

**ENERGEETIKATEADUSKOND
ELEKTROENERGEETIKA INSTITUUT
TEADUS- JA ARENDUSTEGEVUSE AASTAARUANNE 2013**

1. Struktuur

**Elektroenergeetika instituut, Department of Electrical Power Engineering
Instituudi direktor Heiki Tammoja**

- Energiasüsteemide õppetool, Chair of Power Systems, Heiki Tammoja
- Kõrgepingetehnika õppetool, Chair of High Voltage Engineering, Juhan Valtin

2. Instituudi teadus- ja arendustegevuse (edaspidi T&A) iseloomustus

2.1 Instituudi koosseisu kuuluvad uurimisgrupid

2.1.1 Energiasüsteemide uurimisgrupp

Power Systems research group, Heiki Tammoja.

2.1.1.1 Teadustöö kirjeldus

The tasks of the Power System research group are elaboration and assessment of energy sector development scenarios and analysis of activities needed for their realization. The research in energy system planning is done with energy planning models, as the studies are comprehensive and therefore require great number of input data and defining of variables. This modelling software are used for future electricity generation simulations, CO₂ emission prediction, electricity price or CO₂ cap price forecast, feasibility studies for a single power plant, market penetration of new technologies like carbon capture and storage (CCS), solar photovoltaic or different balancing options. One part of Researches is focused on developing methods and algorithms for advanced power system control implementing wide-area information (probabilistic, uncertainty and fuzzy). Key research directions include development of new applications for wide-area based control and protection of power system, implementation of FACTS and HVDC devices for system security enhancement, and development of real-time simulation approach to system control and protection. Other research activities are concentrated on the development and assessment of power quality mitigation methods in transmission and distribution systems considering the availability of modern compensation devices, and on developing modelling and analysing methods for power system optimal control considering data uncertainty and fuzzy information.

2.1.1.2 Aruandeaastal saadud tähtsamad teadustulemused

AR10126 – „Optimization of the functioning of the Energy System to balance changeable loads” (H. Tammoja).

Has created an original system – optimization software OPTEN, which allows to solve the load distribution, unit commitment and operating reserves for energy system optimization problem, by existing in system the thermal plants, hydroelectric power plants and pump-hydro power plants. The system will work directly with database, developed especially for MS Visual FoxPro environment. The maximum length of the

time horizon is 1 week or 168 time intervals, the maximum number of thermal units – 18, hydro and pump-units – either 4. OPTEN can be used for teaching and research.

ETF8760 „Vector optimization of thermal power plants considering incompleteness of information“ (J. Šuvalova).

The scientific objective of the grant is to develop the new mathematical models and methods for the optimization of the TPP operation considering the possibilities of multi-objectives or vector-optimization and the different forms of information. The forms of information studied in the grant are deterministic, probabilistic, uncertain and fuzzy information. 2013 was the third year of the grant. In that year was studied the news references of vector-optimization. The research focuses on one of the alternatives of distributed electricity generation (DG) with condensing power plants and includes its comparison with common distribution structure with the account fuel-costs characteristics. The basic results of research will be published in two articles.

Lep13043 “Service reliability characteristics and influencing factors of changes in different supply reliability areas in transition to the cable network of medium and low voltage networks of Elektrilevi OÜ“ (J. Valtin)

Was determined supply reliability areas of distribution network, supply reliability indices relating to the transition to the cable network in these areas. Has been studied the economic profitability of the transition to the cable network.

Lep13118 “Development and analysis of wide area measurement system (WAMPAC)” (I. Palu)

A method and application for optimal placement of phasor measurement units (PMUs) in Estonian power system is developed. It's found the minimal number of required PMUs for the complete system observability under normal and N-1 conditions.

VNF573 “Smart transmission grid operation and control (STRONgrid)” (I. Palu)

Purpose of the project is to address the challenges that the secure and reliable operation of the power grids will face in the future. One bachelor study level student is defended its bachelor thesis.

VFP514 „Large scale Smart Grids demonstration of real time market-based integration of DER and DR“ (I. Palu)

The key objective of the project is to demonstrate efficient operation of a distribution power system with high penetration of many and variable renewable energy resources. One bachelor study level student is defended its bachelor thesis.

