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# TU Delft MSc. Project Proposal in cooperation with Tennet

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**Working title:** Automation of year-round AC power flow calculations of the European electricity grid

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## Background

Power flow computations are used to determine the state of the electricity grid. Given the demand and supply of electricity together with the topology of the grid, the voltage and phase angles can be computed using AC power flow computations. Tennet is responsible for safe operation of the Dutch transmission grid and parts of the German transmission grid. Tennet uses power flow computations to determine the load and generation pattern in this grid for each hour of the year. The size of this grid is large, namely 20.000 - 25.000 buses, and therefore AC loadflow simulations are expensive and need manual solving. At the moment, DC loadflow<sup>1</sup> simulations are used in order to obtain the results. Tennet uses PowerFactory and PSSE software to do these computations. The long-term focus of Tennet is to do year-round AC power flow computations<sup>2</sup>. The goal of this master project is to 1) automate year-round AC power flow computations and 2) compare the output and computational burden with the currently used DC power flow computations and 3) make a cost/benefit analysis on the added value of AC calculations .

## Approach

1. Literature study on: 1) steady-state AC and DC power flow computations for transmission grids and 2) Tennets DC loadflow simulations.
2. AC loadflow simulations using Matpower (or PandaPower)<sup>3</sup> on small, artificial test-networks.
3. AC loadflow in PowerFactory/PSSE on the European electricity grid
4. Automate AC loadflow in order to do year-round simulations
5. Comparison of AC and DC loadflow: computational burden relative to the benefit of AC
6. Cost/benefit analysis on the added value of AC calculations

## References

- [1] TenneT Holding B.V. Integrated annual report 2019, 2019.
- [2] Charles A. Gross. *Power System Analysis*. John Wiley & Sons, Inc., New York, second edition, 1986.
- [3] R. Idema, G. Papaefthymiou, D. Lahaye, C. Vuik, and L. van der Sluis. Towards faster solution of large power flow problems. *IEEE Transactions on Power Systems*, 28(4):4918–4925, Nov 2013.
- [4] van der Sluis L Schavemaker P. Introduction to Power System Analysis. In *Electrical Power System Essentials*, chapter 1. John Wiley & Sons, Inc., Sussex, United Kingdom, 2008.

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<sup>1</sup>DC loadflow is a linearized method to solve the power flow problem.

<sup>2</sup>More information in the investment report of Tennet.

<sup>3</sup>the Matlab (Python) package to do loadflow computations