

Presentation of the PhD project: Distributed CHP-plants optimized across more electricity markets

Peter Sorknæs, PhD Fellow, AAU

Statement of the project's objectives

The hypothesis of this PhD project is that a transition needs to be initiated from “First Generation distributed CHP” helping only to reduce fuel use through its high efficiency - towards “Next Generation distributed CHP” maintaining this high efficiency but at the same time making (on a macro-economic scale) the integration of fluctuating production from RES less costly by being flexible.

The research will focus on investigating investment and daily operation strategies for distributed CHP, when these plants are participating across more whole sale markets and balancing markets, and will be focused on the needed interaction between the plants when optimizing market participation.

Relation with 4DH

3. The main results of the project

[...]

- *strategies and software tools for decision-making support of local district heating supply companies with a focus on the integration into emerging electricity markets,[...]*

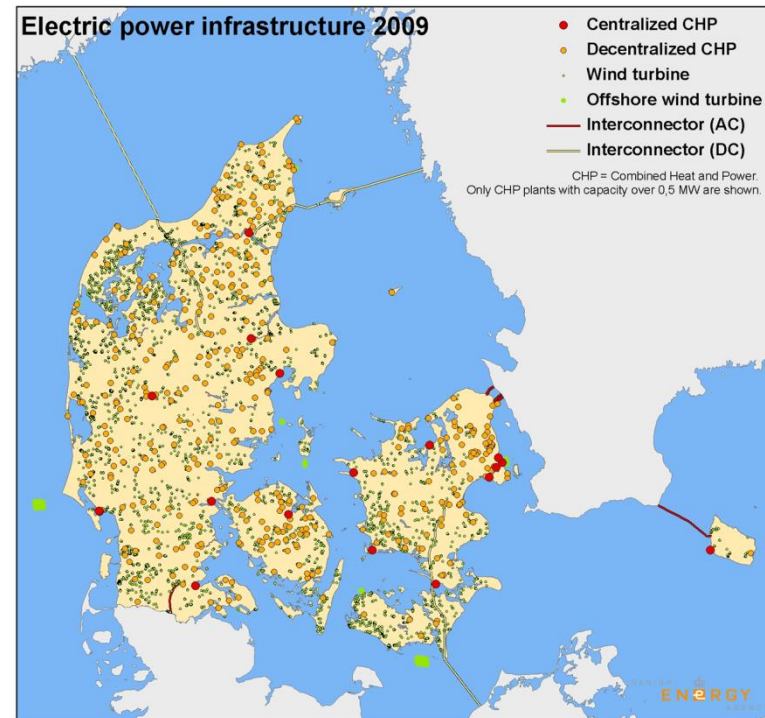
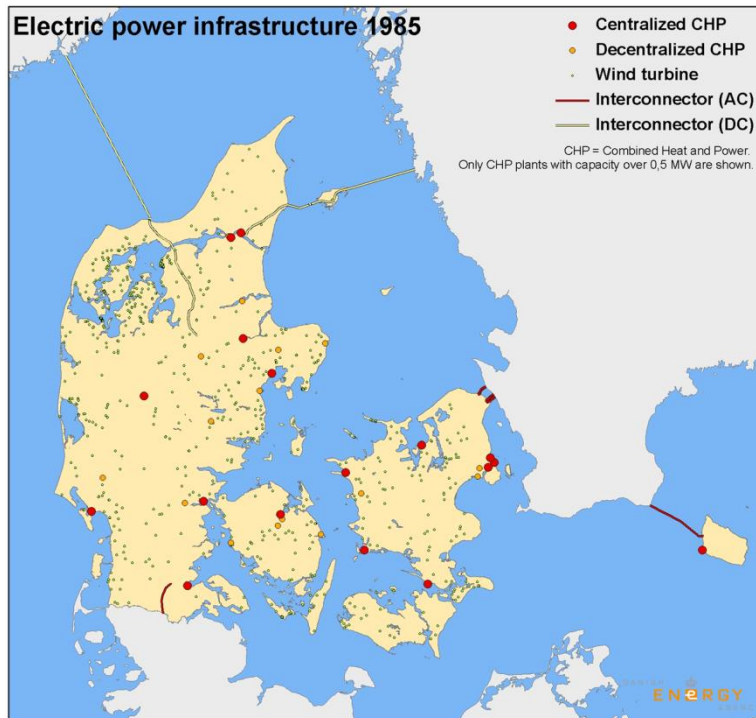
(Appendix B: Project description, page 2)

WP2.2: Integration of energy systems

[...]. Conventional distributed CHP mainly assists the energy system by means of its high efficiency, but 4DH will assist the energy system additionally through its flexibility. Research will develop tools and focus on investigating the investment and daily operation strategies for distributed CHP, when these plants are participating across more wholesale markets and balancing markets. Furthermore, it will focus on the needed interaction between the plants when optimising market participation.