2.1.1.3 Olulisemad publikatsioonid aruandeaastal

Kivipõld, T.; Valtin, J. (2013). Replacement of the regulated price of oil shale-based electricity with open-market price and real-time tariff system opportunities. Oil Shale, 30(S2), 195 - 210. 1.1.

Annuk, A.; Allik, A.; Pikk, P.; Uiga, J.; Tammoja, H.; Toom, K.; Olt, J. (2013). Increasing renewable fraction by smoothing consumer power charts in grid-connected wind-solar hybrid systems. *Oil Shale*, 30(S2), 257 - 267. 1.1.

Astapov, V.; Shuvalova, J. (2013). About suitability of condensing power plants to power distribution system. In: *Proceedings of the 4th International Youth Conference on Energy: 4th International Youth Conference on energy 2013*, Siofok, Hungari, 6-8.06.2013. IEEE, 2013. 3.1.

Drovtar, I.; Landsberg, M.; Rosin, A.; Kilter, J. (2013). Large scale electric vehicle integration and its impact on the Estonian power system. In: *Proceedings of IEEE PowerTech 2013: IEEE PowerTech 2013*, Grenoble, France, 16-20 June 2013. IEEE, 2013. 3.1.

Cross, S.; Hast, A.; Syri, S.; Kuhl-Thalfeldt, R.; Valtin, J. (2013). Progress in development of renewable electricity in Northern Europe in context of the EU 2020 renewables target. In: *IEEE Conference Proceedings: 10th International Conference on the European Energy Market*, 27 - 31 May 2013, Stockholm, Sweden. IEEE, 2013. 3.1.

2.1.2 Kõrgepinge uurimisgrupp

High-Voltage research group, Juhan Valtin

2.1.2.1 Teadustöö kirjeldus

Research of the High Voltage research group is focusing on the studies of the high voltage insulation and applications associated with the high voltages and strong electrical fields. Most research is related to the insulators and insulation used in power lines, both overhead and cable lines are studied. The evolution and deployment of the novel insulating materials increases notably the importance of research and need to understand all the different physical phenomena (high electrical field stresses, partial discharges, dielectric losses, temperature effects, etc.) distinctive to the power cables. Another scope of research is the effects to high voltage equipment (transformers, cable power lines etc.) due to high loading, nonlinear loads and power quality. Influence of power quality and dynamic power loading for the equipment, increased thermal and mechanical stress and aging are investigated. Research aims to provide indexes of reliability, considering different stresses to the power transmission networks during their lifetime, taking into account air pollution, weather, wildlife but also influences of characteristics of the future electric loads, materials etc.

2.1.2.2 Aruandeaastal saadud tähtsamad teadustulemused

Lep13025 “330/110 kV overhead line versus underground cable line” (P. Taklaja)

Expert opinion about main properties of high and extra high voltage alternative current overhead and underground cable power lines.

Lep13034 “Short circuit currents caused by the trees that are fallen to overhead lines. Analysis to reduce the fault currents-induced hazards and risks in 110 kV power grid”

(P. Taklaja)

Short circuit currents caused by the trees that are fallen to overhead lines. Analysis to reduce the fault currents-induced hazards and risks in 110 kV power grid.

Lep13163 “Lightning impulse voltage test of medium voltage circuit-breaker” (P. Taklaja)

Lightning impulse voltage test of medium voltage circuit-breaker.

VE595 *“Evaluation of the used 110 kV insulating strings”* (P. Hyvönen)

Evaluation of the used 110 kV insulating strings.

Lep13138 *“Partial discharge measurements of medium voltage underground power cables”* (P. Hyvönen)

Partial discharge measurements of medium voltage underground power cables.

2.1.2.3 Olulisemad publikatsioonid aruandeaastal

Taklaja, P.; Oidram, R.; Niitsoo, J.; Palu, I. (2013). Causes of indefinite faults in Estonian 110 kV overhead power grid. Oil Shale, 30(2S), 225 - 243. 1.1.

