Multi-annual Work Programme

(A) Collaboration Topic

Electricity risk preparedness and exercises for resilience

Energy systems are becoming a backbone of society, and many other critical infrastructures depend explicitly on electricity supply. Therefore the resilience of the power system and the security of electricity supply plays a vital role in any country or society. The collaboration project between KTU and JRC will develop methodology and tools to assess, quantify, and enhance the resilience of the power systems, using EU regional system as demo study case and contribute to innovative policy proposals. The energy transition significantly changes the structure of the power system, creating new interdependencies and vulnerabilities, thus creating new risks that can negatively affect society by compromising security of supply and resilience of power supply systems. In addition, climate change affects the frequency of natural hazards, tensions at geopolitical level contributes to new threats and attack vectors that all might influence resilience of a power system based on renewable energy generation.

The aim of the project is to develop a comprehensive framework for resilience assessment, combining system modelling, vulnerability analysis, and scenario-based stress testing. The methodological approach includes, but not limited to, quantitative modelling of energy systems under normal and disturbed conditions, development of resilience metrics across a range of disruption scenarios, simulation of the power system behaviour and recovery using time-series optimization. The outcomes of the research will include resilience enhancing strategies such as redundancy, storage, and demand-side flexibility.

The project aligns with shared strategic priorities of KTU and JRC to contribute to a more secure, sustainable, and resilient European energy system.

(B) PhD Work Plan

Project 25-18

The doctoral researcher will be enrolled at the Kaunas University of Technology for the standard **4 year PhD duration**.

The doctoral student will complete **mandatory coursework of 30 ECTS credits**. The doctoral student is required to study at least 4 study modules that are approved by the Doctoral Committee at KTU. At least 1 study module must be completed at a foreign higher education institution, or credits must be obtained at international summer/winter schools organized by foreign higher education institutions (otherwise, the doctoral student must complete a research fellowship of at least 3 months abroad in the course of the period of the doctoral studies, which can be completed in shorter non-consecutive periods). Each doctoral student coordinates this plan within the first month of his/her doctoral studies. It is recommended to take modules related to sustainable energy and environment, power systems reliability models, and power system dynamics and stability.

The research plan includes scientific literature review on energy system resilience assessment, development of methodology, data analysis and computational experiments based on energy system behavior and resilience enhancement methods. Research will focus also on network analysis methods, possibly applying graph flow approaches and computational methods that

emulate the energy system. Additionally uncertainty and sensitivity methods will be studied and applied to realistic energy systems.

Computational simulations will be conducted at both KTU and JRC. KTU will focus on theoretical modelling and scenario analysis, while the JRC will support validation and stress testing using their simulation platforms and relevant datasets.

The doctoral researcher will spend the **first 12 months at KTU**, followed by **24 months at the JRC**, Ispra (Italy), and the final **12 months at KTU**.

Co-supervision will be ensured through regular meetings and joint planning sessions. **Dr. Audrius Jonaitis**, professor of the Department of Electrical Power Systems at KTU, will serve as a primary supervisor of the doctoral thesis, and **Dr. Vytis Kopustinskas**, scientific officer at JRC, will serve as a consultant and a supervisor of the research at JRC.

A doctoral student will be assessed at the academic department of KTU and the doctoral committee at the end of the autumn and spring semesters of each academic year.

The dissertation will be publicly defended and the doctoral degree will be awarded at KTU in the open meeting of the Study Board according to Regulation on Research Doctoral Studies of the Institutions of Joint Doctoral Studies.

References

Asensio Bermejo, I., Foretić, H., Kopustinskas, V. et al. Resilience assessment of a power system due to disruption of interconnectors. Environ Syst Decis 45, 48 (2025). https://doi.org/10.1007/s10669-025-10041-2

Martišauskas, L.; Augutis, J.; Krikštolaitis, R.; Urbonas, R.; Šarūnienė, I.; Kopustinskas, V. A Framework to Assess the Resilience of Energy Systems Based on Quantitative Indicators. Energies 2022, 15, 4040. https://doi.org/10.3390/en15114040

R. Remenyte-Prescott, V. Kopustinskas (eds.) Modelling the Resilience of Infrastructure Networks, Det Norske Veritas, 2021.

Project 25-35

The doctoral researcher will be enrolled at the Kaunas University of Technology for the standard **4 year PhD duration**.

