Національний технічний університет «КИЇВСЬКИЙ ПОЛІТЕХНІЧНИЙ І імені ІГОРЯ СІКОРСЬКОГО»

Ecology and technology of plant polymers

Energy saving at industrial and municipal facilities

Work program of the discipline (Syllabus)

Details of the discipline

Level of higher education	***Second (master's)***
Field of knowledge	*10 Natural sciences*
Speciality	*101 Ecology*
Educational program	*Environmental safety*
Discipline status	*Custom*
Form of study	*full-time (day)/remote/mixed*
Year of preparation, semester	*1st year, spring semester*
Scope of discipline	*4 ECTS credits (120 hours)*
Semester control/ control measures	*Test*
Schedule of classes	*3 hours per week (2 hours lectures and 1 hour of practical classes)*
Language of instruction	*Ukrainian*
Information about thecourse / teachers	Lecturer: *https://eco-paper.kpi.ua/pro-kafedru/vykladachi/vizytky/radovenchik-vyacheslav-mikhajlovich.html* Practical /Seminar: *https://eco-paper.kpi.ua/pro-kafedru/vykladachi/vizytky/radovenchik-vyacheslav-mikhajlovich.html*
Course placement	*https://do.ipo.kpi.ua/course/view.php?id=5447*

The program of the discipline

1. Description of the discipline, its purpose, subject of study and learning outcomes

The amount of energy consumed by humanity has doubled in 25 years. The limited reserves of fossil fuels makes them treat them frugally and look for an alternative replacement for them. Energy saving is the easiest and most effective way to rationally use energy resources. Even at first glance, extremely simple measures in the form of replacing the old equipment with modern, less energy-intensive, allows the enterprise to save significant funds. And alternative energy sources will help to establish energy equilibrium in the world without catastrophic consequences for nature.

A significant increase in anthropogenic human pressure on the environment forces us to urgently introduce various measures that can correct the situation. Rational use of natural resources, modernization of existing technological and municipal equipment, use of alternative energy sources, energy audit – this is not a complete list of the main directions for establishing energy balance in the world. Without studying modern energy-saving technology sand in industrial such-communal enterprises, the ability to assess the effectiveness of various energy consumption systems at enterprises and in everyday life, the study of modern approaches to the organization of energy consumption, promising directions development of energy saving in the world and Ukraine, features of various types of alternative energy in terms of the possibility of their implementation in enterprises, their environmental friendliness and impact of the environment will provide specialists with the necessary set of knowledge to solve these problems.

Subject of the discipline "Energy saving at industrial and municipal facilities"."*It serves to form knowledge among the students, which will ensure a comprehensive analysis of energy consumption and its changes depending on the energy-saving measures carried out, including all aspects of the energy management system in accordance with the international standard ISO 50001, knowledge necessary for*

the implementation of energy management at various facilities, the implementation of an energy audit of power plants, institutions and enterprises, development and ranking of energy saving measures.

The purpose of the discipline "Energy saving at industrial and municipal facilities"

The purpose of studying this discipline is to form a set of knowledge among masters in the field of the basics of rational operation of heat engineering equipment for maximum saving of fuel, materials and economically justified use of secondary energy resources, modern technologies for obtaining and preserving energy, scientific developments in the field of increasing the efficiency of the use of natural energy resources, the creation of effective energy supply systems in industry and municipal enterprises.

- *the ability to search, process and analyze information from various sources* ***C 06;***
- *awareness at the level of the latest achievements, necessary for research and/or innovative activities in the field of ecology, environmental protection and balanced nature management* ***C 09****;*
- *the ability to organize works related to the assessment of the environmental state, environmental protection and optimization of nature management, in conditions of incomplete information and conflicting requirements* ***C 15****;*
- *the ability to assess the level of negative impact of natural and anthropogenic factors of environmental hazards on the environment and humans* ***C 18****.*

*According to the requirements of the program of the discipline "**Energy Saving at Industrial and Municipal Facilities**", students after mastering it must demonstrate the following programmatic learning outcomes:*

- *to demonstrate the ability to organize collective activities and implement complex environmental projects, taking into account available resources and time constraints.* ***PO 05.***
- *to be able to assess the potential impact of man-made objects and economic activities on the environment.* ***PO 13.***
- *to choose the optimal management strategy and/or nature management depending on ecological conditions.* ***PO 16****.*
- *to know up-to-date approaches to the organization of environmentally cleaner production, reorganization and reconstruction of existing production from the standpoint of resource conservation, taking into account the life cycle of the product.* ***PO 21.***

2. Prerequisites and post-requisitions of disciplines (place in the structural and logical scheme of education according to the relevant educational program)

*The study of the discipline "**Energy Saving at Industrial and Municipal Facilities**" is based on the knowledge obtained by students during the course of the laboratory when studying the disciplines "General Ecology", "Environmental Legislation", "Urboecology", "Technologies of Air Protection from Anthropogenic Pollution". Discipline "**Energy saving at industrial and municipal facilities**" is a fundamental basis for ensuring the solution of problems in the field of rational use of energy resources, modernization of existing heat generating and communal facilities, energy audit, use of alternative energy sources and is aimed at creation of holistic knowledge and professional practice in the field of providing humanity with clean energy.*

3. Contents

Section 1. State and directions of energy saving in Ukraine

Basic terms and concepts of energy saving. State of energy consumption and energy use in Ukraine. The main directions of energy saving. Energy audit and energy management.

