



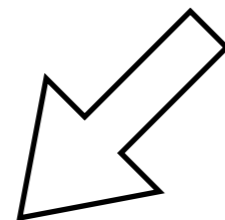
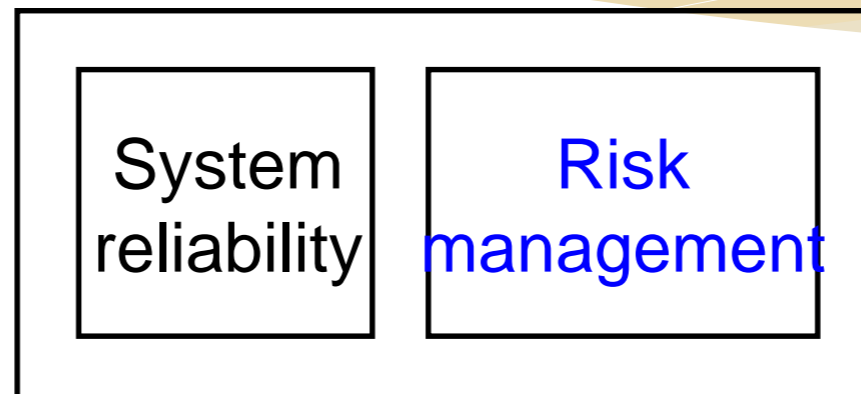
Stochastic Control and Optimization for Electric Power Systems

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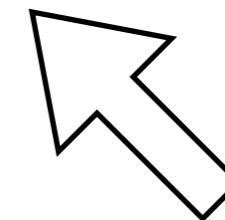
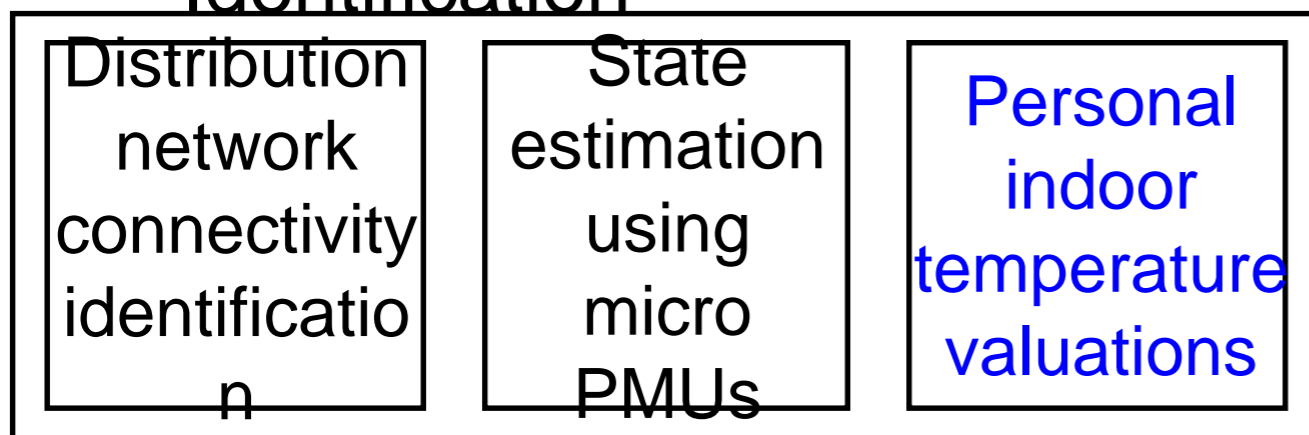


