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Project proposal: On-line Inertia Estimation for the Synchronous Zone of Continental Europe

The Continental European power system is rapidly decreasing the installed inertia due to the shift of generation from classical synchronous generation to power electronics based nonsynchronous generation. Reduced system inertia has a negative impact on the dynamic behaviour of the grid and therefore on the safety of the system operation, particularly during severe incidents like the system split on January 8th, 2021. Indeed, the level of inertia is inversely proportional to the frequency gradient (ROCOF – rate of change of frequency), which is a measure of the power system capability to withstand and counteract power system disturbances.

One of the key technologies for the on-line assessment of the system dynamic state is represented by the distributed monitoring of the so-called synchrophasors via Phasor Measurement Units (PMUs). Swissgrid operates one data coordination centre for Wide Area Monitoring (WAM) of the Continental European TSOs since 2003 and aggregates PMU data flows from 22 PMUs across 11 TSOs.

To re-design the Continental European defence plan, the level of inertia is a key performance indicator, that should be accurately and timely identified. This thesis pursues potential approaches to estimate the level of inertia of the synchronous zone of Continental Europe online based on synchrophasor measurements provided by PMUs. Recent developments in offline model identification techniques applied to power systems are proposed by the state-of-the-art literature. Using these approaches, an online method is developed to determine the level of inertia during normal conditions (disconnection of big generators or loads, deterministic frequency variations at the change of the hour) and critical operating conditions (system split).

The tasks of the thesis include:

1) Review of inertia estimation methods and model identification techniques
2) Development of an on-line inertia estimation method
3) Development of intelligent alarms based on the estimated inertia and PMU measurements
4) Validation of the method and alarms using simulation platforms for which the inertia is known:
    a. Internationally recognized benchmark power system models
    b. Continental European simplified single busbar model
5) Performance assessment of the method and alarms using experimental real Continental European power system data:
    a. PMU data aggregated by Swissgrid
    b. Load/Generation schedules from ENTSO-E transparency platform (European Network of Transmission System Operators for Electricity)

Basic understanding of power system dynamics, system identification and mathematical optimization is desirable. The master thesis is located at the Swissgrid headquarters in Aarau. For more information, please contact Asja.Derviskadic@swissgrid.ch.

Project type: Master thesis, internship, or combination of these (duration 6 – 12 months)