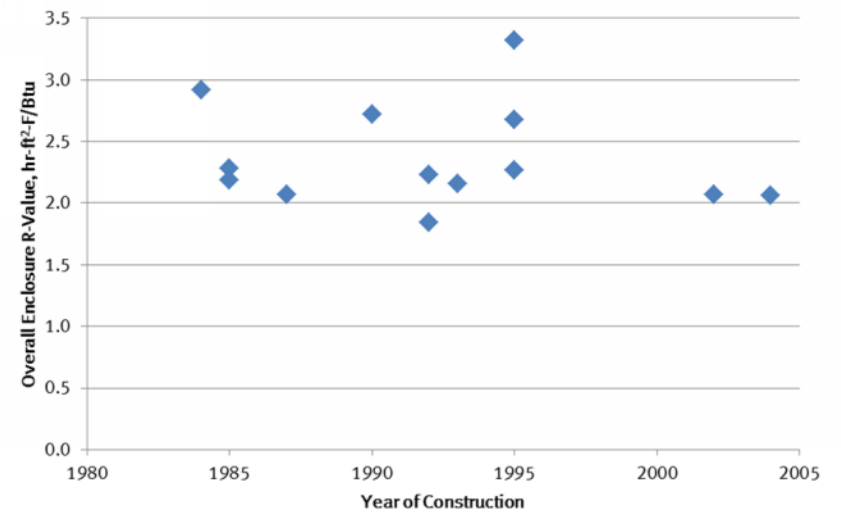
Pre-Rehabilitation

Post-Rehabilitation

Improvement in Overall Thermal Performance: R-value

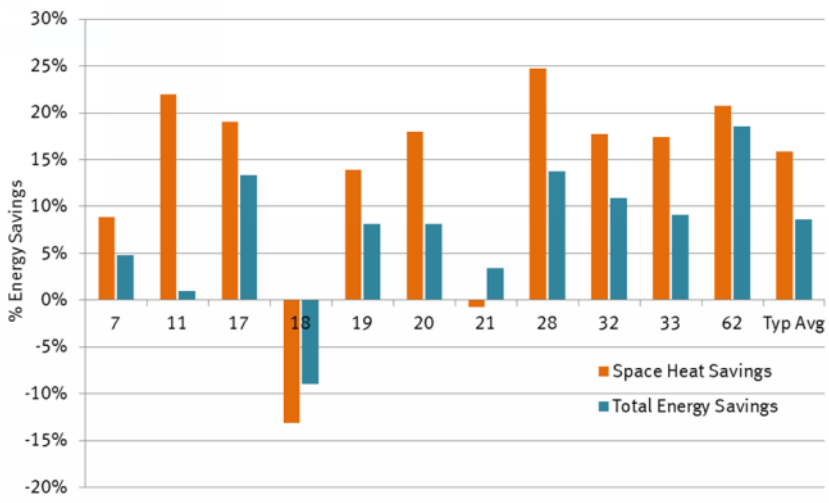


Overall Effective R-value by Year of Construction



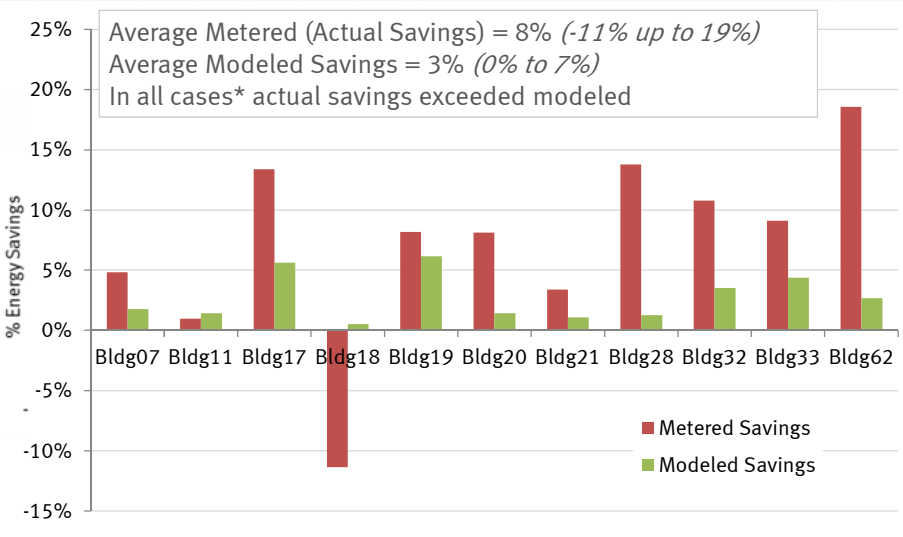
Energy Savings from Enclosure Rehabilitations

