Optimization of energy autonomy of zero emission buildings with battery storage.

Summary

This research will target the development of zero emission buildings, focusing on their energy management methods and optimization of their costs and performance. The cross-disciplinary work will address building's energy consumption, generation and storage from various perspectives, that intensify the use of on-site generated renewable energy and energy storage at the building and community levels.

Research field:	Electrical power engineering and mechatronics
Supervisors:	Dr. Andrei Blinov Martin Thalfeldt
Availability:	This position is available.
Offered by:	School of Engineering Department of Civil Engineering and Architecture 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

Buildings are responsible for more than 40% of the final energy use in EU and their energy efficiency must be improved sharply to cope with the EU climate targets, aiming at the greenhouse gas emissions from buildings reduction by 60% in 2030 and down close to zero in 2050. The achievement of these ambitious targets requires multi-disciplinary approach and coordinated optimization of building's energy performance from different levels, considering the most recent technological innovations and their potential as well as economic feasibility and healthy living conditions. Electrification is the backbone of the future design or refurbishing of buildings needed to achieve the zero carbon emission target. A comprehensive approach would require not only electrifying of heating/cooling but also consider on-site energy generation, mostly by photovoltaic (PV) systems, to achieve synergy in energy efficiency, cost of electricity, and decarbonization. The transition to building stock should be based on accurate and efficient data driven models used for planning, investment decisions, developing novel control and energy management methods. The developed methods and design approaches should assume HVAC devices to be backed up with PV and energy storage for maximizing self-consumption and energy independence and resilience of buildings.

This project will address the energy management issues in the ZEBs and consider various mission profiles for data-driven optimal sizing of PV installation and energy storage for maximization of self-consumption in both new and existing buildings. Development of new approaches of flexible, synergetic control of HVAC and local energy storage is necessary to further increase energy autonomy, resilience and economic feasibility of ZEBs.

Responsibilities and (foreseen) tasks

- Collection, processing and analysis of data on building energy efficiency, consumption profiles and energy use
- Development of the simulation, diagnostics, and prediction tools, such as digital twins, for ZEBs
- Development of models for estimation of battery storage requirements, considering electricity pricing, local PV generation and energy consumption
- Development of improved models for synergetic control of battery, HVAC and other assets aimed at enhanced energy flexibility and resiliency.
- Investigating the benefits of multi-storage systems, with stationery and rolling storage with V2X capability.
- Development of lifetime models of various assets used for energy management
- Feasibility and economic viability analysis of alternative energy storage technologies in the residential sector
- Feasibility analysis of potential grid services and different business models enabled by the smart prosumer buildings with energy storage systems
- Publishing of research findings in top-tier (Q1) journals and dissemination at the flagship conferences of the IEEE, Elsevier and {…}

Applicants should preferably fulfil the following requirements:

- master's degree in electronics, energy systems, civil engineering or related areas;
- B2 English level certificate if English is not native language and language of instruction in MSc study was not English;
- experience in the development of energy management systems;
- experience in the modeling of buildings and their HVAC systems, electric energy systems or renewable energy systems;
- experience in the data analysis and visualization using software tools like Python;
- experience with closed-loop control system design with analog/digital sensors and DSPs;
- understanding of power electronic converters, basics of their control and characteristics;
- excellent command of English and strong and demonstrable writing, presentation and analytical skills;
- capacity to work both as an independent researcher and as part of an international team;
- capacity and willingness to provide assistance in organizational tasks relevant to successful implementation of the project.

(The following experience is beneficial:)

- international publications will be valued;
- internship experience abroad will be considered a plus;
- industrial experience is preferable.

We offer:

- Early Stage Researcher position in one of the well-known universities in EU with a large portfolio of ongoing pan-European and national research and innovation projects
- The chance to do cutting-edge multidisciplinary applied research in collaboration with different institutes and private companies.
- Opportunities for conference visits, research stays and networking with globally leading universities and research centers in the fields of civil engineering, renewable energy systems and energy management.

About the project team

The position is a part of the Estonian Centre of Excellence (CoE) in Energy Efficiency, which is one of the ten national centers that covers issues related to existing and upcoming building stock conversion to ZEBs with maximized co-benefits and improved life quality. Interdisciplinary CoE combines engineering, social, data sciences and economics with central focus on energy performance of buildings and districts, electrification and flexibility, renewable energy generation and storage, energy saving measures and business models with their socioeconomic and regional impacts. The supervision and research activities will be managed jointly by the Power Electronics and Nearly Zero Energy Buildings Research Groups of TalTech. Key research directions include development of improved modelling approaches, such as digital twins; implementation of new components and materials; elaboration of power flow control algorithms and design guidelines to further improve the efficiency, energy performance flexibility and economic feasibility of ZEBs.

(Additional information)

For further information, please contact Andrei Blinov andrei.blinov@taltech.ee and Martin Thalfeldt martin.thalfeldt@taltech.ee

Also, visit:

https://taltech.ee/en/power-electronics-research-group

https://taltech.ee/en/nearly-zero-energy-buildings-research-group

To get more information or to apply online, visit https://taltech.glowbase.com/positions/792 or scan the the code on the left with your smartphone.