technische universität dortmund

Faculty of Electrical Engineering and Information Technology

Institute for Energy Systems, Energy Efficiency and Energy Economics

Master thesis

Date: 16.05.2022

Implementation of decentralised determination of the flexibility potential of a low-voltage grid using hardware-in-the-loop simulation

In the course of the energy transition, large power plants such as nuclear and coal-fired power plants are being shut down in Germany and replaced by decentralised generation plants such as photovoltaic and wind power plants. This leads to a shift of feed-in from the transmission to the distribution grids and thus to bidirectional power flows. In order to detect inverting power flows and possible anomalies in medium and low-voltage electrical grids, algorithms for grid status detection are increasingly used. On the basis of the detected grid status, control algorithms can then intervene in the event of voltage violations or thermal line overloads. In the process, the operating point of available flexibilities such as electromobility, photovoltaic systems, wind turbines and heat pumps are changed in order to ensure the stable operation of the grid. In order to be able to use flexibilities in a grid-serving manner to eliminate bottlenecks, the flexibility potential of the individual voltage levels must be known.

In the context of this thesis, an algorithm for determining the flexibility potential in a smart grid app of the Protection and Automation working group is to be implemented in C++. At the same time, a data model for a reference network under consideration is to be extended to include the function of determining flexibility using the IEC 61850 industry standard. Subsequently, the functionality of the algorithm is to be tested on the basis of reference networks with the help of a hardware-in-the-loop simulation.

The following structuring of the work is proposed:

- Familiarisation with C++ and the algorithm for determining the flexibility potential
- Familiarisation with the IEC 61850 standard and the Smart Grid App
- Implementation of the algorithm and the operating diagrams of individual flexibilities in the Smart Grid App and the input data, respectively.
- Extension of existing IEC 61850 data models by the function call of the flexibility potential
- Familiarisation with the Typhoon real-time simulator
- Validation of the results in real time via hardware-in-the-loop simulation

Following this work, the results are to be reported in a presentation.

This thesis is now being assigned as a Master's thesis to students of electrical/information technology and industrial engineering.

Day of issue: dd.mm.yyyy
Date of submission: dd.mm.yyyy

Responsible: M. Sc. Thomas Schwierz, Thomas.Schwierz@tu-dortmund.de
Dr.-Ing Rajkumar Palaniappan, Rajkumar.Palaniappan@tu-dortmund.de