Electricity Demand as Virtual Storage

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Energy Storage Workshop
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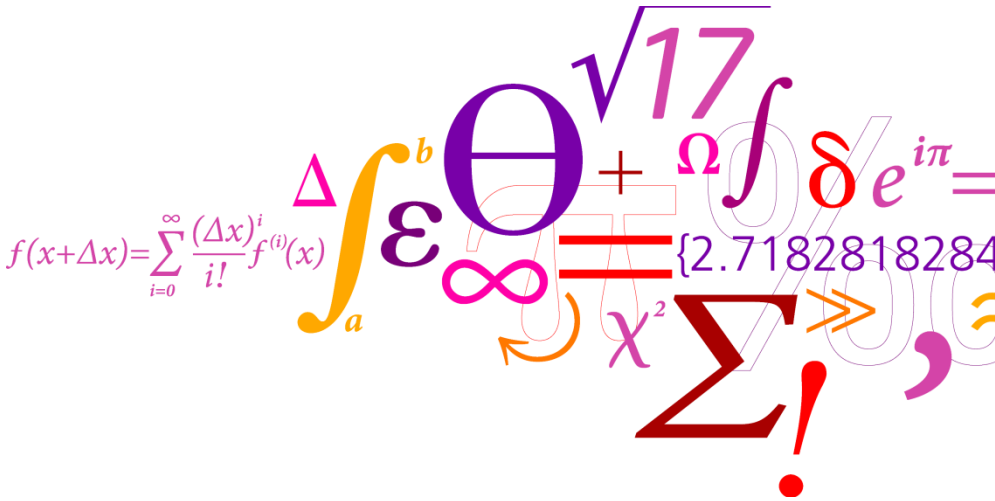
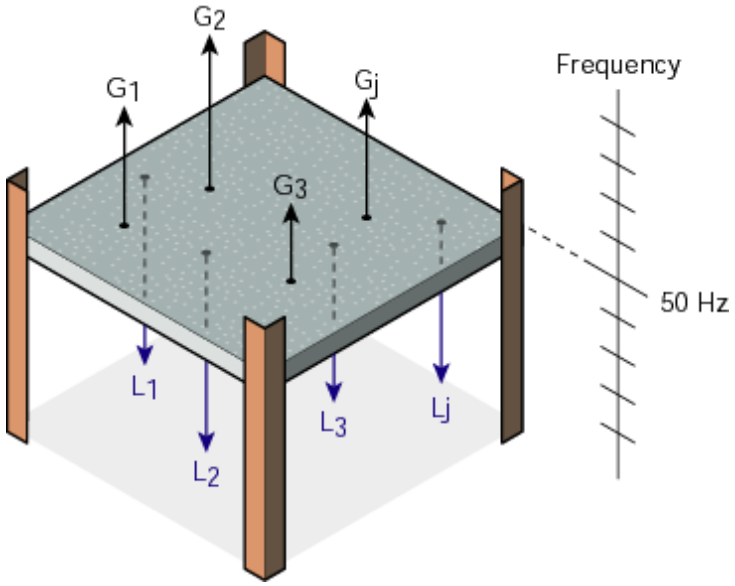


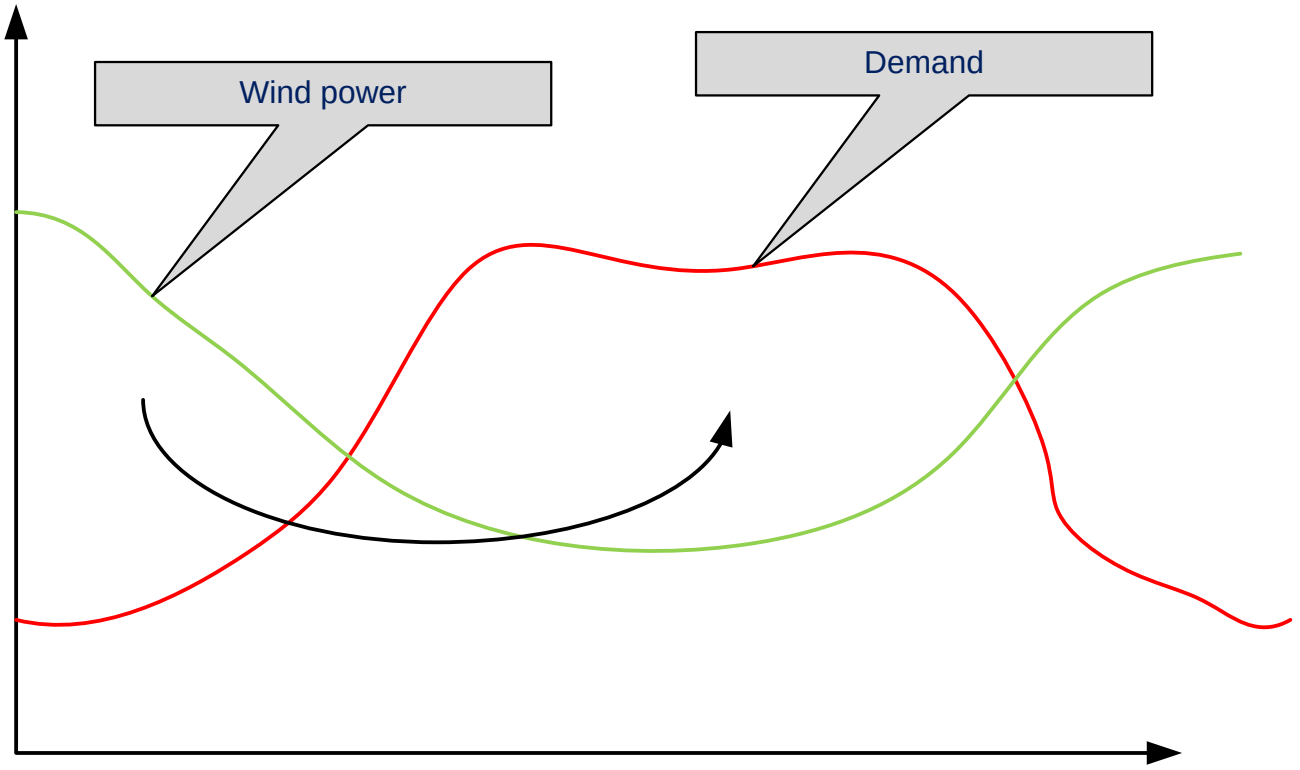
DTU Electrical Engineering
Department of Electrical Engineering