Research focus

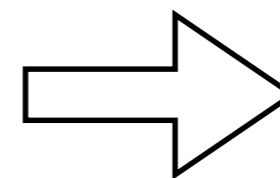
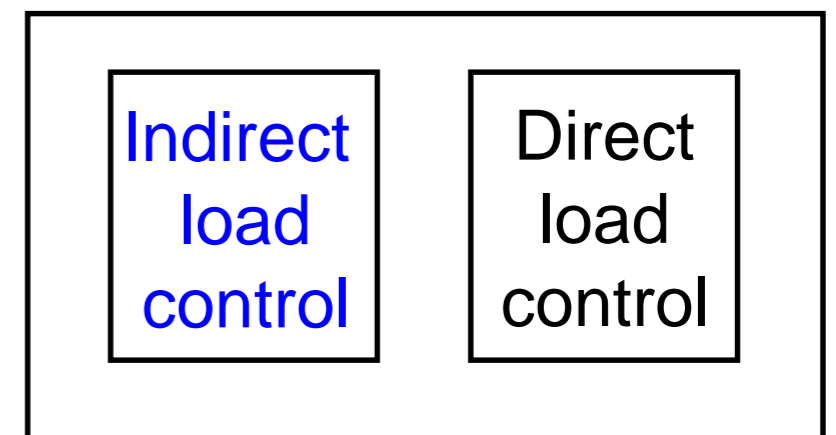
Objective



Sensing & Identification



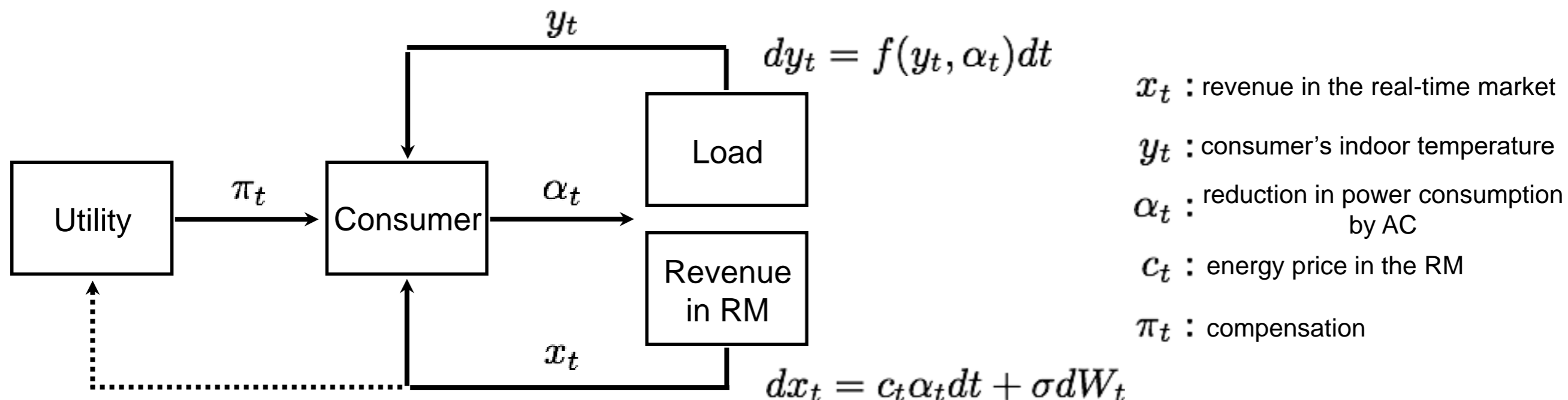
Control & Computation



Indirect load control

Yang, Callaway, Tomlin, *in review*.

- A utility company does **not** have the authority to control consumers' loads.
- The utility company does **not** have the capability of monitoring consumers' loads.
- The utility and consumers **share** the **risk** from uncertainties through a **dynamic contract**.
- The utility chooses a compensation scheme that maximizes its payoff when the consumer executes an incentive compatible control



