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A practical data-driven method to harness buildings as virtual battery for demand response

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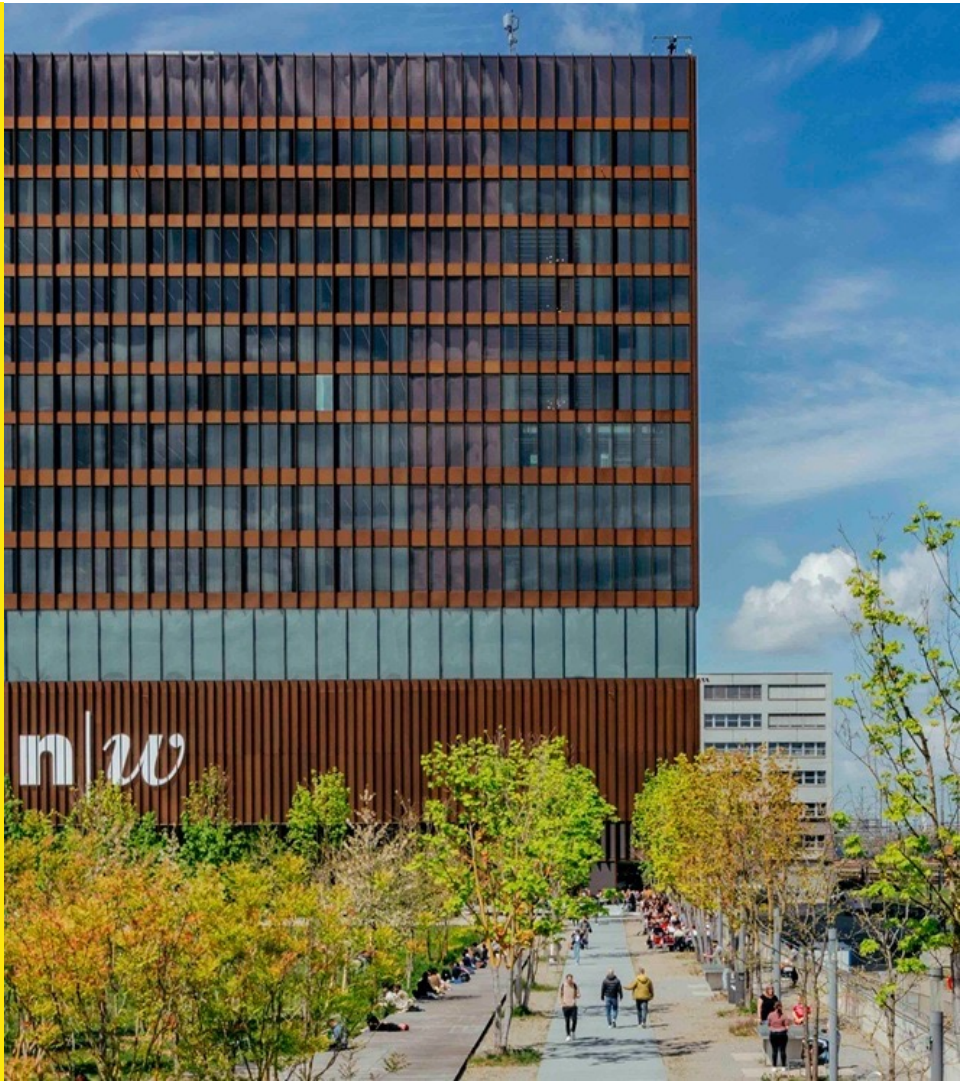

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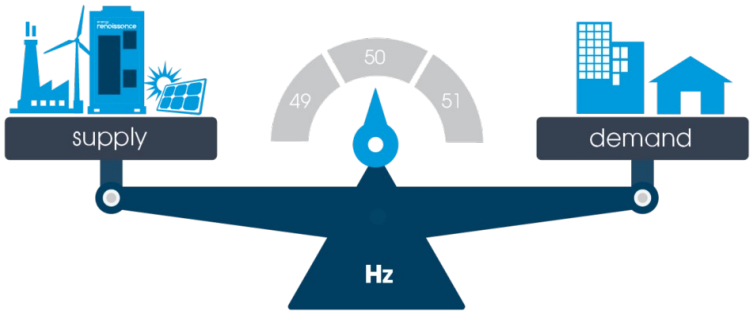
Demand Response with Buildings

