New Methodology for Distribution Grid Planning Considering Impact of Power Flow Pattern Changes on Coincidence Factor

Summary

The overall goal of the project is to research and develop a new methodology for low voltage distribution grid planning considering the impact of power generation and consumption pattern changes on coincidence factor. The long-term strategy of the European Union is aiming at climate neutrality to be achieved by 2050 poses serious challenges to all branches of the economy, incl. the energy sector. It is expected that 50% of the supplementary renewable energy sources will be connected to the distribution network, of which 25...50% are direct current solutions added to the network through power electronics. The increasing sporadic nature of power generation and consumption and frequent changes in power flows constitute a challenge to the electric power system in several aspects: quality of electricity, supply chain security, reliability of network components, network losses as well as unpredictable end-user price fluctuations etc.

Research field:	Electrical power engineering and mechatronics
Supervisors:	Prof. Dr. Argo Rosin Vahur Maask
Availability:	This position is available.
Offered by:	School of Engineering Department of Electrical Power Engineering and Mechatronics
Application deadline:	Applications are accepted between June 01, 2025 00:00 and June 30, 2025 23:59 (Europe/Zurich)

Description

The goal of the PhD project is to develop an innovative approach for planning distribution grids that consider the impact of changing power flow patterns on coincidence factors. By doing so, the project aims to enhance the efficiency, reliability, and sustainability of electricity distribution systems. The specific objectives include creating a new planning methodology, analyzing its effectiveness, and assessing its economic implications. Ultimately, this research contributes to better grid management and resource allocation in the face of evolving energy demands and generation profiles.

PhD project should address several key research questions to advance our understanding and improve distribution grid planning. Here are some relevant questions:

1. How do changes in power flow patterns impact coincidence factors in distribution grids?
2. What are the limitations of existing distribution grid planning methodologies in accommodating dynamic power flow patterns?
3. How can the proposed methodology proactively incorporate the capabilities of Distributed Energy Resources (DER) into grid planning and operation?
4. What data sources and information from current smart grids can be effectively utilized to enhance distribution grid planning?
5. What are the potential operational services that can optimize network capacity utilization at the distribution level?
6. How does the new methodology compare to traditional approaches in terms of cost-effectiveness, reliability, and sustainability?
7. What are the socio-economic implications of implementing the proposed distribution grid planning methodology?

Research tasks would involve a combination of quantitative and qualitative research methods, including data collection through surveys, simulations, and possibly field studies, followed by data analysis using statistical and computational techniques. The goal would be to enhance the efficiency, reliability, and sustainability of electricity distribution in the face of evolving energy demands and generation profiles.

Supervisors

Main supervisor: Prof. Dr Argo Rosin

Co-supervisor: Researcher Vahur Maask

TAL TECH

Responsibilities and (foreseen) tasks

- **Developing a new methodology** for distribution grid planning that can adapt to changes in power flow patterns. Investigate the international and national regulations which could induce developments affecting the coincidence factor in low voltage distribution grid. State of Art study previous scientific studies related PhD thesis topic
- **Analyzing the impact** of these power flow pattern changes on coincidence factors, which are crucial for understanding peak demand and resource allocation. Analyze large-scale data from smart meters, IoT devices, and distributed energy resources to develop models for coincidence factor studies. Develop new scenarios for determination of coincidence factor for different low voltage grid areas, e.g. distributed, mid-dense, dense and super-dense areas simulations
- **Creating models** in DigSILENT to predict and simulate how different scenarios affect the distribution grid
- **Evaluating the effectiveness** of the new planning methodology against current practices. Determine the impact of distribution network changes on the coincidence factor due to the addition of solar parks, EVs, energy storages and aggregated loads using the DigSILENT software
- **Assessing the scalability** of the proposed methodology for different sizes and types of distribution grids.
- **Investigating the economic implications** of the methodology, including cost-benefit analysis.
- **Ensuring compliance** with regulatory standards and environmental considerations.

Applicants should fulfil the following requirements:

- master's degree in electrical engineering, computer science or applied informatics from the last 5 years
- a clear interest in the topic of the position
- principal understanding of electric power systems and a strong background in AI, machine learning
- strong programming skills (e.g., Python, MATLAB)
- proficient English language user (at least CEFR level of C1)
- profound writing and analytical skills
- capacity to work both as an independent researcher and as part of an international team
- capacity and willingness to aid in relevant organizational tasks

The following experience is beneficial:

- (co-)authored published scientific papers
- practical experience in working with DigSILENT, RSCAD, and/or MATLAB
- theoretical experience with power grid planning issues
- basic knowledge of machine learning

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 the leading microgrids research group in the region with a large portfolio of pan-European and national research and development, and study projects, mainly concerned with renewable energy integration and digital and AI applications in electric power systems.
- The opportunity to carry out high-level research in the domain of microgrids and metrology.
- Access to state-of-the-art research facilities for microgrids, renewables integration and power system digitalization.
- Opportunities for student exchange through EuroTeQ and Erasmus+ programmes, visits to scientific conferences and laboratory facilities and networking with leading universities and research centres.

About the department

The Department of Electrical Power Engineering and Mechatronics of Tallinn University of Technology is an interdisciplinary research centre that focuses on socially relevant and future-oriented research and teaching issues related to power engineering and mechatronics. The mission of the Department is to be a leader in electrical engineering and technical studies and development projects in Estonia, known and valued in society, and a respected partner in both national and international cooperation networks and organizations. The department has coordinated and partnered with several international projects, including Horizon 2020, INTERREG, 7FP, Nordic Energy Research etc.

The Department of Electrical Power Engineering and Mechatronics conducts research within 7 research groups and operates state-of-the-art laboratories with high-end equipment, offering also accredited services in the fields of lighting and different electrical measurements. The focus areas of the department are related to domestic and global challenges related to increasing digitalization, decarbonization and decentralization of electric power systems and increasing use of renewable energy sources. The department carries out research in the following relevant areas:

- optimization of electric power systems and system analysis to find possibilities for electrification and decarbonization
- diagnostics and monitoring of equipment and systems
- cyber security, 5G data communications and artificial intelligence
- energy networks and research on green technology, including energy storage, renewable energy, hydrogen systems
- supply and demand-side management, IoT applications in energy systems
- implementation of smart industry, including industrial robotics, automation, 3D printing, computer vision, digital twins

Additional information

For further information, please contact Prof. Argo Rosin, argo.rosin@taltech.ee

To get more information or to apply online, visit https://taltech.glowbase.com/positions/945 or scan the the code on the left with your smartphone.