When is Heat Recovery Cost-Effective in Canadian Buildings?

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Commissioned by Natural Resources Canada and the National Research Council of Canada
NECB

• National Energy Code of Canada for Buildings

• Ongoing improvement process

• NRCan and NRC commissioned study

• Cost benefit of exhaust air heat recovery

• Energy modelling study with CAN-QUEST
Archetype Buildings

- 13 archetypes
- Retail, restaurants
- Hotels, multi-unit residential
- Long-term health care
- Offices, warehouse
- Primary and secondary schools
Canadian Climate Zones

- Victoria
- Windsor
- Montreal
- Edmonton
- Fort McMurray
- Yellowknife
## Heat Recovery Technologies

<table>
<thead>
<tr>
<th>Type</th>
<th>Options</th>
<th>Performance</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat Pipe</td>
<td>Sensible only</td>
<td>50%</td>
<td>$$</td>
</tr>
<tr>
<td>Cross-flow</td>
<td>Sensible and enthalpy</td>
<td>55 to 65%</td>
<td>$$</td>
</tr>
<tr>
<td>Energy Wheel</td>
<td>Sensible and enthalpy</td>
<td>65 to 75%</td>
<td>$</td>
</tr>
<tr>
<td>Reverse Flow</td>
<td>Enthalpy</td>
<td>80 to 90%</td>
<td>$$$</td>
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</tbody>
</table>
Heat Pipe
Cross-Flow or Heat Core
Energy Wheel
Reverse Flow
Energy Modelling

- CAN-QUEST model of each building type
- Simulate with and without heat recovery
- Energy savings calculated
- 13 buildings, 6 climate zones
- 492 energy models simulated
Cost Benefit Analysis

• Cost of equipment obtained from manufacturer’s representatives

• Canadian average energy prices (2014) used to calculate energy cost savings
  – $0.345/cubic metre for natural gas ($0.033/ekWh)
  – $0.113/kWh for electricity

• Simple payback or lifecycle cost savings
<table>
<thead>
<tr>
<th>Building Type</th>
<th>Zone 4</th>
<th>Zone 5</th>
<th>Zone 6</th>
<th>Zone 7a</th>
<th>Zone 7b</th>
<th>Zone 8</th>
<th>Payback Period</th>
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<tbody>
<tr>
<td>Big Box Store Energy Wheel</td>
<td>11.7</td>
<td>6.4</td>
<td>4.6</td>
<td>4.2</td>
<td>3.5</td>
<td>2.5</td>
<td>0-2</td>
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<tr>
<td>Large Hotel Enthalpy HX</td>
<td>24.5</td>
<td>3.4</td>
<td>2.6</td>
<td>2.8</td>
<td>2.0</td>
<td>1.2</td>
<td>2-5</td>
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<tr>
<td>Small Hotel PTACs Enthalpy HX</td>
<td>8.1</td>
<td>5.7</td>
<td>4.2</td>
<td>3.8</td>
<td>3.1</td>
<td>2.2</td>
<td>5-8</td>
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<td>LTHC Reverse Flow</td>
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<td>4.5</td>
<td>3.6</td>
<td>3.2</td>
<td>2.8</td>
<td>2.1</td>
<td>8-15</td>
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<td>12.4</td>
<td>8.8</td>
<td>8.2</td>
<td>7.1</td>
<td>5.8</td>
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<td>40.0</td>
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<td>Medium Office Energy Wheel</td>
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<td>5.2</td>
<td>3.7</td>
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<td>Quick Restaurant Heat Pipe</td>
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<td>Primary School Energy Wheel</td>
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</tbody>
</table>
Discussion

• Almost all building types show good payback in climate zones 5 through 8
• Outdoor air fraction above 20%
• Longer run-times lead to shorter payback
• Bypass of heat recovery prevents overheating
• Higher supply air temperatures in winter to maximize heat recovery
Maximize the cost benefit!

- Design systems to have higher outdoor air fraction with lower supply air flow rates in winter
- Right-size systems (especially VAV)
- Specify heat recovery devices with bypass control
- Supply air reset control – warmer temperatures in heating mode
- Energy wheels a good balance of cost and performance