- Production and consumption must be balanced
- More fluctuating electricity from PV and wind
- ➢ More need for grid control

- Heat pumps in buildings are a large consumer group
- Buildings have thermal inertia
- ➢ Potential for load shifting



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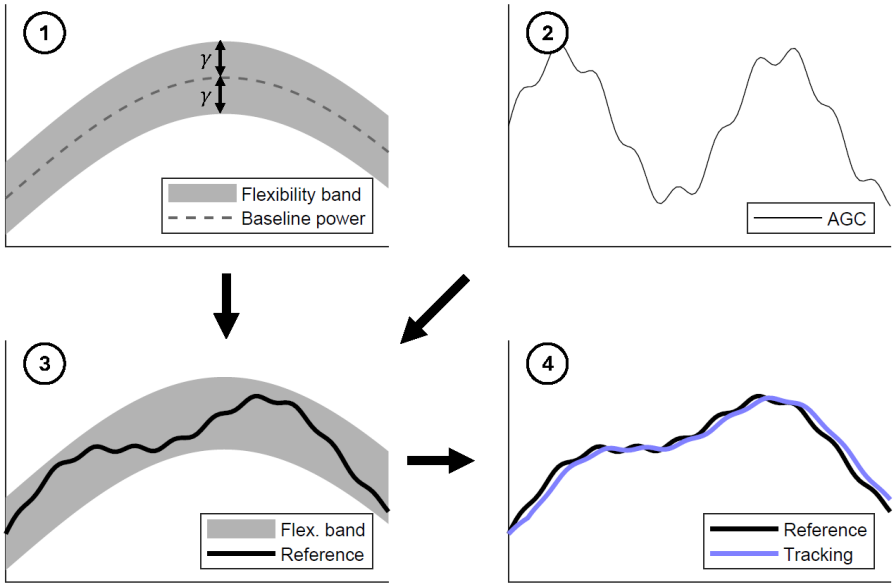
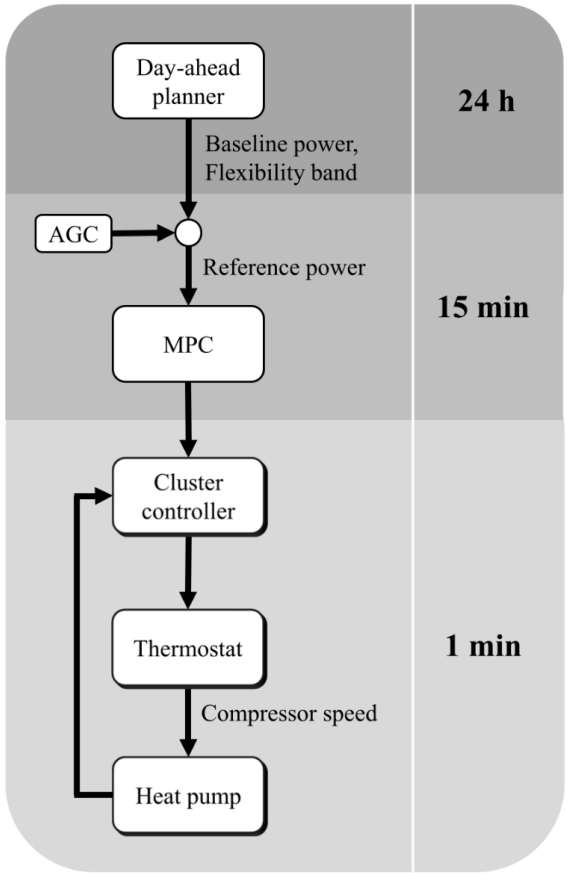
Secondary Frequency Control

