Energy Savings by Retrofitting Multi-Unit Residential Buildings: Case Studies

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Outline

• Energy use in MURBs
• Study Methodology
• Assumptions
• Case Studies:

• Conclusions and Lessons Learned
MURBs in Toronto, Canada

MURB Housing starts in the Toronto Area

- 1950: 28,200
- 1960: 15,900

30-year design life

Housing Stock
- 30%
- 40%

Residential GHG Emissions
- 40%

Figure Adapted from T. Kesik and I. Saleff. 2009. Tower renewal guidelines. University of Toronto.
Methodology

• Building Owner/Manager Interviews

• Pre and Post-Retrofit Energy Consumption Analysis
  • Weather normalization
  • Energy Cost Savings
  • Financial Performance of Retrofit Measures
Historical Utility Costs

Projected Utility Costs

Average Utility Cost per m²

- Electricity
- Natural Gas
- Water

Case Study 1 (Rental)

Pre-Retrofit Condition:

32 suites
Built in 1930’s
High maintenance costs
Frequent equipment breakdowns
Case Study 1 (Rental)

Retrofit Strategy:

Windows

Attic insulation

Boiler controls and steam traps

Common area lighting

Faucets, showers, toilets
**Case Study 1 (Rental)**

<table>
<thead>
<tr>
<th>Actual Performance</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Project Cost</td>
<td>$74,200</td>
</tr>
<tr>
<td>Tonnes CO₂e avoided/annum</td>
<td>46</td>
</tr>
<tr>
<td>Simple Payback</td>
<td>6.5 years</td>
</tr>
<tr>
<td>IRR over 10 years</td>
<td>10%</td>
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<tr>
<td>Net Present Value</td>
<td>$27,000</td>
</tr>
</tbody>
</table>

### Graph

- **Natural Gas Use (m³)**
  - 30,000
  - 45,000
  - 60,000
- **Water Use (m³)**
  - 0
  - 2,000
  - 4,000

- 40%
- 50%
Case Study 2 (Rental)

Pre-Retrofit Condition:

128 suites
Built in 1970
Roof reaching end of life
Original, single-glazed windows
Case Study 2 (Rental)

Retrofit Strategy:

- Improved building envelope (replace windows, balcony doors and roof)
- Reduced reliance on fossil fuels (install a solar thermal hot water system)
Case Study 2 (Rental)

### Actual Performance

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Total Project Cost</strong></td>
<td>$568,000</td>
</tr>
<tr>
<td>(after incentives)</td>
<td></td>
</tr>
<tr>
<td><strong>Tonnes CO$_2$e avoided/annum</strong></td>
<td>160</td>
</tr>
<tr>
<td><strong>Payback based on energy cost savings</strong></td>
<td>16 years</td>
</tr>
<tr>
<td><strong>Payback based on energy cost savings and increased rental income</strong></td>
<td>3 years</td>
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</tbody>
</table>
Case Study 3 (Condominium)

Pre-Retrofit Condition:

- 210 suites
- Built in 1974
- Excessive energy bills
- Wanted to avoid borrowing costs
Case Study 3 (Condominium)

Retrofit Strategy:
- Boiler Replacement
- Air Handling Unit (AHU) Retrofit
- Toilet Replacement
- Chiller Replacement
Case Study 3 (Condominium)

**Actual Performance**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
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<tbody>
<tr>
<td>Total Project Cost</td>
<td>$678,000</td>
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<tr>
<td>Tonnes CO$_2$e avoided/annum</td>
<td>277</td>
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<td>Simple Payback</td>
<td>4 years</td>
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<td>Net Present Value</td>
<td>$267,000</td>
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</table>

**Graphs**

- **Natural Gas Use (m$^3$)**
  - 28% reduction

- **Water Use (m$^3$)**
  - 29% reduction
Case Study 4 (Condominium)

Pre-Retrofit Condition:

116 suite

Occupied in 2001

Investigation into solar energy led to discovery of other energy savings measures
Case Study 4 (Condominium)

Retrofit Strategy:

- Lighting Retrofit
- CO Monitor Installation
- Boiler Replacement
- Installation of Variable Frequency Drive on Make-Up Air Unit
Case Study 4 (Condominium)

**Actual Performance**

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Total Project Cost (after incentives)</td>
<td>$146,000</td>
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<tr>
<td>Tonnes CO$_2$e avoided/annum</td>
<td>153</td>
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<tr>
<td>Simple Payback</td>
<td>2.4 years</td>
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<td>IRR over 10 years</td>
<td>45%</td>
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<td>Net Present Value</td>
<td>$260,000</td>
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</table>
Summary of Retrofit Impacts

- **Boiler Controls/Wndw Replace/Attic insulation (Bldg 1)**
- **Boiler Replacement (Bldg 3)**
- **Boiler Replacement (Bldg 4)**
- **Lighting Retrofit (Bldg 1)**
- **Lighting/Exhaust/MAU (Bldg 4)**
- **Water Fixture Replacement (Bldg 1)**
- **Chiller upgrade (Bldg 3)**
- **Toilet Replacement (Bldg 3)**
- **Boiler Controls/Wndw Replace/Attic insulation (Bldg 1)**

Cost of Avoided GHG Emissions ($/tCO₂e)

- $83/tCO₂
- $200
- $400
- $600
- $800
- $1,000
- $1,200

Simple Payback (yrs)

0 2 4 6 8 10
Lessons Learned

Planning:

- Whole Building Approach
- Establish Baseline Utility Use
- Enhance Existing Maintenance Projects
- Quick Payback + Longer Payback Items

http://www.stlucieco.gov/planning/planning.htm
Lessons Learned

Financing:
- Energy Conservation Incentives
- Financial Analysis Tools

Construction:
- COMMUNICATION!

Operations:
- Ongoing control
For more information...

Energy Retrofit Case Studies on the TowerWise Website
towerwise.ca/case_studies

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