École Polytechnique Fédérale de Lausanne
Distributed Electrical Systems Laboratory
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Student project proposal

Project title
Load Modelling for Backbone Stability Evaluation in Power System Restoration Processes

Project type ☒ MSc thesis ☐ BA semester project ☐ MSc semester project

Project responsible and e-mail
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Project description
In the event of a blackout, Transmission System Operators (TSOs) must have emergency plans prepared to restart the system, commonly referred to as Power System Restoration (PSR) procedures. PSR procedures are commonly divided into three distinct phases: island formation, backbone construction, and load reconnection. Backbone construction requires the buildup of restoration cells to include more generators and loads; it is common to use induction motor loads such as hydraulic pumps for this purpose, especially in the Swiss context. However, the separation point between the second and third restoration steps is often not clearly defined. The goal of this thesis is to evaluate the voltage and frequency stability of a restoration backbone considering induction motor loads. Both the startup and operational behaviour of the induction motors (i.e., provided inertia) should be considered, and various load modelling methods should be compared. The effects of topology and motor location on backbone stability should be evaluated. Depending on student interest, we may have the opportunity to validate the developed models with real restoration test data, subject to agreement of the industrial partner. The student will develop a deep understanding of power system dynamics and transient modelling.

Tasks of the student
- Define acceptance criteria for the backbone considering cold load pickup effects
- Implement load modelling strategies for the induction motor loads (startup and operation)
- Investigate backbone stability considering load models, topology, and load location
- Develop heuristics and recommendations for the TSO context

Requirements
- EE-362 Power Systems Analysis and EE-472 Smart Grids Technologies, or equivalents
- Good programming knowledge, including some experience with Matlab
- Familiarity with EMTP is an asset

Literature
[1] Lei Chen, Xiaohai Wang, Yong Min, Gang Li, Linke Wang, Jun Qi, Fei Xu, "Modelling and investigating the impact of asynchronous inertia of induction motor on power system frequency response," *International Journal of Electrical Power & Energy Systems,* Volume 117, 2020.
[2] H. Sekhavatmanesh, R. Cherkaoui, J. Rodrigues, C.L. Moreira, J.A.P. Lopes, "A convex model for induction motor starting transients imbedded in an OPF-based optimization problem," *Electric Power Systems Research*, Volume 189, 2020.