The doctoral researcher will complete **mandatory coursework of 30 ECTS credits**. The doctoral student is required to study at least 4 study modules that are approved by the doctoral committee at KTU. At least one study module must be completed at a foreign higher education institution, or credits must be obtained at international summer/winter schools organized by foreign higher education institutions (otherwise, the doctoral student must complete a research fellowship of at least 3 months abroad in the course of the period of the doctoral studies, which can be completed in shorter non-consecutive periods). Each doctoral student coordinates this plan within the first month of doctoral studies. It is recommended to take modules related to sustainable energy and

environment, power systems reliability models, and power system dynamics and stability. As the fellow starts their PhD at the JRC, they will take the courses online.

The research plan includes scientific literature review on power system resilience assessment, development of methodology, data analysis and computational experiments based on power system behavior and resilience enhancement methods.

Computational simulations will be conducted at both KTU and JRC. KTU will focus on theoretical modelling and scenario analysis, while the JRC will support validation and stress testing using their simulation platforms and relevant datasets.

The doctoral researcher will spend **24 months at the JRC**, Ispra (Italy). The stay at the JRC can start from the 4th to the 7th semester and end before the end of the doctoral studies.
Co-supervision will be ensured through regular meetings and joint planning sessions. **Audrius Jonaitis**, professor of the Department of Electrical Power Systems at KTU, will serve as a consultant and a supervisor of the research at KTU, and **Vytis Kopustinskas**, scientific officer at JRC, will serve as a consultant and a supervisor of the research at JRC.

The doctoral student will be assessed at the academic department of KTU and the doctoral committee at the end of the autumn and spring semesters of each academic year.

The dissertation will be publicly defended and the doctoral degree will be awarded at KTU in the open meeting of the Study Board according to Regulation on Research Doctoral Studies of the Institutions of Joint Doctoral Studies.

References

Vasylius, Virginijus; Jonaitis, Audrius; Gudžius, Saulius; Kopustinskas, Vytis. Multi-period optimal power flow for identification of critical elements in a country scale high voltage power grid // Reliability engineering & system safety. Oxford : Elsevier. ISSN 0951-8320. eISSN 1879-0836. 2021, vol. 216, art. no. 107959, p. 1-7. https://doi.org/10.1016/j.ress.2021.107959

Jonaitis, Audrius; Gudzius, Saulius; Morkvenas, Alfonsas; Azubalis, Mindaugas; Konstantinaviciute, Inga; Baranauskas, Audrius; Ticka, Vidmantas. Challenges of integrating wind power plants into the electric power system: Lithuanian case // Renewable and sustainable energy reviews. Oxford : Elsevier. ISSN 1364-0321. 2018, vol. 94, p. 468-475. https://doi.org/10.1016/j.rser.2018.06.032

(C) Expected outputs

The project will result in a doctoral thesis, peer-reviewed journal articles, and conference presentations.

The expected dissemination outputs are:

- at least in 2 papers in the international scientific journals with the impact factor in the Clarivate Analytics Web of Science (CA WoS) database and in the Q 1-Q3 quartiles.
- presentation of his/her research results at least in 2 international scientific conferences.

A dissertation (doctoral thesis) can be prepared either as a coherent monograph or can be based on a set of scientific papers. In both cases, the main outcomes of the research should be published in scientific papers and/or presented in conferences.

If the dissertation is prepared as a coherent monograph, it should consist of a text of the dissertation and an abstract. The dissertation includes a list of the scientific papers and scientific conferences which presented the dissertation's research results, and a description of the life, research and creative activities of the individual who has submitted the dissertation for defence. In this case, the minimum number of publications and conferences listed above is valid.

If the dissertation is based on a set of scientific papers, it has to include a review of the published scientific papers, an abstract, along with copies of the doctoral candidate's scientific papers on the dissertation topic which are the basis for the dissertation being defended, while also indicating the specific contribution of the author. The key research results are required to be published by the doctoral candidate at least in four scientific papers (where, specifically, the doctoral candidate is the sole author or the lead co-author at least in two of them), published or accepted for publishing (with a digital object identifier (hereinafter - DOI) or another justification for acceptance for publication) in international scientific journals in the Q 1 or Q2 quartiles at the time of the publishing of the paper in international scientific publications with the impact factor in the Clarivate Analytics Web of Science (CA WoS) database.

Beyond academic outputs, the research aims to contribute into a resilience assessment framework that could support EU institutions and Member States in policy design, especially regarding the implementation of the Risk Preparedness Regulation, the European Climate Adaptation Strategy, and grid infrastructure planning under the European Green Deal.