

## **Proposal for M.Sc. work at SON-ID**

### *Introduction to the topic:*

The European electricity system is highly meshed on the transmission level and its operation has become more complex and largely influenced by wide-area phenomena. This impacts the network of several Transmission System Operators (TSO). The high penetration of renewable energy sources (RES) and corresponding dispersed and intermittent generation, which combined with the difficulty to build new assets to increase transmission capacity, results in operating the Transmission System with increased uncertainty and closer to its stability limits under high stress conditions.

The power flows in the transmission network are getting more volatile and significantly increasing, including the part used for commercial exchanges. These flows are largely determined by the European zonal market exchanges. The network security analysis including exchanges between bidding zones is performed on the basis of congestion forecast network models. The allocated exchanges should always remain within the security levels of the international power system networks. The actual realised flows often differ from the scheduled flows and require operational remedial actions to avoid the overloading of specific network elements. In case of specific critical grid situations, multilateral costly remedial actions are necessary.

Several methodologies for calculating partial flows and cost sharing keys have been proposed in the European context. TenneT TSO the Netherlands is a key player in these developments, and wants to continue the research work on the topic. There is already previous research at TenneT that can be used as a starting point for this M.Sc. work proposal [1, 2]. Reference [2] describes a novel approach that has been developed for the identification of various flow types in the transmission network, such as "import", "export", "transit" and "loop" flows according to the definitions established by ENTSO-E. This method needs to be tested and applied to real situations. The applicability and feasibility, also in respect to the regulatory framework have to be further developed.

### *Description of the proposed M.Sc work:*

1. Gain knowledge in previous work on Flow Decomposition as well as in Flow Based Market Coupling (FBMC) methodology, in the context of the methods internally developed at TenneT.
2. Make a comparison between the existing methods, highlighting pros and cons in each method. Evaluate improvement possibilities in [2].
3. Perform statistical analysis on the types of flows in the network using pan-European congestion forecast network models (uct format). How does the flow in the main European corridors looks like? Identify polluters and main causes.
4. How to handle DC connections inside the methodology
5. How could a strategy on loop flow reduction be applied in the network planning phase? Which kind of sensitivity analysis can be implemented?

6. (in case there is time left): research on possible cost-sharing keys, based on defined principles: fairness, incentive to invest, etc.

***Required Knowledge and Competences:***

- Matlab

The work is to be done in Matlab, to be integrated into the existing Matlab network analysis toolboxes of TenneT.

- Power System and Network analysis knowledge

Without this basic competence the student will not be able to perform the work in due time

- Conceptual thinking and comfortable in Mathematics

The concepts to be developed are abstract and involve in-depth understanding of mathematical algorithms.

***Supervisory Team at TenneT:***

Formal Supervisor: Susana de Graaff

Daily Supervisor: Jasper van Casteren

***Your application***

To apply for this role, please send your CV and motivation to Dirk Veldman, quoting 'Master Thesis SON-ID', via [dirk.veldman@tennet.eu](mailto:dirk.veldman@tennet.eu).

***References:***

- [1] Peter Hoffmann, Susana Almeida de Graaff, Jochen Bammert, "The Simple Tie-Line Decomposition Method – a new approach for a causation based cost-sharing key", on CIGRE Science & Engineering, June 2016 edition.
- [2] Marco Pavesi, M.Sc, thesis at TenneT TSO B.V. with TU Eindhoven, "Tracing and decomposing the flow of electricity" (provisional title). This work will be concluded in August 2017.
- [3] Konstantin Vandyshv, Jasper van Casteren, Susana Almeida de Graaff, Using Optimized Flow Based Market Capacity Indices in TSO Investment Evaluation, EEM2016, Porto, Portugal, June 2016.
- [4] Using the flow-based method for network investments' evaluation – a new concept, Nikoleta Kandalepa, Dr. Jasper van Casteren, Dr. Susana Almeida de Graaff, Danny Klaar, Cigre Science & Engineering, N°7 February 2017.