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Fakultät für Elektrotechnik
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Institut für
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Research Field: Power System Stability and Operation

Development of a methodology for integrating flexibility dynamics to grid operations for optimal grid planning

Decentralized energy resources (DERs) have increased tremendously in the past few years, which leads to the need of sophisticated operational schemes in power systems. With the integration of such an extensive amount of DERs into the electricity grid, control algorithms play a pivotal role. Optimal utilisation of the flexibilities in the grid is also very crucial, considering the potential of voltage and thermal congestions. In such cases, the individual performance of all the individual flexibilities has to be taken into consideration when using them for congestion management.

Institute ie³ has various research projects dealing with grid stability and real-time control of the flexibilities in the grid. However, the ideal use case for distribution grid planning and real-time congestion management should consider the dynamic performance of each flexibility. Only when the dynamic characteristics of the individual assets/flexibilities are understood, the dynamic interaction of those assets with the voltage profile of the grid could be estimated better. There are some works in the literature that try to combine system dynamics and system operation together. However, these works do not consider the dynamic performance of the flexibilities for real-time control of the grid.

In this thesis, the candidate has to first perform experiments in the smart grid technology laboratory (SGTL) with the available flexibilities to characterise the dynamic response behaviour of each asset or groups of assets operating at certain voltage levels. This information has to be used to create a transfer function and has to be recreated to a modified differential equation that can be solved for congestion management in the grid.

As part of this thesis, the candidate has to identify works in the literature that try to combine flexibility dynamics with real-time operation. Various use-cases for congestion management and flexibility availability must be determined and countermeasures are to be implemented. To verify the functionality of the implementation, tests using a real-time simulator existing at the ie³ lab shall be carried out.

This work is recommended to be structured in the following way:

- Literature review and understanding works that combine system dynamics and operation
- Performing tests in the SGTL to characterise the dynamic performance behaviour of the various assets and mapping those to proper transfer functions.
- Forming new differential equations that already considers the dynamic performance of the assets and providing operational planning solutions with integrated dynamics for congestion management
- Analysis of the implementation and drawing of conclusions & and recommendations
- Documentation of the thesis

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