




LAND OF THE CURIOUS




 29.11.2024

LABORATORY OF ELECTRICITY MARKETS AND POWER SYSTEM

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AGENDA

- 
- »» Introduction
 - »» Ongoing Projects
 - »» Submitted Proposals
 - »» Supervision
 - »» Teachings
 - »» Publications
 - »» Next plans

Laboratory of Electricity Market and Power Systems



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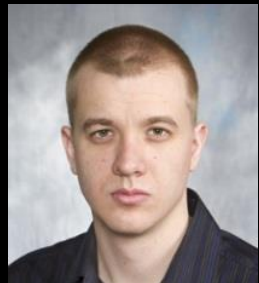
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Dr. Antti Pinomaa



Dr. Aleksi Mattsson



Dr. Aleksei Romanenko



Henock Dibaba



Ville Sihvonen



Narges Ghorbani




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Madia Safdar

ONGOING PROJECTS

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- Project Title: **Optimal planning of hybrid energy storage systems in the renewable energy dominated power systems**
 - Role: **PI (LUT Side)**
 - Funder: **LUT Doctoral School Funding**
 - Partner: Leibniz University Hannover
 - **Summary:** Hybrid energy storage systems (HESS) are gaining attention in power systems development as they combine different ESS technologies to outperform each subsystem. The integration of HESSs is important for clean energy abundance. Optimization models are necessary to facilitate the participation of distributed energy resources in energy markets and power system operations. Tentatively, this project will consist of four work packages **1)** analysis of state of the art in energy storage technologies and different services that can provide by them, **2)** Identification of the required services by energy storage systems in the selected power system, **3)** Techno-Economic and Environmental analysis of the different hybrid EES technologies, and **4)** Optimal planning of the distributed HESS.

ONGOING PROJECTS

» Project Title: **Reliable 6G for Energy Vertical Applications (REEVA)**
Role: PI (LUT Side)



» Funder: **Business Finland** (Extended by end of 2026)

Distribution grid protection

UC1: Virtual fault passage indication on edge–cloud continuum

UC2: Latency-critical intertrip and line differential protection

Microgrid control

UC3: Coordinated grid-forming and grid-following frequency converter control

UC4: Operation of electrified loads and storage units in microgrids based on local weather forecasts


Virtual power plant control

UC5: Event-triggered communication for control of space heating

UC6: Packetized energy management for electrified transportation considering spatial-temporal dynamics



ONGOING PROJECTS

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- Proposal Title: **Universal, open-source and cybersecure Digital Twin to provide investors in onshore wind farms valuable insights about current operations and future investments (TWINVEST)**
 - Role: **PI (LUT Side), Funder: EU-Horizon program**
 - Partner: **14 Partners from BE, NO, IT, UK, GR, TR, and AT**
 - **Objectives:**


TWINVEST intends to create the foundations of a universal, open-source and cybersecure Digital Twin (DT) to provide investors in onshore wind farms valuable insights about current operations and future investments. Guide investment decisions in wind energy is a complex as it involves various factors to monitor or assess such as energy production, maintenance, investment framework and characteristics of the wind farm.

ONGOING PROJECTS


- Proposal Title: **Port of Mussalo Energy Community Pilot**
- Role: **Collaborator (leading task related to energy storage planning)**
- Funder: **JTF**
- Objectives:
- The objective of the project is to improve the competitiveness of the local stakeholders by providing clean and affordable electricity to the participants and by helping them to meet their greenhouse gas reduction targets. The needs for regulatory changes are reported to the respective authorities and politicians.



ONGOING PROJECTS

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- **Project Title:** Joint Optimization of Data and Energy Networks for digitizing Sustainable Communities (COALESCE)
 - **Role:** Team member (LUT Side)
 - **Funder:** Horizon (Staff Exchange)
 - **Other Partners:** South East Technological University (IE), Trinity College Dublin (IE), University of Cyprus (CY), DHA Suffa University (PK), Millennium Institute of Technology (PK), Cleanwatts Digital (PT), CY.R.I.C (CY), Huawei Ireland Research Center (IE), Volve (FI)
 - **Objective:** COALESCE aims to develop a cross-optimization platform that enables integrated operation and interplay between the energy grids and the data and telecommunication networks. Telecommunication and data networks need energy, while energy grids need data to operate efficiently. This project will develop a framework that will optimize the interplay between energy grids and telecommunications and data networks in a way that both the infrastructure pillars (energy and telecommunications) are jointly sustainable and efficient. Through the Staff Exchange program, we will be able to exchange expertise and know-how between energy, data and telecommunications sectors across both academia and industry.

