Short report for the research project
"Optimization of Monitoring, Operating and Control Strategies for CHP-Plants"

Research Initiative "Zukunft Bau" of the Federal Institute for Research on Building, Urban Affairs and Spatial Development"

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Title:

Development, Implementation and Evaluation of Optimized Monitoring, Operation and Control Strategies for Combined-Heat-and-Power-Plants

Motive / Initial situation:

Combined-Heat-and-Power (CHP) plants play a key role in the decentralized heat supply of housing estates and heating networks as part of the energy transition in Germany. It is important to adapt the design as well as the operating and control strategy of new and existing CHP plants, in order to tap the full potential of efficiency.

Topic of the research project:

The aim of this project is to investigate the potential for improvement in terms of energy efficiency and cost-effectiveness for existing CHP-plants by implementing optimized monitoring, operating and control strategies. A total of four CHP-plants with a variety of configurations and power ratings were chosen as part of the study:

- CHP-plant A, which supplies a pre-school with adjacent buildings
- CHP-plant B, which supplies a heating network for a housing estate
- CHP-plant C, which supplies a heating network for an industrial park
- CHP-plant D, which supplies a hospital

A survey was carried out at the four plants in order to collect the technical data on that particular plant, the installed measurement and process control systems and the existing storage of operational data. Based on the survey a monitoring concept was developed for each of the four CHP-plants and a software-based energy monitoring system was installed, which uses the existing measuring devices of the various CHP-plants. The operational data could then be independently stored, visualized and evaluated.

In order to generate a base for comparisons the operational data of the four CHP-plants was collected and evaluated in a first monitoring phase. The evaluated data included the energy generation and efficiency, the operating behaviour and the ecological effect, in the form of primary energy savings and CO_2 emissions, of the CHP-plants. Based on the evaluated data the optimization potentials were identified and practical measures for improvement in terms

of energy efficiency and cost-effectiveness were derived. A number of measures were selected and implemented with the help of the operators of the CHP-plants. The implemented measures for optimization were then evaluated in a second monitoring phase. The monitoring phases were defined individually for each CHP-plant and ranged from eight months to a year. In cases where the monitoring phases spanned periods of different length, an identical comparison period was formed for two consecutive years.

As part of the project the following optimization measures were investigated for the respective CHP-plants:

- CHP-plant A: Optimization of the boiler controls with regard to the CHP-unit in order to avoid frequently short cycles of operation / frequent pulsing operation
- CHP-plant B: Implementation of an optimized order of priority for the CHP-units and an analysis of the potentials of different operating modes (modulating / pulsing) for the CHP devices
- CHP-plant C: no optimization measures were implemented, this plant served as a reference for the other CHP-plants
- CHP-plant D: Implementation of optimized control strategies for the operation during summer in order to use the heat storage to full capacity and avoid frequent pulsing operation. Analysis of the potentials provided by operation according to the electric load profile instead of the thermal load profile during summer
- For all CHP-plants: Analysis of potentials provided by the balancing energy market

On the basis of the results of the monitoring phases general recommendations for the optimization of monitoring, operating and control strategies for new and existing CHP-plants were devised.

Conclusion:

Energy monitoring proved to be a useful tool for identifying optimisation measures for operation and control of CHP plants. Potential for optimisation was identified especially during the transition period between winter and summer and during summer operation. In this regard CHP-plants with more than one CHP unit require particularly careful adjustment of the control strategy. Simple control and operating strategies orientated towards the heat demand should be preferred. They can be supplemented by strategies orientated towards the electric demand, e.g. for covering the electric load demand of a facility or for provision of balancing power in the electric grid.

Basic Data:

Short title:	Optimization of monitoring, operating and control strategies for CHP plants
Researcher / Project management:	Prof. Dr.-Ing. Markus Brautsch
Total Cost:	368.349,01 €
Federal subsidy:	193.595,57 €
Project duration:	1st November 2014 to 31st December 2016

Pictures / Diagrams:

