Dynamic simulation of a biogas plant providing control energy reserves

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Abstract

The increasing integration of renewable energy sources into the energy system leads to a rising share of plants with fluctuating power production, especially photovoltaic and wind power plants. In order to ensure grid stability, there is a growing demand for flexibility in the electricity grid. This flexibility can be provided by energy storage systems and plants that are operated flexibly.

Plants operating on biomass-based technologies, like biogas plants, are characterized by almost unlimited storability of the energy carrier. Therefore, they have a high potential for demand-orientated energy generation. Heat and power can be produced flexibly at biogas plants by using CHP units. One possibility for flexible power production is by providing positive or negative control reserves. These reserves must be held available by the plant operator and are activated by the transmission system operator to regulate the supply frequency.

In this work dynamic models for the simulation of flexible operation of biogas plants are presented. Additionally the effects of providing positive control reserves on the required gas and heat storage capacities at an Austrian biogas plant are investigated. For this reason ex-post evaluations of the plant operation are carried out. The plant under investigation is a waste recycling plant whose operation is currently designed to convert biogas into biomethane by a gas permeation process. Alternatively the produced biogas can be converted into heat and power by two CHP units with a total capacity of 1.36 MW.

The biogas plant, including the gas processing plant and the CHP units, is modeled in the process simulation programme IPSEpro. The aim is to simulate the flexible plant operation dynamically. The model of the plant is based on data collected during a one year monitoring. The modeling of the CHP units, in particular the partial load operation of the
motors, is performed by evaluating the real power production curves. For dynamic simulation of the biogas utilization a gas storage model is developed, with which the current gas storage level can be calculated and displayed. This makes it possible to determine the gas storage capacity needed for providing control reserves.

In addition the heat management of the plant is examined by evaluating the heat demand and heat production curves. In combination with dynamic methods of cost efficiency analysis the rentability and optimal capacity of a heat storage are evaluated.