ONGOING PROJECTS

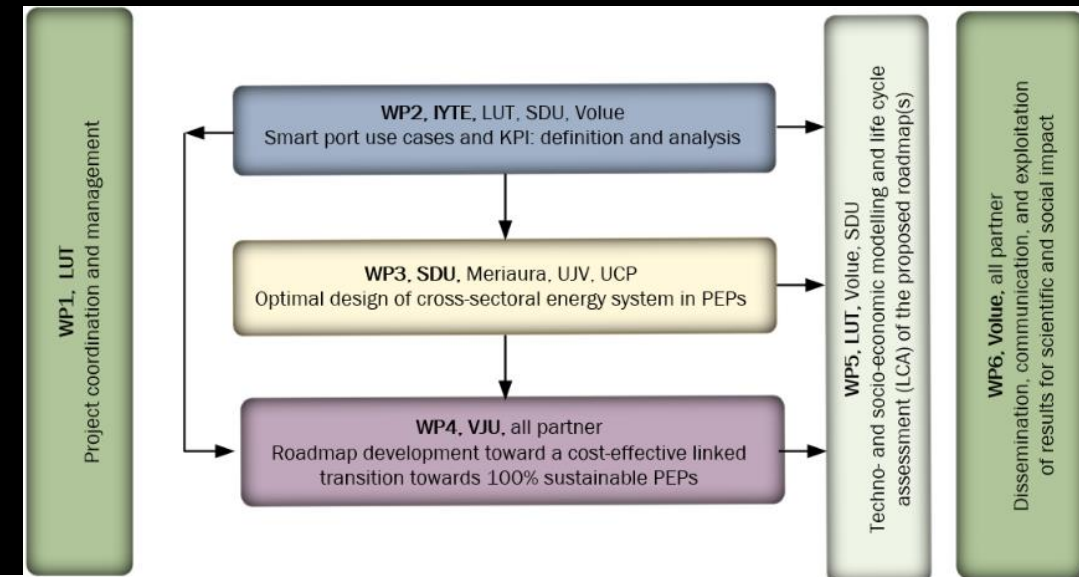
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- Project Title: **Pathways out of Energy Crises to a Resilient and Just Energy System – PHOENIX**
 - Role: Team member (LUT Side)
 - Funder: Academy of Finland (STN call)
 - Other Partners: LUT University, University of Helsinki, VATT, University of Eastern Finland, University of Tampere
 - Project Summary: PHOENIX seeks to assess how the benefits and costs of the energy system are distributed in Finland and design solutions, actions and policies that would support a more equitable distribution. PHOENIX addresses resiliency of the energy system and the sectors of the society impacted by the green energy transition, such as manufacturing, rural areas, and energy end users. It explores new energy solutions that strengthen resiliency. PHOENIX focuses on energy justice and resilience from the perspectives of households and firms, and different industrial sectors and regions. It seeks to promote fundamental societal change in Finland that is needed to achieve a just green transition. Finland's transition will produce valuable global lessons on how a vital democratic society and a Nordic welfare state, with liberalized electricity markets and an energy-intensive goods export sector, can implement a just energy transition.

FINALIZED PROJECTS

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- » Project Title: Vetyä, virtaa Kaakkoon – mallinnuksesta markkinoille
 - » Role: Collaborator (LUT Side)
 - » Funder: REACT EU
 - » Summary of the Work: This project aims to identify the requirements for modeling future energy systems, focusing on evaluating the current capabilities and shortcomings of existing modeling tools. The objective is to enhance our understanding of the evolving energy landscape, ensuring that modeling approaches align with the dynamic needs of the industry.

