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HeatReserves RTD 2013

FNSNF

Demand Response for Ancillary Services: Thermal Storage Control

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Abstract:

- The power output of renewable energy sources, such as wind and solar, is hard to predict.
- In power grid demand and supply must always be balanced.
- This balance is achieved by ancillary services. Today, in Switzerland, ancillary services are mainly provided by hydro power plants or conventional generators.
- Increase in renewable energy sources leads to increase in uncertainty in supply power. Thus, additional ancillary services are required to balance supply and demand.

HeatReserves Idea:

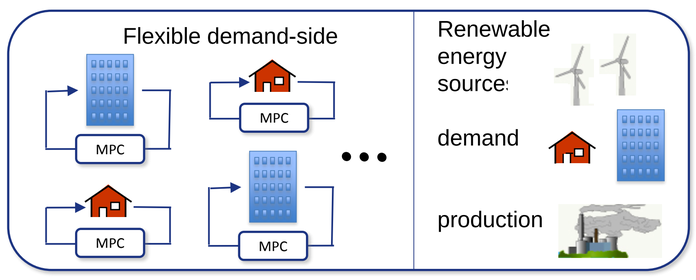
➢ Control demand side to provide additional means of ancillary services through:
- Control of Heating, Ventilation, and Air Conditioning (HVAC) systems of an aggregate of several offices.
- Control of appliances of an aggregate of thousands of households.

➢ Potential benefits of controlling above thermal loads:
- Reduce transmission line loads.
- Improve ancillary service market.

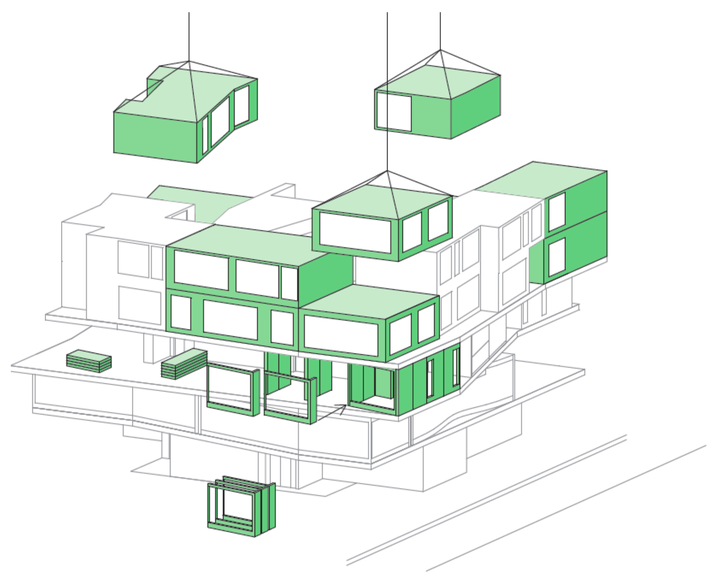
Problem Description:

HeatReserves develops methods for control of an aggregate of **offices** so that their total power consumption tracks a desired signal provided by the grid operator while ensuring users' comfort. Our research:

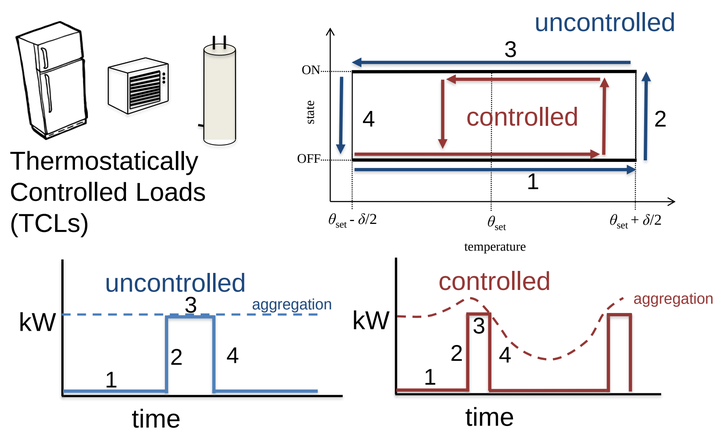
- Determines the economic value of HeatReserves for the Swiss grid.
- Develops models and control algorithms for a large scale aggregate system.
- Develops optimal bidding strategies for aggregators in the ancillary service market.



The models and control algorithms developed will be verified and tested in the EMPA plug and play test-bed building, called NEST.