Average 14% Space-Heat Energy Savings & 8% Total Building Energy Savings



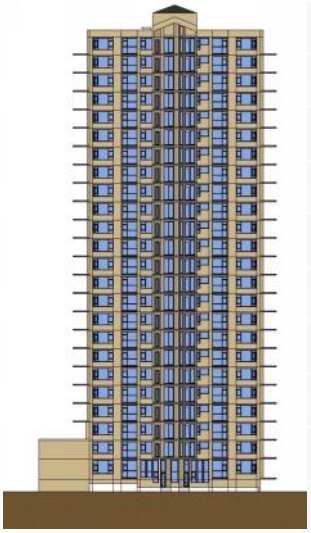
Calibrated Energy Model Predictions vs Actual Savings

Average Metered (Actual Savings) = 8% *(-11% up to 19%)*
Average Modeled Savings = 3% *(0% to 7%)*
In all cases* actual savings exceeded modeled

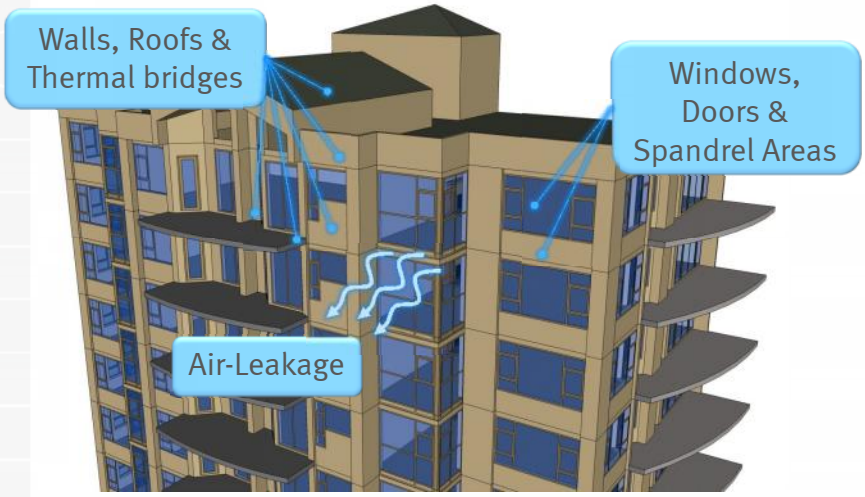


Energy Retrofit Potential for Existing MURBs

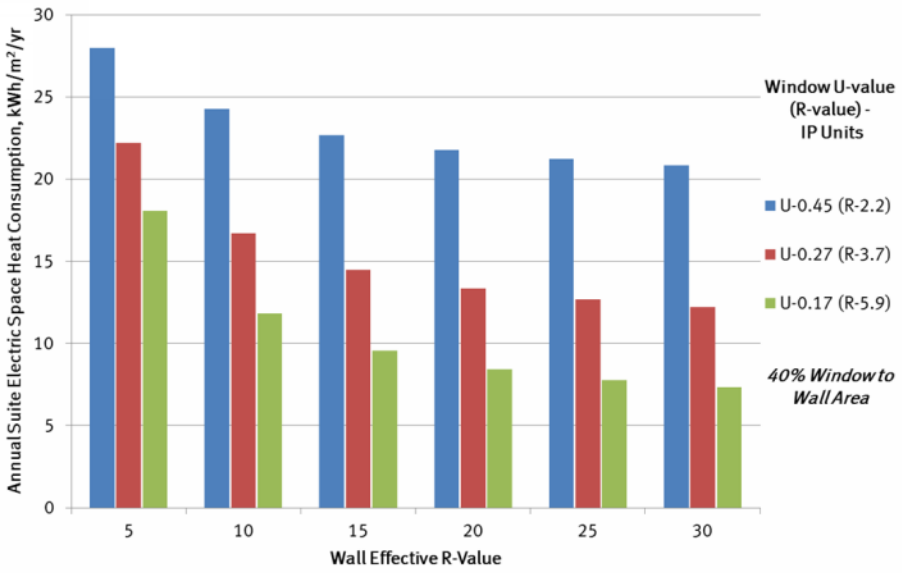
- Findings from study identified several key components of MURBs which can be improved during enclosure rehabilitation work or as part of specific energy retrofits
  - Building enclosure upgrades
  - Mechanical ventilation system upgrades and tune-ups
  - Installation of better space-heating controls
  - Elevator & mechanical system retro-commissioning and upgrades
  - Lighting upgrades



