TransiEnt.EE – Transient Behavior of Integrated Energy Networks with a High Share of Renewable Energies

Short Description

The aim of the German Energy Transition (Energiewende) is to reduce the emissions while ensuring the security of the energy supply. For this purpose, a large share of renewable energies is essential. The fluctuating nature of these renewable energies create however significant challenges with respect to their integration into the existing electricity grid. In the research project TransiEnt.EE different approaches to solving this integration problem are investigated and assessed by means of the dynamic simulation of Hamburg's energy system. The system modeling is done with the object-oriented programming language Modelica and considers the coupling effects between the electricity, district heating and gas grids.

The project relies on the concept of an energy system composed of several closed but not necessarily isolated supply areas. Each of these areas is self-sufficient, i.e. their own local energy demand is covered by converting different sources of primary energy while integrating the highest possible amount of renewable energies. The dynamic modeling enables the study of coupling effects between the various participants of the energy system. Combined heat and power plants present a good example of such coupling effects. These plants feed energy into both the heat and the electricity grid. If a high heat demand and high supply of electrical energy are simultaneously available, the electricity generation of these plants cannot be curtailed, otherwise the coverage of the heat demand would be jeopardized. In such cases, renewable energy sources, such as offshore wind farms would have to be curtailed to ensure the stability of the power network.

The transient modeling makes it possible to detect integration opportunities such as the temporal shifting of generation or demand through the strategic use storage technologies. With the dynamic model of the system, the question of what kind of storage, in which size and in which place makes sense could be answered. The dynamic simulation also allows the analysis the overall system with a high temporal resolution. The integration of models with very different time constants in an integrated energy system model represents a particular challenge to the architecture of the model.

Using different scenarios and the developed models, the TransiEnt.EE project looks for ways to realize a reliable integration of renewable energies into the existing energy system. The final evaluation of the different scenarios is based on the system's annual CO_2 emissions. This allows the drawing of conclusions regarding the achievement of the energy transition's objectives by the implementation of the investigated integration strategies.

Keywords: dynamic simulation, integrated energy grids, integration of renewable energies, Modelica, CO_2 emissions.

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