International Energy Systems in Transition
- Perspectives from Science and Industry -
The 15th IERE General Meeting & German Forum

Improving the Flexibility of Thermal Power Plants Using Dynamic Simulation - Potential and Practical Examples

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Keywords: *power plant flexibility, dynamic simulation, control system optimization, coal fired power plant, combined cycle power plant*

Abstract

In the course of changing power generation structures in Europe, there is an increase in the demands on fossil-fired power plants. Especially but not exclusively in Germany, the expansion of power generation from renewable energy sources poses a challenge for the overall energy system. Because of decreasing electricity stock prices, power plant operators are exposed to an increased economic pressure. At the same time, grid operators have a short-term demand for flexible controllable capacities. The flexibility of thermal power plants and the energy system itself is beneficial for both parties and a crucial feature of a successful integration of renewable energies.

In cooperation with industrial partners, the Institute for Energy Systems at the TUM is using dynamic process simulation as a tool, helping to optimize power plant operation processes. One central step to prepare existing power plants for future requirements, is the modification of plant control systems. Dynamic simulation gives deep insights in process dynamics and the potential for optimization. A thorough operation analysis is essential to maintain operational safety while increasing the load gradients or varying dynamic process procedures. As a result, expanded flexibility features allow operators various marketing options for the produced electricity with low investment costs.

The first step of dynamic simulation is the development of a detailed process model that has to be validated on the basis of operational data. The next step is the identification of limiting factors in the control system regarding the flexibility. This could be e.g., predefined maximal load gradients based on a former conservative estimate. During the optimization process, the simulation model is used to tune control parameters, to modify the architecture of the control loops, and to investigate the effect of faster load gradients or startups on the lifetime of critical components.

The authors introduce two completed studies: In cooperation with E.ON Technologies the start-up of a coal fired steam power plant has been investigated and measures for a faster process were defined. In collaboration with Stadtwerke München, the start-up capability of a cogeneration combined cycle power plant has been examined. The fast start of a gas turbine and its impact on the lifetime of the heat recovery steam generator has been analyzed. The measure has successfully been implemented and the power plant is now able to provide frequency response from stand still within 15 Minutes. An overview of current investigations will be given in the presentation and further possible measures will be discussed.

The completed work as well as the on-going research projects at TUM show the benefit of this university-industry-cooperation in a changing energy system. Researchers at university can use secured and real data for their simulations and industry partners benefit from pre-validated measures and can choose the best one to be implemented. One prevailing goal is the estimation of their effects on the power plant fleet in order to assess the role of the thermal power plant’s flexibility in the dynamic market environment in Germany and other European markets.