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Bachelor thesis for cand. B.Sc. first name last name

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Development of an algorithm for the use of standardized CIM CGMES grid models in a smart grid application

Distribution grids are playing an increasingly important role in electrical energy systems. On the one hand, the feed-in to the medium and low-voltage grid is increasing due to decentralized energy generation plants. On the other hand, the electrification of the mobility and heating sector, particularly in the form of e-mobility and heat pumps, is placing an additional load on the grids, meaning that voltage band violations or line overloads can occur as a result. For these and other reasons, such as the dynamization of electricity consumption, so-called smart metering systems are being installed at end customers. These offer grid operators the opportunity to monitor the status of their low-voltage grids and allow end customers to use their flexibility through controllable consumers and decentralized generation systems. The use of grid status data from smart metering systems, the measurements of digital local network stations in smart grid applications and the integration of decentralized generation plants and loads into the energy system requires the integration of standardized grid models from digital twins into those smart grid applications.

This paper begins with a detailed introduction to the CIM CGMES grid modeling standard and the IEC 61850 automation standard. Subsequently, a reference implementation of the conversion of CIM CGMES network models into a separate network model format in Python can be familiarized with in order to examine an exemplary solution to the research question. Subsequently, a literature analysis of existing libraries for the integration of CGMES in C++ will be carried out, a suitable library will be selected and implemented in the Smart Grid App. Particular attention is to be paid to the integration of topology information and information on parameters and the location of decentralized generation plants and loads. In the next step, existing mapping files for mapping the measurement topology and for parameterizing decentralized generation plants and loads are to be updated for use with CGMES. Finally, the developed algorithm will be validated by a static grid state calculation in comparison to Powerfactory or Pandapower, and the integrated data of the decentralized generation plants and loads will be compared with the CIM CGMES grid model.

The following structure is proposed for the work:

- Familiarization with the CIM CGMES grid model standard and data models of the IEC 61850 station and grid automation standard, as well as performing a state estimation in the given smart grid application.
- Familiarization with the conversion of CIM CGMES network models into network model format in Python as a reference implementation
- Literature analysis for libraries for the integration of CGMES grid models in C++
- Integration of a suitable library for processing CGMES grid models in the smart grid application
- Development of an algorithm for processing the CGMES grid model in data on the grid topology and decentralized generation plants and loads
- Adaptation of existing mapping files to map the grid topology and flexibility parameters to IEC 61850 logical nodes
- Validation of a reference grid model using a state estimation in Powerfactory/Pandapower and the smart grid application

This thesis is now available as a bachelor thesis for students of industrial engineering and electrical

engineering and information technology.

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