LITHUANIAN ENERGY INSTITUTE

ADMISSION TO PHD STUDIES FOR THE YEAR 2025

DOCTORAL RESEARCH TOPIC:

Research on Energy Systems Integration for Smart Climate Neutral Cities

RESEARCH FIELD:

Energetics and Power Engineering (T 006)

BRIEF DESCRIPTION OF RESEARCH TOPIC:

One of the EU's goals is to achieve that by 2050 the European continent would become climate neutral. One of the five announced missions of the EU's "Horizon Europe" programme is "**Climate-neutral and smart cities**". This mission is very important because cities are concentrated sources of pollution and climate change. Cities cover 3% of the Earth's surface, however, generate around 72% of greenhouse gas (GHG) emissions. This share may increase even more in the future as cities grow rapidly. It is projected that in 2050 almost 85% Europeans will live in cities.

In order to achieve these ambitious goals of climate neutrality, energy systems are undergoing a transformation: fossil fuels are being replaced by renewable energy sources (RES), energy-intensive consumers are emerging, and sustainable solutions for non-renewable energy generation are needed. **The energy systems integration** plays a key role in this transformation process and the inevitable interactions between heating, cooling, electricity supply systems, RES, energy storage, hydrogen technologies, as well as the interfaces between energy systems and transport infrastructure (charging stations for electric cars), which will become a major consumer of energy, must be taken into account. All this results in an environment that is optimised, reliable and responsive to the people themselves and their needs (which includes so-called ambient intelligence).

In order to have as many climate-neutral and smart cities as possible, it is important for cities to have a vision of what the urban energy sector will look like, to choose the right energy generation and storage technologies to ensure uninterrupted and reliable energy supply for citizens, businesses, transport and all urban infrastructure. To this end, models are needed that evaluate the performance of energy systems under different conditions and allow the selection of the optimal infrastructure for the urban energy sector. Various tools and models have been developed for modelling the operation of individual energy systems (electricity, heat, gas supply) as well as for economic-technical evaluation of the global energy sector. However, there is no uniform methodology, tools and models for detailed evaluation of integrated energy systems operation and their technical parameters, taking into account synergies between heating, cooling, electricity systems, RES, energy storage, hydrogen, waste heat recovery and other innovative technologies. The developed methodology and new models would help to develop visions for smart, climate-neutral cities and serve them in the future, thus, creating a fundamentally new high-quality and sustainable environment for society.

The topic of the dissertation "Research on Energy Systems Integration for Smart Climate Neutral Cities" will aim to develop a methodology for the modelling and evaluation of the integrated energy systems of a smart climate-neutral city, the performance and parameters of these systems, taking into account the

interactions of technologies and possible disconnections of individual technologies and their support systems. The developed methodology will be verified by modelling and analysing selected integration scenarios of energy technologies and systems.

The following tasks will be addressed in the dissertation topic (theme):

- Investigate scenarios for the development of smart low-temperature heating and cooling supply networks and their integration into other sustainable energy systems, and develop methodology and models for modelling their operation.
- Apply the developed methodology to the research on integrating waste heat of various parameters into low-temperature/high-temperature heat supply networks.
- Investigate scenarios for integrating hydrogen technologies into sustainable energy systems and develop methodology and models for evaluating integrated systems' operation.
- Develop a methodology for modelling integrated energy systems and their operation, taking into account the parameters and interoperability of potential energy systems and transport infrastructure.
- Assess the reliability and optimization of energy supply in various scenarios for the transformation and development of energy systems, taking into account their resilience to extreme weather events and events caused by climate change.
- Develop and analyse, considering resource consumption and reliability, a model of smart city demo project.
- Prepare models of alternative scenarios for the transformation of a specific Lithuanian city / city-district into a smart city.
- Assess the applicability of the developed methodology to various smart cities.

A methodology for modelling the operation of climate-neutral integrated energy systems in a smart city will be developed and verified. This will enable the optimal selection of energy technologies according to the set of criteria and constraints.

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