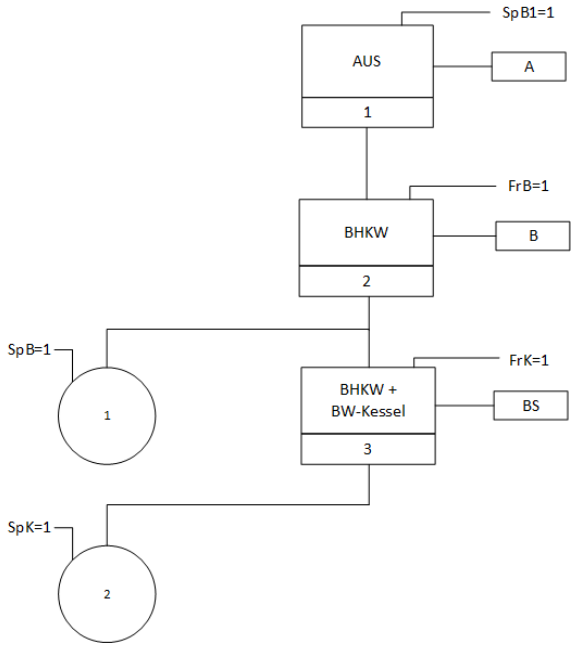

Fig. 1: State graph of CHP-plant A

Fig. 2: CHP-units of CHP-plant A

Fig. 3: CHP-unit of CHP-plant C

Fig. 4: CHP-units of CHP-plant D

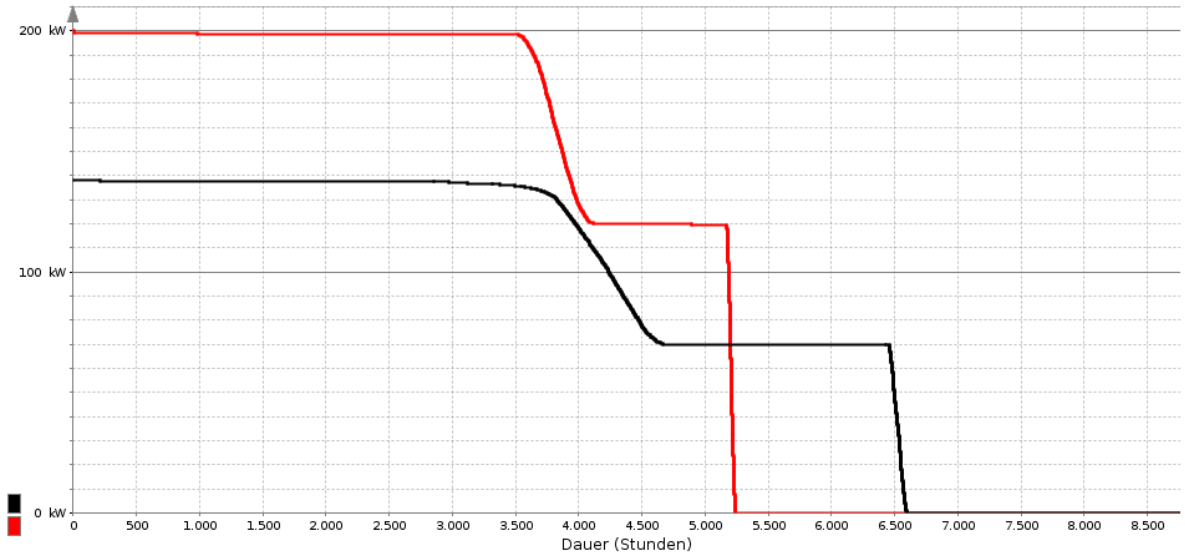

Fig. 5: Annual load duration curves of CHP-plant B

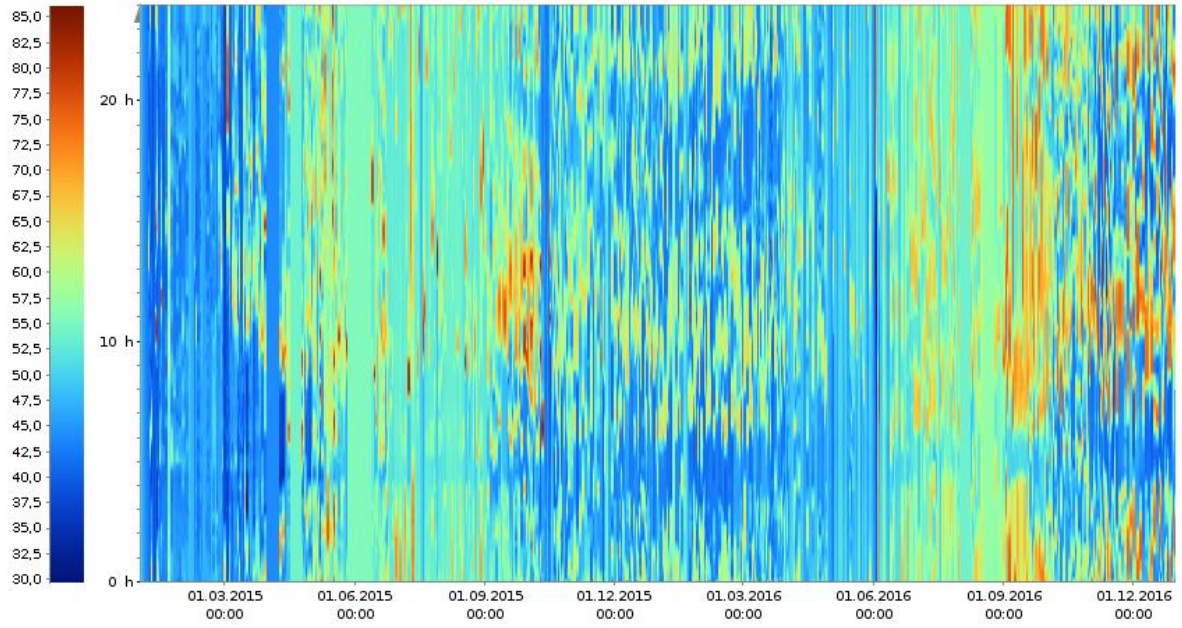

Fig. 6: Carpet plot of the heat storage charging level of CHP-plant D