Power system balance



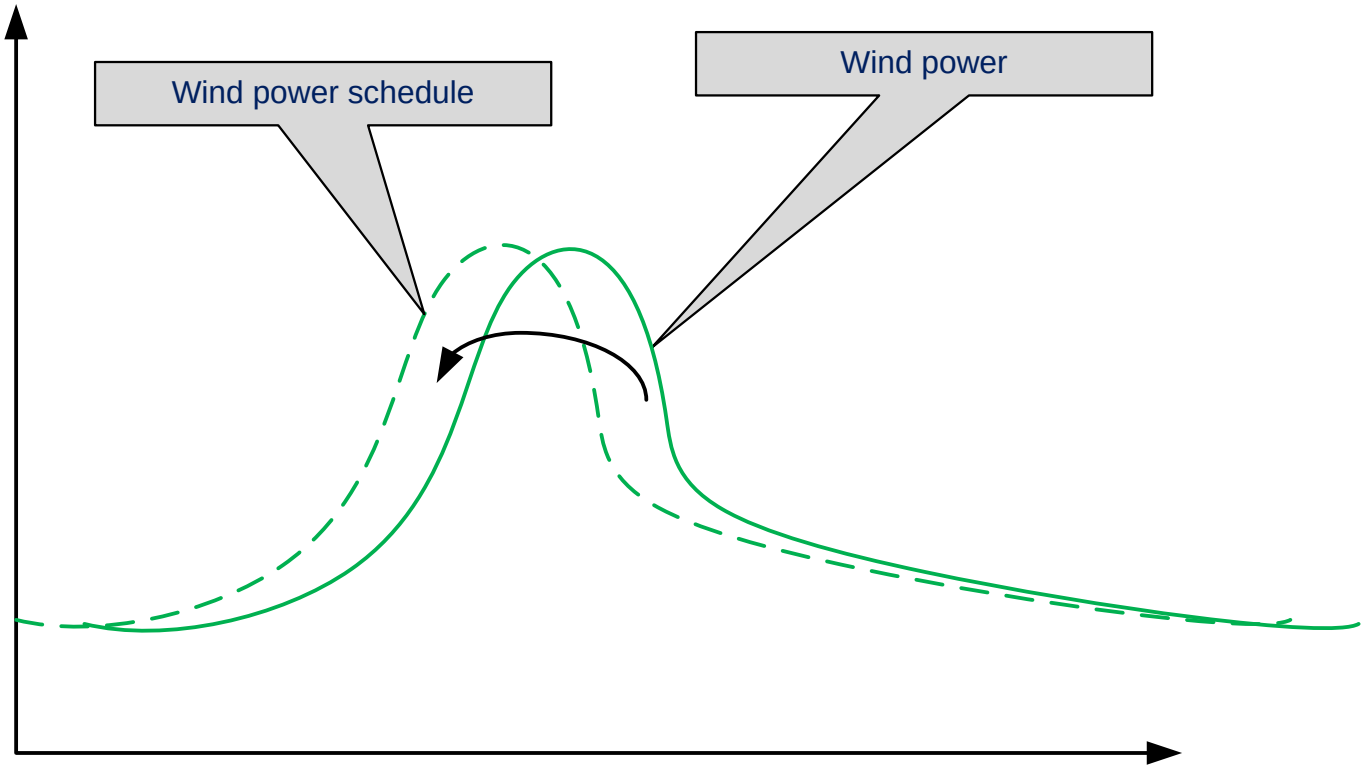
What is storage?

- Storage can shift energy in time

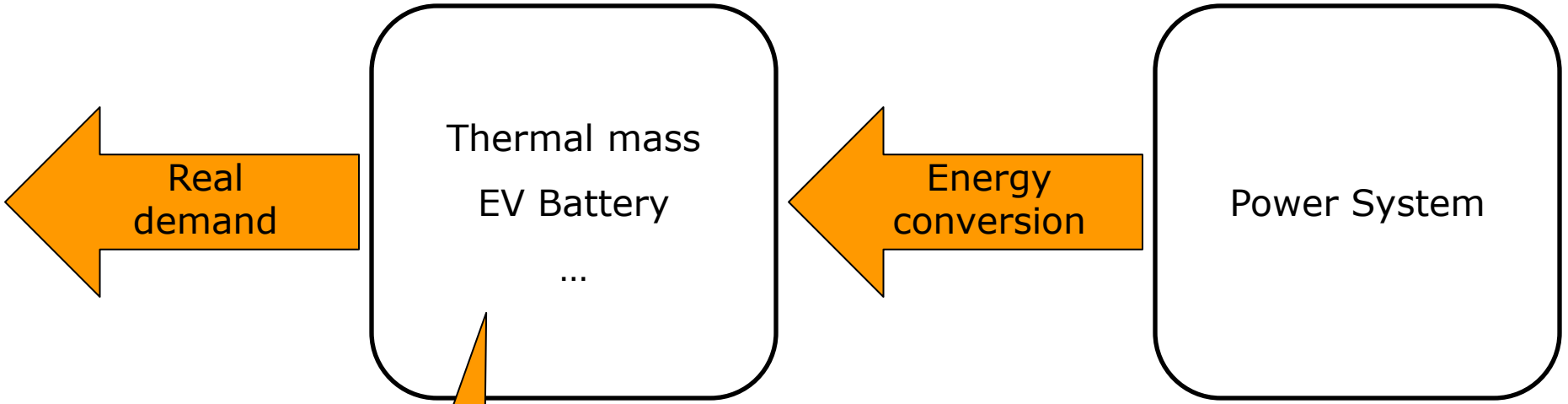


Forecast errors

- Storage can shift energy in time



Load rescheduling



E.g. warm home

Cold food

Drive car

FREE energy storage!

