Heuristic Control Strategies for a Multi-Zone Commercial Building Employing a Direct Expansion System

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Objectives

• Establish an inverse modeling approach for direct expansion (DX) cooling unit aiming at development of control heuristics

• Combine control heuristics with model-predictive control (MPC) to improve scalability of optimal control

Modeling methods
Heuristic control
• High supply air temp. = lower power consumption
• **Heuristics**: increase supply air temperature whenever possible

**Simplified MPC (precooling scenario)**
DX unit has **higher efficiency** at
• lower ambient temperature
• part load condition

<table>
<thead>
<tr>
<th>100-day cooling season simulation</th>
<th>Total Elec Usage</th>
<th>Energy savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional w. constant $T_{sup}$</td>
<td>69383 kWh</td>
<td>0</td>
</tr>
<tr>
<td>Optimal $T_{sup}$ reset only</td>
<td>59133 kWh</td>
<td>15.1%</td>
</tr>
<tr>
<td>Heuristic $T_{sup}$ reset only</td>
<td>59716 kWh</td>
<td>14.18</td>
</tr>
<tr>
<td>Heuristic $T_{sup}$ reset + MPC</td>
<td>56783 kWh</td>
<td>18.4%</td>
</tr>
</tbody>
</table>
Conclusions

- Heuristic controller for supply air temperature is simple and implementable in real buildings with performance almost as good as the optimal controller
- Precooling strategy is more energy efficient than a normal night setup strategy by exploiting DX unit’s high efficiency at lower OAT and part load condition
- Supply air temperature reset strategy provides most of the energy savings (14%) and longer-time prediction horizon MPC can lead to another (4%) savings

Impact

- Combing simple heuristics with MPC could reduce computational requirements and provide tractable solutions to building optimal control
- A generalized heuristic control can further reduce modeling efforts but still maintain near-optimal performance for DX units