Taklaja, P.; Oidram, R.; Niitsoo, J.; Palu, I. (2013). Main bird excrement contamination type causing insulator flashovers in 110 kV overhead power lines in Estonia. Oil Shale, 30(2S), 211 - 224. 1.1.

Taklaja, P.; Hyvönen, P.; Niitsoo, J.; Palu, I.; Klüss, J. (2013). Impulse characteristics of 24 kV overhead line pin insulators. 12. International Conference on Environment and Electrical Engineering - Wroclaw, Poland, 5 - 8 May 2013. IEEE, 2013, 641 - 645. 3.1.

Taklaja, P.; Hyvönen, P.; Niitsoo, J.; Palu, I.; Klüss, J.; Kütt, L. (2013). Volt-time characteristics of medium voltage overhead line porcelain pin insulators. In: Proceedings of the 14th International Scientific Conference Electric Power Engineering 2013: EPE 2013, May 28-30, 2013, Kouty nad Desnou, Czech Republic. (Toim.) Rusek, S.; Goňo, R.. IEEE, 2013, 423 - 427. 3.1.

2.3 Loetelu struktuuriüksuse töötajatest, kes on välisakadeemiate või muude oluliste T&A- ga seotud välisorganisatsioonide liikmed:

Elektroenergeetika instituut on CIGRE liige.

Assistent Jaan Niitsoo on IEEE liige.

Assistent Paul Taklaja on IEEE ja NorKab liige.

Dotsent Jako Kilter on:

- CIGRE B4.62 liige (Connection of Wind Farms to Weak AC networks)
- CIGRE B4.64 liige (Impact of AC System Characteristics on the Performance of HVDC schemes)
- IEEE Power and Energy Society liige
- ENTSO-E EPS & CC DT HVDC AdHoc töögrupi liige
- CIGRE WG B4.55 liige (HVDC connection of offshore wind power plants)
- CIGRE WG C4.112 (Guidelines for Power quality monitoring – measurement locations, processing and presentation of data) liige
- ENTSO-E EPS & CC töögrupi liige
- ENTSO-E WG EPS Requirements for Generators töögrupi liige
- IEEE liige
- MELECON 2014 konverents, artiklite hindamiskomitee liige

Professor Petri Hyvönen on :

- Aalto Ülikooli Kõrgepinge labori juhataja
- NorKab liige

- Advisory council member of Nordic Insulation Symposium - Nord-IS 13 - Trondheim, Norway, June 9 - 12, 2013

2.4 Ülevaade teaduskorralduslikust tegevusest:

Professor H. Tammoja on:

- Elering AS nõukogu liige
- Elektrilevi OÜ kahjude erikomisjoni esimees
- Tallinna linna energeetika komisjoni liige

Emeriitprofessor M. Valdma on Eesti Teaduste Akadeemia energeetikanõukogu liige.

Professor A. Hamburg on:

- Eesti Inseneride Liidu president
- Eesti Teaduste Akadeemia energeetikanõukogu esimees
- Elektroenergeetika Seltsi aseesimees
- Tallinna Polütehnikumi nõukogu esimees
- Tallinna Tehnikakõrgkooli nõukoja esimees
- Teadusagentuuri SA Archimedes TEAME programmi nõunike kogu liige
- Kolleegiumi liige ajakirjas INSENEERIA
- Kolleegiumi liige ajakirjas OIL SHALE
- Kehtna Majandus- ja tehnoloogiakool nõukogu esimees
- Energiatehnoloogia programmi nõukoja liige
- WEC-Estonia juhatuse liige
- Majandus ja Kommunikatsiooniministri energeetikanõukogu liige
- Teadusaasta saadik

Dotsent Jako Kilter on:

- Eesti Standardikeskuse Kõrgepingekomitee EVS/TK 19 esimees

Assistent Jaan Niitsoo on:

- Tallinna Tehnikaülikooli nõukogu liige
- Tallinna Tehnikaülikooli üliõpilaste esinduskogu liige

Teaduse ja arendustegevuse eesmärgid on põhilises osas saavutatud ning püstitatud ülesanded täidetud.

Hinnang instituudi aruandeperioodi teadus- ja arendustegevuse kohta on hea.