Can be rescheduled:

Advanced or postponed for seconds, hours …

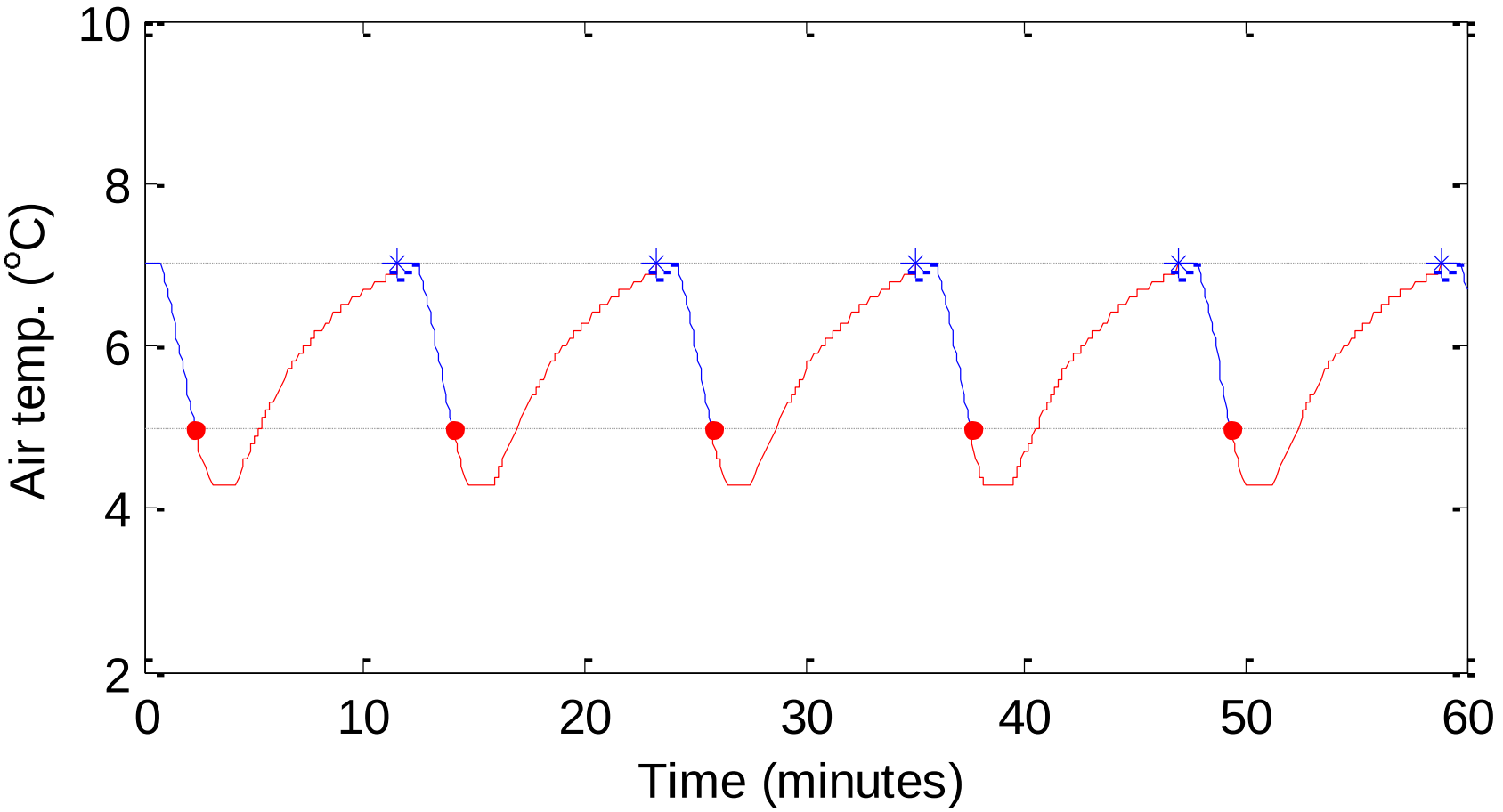
How to utilize this potential

"Computing and communication are among the few things left in our society that are decreasing in cost."

