Enhancing Grid Performance under High Penetration of Stochastic Loads and Generation

Summary

Problem formulation: EU goals regarding to green energy and emissions (raise of photovoltaic and wind generation); No combustion engines from 2030 (raise of Electrical Vehicles); Grid contingency (problem with the transfer capacity and voltage). Optimization tasks: power flow, losses, voltage, costs (for grid operators and prosumers). Solutions and methods: BESS, control strategies for EV and RES, reactive power control. Tools: Matlab (optimization) and DIgSILENT (grid simulations). Implementation area: Distribution grid, point of common coupling between Distribution and Transmission systems.

Research field:	Electrical power engineering and mechatronics
Supervisors:	Prof. Dr. Ivo Palu
	Dr. Victor Astapov
Availability:	This position is available.
Offered by:	School of Engineering
	Department of Electrical Power Engineering and Mechatronics
Application deadline:	Applications are accepted between January 01, 2024 00:00 and January 22, 2024 23:59 (Europe/Zurich)

Description

The research

This study addresses key challenges and goals related to the European Union's green energy and emissions targets, including the increased integration of renewable energy sources (RES), as well as the transition to electric vehicles (EVs). The focus of the thesis is to enhance grid operation to overcome issues such as grid contingency, transfer limitations, and voltage fluctuations.

The optimization tasks involve and consider factors such as power flow, power losses, costs for both grid operators and prosumers (consumers who also produce energy), voltage fluctuations, and grid capacity. To tackle these challenges, the study proposes several solutions and methods. These include implementing battery energy storage systems (BESS), developing control strategies for EVs and RES operation, and managing reactive power control.

The software and tools used in this study are Matlab for optimization purposes and DIgSILENT for grid simulations. To streamline the process, an interface should be created between Matlab and DIgSILENT, enabling automation of the optimization process.

The implementation area for this study focuses on the distribution grid and on the point of common coupling between the Distribution System Operator (DSO) and the Transmission System Operator (TSO). By addressing these key aspects, the research aims to contribute to the efficient and effective integration of green energy sources and the reliable operation of the grid in the face of increasing renewable energy penetration and EVs adoption.

Responsibilities and (foreseen) tasks

- Conducting a comprehensive literature review to understand the state of the art in your research area
- Collecting and analyzing data, conducting case studies and simulations
- Developing mathematical models, algorithms, or simulation frameworks to investigate and analyze electrical grid, renewable energy integration, control strategies, or other relevant topics
- Regularly updating your supervisor or advisory committee on your progress, discussing research challenges, and seeking guidance on the next steps.
- Preparing research papers, conference papers, and journal articles to disseminate your findings, including writing, revising, and submitting manuscripts to relevant conferences and journals for publication.

Applicants should fulfil the following requirements:

- a completed master's degree in electrical power engineering
- a clear interest in the topic of the position

- working knowledge of stochastic processes
- working knowledge of optimization techniques
- strong skills in Matlab
- excellent command of English
- strong and demonstrable writing and analytical skills
- capacity to work both as an independent researcher and as part of an international team

(The following experience is beneficial)

- working knowledge of statistics
- familiarity with DIgSILENT is highly valued
- demonstrated research experience in electrical power engineering through a master's thesis, research projects, or publications

The candidate should submit a research plan for the topic, including the overall research and data collection strategy. The candidate can expand on the listed research questions and tasks, and propose theoretical lenses to be used.

We offer:

- 4-year PhD position in one of the largest, most internationalized Estonia's leading technical university and a hub for innovation and academic excellence.
- Positive work environment, which includes collaborative, inclusive, and diverse workplace where all of the members are respected, supported, and encouraged to bring their best selves to work.
- Opportunities for conference visits, research stays and networking with globally leading universities and research centers, participation in student exchange programs.

About the department

Tallinn University of Technology (TalTech) is the only flagship in engineering and IT science and education in Estonia, providing higher education at all levels in engineering and technology, information technology, economics, science, and maritime. TalTech's mission is to be a promoter of science, technology, and innovation and a leading provider of engineering and economic education in Estonia. The university has over 2,000 employees and 10,000 students, and almost 70,000 alumni.

TalTech has a green and one of the most compact university campuses in Europe that includes the Tehnopol Tallinn Science Park. Low hierarchy, academic freedom and a balanced work and family life are valued at TalTech. The university provides individual development and training opportunities, material and non-material tokens of acknowledgement, sporting opportunities at TalTech Sports Club and all-staff activities.

The Department of Electrical Power Engineering and Mechatronics maintains strong partnerships with leading industrial companies, grid operators, and foreign universities. These connections provide our students with access to internships, practical training, and networking opportunities, helping to kickstart their careers and establish valuable professional contacts. The Department actively engages in research activities, providing students with opportunities to participate in cutting-edge research projects.

The Department boasts state-of-the-art facilities, including modern laboratories and technology-driven learning spaces. You will have access to modern equipment, licensed software, and resources that facilitate learning, experimentation, and innovation.

(Additional information)

For further information, please contact Dr. Victor Astapov victor.astapov@taltech.ee and Prof. Ivo Palu ivo.palu@taltech.ee or visit https://taltech.ee/en/epem-organisation

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