SE-7.3 Mathematical Optimization for Energy Market Design – Challenges and Solution Approaches (S)

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At least since Germany agreed on the energy turnaround, energy market design is an important topic among European politicians and economists. The decision to shut down all nuclear power plants and replace them with green energy greatly affects the reliability of the European electricity network. Important questions in this context are: “How should we expand the network?”, “Where should we place renewable energy systems?” or “Should we implement price zones?”. These questions need to be evaluated carefully to make the energy turnaround a success story. Their evaluation leads to mathematical optimization problems that are hardly investigated in the literature. The correct modeling of the combinatorial structure, e.g., of network expansion or price zone partitioning, multiple market participants, or the analysis of long-term horizons make these models very challenging – both, theoretically and computationally. In this talk, we present typical optimization problems arising in energy market design and point out their mathematical challenges. We then propose novel solution techniques from the area of mixed-integer multilevel optimization and machine learning and demonstrate their effectiveness from a computational point of view. Finally, we present some economic insights gained by applying these methods to a model of the German electricity network.