Fred C. Schweppe, MIT

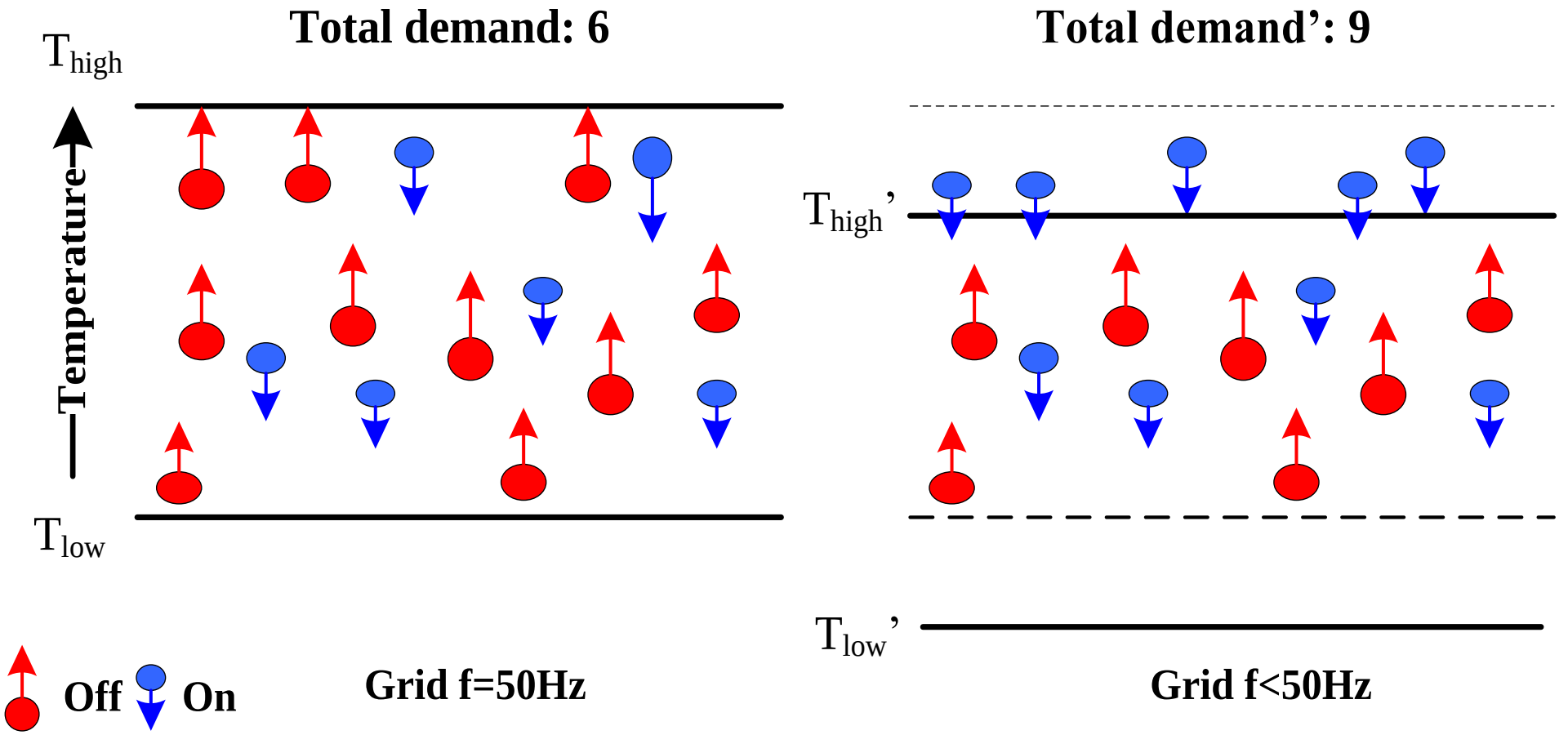
- "Homeostatic utility control" revisited:
  - Frequency-responsive demand (seconds to minutes)
  - Price-responsive demand and generation (minutes to hours/days)

Case 1: Frequency-responsive refrigerators (droop control)