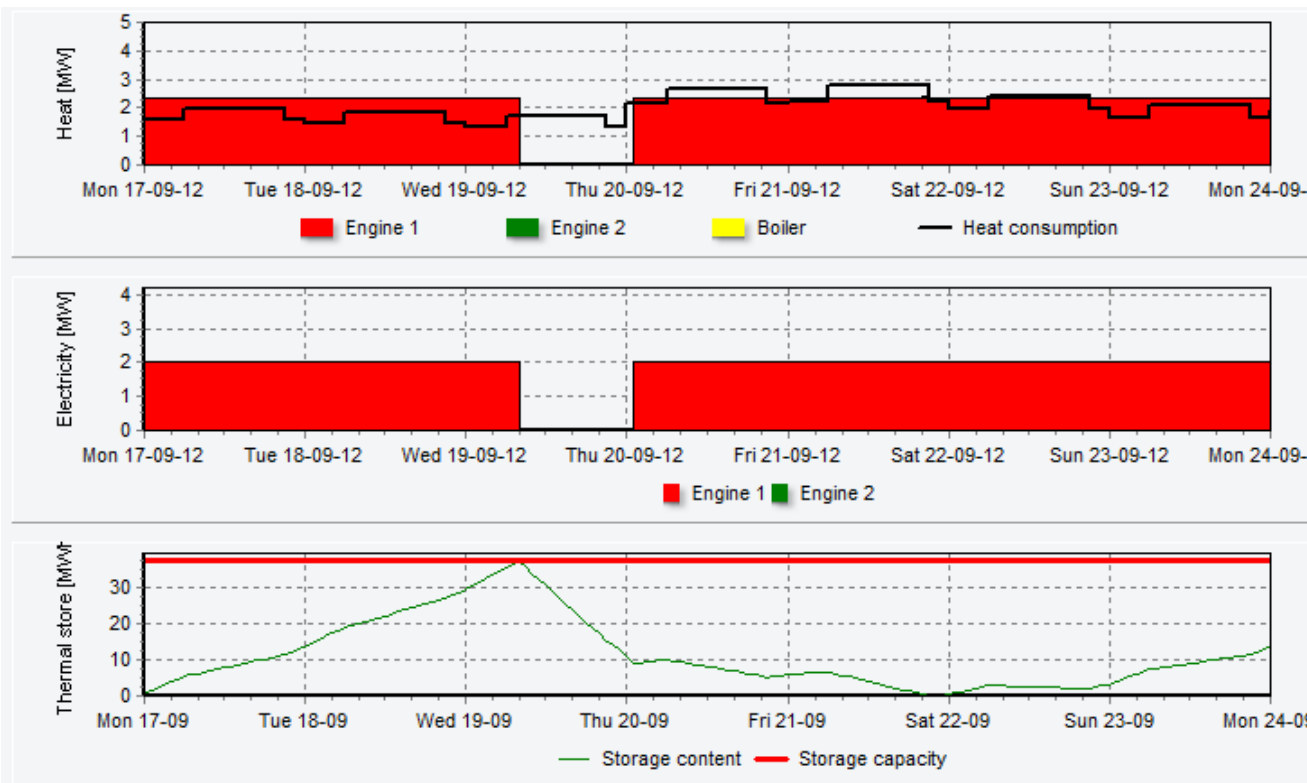
(Appendix B: Project description, page 7)

