On flexibility analysis and management in renewables-based energy systems

Doktorandenkolloquium am Mittwoch, 16.7.2025
im Raum VR 147b, JUR, Innstr. 39, Universität Passau, 94032 Passau
um 14:25 Uhr
von Herrn M. Sc. Michael Lechl

Betreuung: Prof. Dr. Hermann De Meer

Renewables are increasingly replacing conventional, dispatchable power generation plants. Renewables like solar power plants tend to be distributed, often volatile, and therefore not dispatchable. The volatility of renewables and new energy demand patterns increase flexibility requirements, i.e., feed-in or consumption deviations from planned values, in energy systems. To maintain system stability, flexibility requirements must be balanced by flexibility potentials, which are controlled feasible deviations of a flexibility resource (e.g., gas-fired power plant) from its scheduled operating point. A key challenge is unlocking the flexibility potentials of the growing number of controllable (demand-side) resources, such as battery storage systems, to reduce dependence on carbon-intensive flexibility resources. This thesis contributes to overcoming this challenge by first introducing a formal flexibility taxonomy to address ambiguities in flexibility definitions and terminology. Based on the flexibility taxonomy, deterministic and stochastic models of flexibility requirements and potentials are developed, inspired by (stochastic) network calculus. For example, these models allow for analyzing the risk of insufficient flexibility potentials in a system by considering uncertainty in flexibility requirements and potentials. In this work, the developed models are successfully used in different applications, e.g., for analyzing the flexibility potentials of renewable energy communities, scheduling battery storage systems considering multiple objectives, and disaggregating flexibility requirements to a set of distributed flexibility resources. Methodologically, this requires formulating and solving (chance-constrained) optimization problems and integrating the developed flexibility models with evolutionary algorithm.