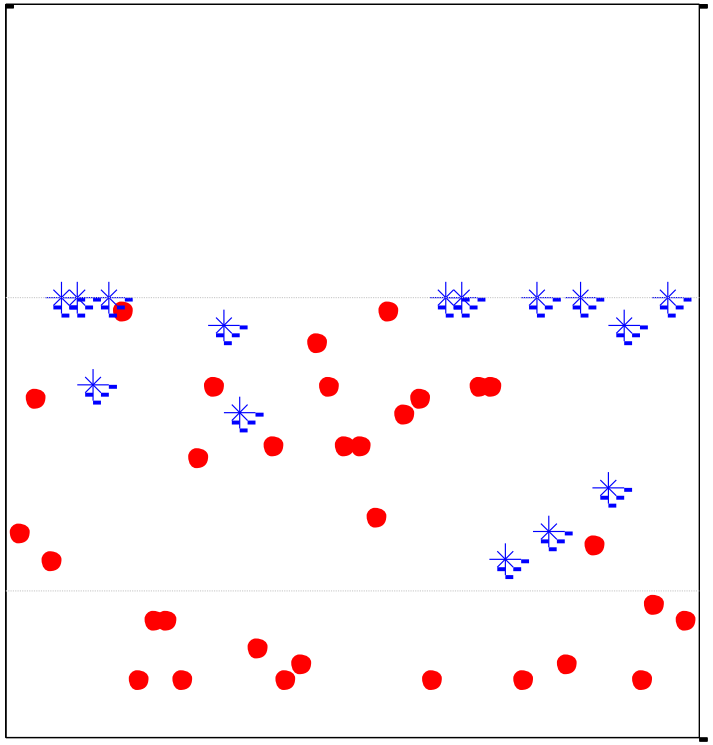


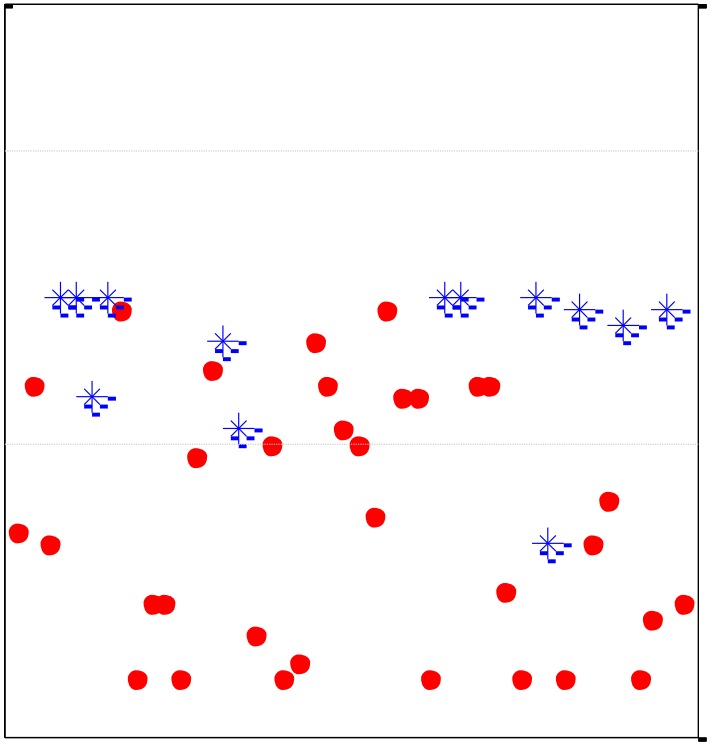
The compressor did not need to switch on at all in this hour!

