Valuing Demand Response Controllability

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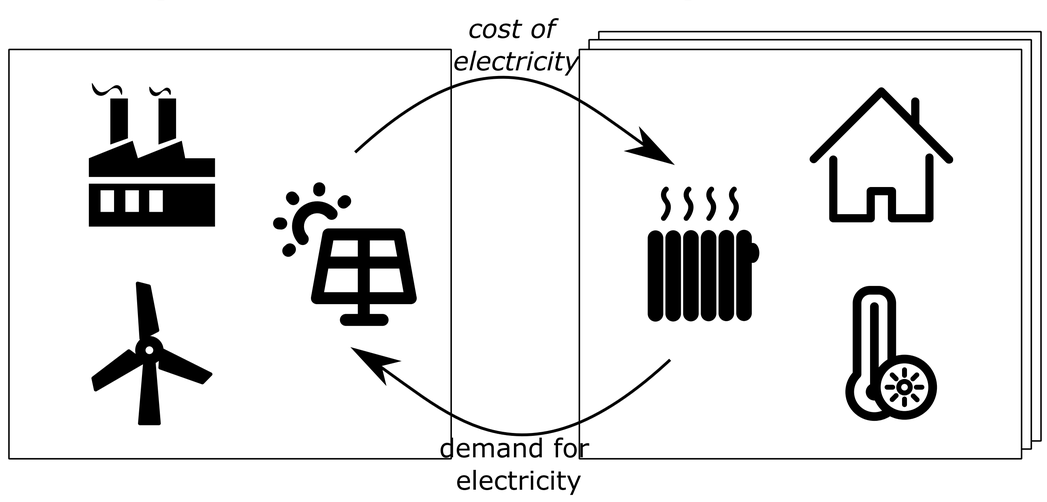
Highlights

1. Short-term load shifting (i.e., arbitrage) and reserve provision (i.e., regulation services) with electric heating systems, leveraging thermal energy storage in residential building stock.
2. Unit commitment model w. probabilistic reserve constraints coupled to physical model of heating systems and thermal response buildings and hot water storage tanks. Chance constraints to account for limited controllability DR.
3. Significant operational cost savings attainable: 6% (arbitrage) to 7% (arbitrage and regulation services), which may be increased by allowing limited discomfort.
4. Imperfectly controllable demand response may hold limited value for a risk-averse power system operator.

