Reinforcement-learning Models for Adaptive Low-voltage Power System Operation

Supervisors Dr. Eleni Stai, elstai@ethz.ch
Dr. Mathias Duckheim (Siemens Technology), mathias.duckheim@siemens.com

Type Semester/Master

Background The low-voltage grid is the "last mile" of the power system supplying energy to end-customers. It is expected that this part of the grid will experience accelerated installations of renewable energy sources (RESs), battery storage, and electric vehicle charging infrastructure. RESs and electric vehicles introduce significant uncertainties into the low-voltage grid, while they may also drastically increase the peak load and generation. This pushes low-voltage grids to the limits of their initial designs and makes new secure and efficient operation strategies necessary. Controlling charging processes and RES is an option to avoid grid congestions.
However, the large number and diversity of low-voltage grids prohibits manual configuration of controllers. It is desirable to use a control strategy that adapts autonomously to each of the many low-voltage substations. For this autonomous operation new concepts need to be applied, such as reinforcement-learning (RL) models.
Siemens Technology: Siemens' global research and development department is a strategic partner for its business units driving forward technology and innovation with customers and universities.

Description In this project, we would like to investigate the feasibility of using reinforcement learning models to operate several control degrees of freedom in a low-voltage distribution grid to ensure safe system states. A focus of this investigation is how pre-trained models adapt to different test grids.

1. Research literature and available implementations for reinforcement models applied to power systems.
2. Adapt an existing simulation environment to model the low-voltage grid with control degrees of freedom and limited measurements as the environment for the RL agent.
3. Implement and train a reinforcement learning agent.
4. Analyze and evaluate the control performance of the agent in several low-voltage test systems.

Prerequisites Interested students should have some experience with a programming language, e.g., python, and, ideally, with a machine learning framework. The attitude to write reusable code is expected and experience with version control tools and automated testing are advantageous.