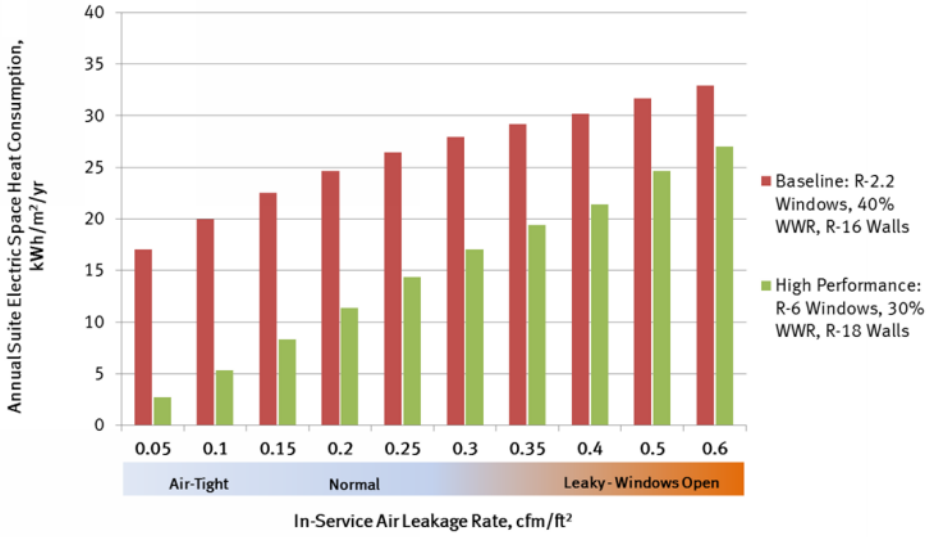
Building Enclosure Improvements



Impact of Wall and Window R-values



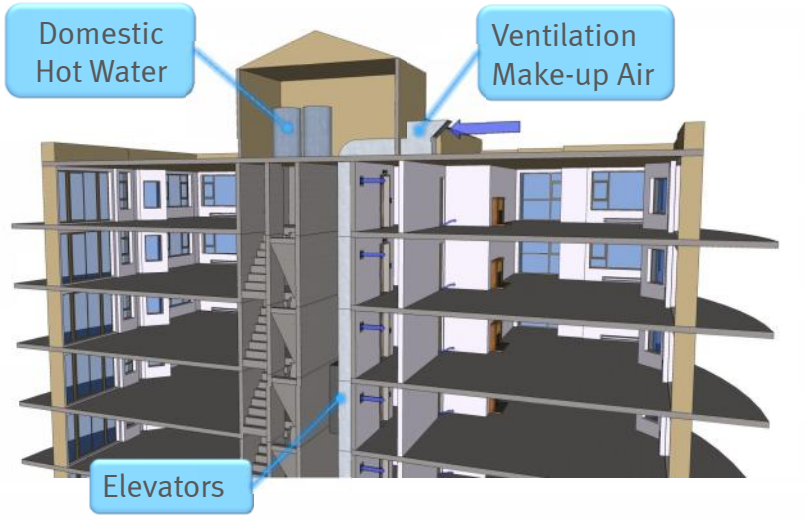
Impact of Air-Leakage



Incremental Cost of Rehabilitation Energy Upgrades

- Energy savings from full enclosure rehabilitations will not pay for the rehab anytime soon, however…
- Incremental cost and energy savings analysis of the several retrofit measures was performed
  - In most buildings the incremental cost in reducing thermal bridging (i.e. more effective use of provided insulation) or adding extra insulation (i.e. 1-2") to the walls would have paid back over the life of the upgrade in energy savings
  - In most buildings the incremental cost for some higher performing window components (frames, IGUs) would have paid back over the life of the windows in energy savings
- Beneficial to model the potential for incremental energy efficiency improvements while performing building enclosure rehabilitation work

