Dynamic pricing in district heating systems and the impact of heat storage
Nina Dupont, Bjarne Bach and Mikael Togeby

Introduction
Using dynamic pricing is well known in the power sector. The focus of this poster is the impact of using hourly marginal pricing in district heating systems in stead of the heat tariffs currently in use.

Definition of marginal heat price: The extra total cost associated with a marginal increase of heat demand.

Marginal heat price depends on:
- Heat demand, which changes the level of production in the merit-order curve.
- Electricity price, which influences the revenue the production units.
- Congestion, which ensures different marginal prices on each side of the congested line.
- Grid losses and fuel prices.

Impact of heat storage on the marginal heat price is a major focus point in this poster.

Modelling
The Aarhus district heating system is modelled in the least-cost optimization model Balmoral for the years 2015 and 2035.

Heat demand
The annual heat demand is assumed to be 2.86 TWh in both years. The total demand is distributed over 47 interlinked demand nodes.

Heat production
In 2015, existing units are modelled, where the units in 2035 represent a possible future for the Aarhus district heating sector, and technologies such as solar thermal heat and heat pumps are introduced in the mix.

Heat storages
1. The heat storage in Studstrupværket (SSV) exists in 2015 and is a short-term storage which optimizes circularly per week. It has no losses, Storage volume: 2 GWh – Storage (un)load capacity: 333 MW
2. The storage that’s is added in 2035 in Aarhusværket is a larger seasonal storage and can optimise over an entire year. It has a 12.5% loss. Storage volume: 42 GWh – Storage (un)load capacity: 250 MW

Results: Marginal pricing vs average pricing
As the marginal heat price uses the marginal cost of the most expensive supplier, it’s always higher than the average short-term heat costs. The variation of the marginal price is larger (in the order of 50% to 100% larger) than that of the average price.

Using marginal pricing reflects the true hourly marginal cost. The total revenue for the heat producers when using marginal prices is larger than the total variable costs. This surplus could be used to finance (part of) the fixed costs. The difference is bigger in 2035 than in 2015. It is still possible to keep the non-profit obligation.

Results: Use of heat storages
Where the storage in Studstrupværket is used as a daily storage to balance daily variations in the demand and heat prices, the storage in Aarhusværket is used as a seasonal storage. The storage buys during the summer when heat demand is low (and solar heating production is high) and sells heat in the winter hours where the heat prices are highest. Due to the storage losses, the storage is not used much for balancing the (smaller) short-term price variations.

Discussion
Fixed prices for heat delivered to district heating systems do not reflect the actual value of the heat. Using hourly marginal prices would give the correct incentive to new heat suppliers coming to the district heating market, such as industrial surplus heat, or independent heat generators with e.g. solar heat plants or heat pumps. Dynamic pricing would be technology neutral and economically efficient. Heat storages have a large impact on marginal heat prices. Both seasonal and daily storages can be used in a district heating system such as in Aarhus. Next steps would be to look at practical implementation of dynamic heat prices in a district heating system such as Aarhus.