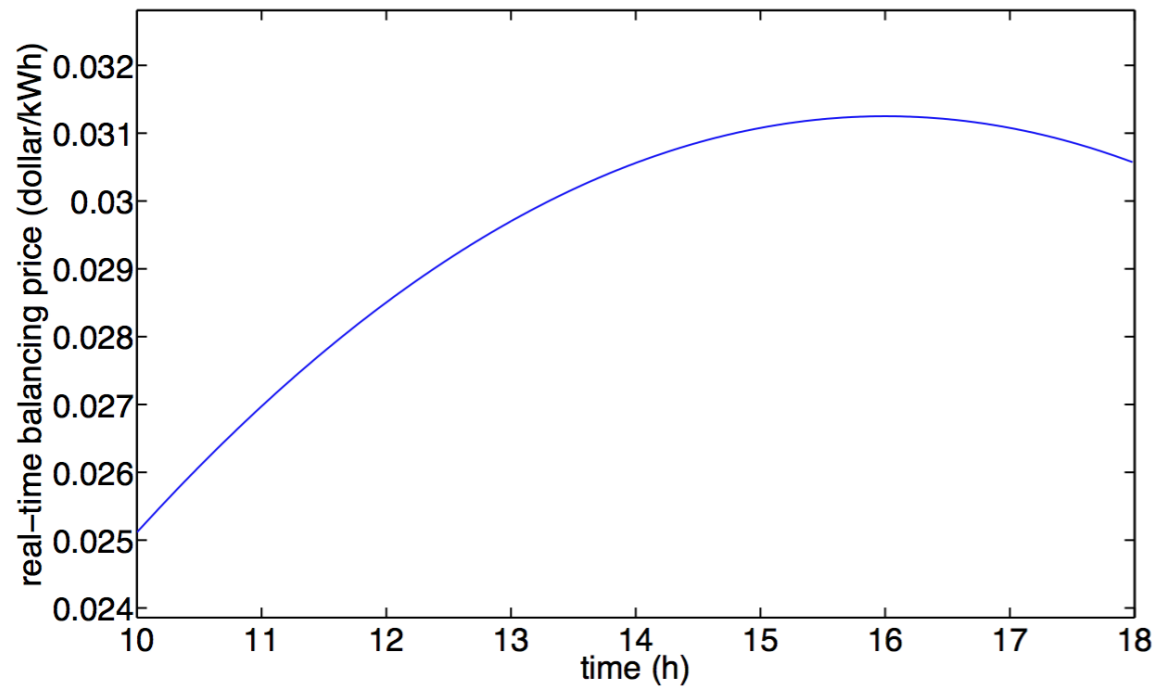
Dynamic contract design

1. Characterize a condition in which the consumer's control maximizes his payoff.

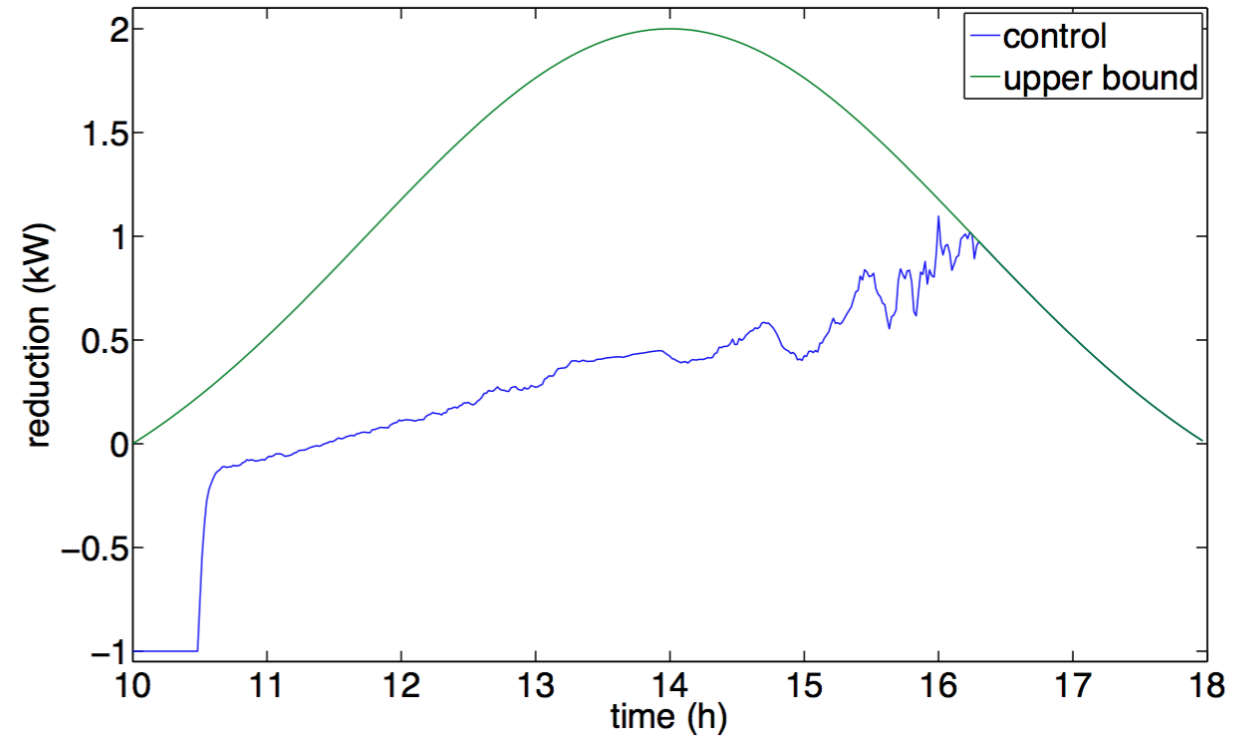
2. Choose real-time and end-time compensation such that (the compensation scheme and) the consumer's incentive compatible control
