CHP production and district heating networks as flexibility providers

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Introduction

The optimal usage of combined heat and power (CHP) production and district heating (DH) networks requires higher level of automation when the fluctuations in power generation increases. The main objectives of the study were to increase the predictability, energy efficiency and the capabilities to respond to the requirements of the future energy system.

The research consists of two case studies. First [1] concentrates on dynamic optimization of supply temperature to increase observability and efficiency of DH network (DHN). Second [2] considers the usage of DHN as a heat storage to execute fast power level change in the form of automated frequency restoration.

DHN supply temperature optimization

Optimizer predicts the heat consumption 24 hours forward and optimizes the supply temperature to minimize the total operating costs. Developing advanced supply temperature control methods requires modelling of heat consumption and DH water distribution dynamics. In this study, the heat transfer dynamics is modelled by a delay distribution model. As result, the optimization would reduce total heat delivery costs of DHS by 1 – 2 % in Kuopio in current conditions. [1] In addition to the controlled supply temperature, the developed models enable better monitoring and forecasting of the DHN.

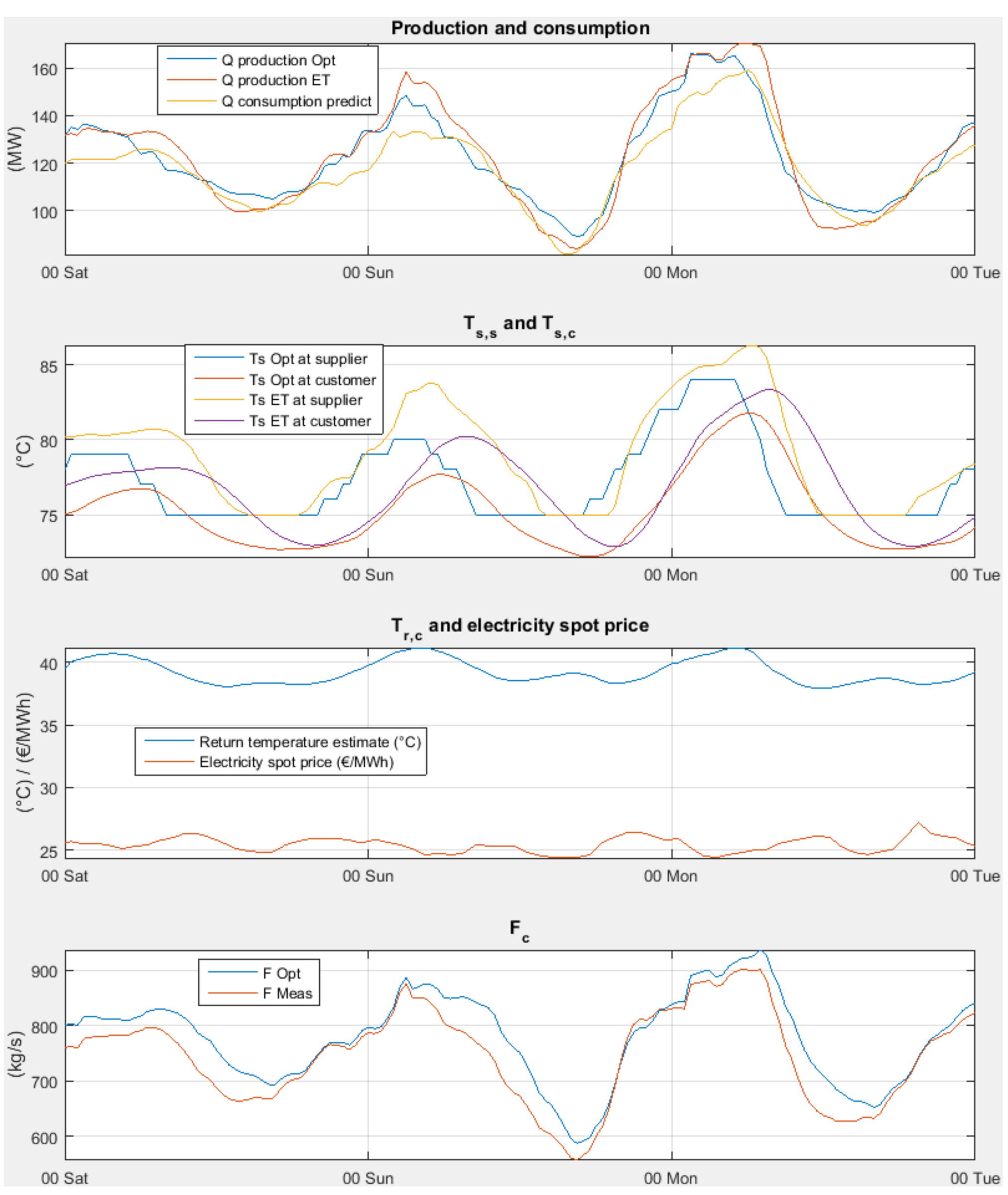

Figure 1. Example of supply temperature optimization.

