Commercial buildings as batteries: utilizing flexible loads to help renewable energy integration into the power grid

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Motivation

• Why do we need more resource to provide *ancillary service*?
  – Generation and demand must be in balance at all time scales
  – Renewable energy sources (wind, solar, etc.) are volatile

*Wind generation from BPA (MW)*

*BPA: Bonneville Power Administration*
• Our proposal: **buildings as batteries**
  
  – Vary HVAC power consumption, a little, continuously in response to the grid’s needs
  
  – Large potential in commercial buildings: consume 40% of US electricity
  
  – No effect on room climate, software add-on to existing BAS
Method and Preliminary Experimental results

- Method: closed-loop control
  
  \[ u = \text{Air flow rate command} \]

- Experiments results in Pugh Hall
  - PJM’s RegD signal
  - Utilized 10% of fan motors’ capacity
  - Small effect on indoor temperature
  - Potential income in PJM’s market: $2000 in 2013
## Summary of ASFL (Ancillary Service from Flexible Loads)

<table>
<thead>
<tr>
<th>Type of ancillary service</th>
<th>Potential nation-wide capacity</th>
<th>Frequency range</th>
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</thead>
<tbody>
<tr>
<td>High frequency</td>
<td>5.2 GW</td>
<td>seconds-minutes</td>
</tr>
<tr>
<td>Mid-range frequency</td>
<td>47 GW</td>
<td>A few minutes – 1-2 hours</td>
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</tbody>
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Total demand in US is 10 GW!

- Difference from traditional demand response
  - No adverse effect on the building climate
  - Not intermittent but continuous and automated
- Low cost, low emissions
- New policies incentivize demand side participants: FERC order 784, 755, 745
- Currently being extended to low-frequency ancillary service using large collection of on/of loads