 - (a) maximize the utility's expected payoff,
 - (b) make the consumer's expected payoff exceed some threshold.

3. The contract specifies
 - (a) optimal compensation scheme
 - (b) recommended (incentive compatible) control strategy

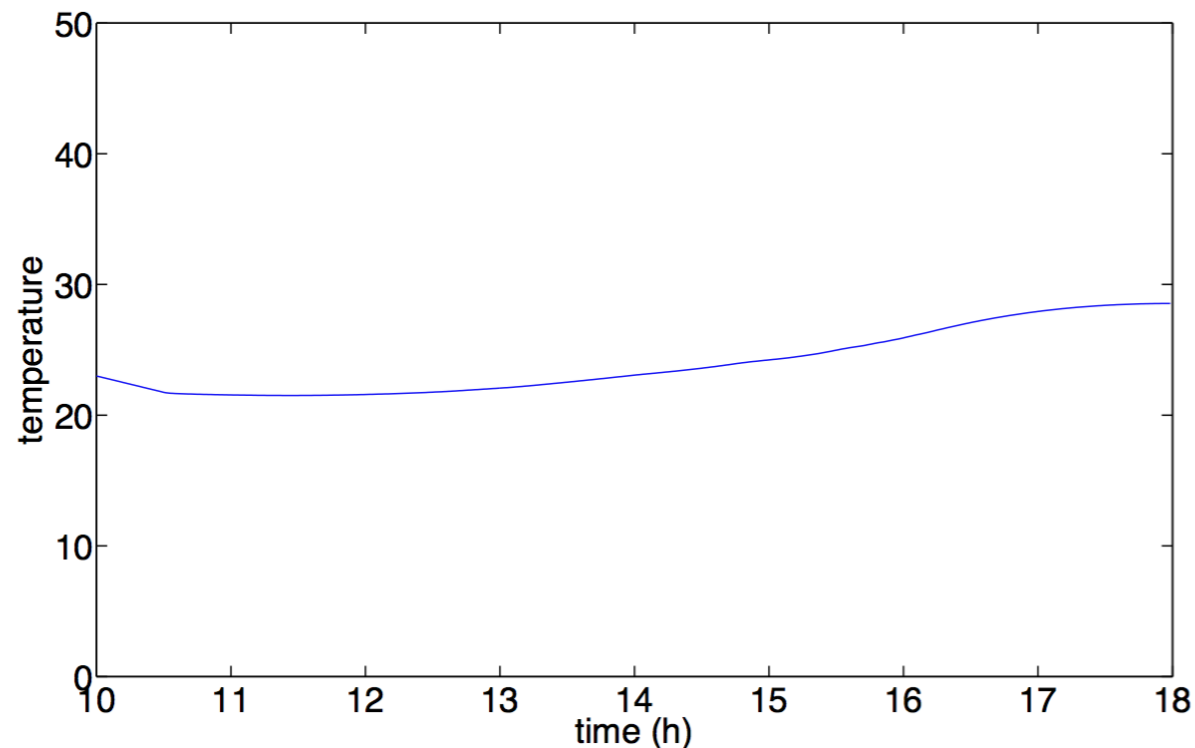
Balancing price, c_t , in the real-time market



