



## Syllabus Course Program



# Prospects of Electrical Engineering and Electromechanics Development

### Specialty

141 – Electric Power Engineering, Electrical Engineering and Electromechanics

### Educational program

Electrical Power Engineering

### Level of education

Master's level

### Semester

1

### Institute

Institute of Education and Science in Power Engineering, Electronics and Electromechanics

### Department

Electric Power Stations (130)

### Course type

Special (professional), Mandatory

### Language of instruction

English, Ukrainian

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## Lecturers and course developers



### Kostiantyn Makhotilo

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PhD, Senior Research Officer, Professor

Author of more than 90 scientific, educational, and methodological publications. Leading lecturer of the disciplines: "Fundamentals of information technology in electric power industry", "Accounting and management of power consumption", "Energy Policy and Energy Marketing", "Modeling and forecasting of power consumption", "Problems and Prospects of Electrical Engineering and Electromechanics Development".

[More about the lecturer on the department's website](#)

## General information

### Summary

The course is designed as an interactive workshop-based learning experience to provide students with knowledge and skills related to understanding the current state of energy in the world and trends of its future development. During the workshops, students delve into various aspects of energy production, transmission and consumption, analyzing challenges and exploring future perspectives. Topics cover both traditional and renewable energy technologies, advances in energy transmission technologies, smart grids, storage systems, and energy efficient consumption technologies. The topics of individual tasks are pilot projects on these technologies and their critical SWOT analysis. Knowledge of the general foundations of electric power engineering, and the foundations of scientific research are required to take this course.

### Course objectives and goals

Goal.

Formation of knowledge about formation of knowledge about current problems, new technologies and prospects for the development of energy all over the world.

Objectives.

To know:

- the latest and promising technologies of energy generation, distribution and consumption
- trends in the development of the global energy sector, in particular renewable energy
- issues and problems threatening the application of promising energy technologies

To be able to:

- Conduct SWOT analysis of cutting-edge energy technologies: evaluate strengths and weaknesses, identify opportunities and threats to their further development and implementation.
- Set objectives for the application of advanced energy technologies in the process of design and operational professional activities.

### **Format of classes**

Lectures, workshops, consultations, self-study. Final control – exam.

### **Competencies**

PC 1 Ability to apply acquired theoretical knowledge, scientific and technical methods and appropriate software to solve scientific and technical problems and conduct scientific research in the field of electric power, electrical engineering and electromechanics.

PC 5 The ability to understand and take into account social, ecological, ethical, economic and commercial considerations that affect the implementation of technical solutions in electric power, electrical engineering and electromechanics.

PC 8 Knowledge and understanding of modern technological processes and systems of technological preparation of production, technical characteristics, design features, purpose and rules of operation of electric power, electrotechnical and electromechanical installations and equipment.

PC 11 The ability to use the acquired knowledge and skills to conduct scientific research of the appropriate level.

PCs 13 The ability to collect and analyze the necessary data on the characteristics of power plants, the main auxiliary electrical equipment, as well as trends in their development, in particular with the use of modern information and computer technologies.

PCs 18 The ability to collect and analyze technical data on the current state of the prospects for the development of energy sources and, on this basis, to develop measures to increase the energy efficiency of facilities.

### **Learning outcomes**

PO 2. Analyze processes in electric power, electrotechnical, and electromechanical equipment and their corresponding complexes and systems.

PO 3. Find options for improving the energy efficiency of electric power, electrotechnical, and electromechanical equipment and their corresponding complexes and systems.

PO 11. Choose a direction for scientific research and participate in it, considering current problems in the field of electrical power, electrical engineering, and electromechanics.

POs 17. Understand methods of organization, technology, and production processes of electrical energy based on traditional and renewable energy sources, and energy storage for maneuvering and maintaining balance in energy systems.

POs 22. Effectively apply modern methods to determine the conditions and parameters of operation for non-conventional and renewable energy systems.

### **Student workload**

The total volume of the course is 120 hours (4 ECTS credits): lectures – 32 hours, practical classes (workshops) – 16 hours, self-study – 72 hours.

### **Course prerequisites**

Fundamentals of scientific research

## Features of the course, teaching and learning methods, and technologies

Lectures are conducted interactively using multimedia technologies. At workshops, the skills of presenting professional information, its critical engineering analysis and the ability to defend it are practiced. Practical tasks are performed using the Microsoft 365 platform. Learning materials are available to students through the OneNote Class Notebook.

## Program of the course

### Topics of the lectures

#### Content module 1. Energy generation technologies, problems and development prospects

##### Topic 1. Modern problems of global and domestic energy.

Problems of energy generation, distribution and consumption in the world, EU, and Ukraine. Method of SWOT analysis of energy technologies.

##### Topic 2. Prospects of modernization of traditional technologies of electric energy production

Technologies of coal-fired power plants and their future. Technologies of gas fired power plants. Problems and ways of development of hydraulic and pumped storage power plants. Prospects for the development of cogeneration.

