
Commercial buildings as batteries:

utilizing flexible loads to help renewable energy integration
into the power grid

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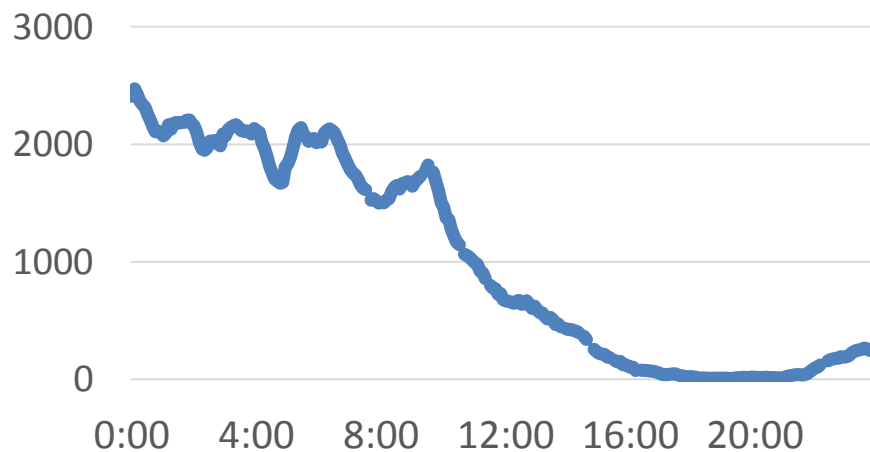
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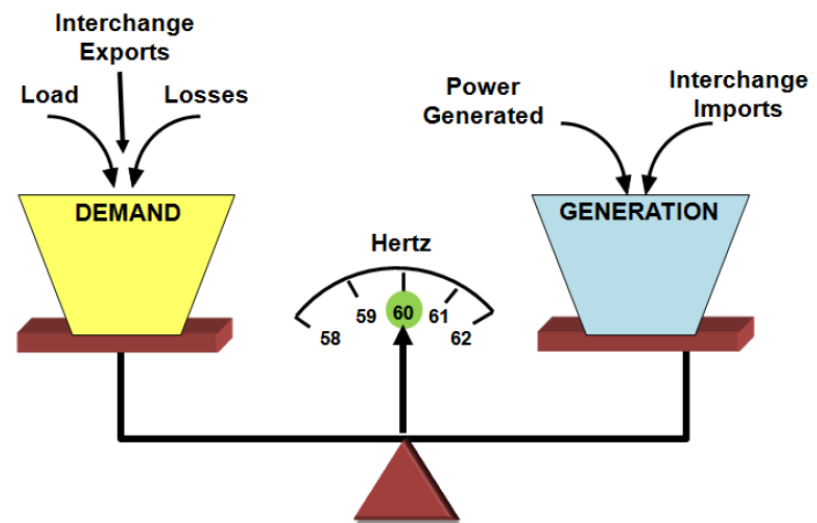
Motivation

- 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

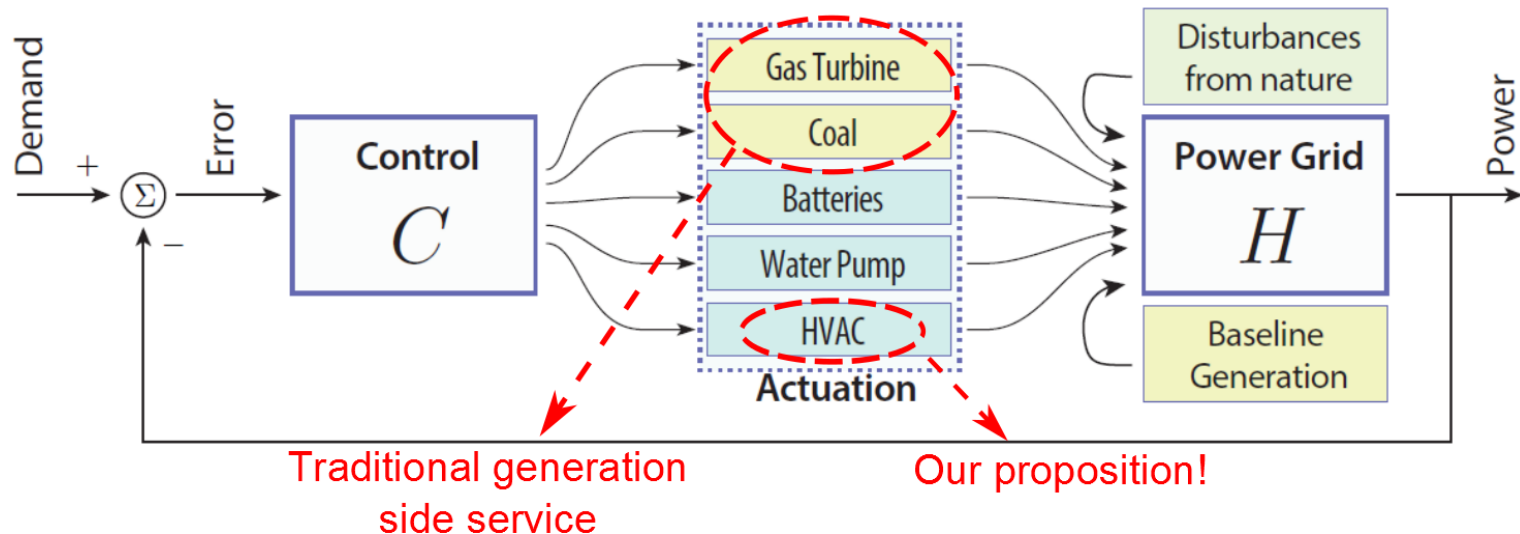
Wind generation from BPA (MW)