Incentive compatible control (reduction in power consumption)



Indoor temperature



The contract induces the desired behavior of the customer:

- to increase power consumption when the price is low (overcooling)
- to decrease power consumption when the price is high

Ongoing and future work

Sensing & Identification

- Distribution system state estimation with micro PMU data
(joint with Alexandra von Meier)
- Identification of personal indoor temperature valuations
(joint with Lillian Ratliff)

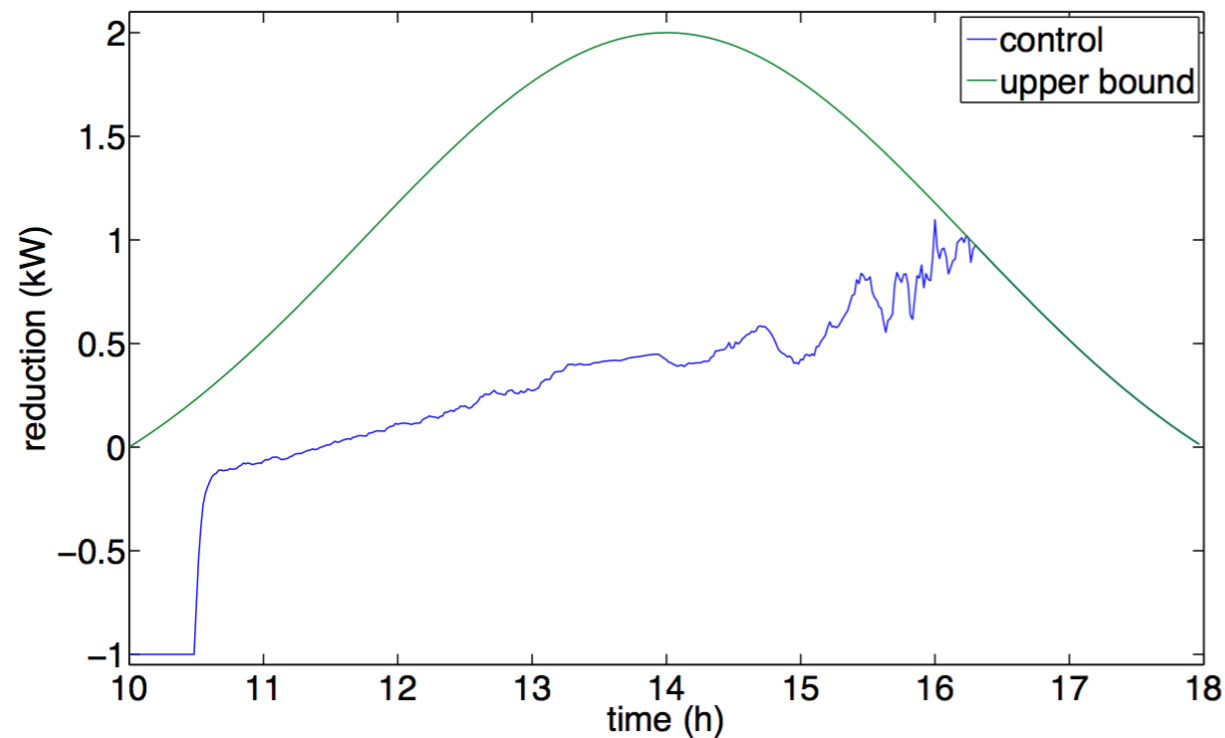
Control & Computation

- Dynamic contracts for heterogeneous customers
(joint with Duncan Callaway)
- Memory efficient high dimensional stochastic optimal control
(joint with Matthias Morzfeld)