##### Topic 3. Prospects for the development of renewable energy

Prospect technologies for using energy of the Sun, wind, water, and the Earth. Use of landfills and waste for energy production. Hydrogen energy technologies. Problems of increasing the share of renewable energy.

##### Topic 4. Prospects for the development of nuclear technologies

The place of nuclear energy in the perspective balance of the energy system. Technologies for increasing the reliability and maneuverability of nuclear power plants. Small modular reactors. Tokamak, stellarator, and laser-powered technologies of nuclear fusion and their prospects.

##### Topic 5. Distributed generation and accumulation.

Problems and prospects of the development of small distributed generation. Energy storage technologies on generation side.

#### Content module 2. Energy transmission technologies, problems and development prospects

##### Topic 6. Promising technologies of electric energy transmission

Prospects for the use of alternating and direct current in the power system. Prospects for reducing losses by raising the voltage in all network links.

##### Topic 7. Prospects for the use of superconductors for energy transmission and distribution

Superconducting cables. Superconducting substations.

##### Topic 8. Promising technologies of switching, protection, and control equipment

Energy digitalization. Substation automation, integration into complex solutions, increase in functionality.

##### Topic 9. Smart grids

Changing the architecture of electrical networks to create a smart grid. Information component of smart grids.

##### Topic 10. Promising technologies of thermal energy transfer

Heating networks with local heat and electricity sources. Heating networks of large length. Multi-pipe heating networks.

#### Content module 3. Energy consumption technologies, problems and development prospects

##### Topic 11. Smart home technologies

Prospects for use smart home technology in energy management.

##### Topic 12. Active houses and prosumers

Active houses. Prosumer as a new type of consumer.

##### Topic 13. New energy-efficient lighting technologies

LEDs with high brightness and large emitting surface. Filament LED lamps. Hybrid lighting technologies.

##### Topic 14. Accumulation technologies at the consumer side

Problems of EV charging stations infrastructure. Prospects of a consumer energy storage system for use in energy management.

##### Topic 15. New energy-efficient technologies of heating and hot water supply

Heat pumps and storage water heaters. Prospects for use in prosumer's energy management system.

## Topics of the workshops

Topic 1. Reports of students on selected essay topics. Part "Generation"

Topic 2. Reports of students on selected essay topics. Part "Transmission"

Topic 3. Reports of students on selected essay topics. Part "Consumption"

## Topics of the laboratory classes

### Self-study

#### Individual task – Report

Topic "Technologies, problems and prospects for the development of the future energy industry" in the form of an essay of 15–30 pages and oral presentation.

Assignments of free choice from the provided list or upon approval of the lecturer.

The report is prepared and defended at workshops during the semester in parts.

Example content:

Part 1. Energy generation

Part 2. Energy transmission

Part 3. Energy consumption

Each part has to contain:

- a brief description of the essence of the considered energy technology
- a description of the current state of technology implementation and implementation examples
- an analysis of the benefits of using technology
- an analysis of the shortcomings of the technology
- an analysis of factors that can support the further development and implementation of the technology
- an analysis of factors that can jeopardize or postpone the implementation of technology

## Course materials and recommended reading

Compulsory.

1. Eremia, M., Liu, C. C., & Edris, A. A. (Eds.). (2016). Advanced solutions in power systems: HVDC, FACTS, and Artificial Intelligence. John Wiley & Sons.
2. Dorr, A., & Seba, T. (2021). Rethinking Energy. The Great Stranding, 1-32.

Additional.

1. UNECE Renewable Energy Status Report 2022 – Access: <https://unece.org/sustainable-energy/renewable-energy/unece-renewable-energy-status-report>

Resources on the Internet

1. <https://spectrum.ieee.org/energy>
2. <https://www.irena.org>
3. <https://www.iea.org>

## Assessment and grading

### Criteria for assessment of student performance, and the final score structure

Final score consists of up to:  
60 points for 3 workshop presentations,  
20 points for report, and  
20 points for final tests.

Oral report presentation during workshops are mandatory.

### Grading scale

Total points	National	ECTS
90-100	Excellent	A
82-89	Good	B
75-81	Good	C
64-74	Satisfactory	D
60-63	Satisfactory	E
35-59	Unsatisfactory (requires additional learning)	FX
1-34	Unsatisfactory (requires repetition of the course)	F

## Norms of academic integrity and course policy

The student must adhere to the Code of Ethics of Academic Relations and Integrity of NTU "KhPI": to demonstrate discipline, good manners, kindness, honesty, and responsibility. Conflict situations should be openly discussed in academic groups with a lecturer, and if it is impossible to resolve the conflict, they should be brought to the attention of the Institute's management.

Regulatory and legal documents related to the implementation of the principles of academic integrity at NTU "KhPI" are available on the website: <http://blogs.kpi.kharkov.ua/v2/nv/akademichna-dobrochesnist/>

## Approval

Approved by

Date, signature

**Head of the department**  
Oleksandr LAZURENKO

Date, signature

**Guarantor of the educational program**  
Oleksandr LAZURENKO