Development of the Danish electricity system



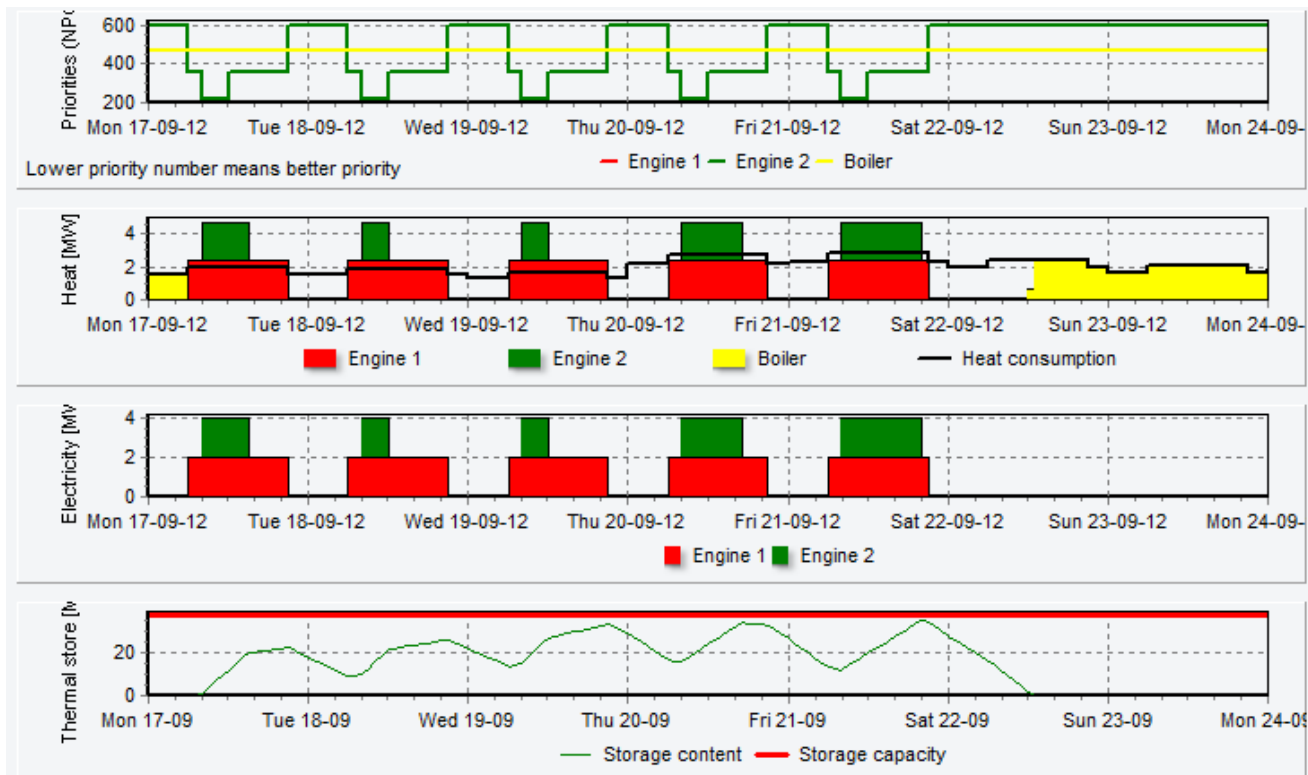
Development of distributed CHPs interaction with the electricity system

- **Stage 1** - Electricity was sold at a fixed price, in which the price does not vary in time.

