New Methodology for Assessing the Dynamic Response of Demand-Side Energy Flexibility Measures

Summary

The overall goal of the project is to research and develop a new methodology for assessing the dynamic response that occurs after the activation of demand-side energy flexibility. The activation of energy flexibility, especially on an aggregated level, causes a deviation in the usual demand profile. This intentional deviation is sometimes necessary for proper grid management. However, after the activation of energy flexibility, the system needs to return to its normal state. During this process, dynamic responses such as the rebound and overshoot effects occur that need to be investigated.

Research field:	Electrical power engineering and mechatronics
Supervisor:	Prof. Dr. Argo Rosin
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, 2024 00:00 and June 30, 2024 23:59 (Europe/Zurich)

Description

The proposed PhD thesis aims to develop a novel methodology for assessing the dynamic response of demand-side energy flexibility measures. This research focuses on investigating dynamic responses following flexibility activation, particularly rebound and overshoot effects, crucial for understanding deviations from typical demand profiles. Leveraging advanced data analytics and simulation techniques, the study seeks to quantify and analyze these responses, providing insights for utilities and policymakers to optimize grid operations and integrate renewable energy resources effectively.

PhD project should address several key research questions to advance our understanding and improve the grid operations and the integration of renewable energy resources. Here are some relevant questions:

1. How do demand-side energy flexibility measures impact the dynamic response of aggregated energy consumption profiles, particularly in terms of rebound and overshoot effects?
2. What are the key factors influencing the magnitude and duration of dynamic responses following the activation of demand-side energy flexibility measures?
3. How can advanced data analytics and simulation techniques be utilized to accurately quantify and model the dynamic responses of demand-side energy flexibility?
4. What are the implications of the observed dynamic responses for grid stability, reliability, and the integration of renewable energy resources?
5. How can the developed methodology be applied to optimize demand-side management strategies for better grid management and energy efficiency?

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.

Responsibilities and (foreseen) tasks

- **Developing a new methodology** by conducting an extensive literature review to identify gaps and challenges in existing methodologies for assessing demand-side energy flexibility. Based on these findings, a novel methodology will be formulated to evaluate the dynamic responses, including rebound and overshoot effects, that occur following flexibility activations.
- **Creating the models** to simulate the dynamic behavior of energy flexibility measures. These models can be implemented using programming languages such as Python, MATLAB, or R

- **Case study** simulation will be conducted to demonstrate the application and effectiveness of the proposed methodology. The methodology will be applied to these case studies, and the results will be analyzed to validate the practicality and relevance of the approach.
- **Analyzing the impact** of demand-side energy flexibility activations on grid stability, reliability, and efficiency will be investigated. The magnitude and duration of dynamic responses, such as rebound and overshoot effects, will be quantified, and the implications for grid management and the integration of renewable energy resources will be assessed.

Applicants should fulfill 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 basic understanding of AI
- strong programming skills (e.g., Python, MATLAB, R)
- 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

<u>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.</u>

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, energy flexibility 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/799 or scan the the code on the left with your smartphone.