Move setpoint to charge/discharge

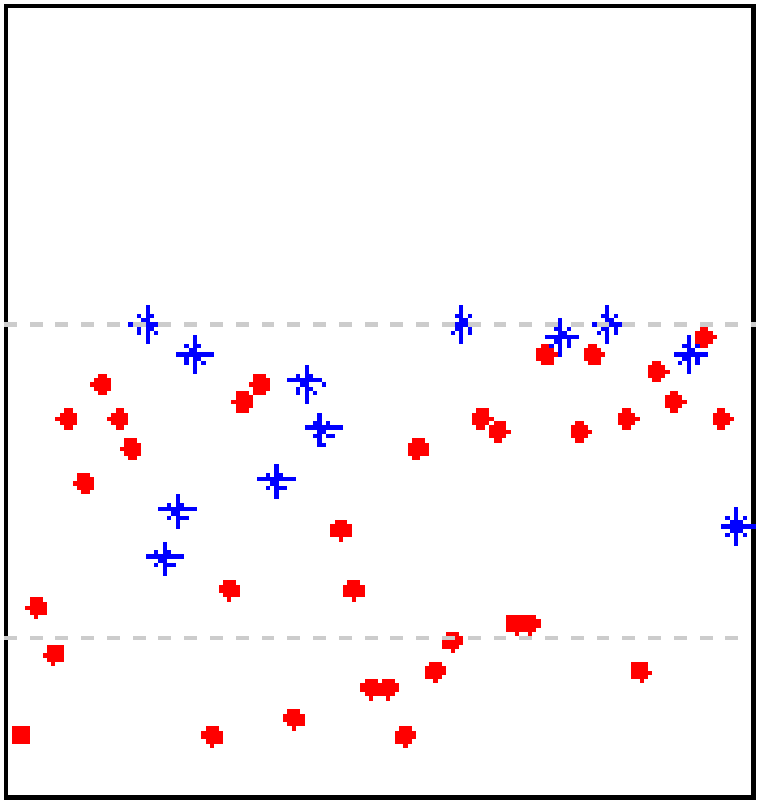


Setpoint step

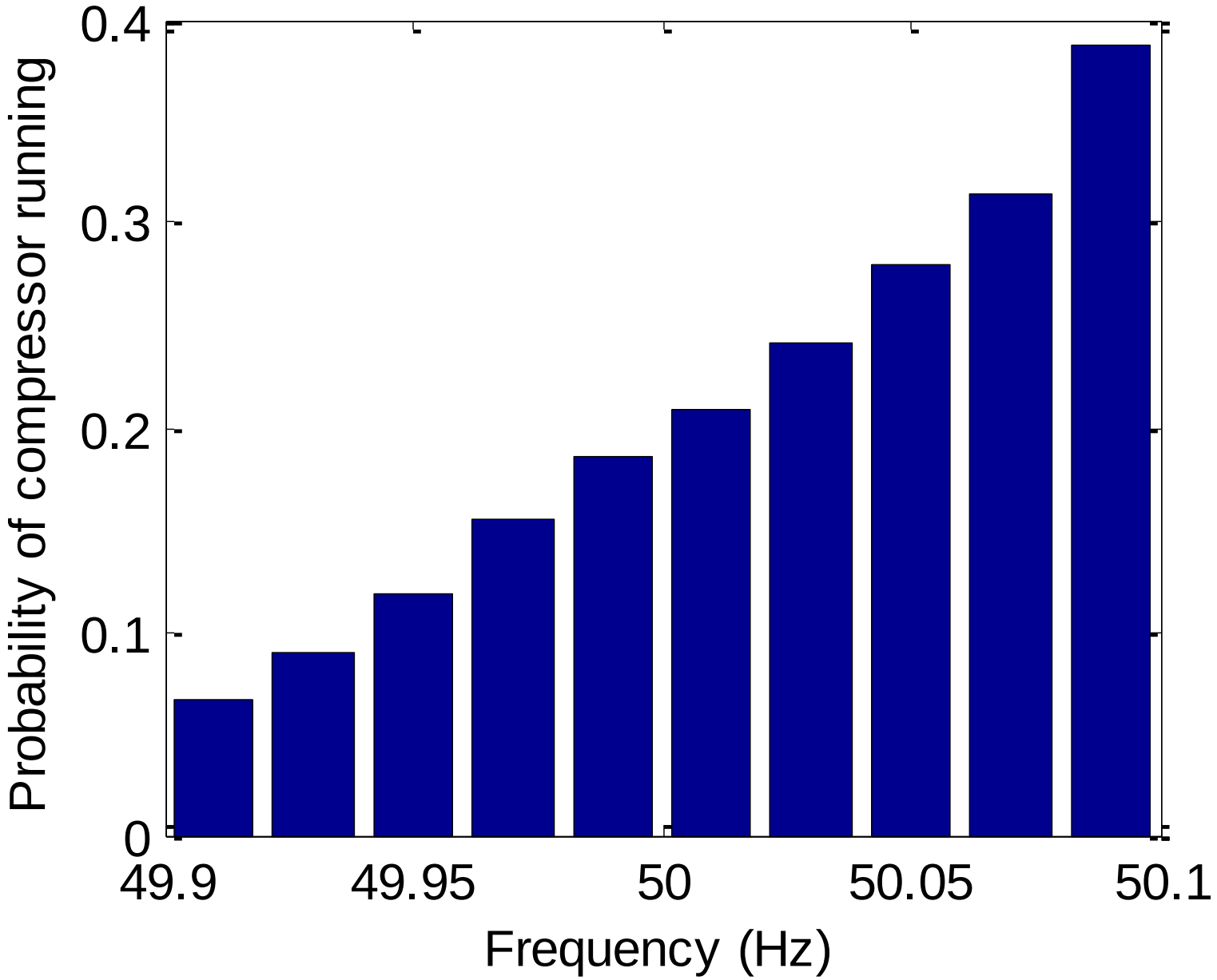




Setpoint step



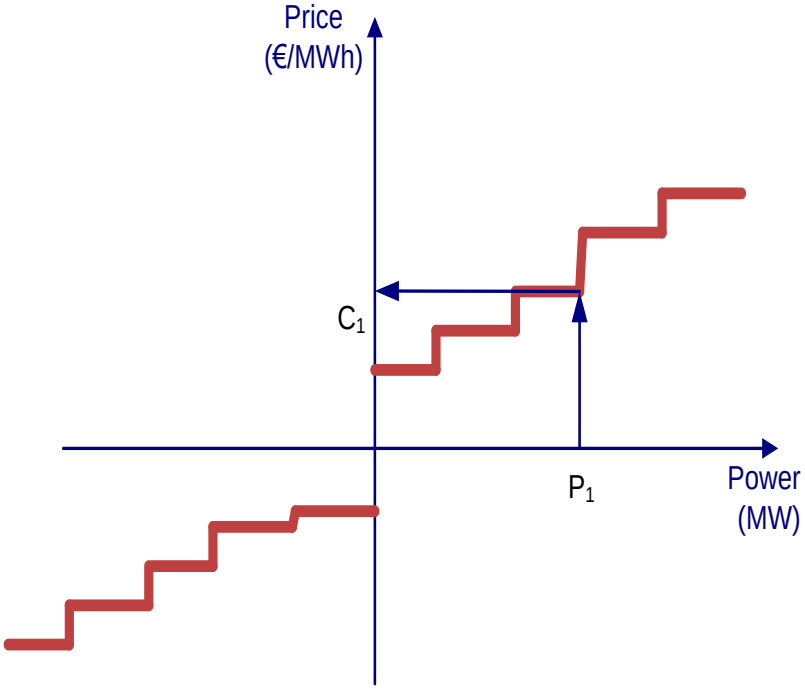
Lab results with refrigerator (droop control)



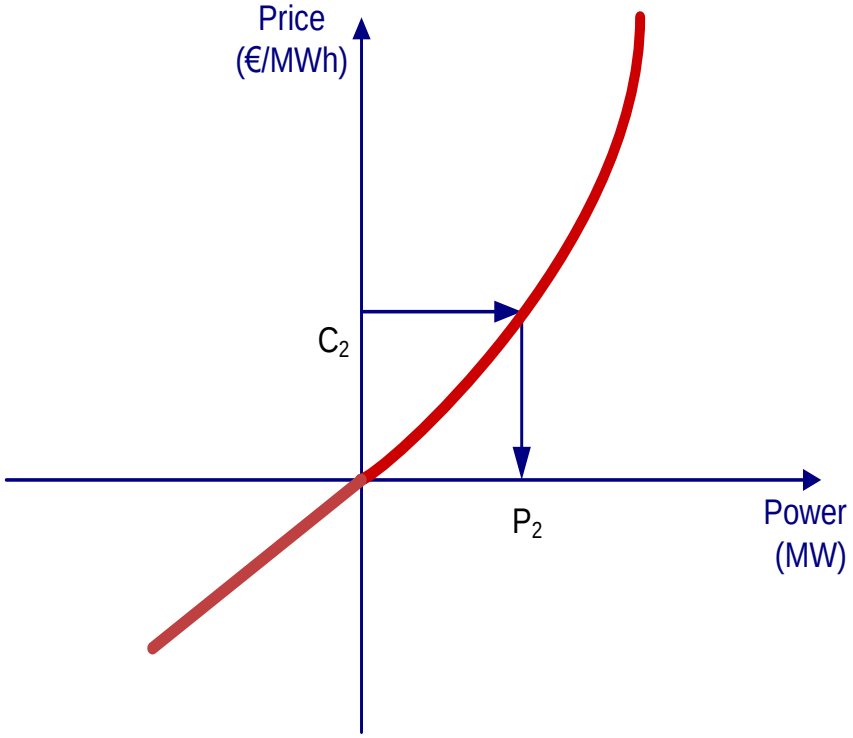
Case 2: Price-responsive demand

- Space heating:
  - High power per installation (several kW)
  - Large heat capacity (several hour cycles)
  - Drawback: Seasonal variation
- EV chargers:
  - High power per installation (several kW)
  - Large capacity (several hour cycles)
  - Large potential for postponing (maybe even days)

Assumption: One-way price signal (no bidding and clearing process)