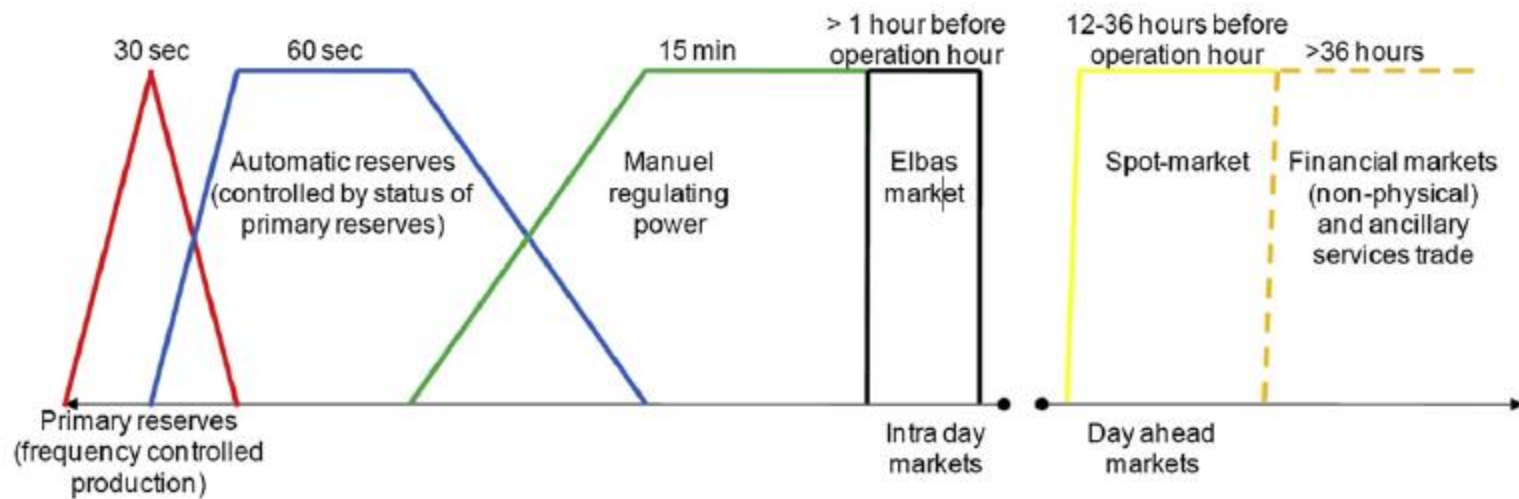


Development of distributed CHPs interaction with the electricity system

- **Stage 2** - Electricity was sold according to the triple tariff (or similar), in which the price varies in accordance with typical variations in the demand. The variation was known in advance and did not change if, for example, the demand changes.