BPA: Bonneville Power Administration



Ancillary service, what is vs. what can be



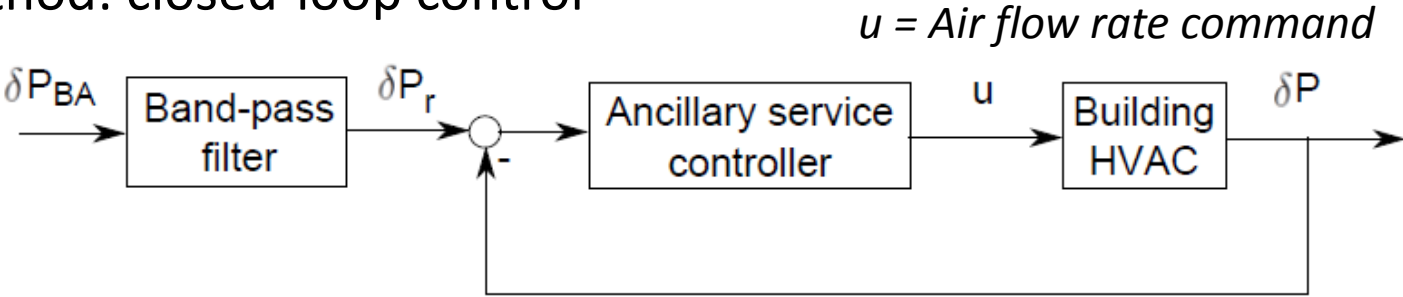
- Our proposal: **buildings as batteries**

- 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



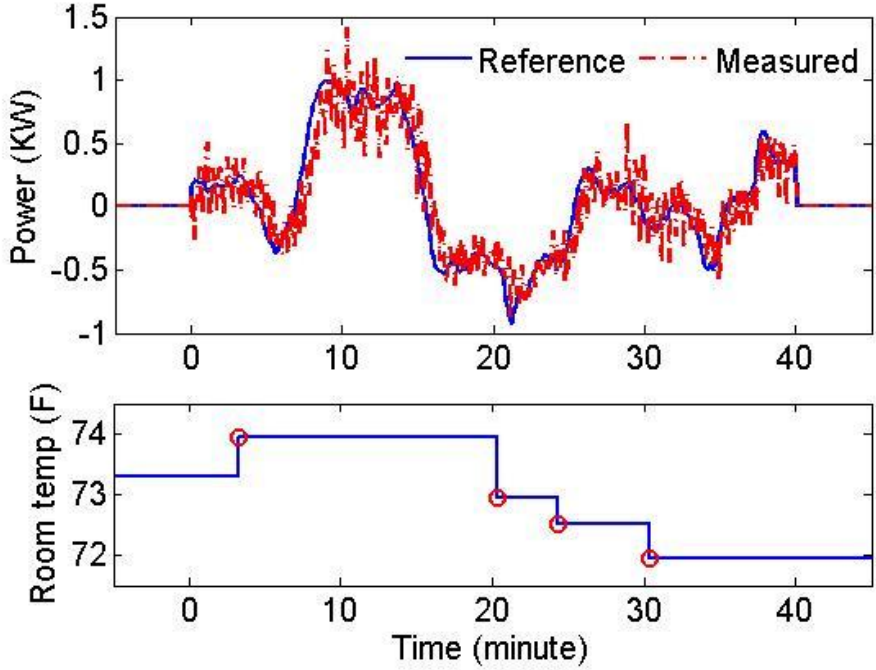
Method and Preliminary Experimental results

- Method: closed-loop control



- 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)

Type of ancillary service	Potential nation-wide capacity	Frequency range
High frequency	5.2 GW	seconds-minutes
Mid-range frequency	47 GW	A few minutes – 1-2 hours

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