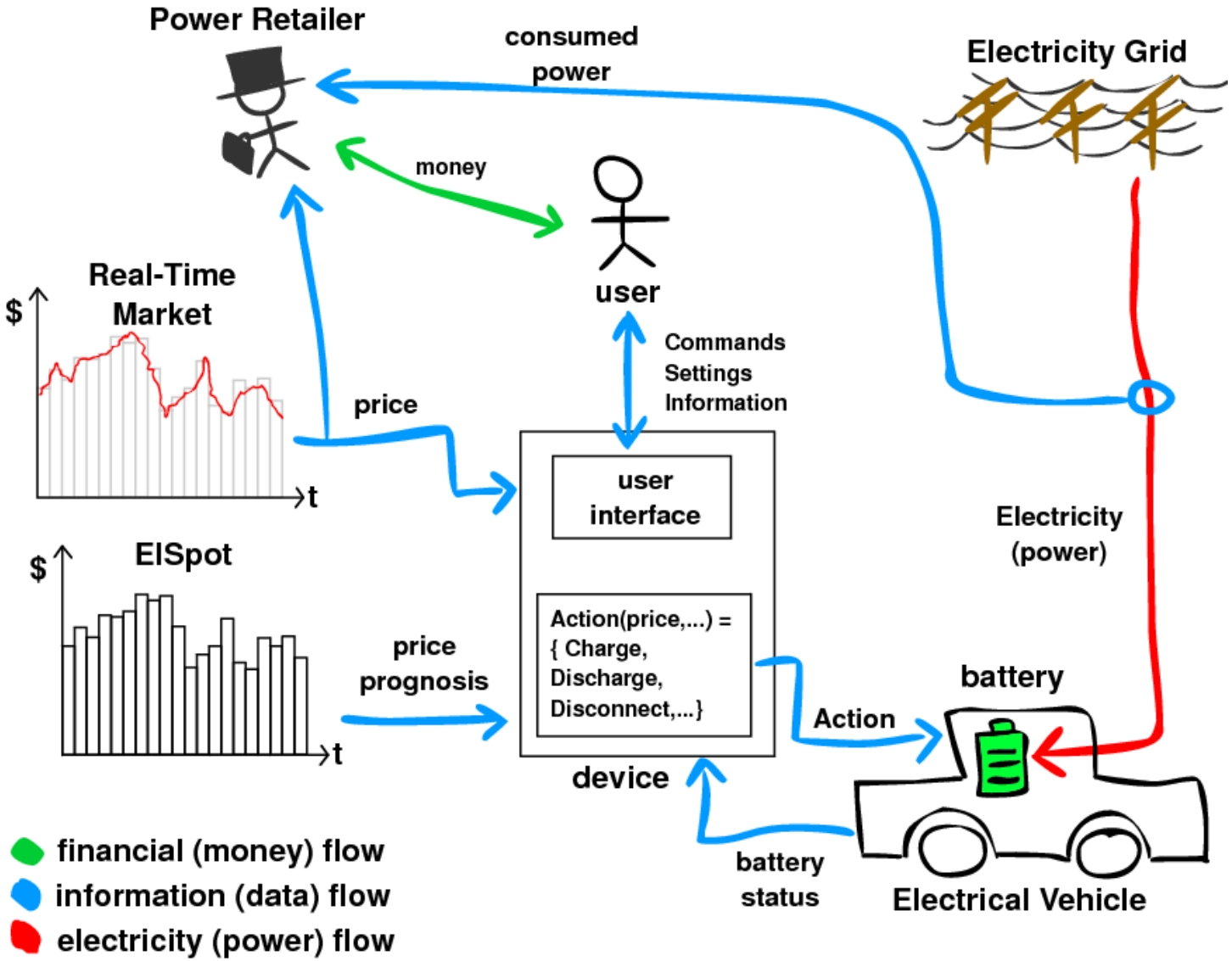


Traditional regulating power market

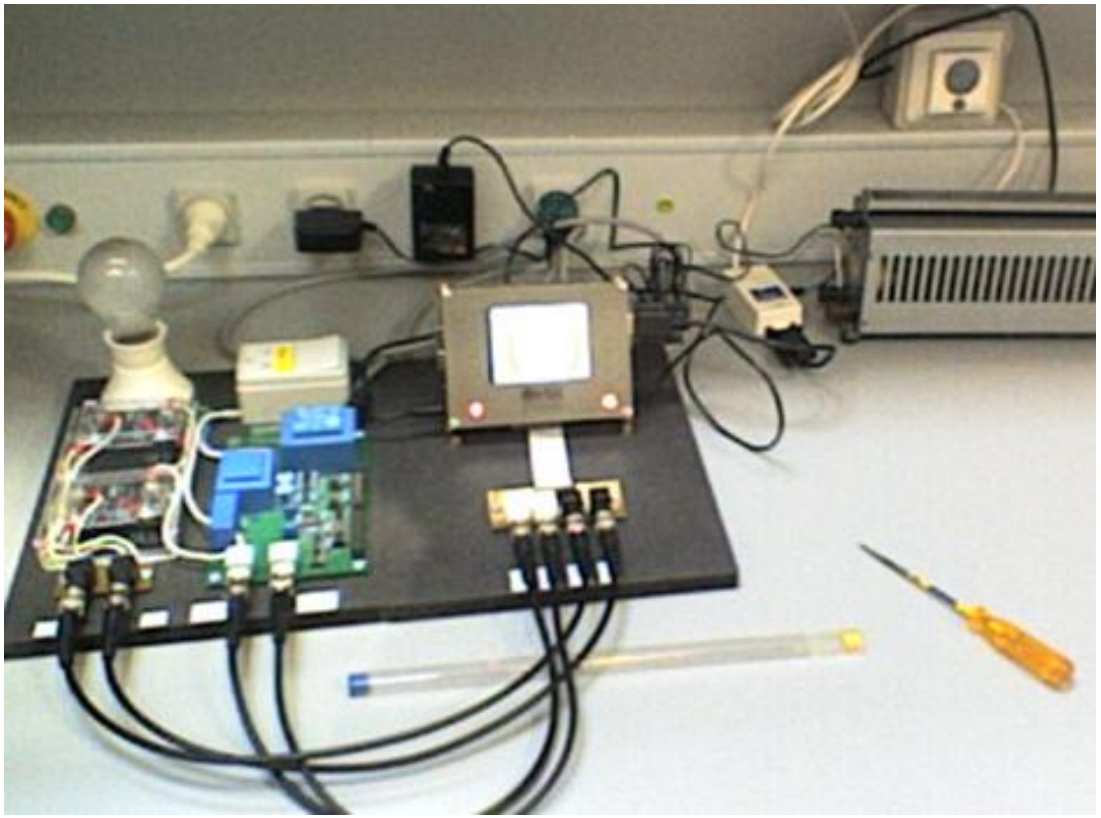


Real-time price signal

Architecture



Implementation

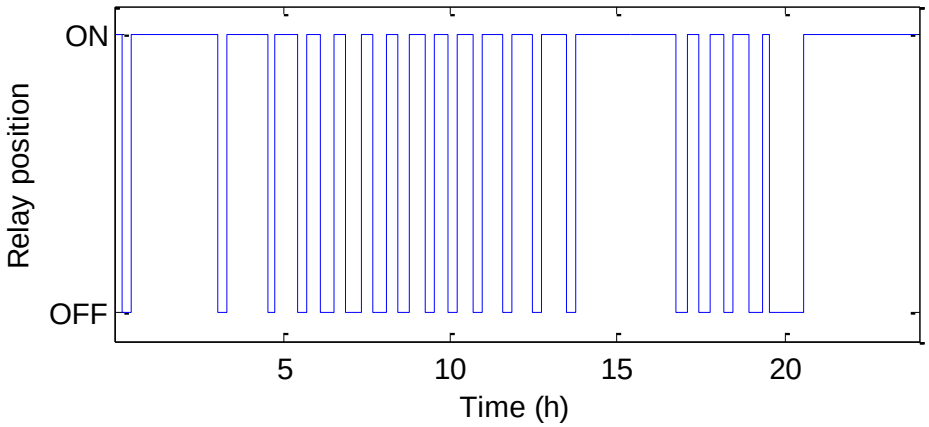


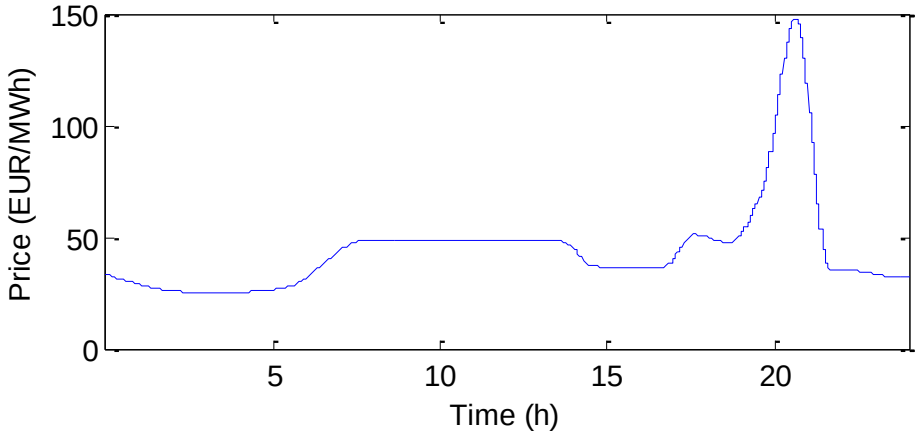
Lab model, 1:1000 living room in polystyrene box

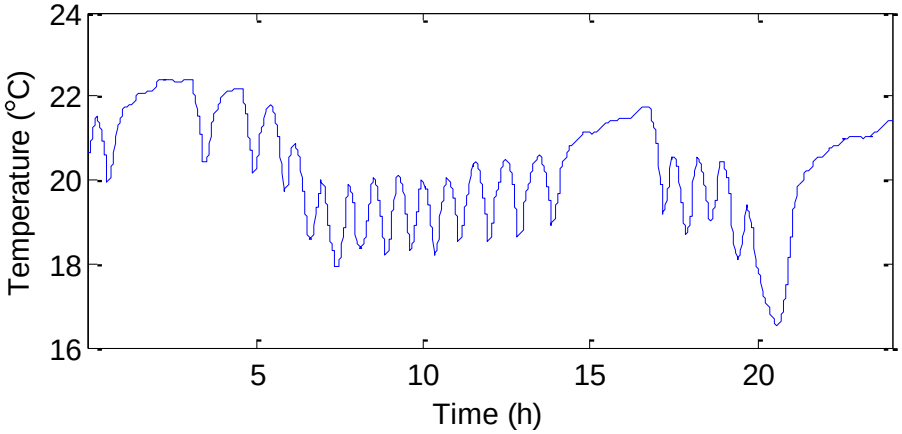
”Space heating” lab results

5% reduction of electricity cost

Temperature deviations not realistic (lack of thermal mass)







Summary

- Many loads inherently contain energy storage
- It is FREE
- Except for the ICT needed to utilize it…
  - Frequency response
  - Price response
- Customer and industry acceptance is the largest problem
- Demonstration projects needed
  - Frequency-responsive demand demo to start August 2010

Thank you !