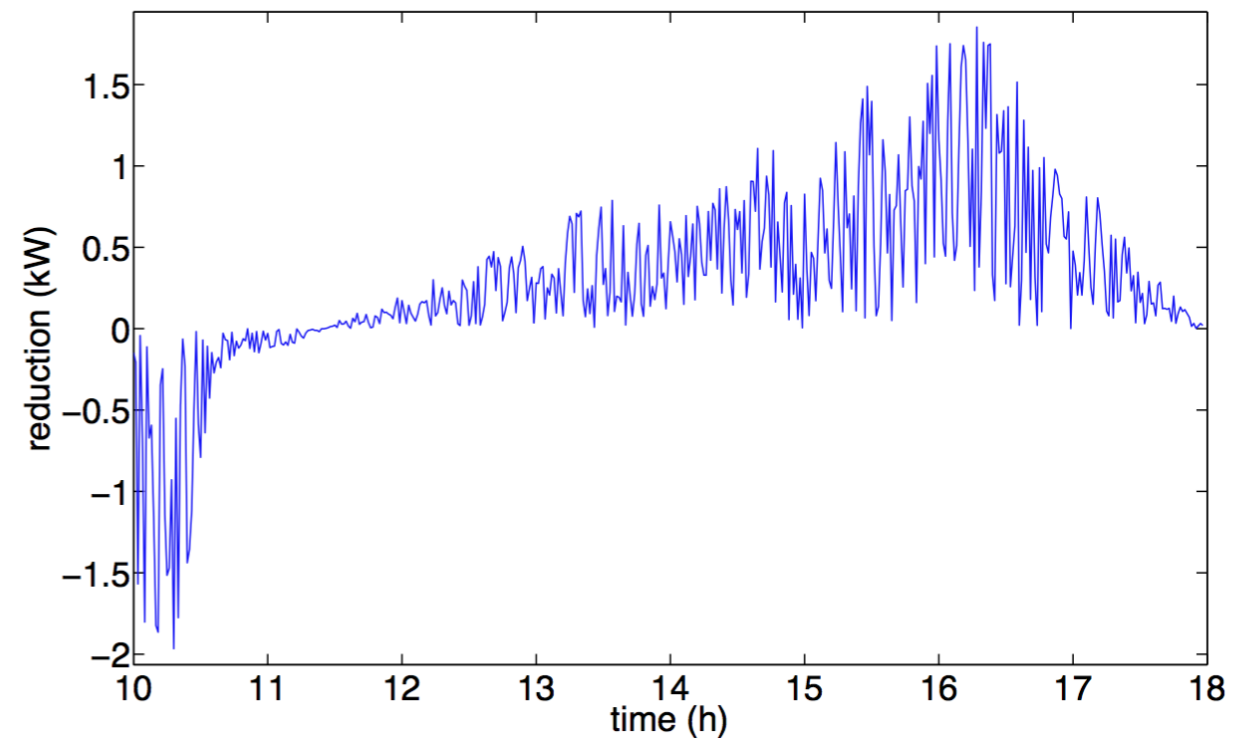
Unified theory for the quantification and management of risk, private information and system reliability

Robustness to implementation errors

Incentive compatible control
(reduction in power consumption)



100 percent implementation error
(reduction in power consumption)



Robustness to implementation errors

The utility's profit due to the control and compensation is not significantly affected by the implementation