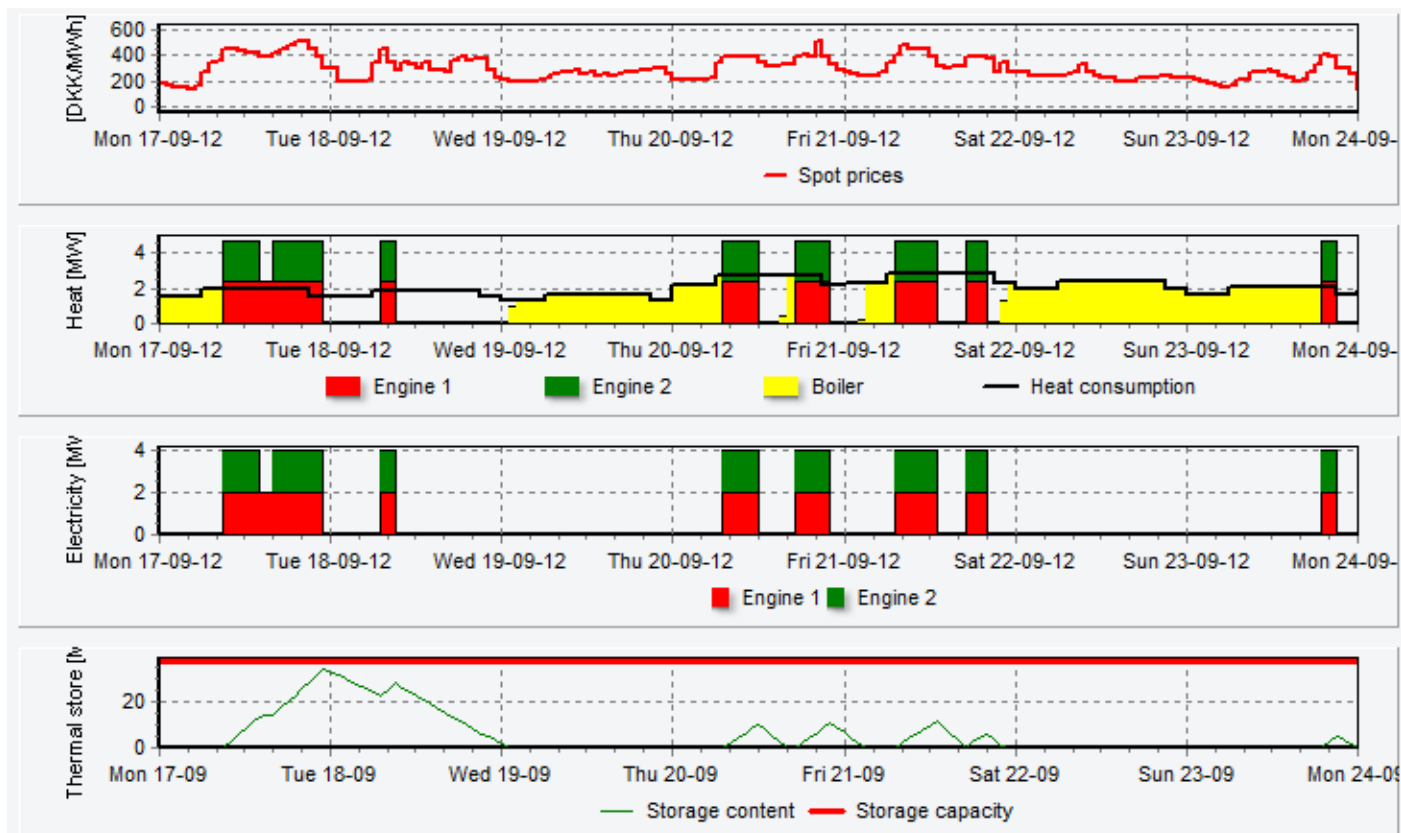


Electricity markets in Western Denmark



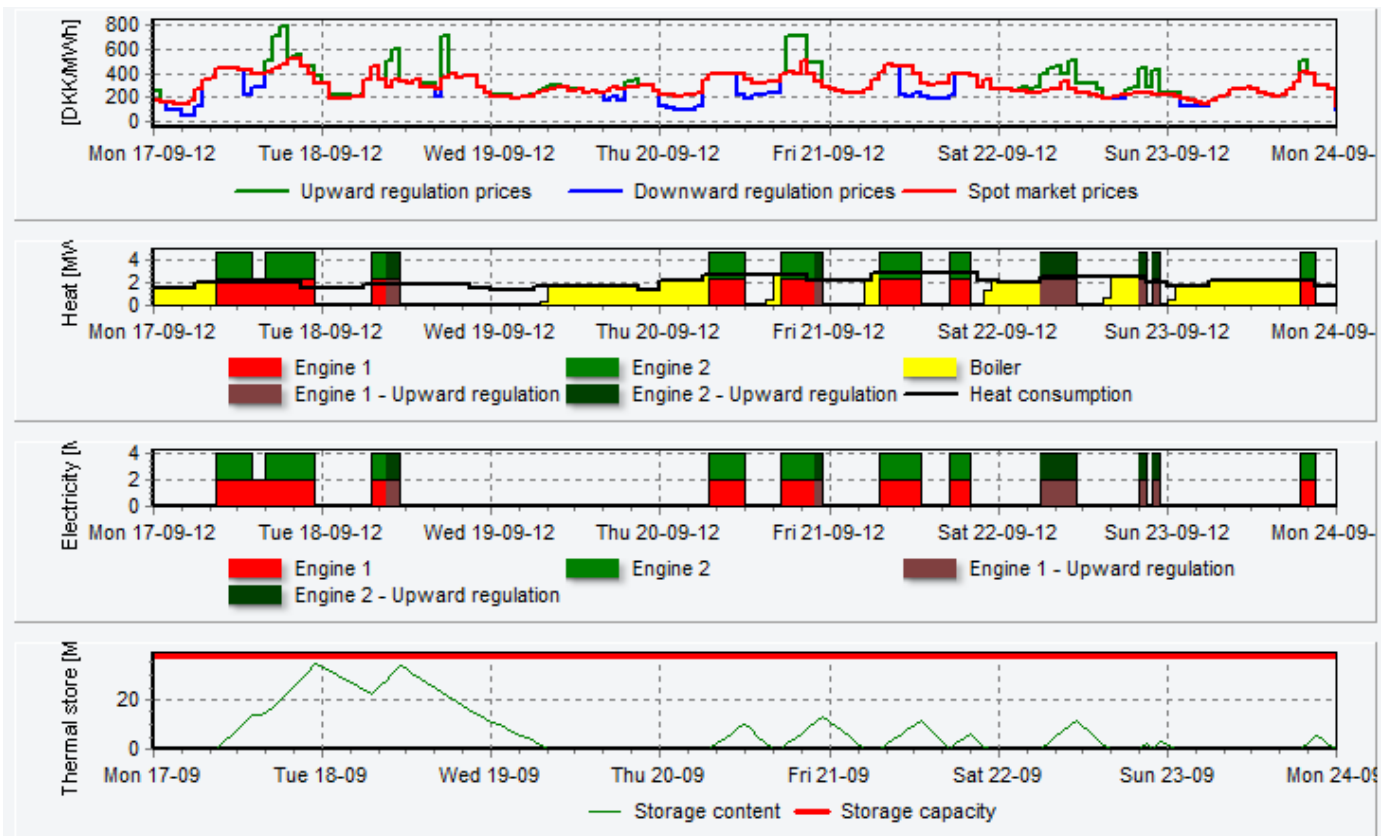
Development of distributed CHPs interaction with the electricity system

- **Stage 3** - Electricity is sold on electricity spot market (Nord Pool Spot), in which the prices vary from hour to hour. The prices are negotiated 12-36 hours in advance.



