

Master thesis idea for Joint collaboration between OFFIS – Institute for Information Technology and the University of Hannover

## Optimal congestion management approach in flexibility market including correlated uncertainties

### Motivation

Nowadays, renewable energy sources, small-scale generation units, and electrical energy storage systems are strongly promoted. Consequently, the use of decentralized energy resources (DERs), is increasing, and it imposes considerable uncertainties on the operation of smart grids. In such an environment, congestion management in the distribution system is challenging. Therefore, the probabilistic analysis of smart grids, e.g., congestion management with high penetration of DERs is one of the current hot research topics. However, in most studies and proposed models, an individual probabilistic modeling approach is considered, while the DERs (such as wind turbines and PV units) are inherently temporally and spatially correlated to each other and not considering the correlations would lead to unrealistic uncertainty modeling. Therefore, it is necessary to propose an uncertainty modeling based on the correlation approach for more accurate and efficient congestion management of smart grids. Furthermore, the flexibility to be reserved also depends on the energy market. Considering the time horizons of the flexibility market (day ahead, intraday and spot), the deviation of uncertainties and the corresponding reserving of flexibility needs consideration. Considering the probability of occurrence of particular congestions, adaptation of the bids and reserve flexibility is required.

### Overview of the topic, literature research, and introductory tasks

- Familiarisation with the energy market (day-ahead, intra-day, spot market, and flexibility market)
- Familiarisation with steady-state load-flow analyses and optimization techniques for congestion management
- Performing literature research on the relevant topics:
  - Congestion management optimization modeling and techniques
  - Modeling of flexibility markets
  - Special and temporal correlation modeling for uncertainty scenario generation

### Modeling

- Familiarization with uncertainty generation tools
- Implementing Copula-based correlated uncertainty modelling
- Employing a linear programming-based optimization approach
- Steady-state load-flow analyses concerning congestions and uncertainties
- Develop a method for optimal congestion management considering the market time horizons and optimal bid offers

### Simulation study

- Steady-state analyses to be carried out in CIGRE MV benchmark grid
- Determination of uncertainty deviations considering the time horizon of flexibility market
- Probability analyses of congestions and the affected branches of the network
- Determine optimal bids considering congestion management schemes

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