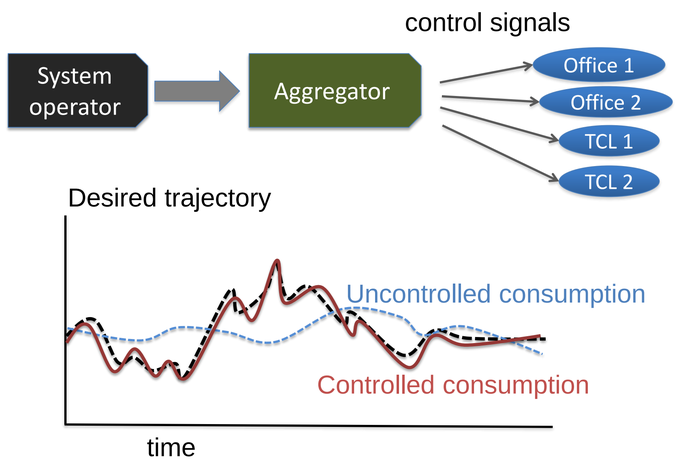
Household appliances, specifically thermostatically controlled Loads (**TCLs**), provide thermal storage and therefore can shift their demand. They usually operate within a temperature dead-band. They can be controlled by turning them on/off prematurely or by adjusting their dead-band.



Figures of TCL control courtesy of Mathieu, Dyson and Callaway, 2012

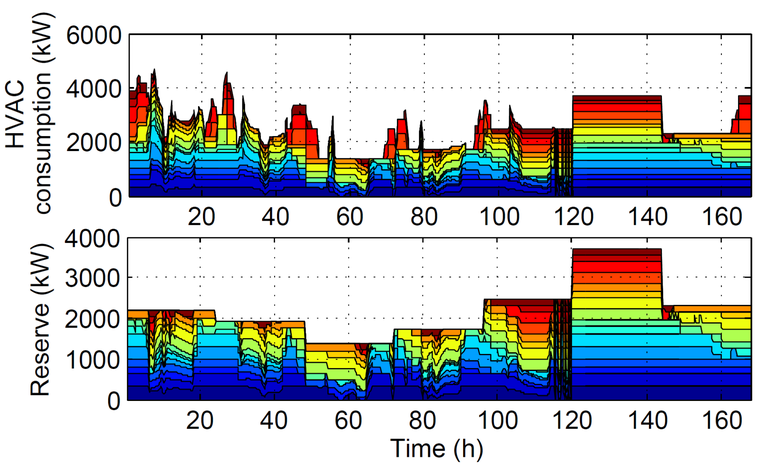
First Year Progress:

HeatReserves develops methods to control a population of office buildings and TCLs to shape the aggregated power consumption to track a reference signal provided by the grid operator while ensuring users' comfort.



Offices:

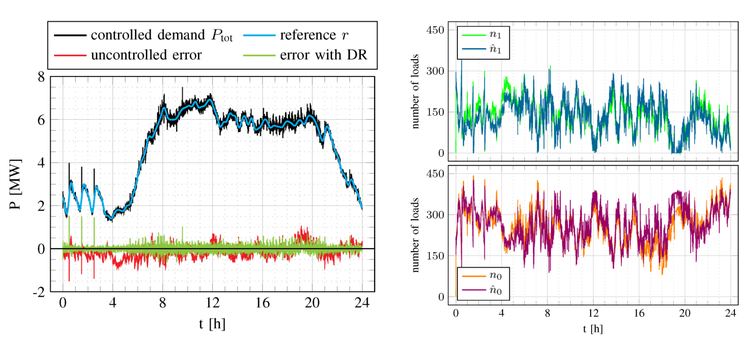
- Energy-efficient operation of offices.
- Model-based optimal control is challenging.
- Complex infrastructure calls for hierarchical control structures.



HVAC system consumption and optimal reserve allocation among 16 different buildings in winter.

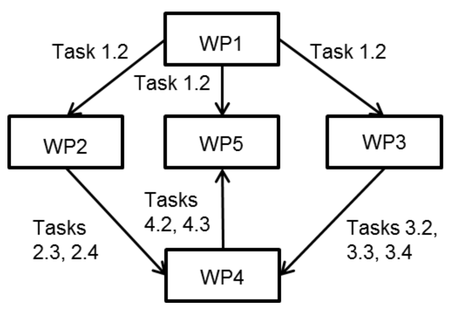
TCLs:

- Modeling of large TCL aggregations.
- Strategies for minimal communication requirements.
- State estimation and control.
- Business models and optimal load schedules.
- Strategies for customer involvement.



HeatReserves is divided into five work packages:

- WP 1: Economic and Technical Analysis
- WP 2: Building Climate Control
- WP 3: Aggregate Household Appliances Control
- WP 4: Field Testing
- WP 5: Consumer Involvement, Management and Policy



Research team:

- ETH Zurich, Automatic Control Systems Laboratory
- ETH Zurich, Power Systems Laboratory
- University of St. Gallen, Institute of Economy & the Environment
- Swissgrid, the Swiss transmission system operator
- EMPA Dübendorf, Laboratory of Building Science & Technology