

# Real-time modeling and optimisation of demand side flexibility

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## Summary

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*This PhD project focuses on creating a real-time co-simulation platform to optimize the scheduling of energy flexibility in nearly Zero Energy Districts (nZEDs). It integrates various models and advanced forecasting algorithms to manage flexibility resources accurately. The research aims to develop new methods for aggregating and forecasting energy flexibility using deep learning, and to optimize resource scheduling to minimize costs while adhering to grid constraints. The project will validate its methods to ensure practical and reliable application in smart grids, enhancing their efficiency and sustainability.*

Research field:	Electrical power engineering and mechatronics
Supervisors:	Dr. Roya Ahmadihangar Prof. Dr. Jako Kilter
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

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The main objective of this PhD project is to design and implement a cutting-edge co-simulation platform aimed at the real-time, optimal scheduling of flexibility vectors to enhance the flexibility of nearly Zero Energy Districts (nZEDs). This interdisciplinary research will integrate energy district models, electrical grid constraints, and advanced forecasting algorithms to create a realistic, accurate, and optimized operation plan for flexibility resources. The focus will be on the development of a sophisticated platform capable of real-time assessment and management, leveraging tools such as RTDS, MATLAB, and Python. The ultimate goal is to minimize electricity costs and ensure efficient grid operation by harnessing demand-side flexibility.

### *Responsibilities and (foreseen) tasks*

- **Research and Development:** Investigate and develop methods for aggregating energy flexibility from different vectors, distinguishing between AC and DC bus flexibility.
- **Forecasting Models:** Create a novel deep learning-based multi-task learning model for accurately forecasting aggregated energy flexibility.
- **Co-Simulation Platform:** Design and implement a comprehensive co-simulation platform that integrates building models, electrical models, grid constraints, and various electricity sources.
- **Optimization Algorithms:** Develop and apply a multi-objective real-time optimal flexibility resource scheduling method to minimize electricity costs while considering grid technical constraints.
- **Validation and Evaluation:** Conduct rigorous validation and evaluation of the designed co-simulation platform and optimization methods to ensure accuracy and reliability.
- **Documentation and Dissemination:** Document research findings, methodologies, and outcomes, and disseminate results through academic publications and presentations.

### *Applicants should fulfil the following requirements:*

- a master's degree in Electrical engineering from last 3 years
- a clear interest in the topic of the position
- Profound knowledge of electric power systems, Machine learning methods.
- 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
- capacity and willingness to aid in relevant organizational tasks

*(The following experience is beneficial: )*

- (co-)authored scientific papers published in Q1 or Q2 journals
- programming using high-level programming languages (e.g., Python, C++, C#, Java or similar)
- mathematical optimization, programming, and algorithm development
- power system economics and electricity market

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 Estonia 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 chance to do high-level research in the domain of microgrids and renewables integration in an international and enabling environment with state-of-the-art research infrastructure.
- Opportunities for conference visits, research stays and networking with globally leading universities and research centers in the fields of public administration, innovation studies and digital government.

*About the department*

The Department of electrical Power Engineering and Mechatronics of Tallinn University of Technology is an interdisciplinary research center 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 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 hydrogen technologies, including energy storage, renewable energy, low carbon technologies, consumption management, iot applications in energy
- Implementation of smart industry, including industrial robotics, automation, 3d printing, machine vision
- Implementation of energy and resource efficiency, including digitization of supply chains, mapping of opportunities to optimize systems and reduce energy consumption
- Development of smart city solutions, including environmentally friendly and self-driving vehicles / drones, digital twin applications.

*(Additional information)*

For further information, please contact Dr Roya Ahmadi, [roya.ahmadi@taltech.ee](mailto:roya.ahmadi@taltech.ee)



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