HVAC and Mechanical System Improvements



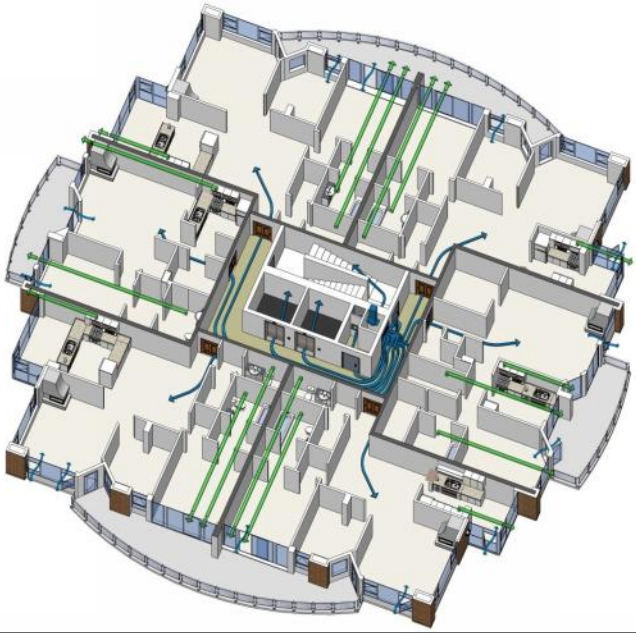
Ventilation Distribution and Air Flow within MURBs

Pressurized Corridor:

Design flow rate varies ‹30 cfm/suite in older buildings up to ›130 cfm/suite post 2000s.

Actual flow rate making it into the suites less, often as low as 1/3 of supply.

Ventilation/IAQ problems were common in most study MURBs

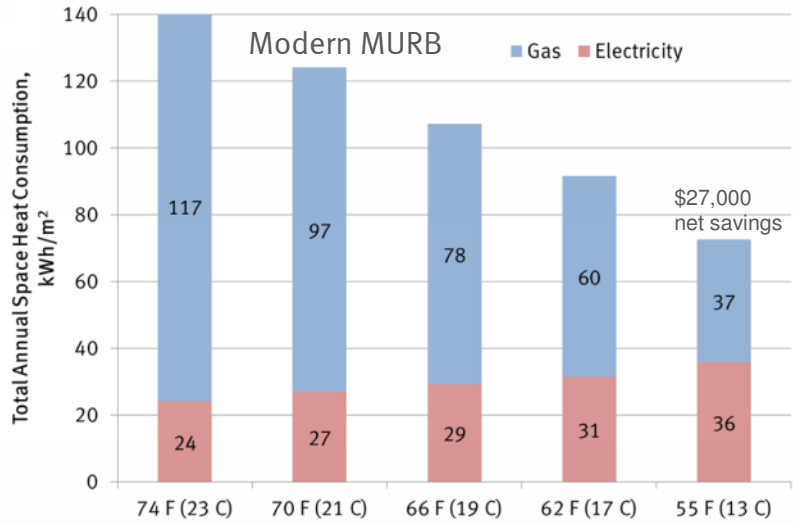


Ventilation Make-up Air

- Gas used to temper ventilation by make-up air is single largest component of energy use in most MURBs
  - Regular service of make-up air units, burners, controls, filters etc. necessary for optimal energy performance
  - Dirty MAU filters found to reduce flow rate significantly affecting both energy consumption and IAQ
- Ventilation is for occupant health
  - Flow-rate should never be turned down, off, setback, or on a timer unless sufficient ventilation is actually being delivered to occupants within the suites (not corridors)
- Consider set-back of temperature & controls to do so
  - Typically temperature of21C or higher set by strata or by maintenance contractors – large savings from lowering this.