SUBMITTED PROPOSALS-UNDER REVIEW

- Pre-Proposal Title: *Climate Neutral Positive Energy Ports: Linking Energy and Ship Transportation Sectors Transitions (CI-Port)*
- Role: Coordinator, Funder: DUT call (EU+regional funding agencies)
- Partners: Izmir Institute of Technology (TR), UJV (CZ), Meriaura Energy Oy (FI), University of Southern Denmark (DK), ULUSOY CESME PORT (TR), Value (FI)
- Summary: *CI-Port advances the state of Positive Energy Districts (PED) research and innovation by establishing connections between port cities and the maritime sector. Port cities play a pivotal role in the transition to smarter societies, serving as central hubs where energy and maritime activities converge. Through CI-Port, we delve into the interconnected evolution of the maritime sector and port cities toward sustainability, energy efficiency, and cost-effectiveness*



SUPERVISION-POSTDOC AND PHD STUDENTS



PostDoc: Reliable 6G for Energy Vertical Applications (M. Norouzi)

PhD thesis: Peer to Peer market mechanism for multi-service trading of hybrid electric energy storage systems in power grids (H. Aghamohamamdloo)

PhD thesis: Deep reinforcement learning methods Applications in Sector Coupled Energy systems (M. Seyfi)

PhD thesis: Optimal planning of hybrid energy storage systems in the renewable energy dominated power systems (M. Safdar)

PhD thesis: Developing Forecasting Tools for Wind Power Investment (R. Akhtar)

SUPERVISION-MASTER STUDENTS



Graduated 2024

M.Sc thesis: Optimal Design of a Hybrid Renewable Plant-Based Hydrogen Production System Considering Electricity Market Prices in Finland (A. Mirzaei-July 2024)

M.Sc thesis: Standard Design Criteria for High Voltage Substations (R. Mustajärvi-July 2024)

M.Sc thesis: Estimating potential revenue generation by energy storage systems providing multiple services to the Nordic electricity markets (Finland) through the QuEST Valuation Application (Md Arafath Uzzaman-Aug 2024)

Ongoing 2024

M.Sc thesis: Utilizing a novel technology arc suppression coil in US network (T. Matilainen)

M.Sc thesis: Energy Demand and Price Prediction in the Nordic Area (Amin Hasanzadeh)

M.Sc thesis: Pre-charge resistor protection in STATCOM (M. Gheiasvandi)



Electric Power Transmission (5 credits, Autumn 2024)

81 Students are enrolled.

- Introduction of the course, Finnish power system, and Nordic market
- Modeling of transmission systems
- Active power and frequency control
- Reactive power and voltage control
- Power flow calculations
- Short circuit studies
- Stability analysis
- Protection of transmission network
- High voltage direct current transmission

»» Total ECTS: 10



»» Time: Winter 2024

- 1) **PhD course: Advanced Optimization Techniques for Energy Systems Planning and Operation (Organizer and Co-instructor)**
- 2) **PhD course: Energy Markets and Analytics (Organizer and Co-instructor)**

»» Time: Spring 2024

- 1) **Renewable Energy Integration (Organizer)**

PUBLICATIONS-JOURNAL ARTICLES

- » Unveiling the potential of renewable energy and battery utilization in real-world public lighting systems: A review, Renewable and Sustainable Energy Reviews
- » Fuel cell preventive maintenance in an electricity market with Hydrogen storage and Scenario-Based risk management, Sustainable Energy Technologies and Assessment
- » Learning-based Virtual Inertia Control of an Islanded Microgrid with High Participation of Renewable Energy Resources, IEEE Systems Journal
- » Energy management of hybrid fuel cell and renewable energy based systems - A review, International Journal of Hydrogen Energy
- » A Smart Building Energy Management Incorporating Clustering-Based Tariffs in the Presence of Domestic Solar Energy, Battery, and Electric Vehicle, Solar Energy
- » Electric Load Forecasting under False Data Injection Attacks via Denoising Deep Learning and Generative Adversarial Networks, IET Generation, Transmission and Distribution
- » Review on Techno-Socio-Economic Studies of Electric Vehicles in Electrical Energy Systems, E-Prime
- » An IGDT-stochastic model for low-carbon economic dispatch of integrated electricity-natural gas systems considering grid-enhancing technologies, IET Generation, Transmission and Distribution

PLANS FOR SUBMISSION OF THE PROPOSALS



Academy of Finland Call (Research Project: Initial idea is about Resilient Data Centers with Integrated Energy Storage for Finland's Energy Industry)

Horizon Call-PV integrated EVs