Methodology

Joint optimization: min. total operational cost

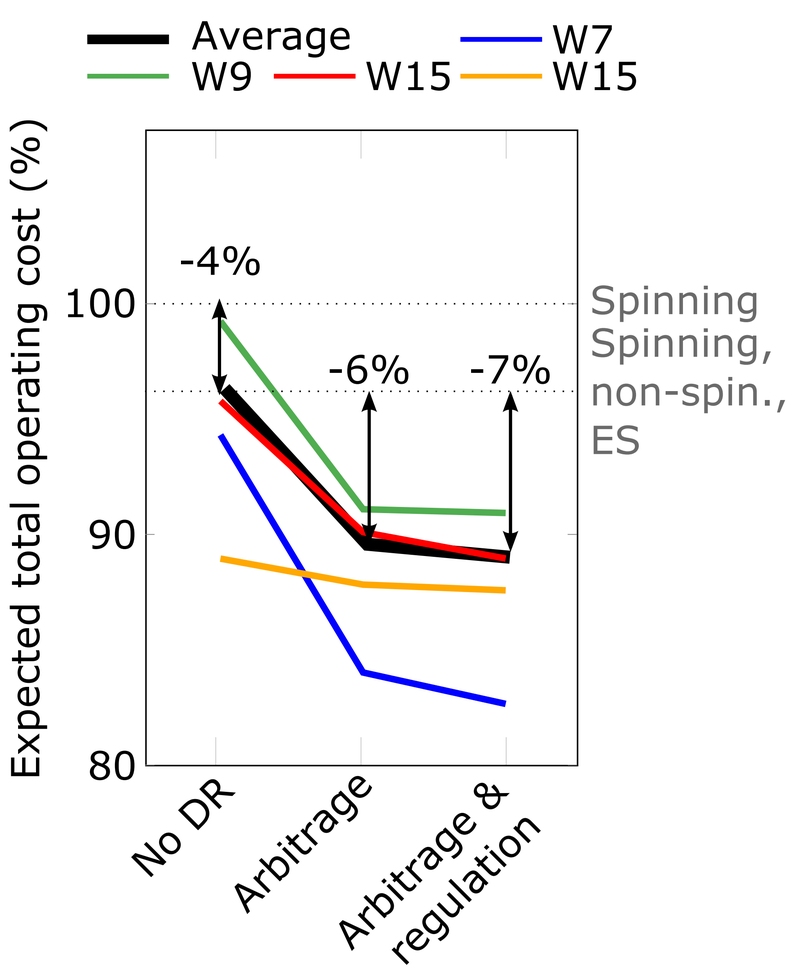


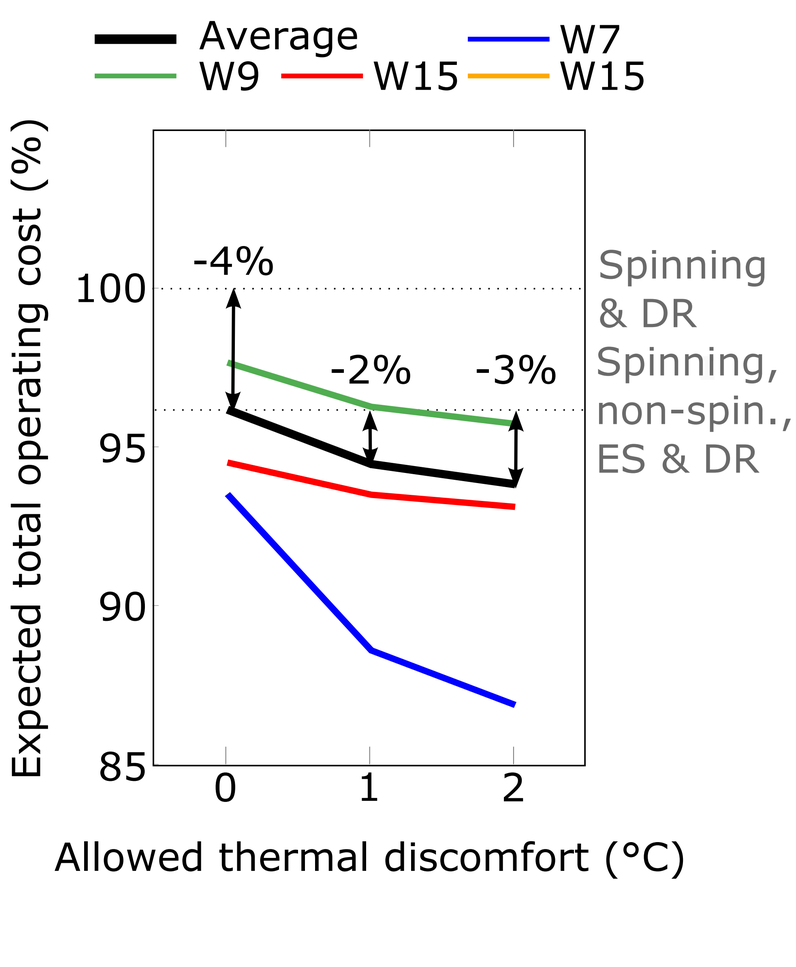
Conventional & stochastic RES-based electricity generation

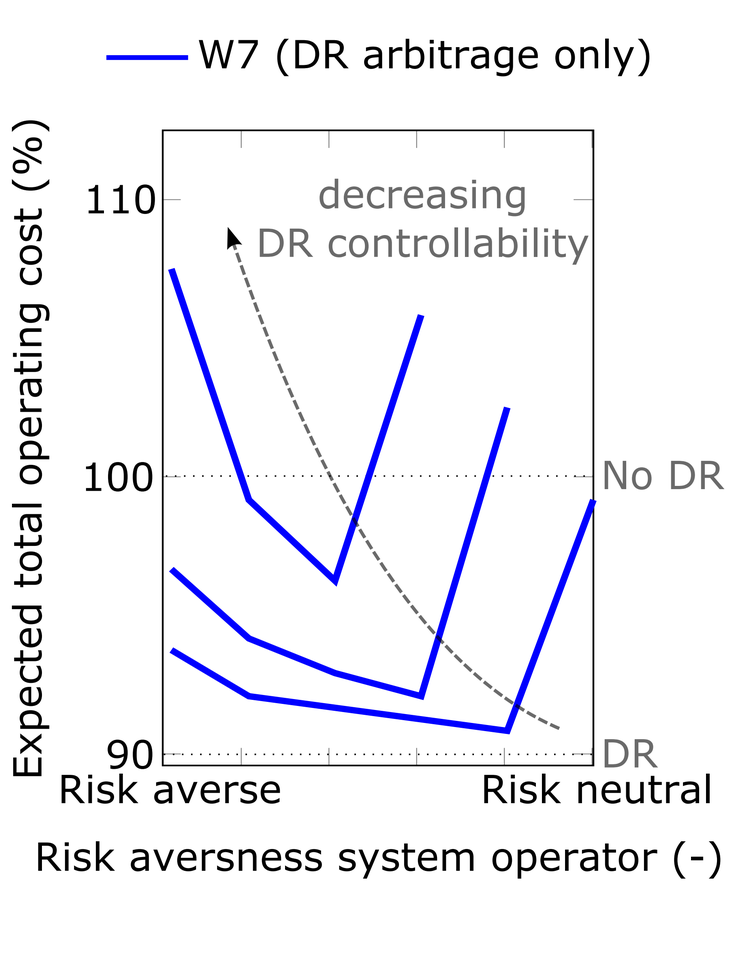
Population of buildings with electric heating systems, governed by comfort constraints

The system value of DR-based arbitrage & regulation services

1. Controllable DR, guaranteed comfort
2. Controllable DR, discomfort allowed
3. Limitedly controllable DR (arbitrage)







- Increased utilization RES
- More cost-efficient scheduling of conventional power plants.

- Increased operating cost savings, limited thermal discomfort.
- Compensations < 0.46€/Kh.

- Risk-averse: RES spillage & ineffecient UC schedule.
- Risk-neutral: load shedding.

Next steps

1. How does a strategic DR aggregator interact with limitedly controllable DR providers?
2. Representation of heterogeneous DR resources.

Further reading

K. Bruninx et al., *Valuing Demand Response Controllability using Chance Constrained Programming*, IEEE Transactions on Sustainable Energy, 2017.

D. Patteeuw et al., *Integrated modeling of active demand response with electric heating systems coupled to thermal energy storage systems*, Applied Energy, 2014.

K. Bruninx and E. Delarue, *Endogenous Probabilisitic Reserve Sizing and Allocation in UC Models: Cost-effective, Reliable & Fast*, IEEE Transactions on Power Systems, 2016.