Development of distributed CHPs interaction with the electricity system

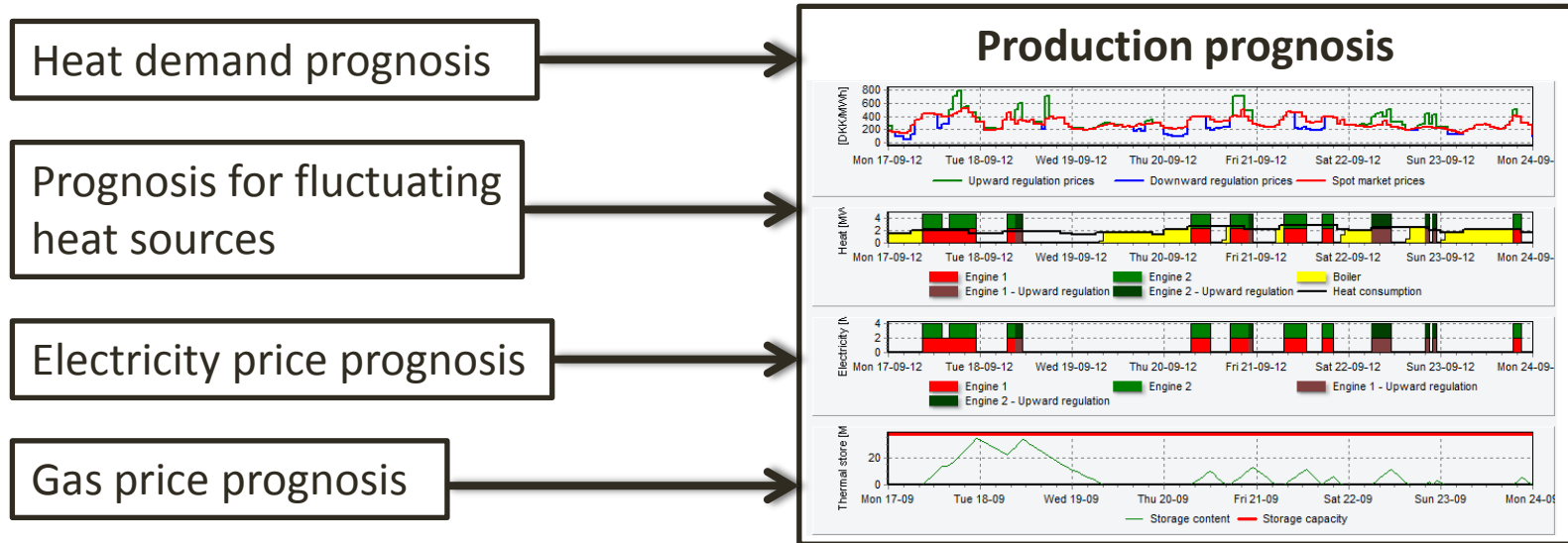
- **Stage 4** - Full electricity market integration. Participation on both the spot market and the electricity system balancing markets.



Other important changes to the daily operation of distributed CHPs

- Increasing capacity of electricity consuming heat production units, such as electric boilers and heat pumps
 - Makes the low electricity prices relevant for the distributed CHPs
- Increasing capacity of solar heating
- Distributed CHPs are increasingly purchasing natural gas on gas spot markets, such as Nord Pool Gas, where the gas price varies each day depending on offers and purchases
 - Traditionally distributed CHPs made natural gas contracts with gas prices fixed in each month or year
 - The gas price prognosis could become increasingly important if CHP plants started to become gas producers, as is indicated in some energy system scenarios for Denmark

Prognoses used in daily operation



- The increasing amount of prognoses in the daily planning makes the production planning increasingly complex
- Each prognosis introduces new uncertainties to the daily planning