CHP plants grid balancing capabilities

Test runs on two municipal CHP plants were conducted to measure the system dynamics for Automatic Frequency Restoration Reserve (FRR-A) markets. The results indicate that both cases fulfil the requirements of FRR-A and that the DH network operation is affected only slightly. However, the rapid power level changes are disturbances to CHP boilers and DH networks that the process components and their automation systems must adapt to. Therefore, these aspects must be carefully considered when applying such new operation practices in existing CHP plants.

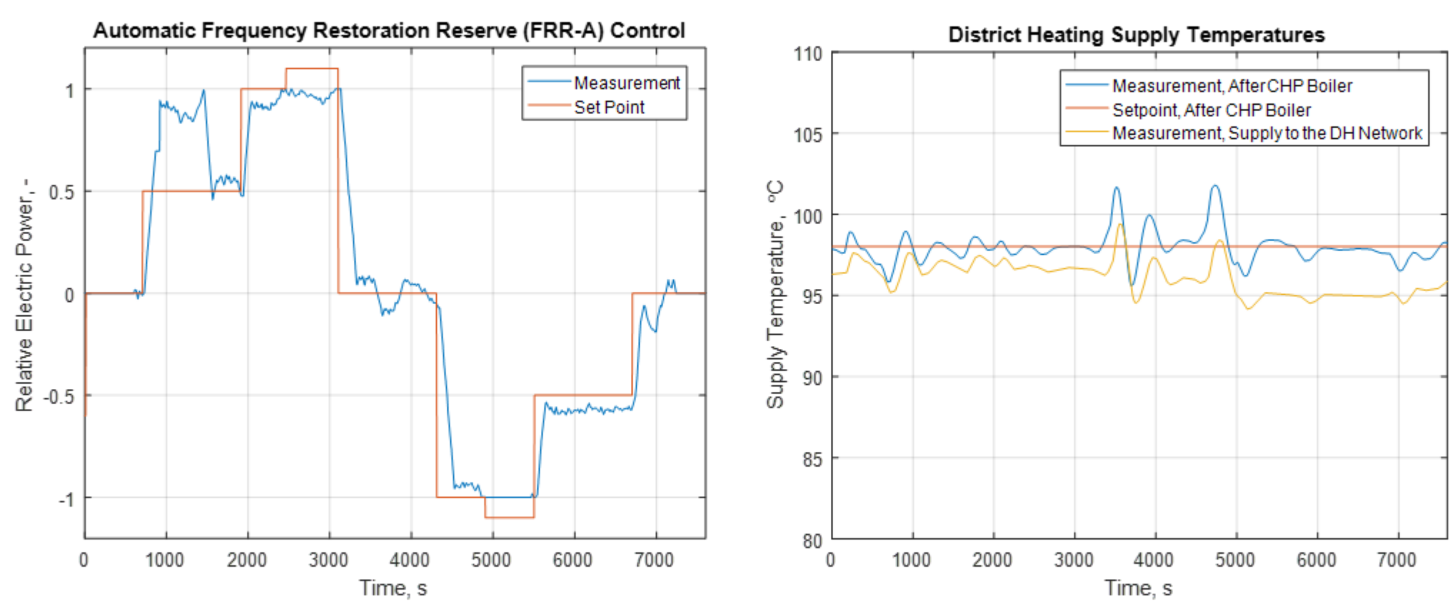

Figure 2. CHP plants and DHN's response to FRR-A signal.

Conclusions

The research appoints that the CHP production and DH systems can contribute to the requirements of the future energy system with improved control systems.

References

[1] Laakkonen, L., Korpela, T., Kaivosoja, J., Majanne, Y., Vilkko, M., Nurmoranta, M. 2016. Predictive Supply Temperature Optimization of District Heating Networks Using Delay Distributions. The 15th International Symposium on District Heating and Cooling, September 4–7, 2016, Seoul, Korea.

[2] Korpela, T., Kaivosoja, J., Majanne, Y., Laakkonen, L., Nurmoranta, M., Vilkko, M. 2016. Utilization of District Heating Networks to Provide Flexibility in CHP Production. The 15th International Symposium on District Heating and Cooling, September 4–7, 2016, Seoul, Korea.