1) Calculate baseline power consumption and flexibility band
2) Automatic Generation Control (AGC) signal
3) Resulting reference power
4) Obligated to track



Methodology

- Simulation with 1000 building models generated from real-world dataset
- Data-driven linear model with output saturation
- Control architecture
  - Robust optimization for day-ahead planning
  - Model Predictive Controller translates reference trajectory into thermostat setpoints
  - Cluster controller distributes commands to buildings handles fast disturbances

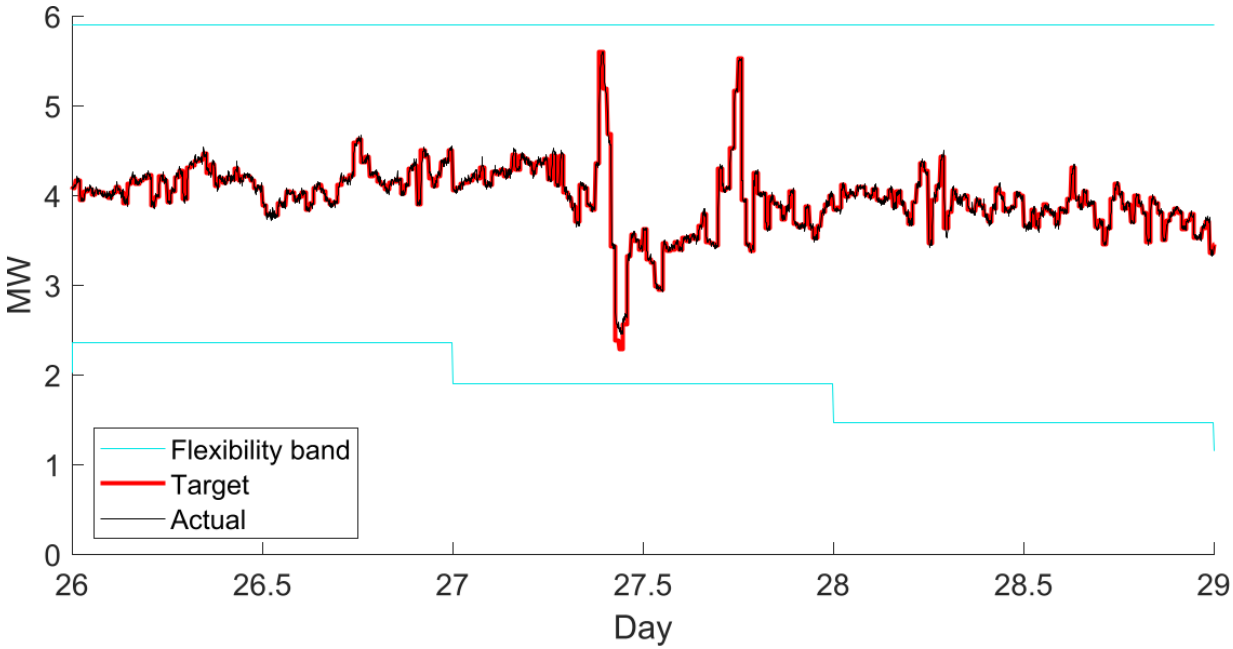


Results

- Significant flexibility band realized
- Good tracking accuracy
- Optimization problems solved quickly and reliably
- Estimated to break even at **000-000** MWh_{el} per year

Default energy consumption	MWh	000
Total flexibility band (realized)	MWh	000
Total load shifted	MWh	000
Total absolute tracking error	MWh	000

Preliminary unpublished results redacted.



Conclusions and Call-to-Action

- Control architecture well-suited for secondary frequency control with buildings
- Requiring only
  - A few weeks of training data
  - Indirect control of heat pumps through thermostats

➢ Call-to-Action: Follow-up study with more detailed simulation or real buildings desirable
  - Implementation within local or virtual electricity communities (**LEG** and **vZEV**)
  - Real estate portfolio managers / Local grid operators