Impact of Make-up Air Set point Temperature

Total Space Heat Energy Consumption (Gas & Suite Electric) - Vancouver



Domestic Hot Water Systems

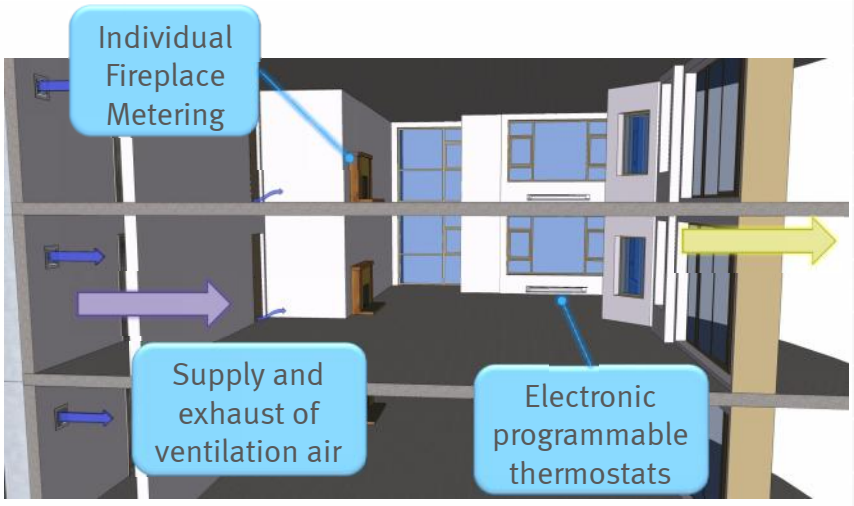
- Average DHW Load in typical MURB, 12 GJ/suite/yr (~$140/suite)
- Significant energy savings in MURBs where DHW system upgrades were performed during study period
- Mid-1980s continuous re-circulating DHW systems replaced with on-demand w/electric heat tracing in 2 study MURBs
  - Building 32 (135 suites), 50% reduction in DHW gas, savings of 1,285 GJ/yr ($14,000/yr, $104/suite)
  - Building 33 (165 suites), 64% reduction in DHW gas, savings of 2,200 GJ/yr ($26,000/yr, $160/suite)

Elevators and Controls

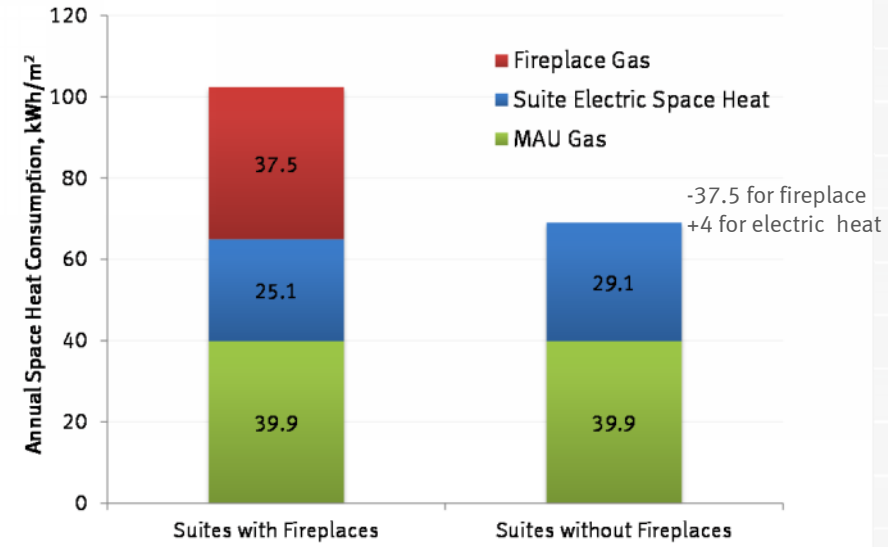
- Elevators rely on controls to be energy efficient
- Several of the 1980s-1990s MURBs within the study had AC-DC convertors running continuously (timers were broken for several years, or not installed), resulting in significant energy waste

