SERVICE DE METROLOGIE NUCLEAIRE
RELIABILITY AND SAFETY OF POWER SYSTEMS

MASTER THESES

Academic year **2019-2020**

*The topics listed below correspond more to **themes** in which master theses can be realized, than to a detailed description of topics. Depending on the interest of the students, more theoretical or instead industry-related topics will be developed. Some of the proposed themes are more convenient for an internship, to be made before the master thesis.*
*The themes proposed are preferably **accessible mainly to students in engineering physics and in electromechanical engineering**.*

6. Decision-making under uncertainties in grid development – optimization of grid reinforcement in the presence of a large amount of Distributed Generation (DG) units (in collaboration with Elia)

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The amount of distributed energy resources (DER) has been increasing in the recent years, namely photovoltaic (PV) panels and wind turbines. These new resources are mainly considered as renewable energy resources (RES) but can include also combined heat and power **(**CHP**)** units, decentralized storage units, flexible and active loads… connected at both Low-Voltage and Medium-Voltage levels. These units affect directly the distribution system operator (DSO) operation and planning. However, the aggregated effect of DERs can also affect, and will affect more and more in the upcoming years, the transmission grid operation and planning. The deterministic approach classically used for the network planning calculations assumes that the data (annual power demand, annual power generation, power demand growth…) are known with a quite good certainty. RESs, such as wind turbines typically, behave rather differently from conventional generation facilities, since they are intermittent. RES generators introduce therefore uncertainties that cannot be disregarded. The maximum/minimum load conditions of the electrical system are no longer always the most critical cases to be studied, in order to ensure a secure grid operation. The application of strict deterministic criteria would strongly limit the amount of connectable generation to a given grid infrastructure.
Furthermore, systematically reinforcing the network in order to absorb the last MWh produced by generators located in unfavorable areas is not efficient i.e. neither economically viable for the community nor acceptable from an environmental impact point of view. In order to increase the amount of DERs likely to be connected, an Active Network Management (ANM) scheme can be envisioned: if specific conditions of generation and load cause congestion on the grid, this congestion is solved by curtailing optimally the production of some units.
At some point, however, the transmission system operator can decide to plan a grid reinforcement, in order to accommodate in the future a larger amount of DG units in a specific part of the grid. Such reinforcement takes 4 to 5 years to be carried out, given the heavy administration associated with such a process. In the meantime, the actual landscape of newly connected DG units to the corresponding part of the grid is likely to evolve in a non-fully known

way. In a similar fashion, drops in the non-residential part of the load could be observed, entailing larger congestion risks than expected at the time the reinforcement had been decided. The present thesis will aim to develop a methodology for the optimization of such grid reinforcement in an unknown evolution of the characteristics of the electrical system.