- Building 33 Elevator (2 cabs, mid-80s controls)
  - w/ Faulty Timer (122,000 kWh/yr, ~$8,500/yr)
  - w/ Fixed Timer (46,000 kWh/yr, ~$3,200/yr)
  - w/ new VVVF system (21,000 kWh/yr, ~$1,500/yr)

In-Suite Space Heating and Ventilation



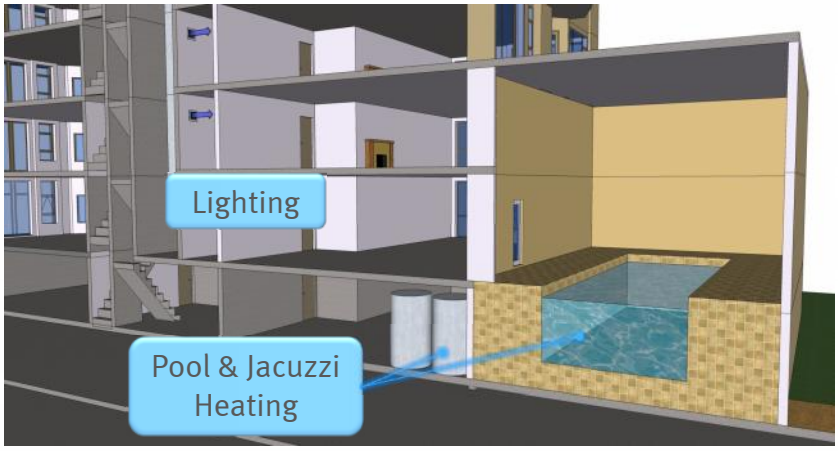
Impact of Fireplace Energy Consumption: Typical MURB



Individual Fireplace Sub-metering

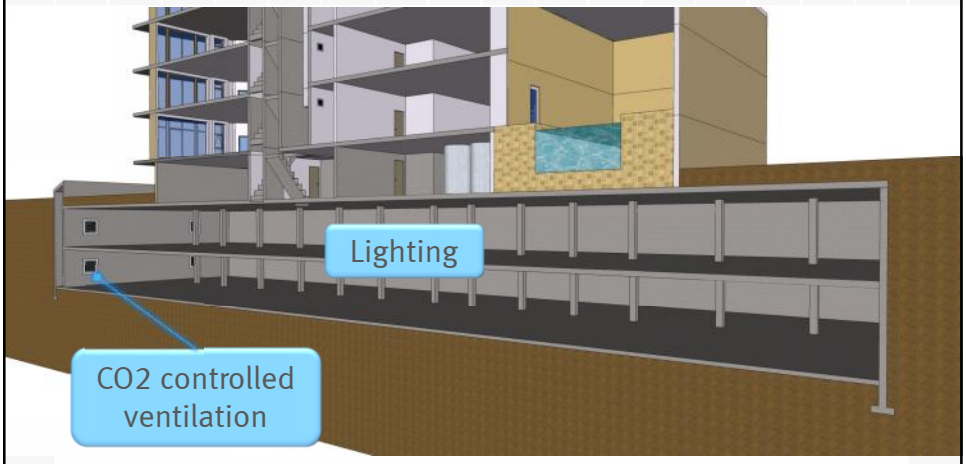
- Gas for fireplaces on single utility meter paid for by strata as part of maintenance fees – not directly by users
- Sub-metering is recommended to encourage conservation
  - Thermal meters are available to monitor time of use
  - Pilot project within a study MURB estimated that after first year of sub-metering and shutting off pilot lights during summer – fireplace gas consumption was reduced by approximately half.
    - Cost of meter installation will be paid for by savings in few years
    - Sub-metering also found that 60% of the 138 occupants in same MURB leave pilot lights on year round, and 12 occupants use their fireplace regularly (i.e. to heat) over the summer.
  - Building wide pilot-light shutoff/lighting programs suggested
- Alternately replace on-off switches with thermostat and/or timer controls

Common Areas and Amenity Spaces



Pool/Jacuzzi gas at one study MURB – 2,500 GJ/yr.
Total gas for all hot water/ventilation air for same MURB– 5,000 GJ/yr

Parking Garages



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Questions

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