Section 2. Formation of energy supply strategies

Types of energy supply strategies. Economic justification of energy supply strategies. Methods for evaluating investments in strategic energy supply.

Section 3. Areas of energy saving and evaluation of their effectiveness

Priority areas of energy saving in industrial sectors. Energy efficiency of heat process equipment.

Section 4. Management of energy supply processes

Basic principles of energy use management. Coordinated planning. Energy load management. Marketing of energy supply.

Section 5. Energy and environment

Power supply systems. Basic power plants in power supply systems. Small energy industry. Ecological aspects of basic energy. Environmental aspects of alternative energy and renewable energy sources.

Section 6. General energy saving measures

Use of secondary energy resources. Organization of recycling systems. Passive methods of energy saving. Intensification of heat transfer in heat processing plants. Use of efficient heat-conducting devices. Integrated use of cold, heat and electricity. Heat accumulators. Heat transformers.

Section 7. Renewable energy sources

Solar power engineering. Intensity of solar radiation. Basic parameters of solar radiation. Laws of distribution of solar radiation in different parts of the globe. Classification of solar systems. Photoelectric transformation of solar radiation. Materials and designs of solar cells. Block diagram of the conversion of solar radiation into electricity. Solar heat supply systems. Concentration of solar radiation. Basic elements of solar heat systems. Other methods conversion of solar radiation.

Wind energy and possibilities of its use. Wind formation. Intensity of wind energy on the territory of Ukraine. Principle of operation of a wind turbine. Concept of an ideal windmill. Classification of wind turbines according to the principle of operation. Torque and power of a windmill.

Energy resources of the ocean.

Classification of usable ocean energy resources. Use of tidal energy. The structure of tidal power plants. Estimation of the power of tidal currents. The energy transformation of ocean waves. Classification of devices for converting wave energy. Efficiency of implementation of wave power plants. The use of the energy of ocean currents. Assessment of the power of the most well-known ocean currents. Transformation of ocean thermal energy.

Hydropower resources of the planet. The main types of hydropower installations. Assessment of land hydropower in different regions of the world and Ukraine. Development of hydropower resources. Small hydropower and its prospects.

Use of geothermal energy. Methods of using the thermal energy of the earth's crust. Underground thermal waters and their distribution. Use of geothermal energy to obtain heat and electricity. Principle of operation of the heat pump. Geothermal power plants and systems to provide the population with thermal energy.

Biofuels. Concept and classification of biofuels. Use of biomass for electricity and heat. Modern use of biomass and general volumes of its synthesis. Thermal processes of biomass processing. Biomass processing with biogas production. Raw materials for biogas production. Basic properties of biogas and its preparation. Alcohol fermentation and fermentation of biomass. Bioenergy plants.

Section 8. Energy efficiency in the municipal sector

The need to improve the energy efficiency of existing buildings in Ukraine. Approaches to thermal modernization of housing and communal services facilities. Development of measures to improve the energy efficiency of housing and communal services. Modern approaches to thermal modernization of housing and communal services facilities. Modern approaches to the modernization of heat generation systems.

4. Learning materials and resources

4.1 Basic literature

1. *Klymenko V.V., Kravchenko V.I., Telyuta R.V. Energy saving in heat technological processes and installations: Textbook. – Kropyvnytskyi: PE Exclusive – System, 2020. – 2019 p.*
2. *Dziadykevych Yu.V. Energy Management / Yu.V. Dziadykevych, M.V. Buryak, R.I. Rozum. – Ternopil: Economic Thought, 2010. – 295 p.*

3. *Chichulina K.V., Byba V.V., Minyaylenko I.V., Skryl V.V. Potential of energy efficiency of Ukraine: prospects for cooperation with the EU. – Poltava: NU "Poltava Polytechnic named after. Yu. Kondratyuk, 2021. – 109 p.*
4. *Malyarenko V.A., Nemirovsky A.I. Energy saving and energy audit: a textbook. – Kharkiv: NTU "KhPI", 2010. – 344 p.*
5. *Law of Ukraine "On Energy Saving". – Bulletin of the Verkhovna Rada, 1994. - No. 30. – P. 283.*
6. *Kudrya S.O. Non-traditional and renewable energy sources: a textbook. K.: NTUU "KPI". 2012. 492 pp.*
7. *Malyarenko V.A. Energy and environment. - H.: SAGA Publishing, 2008. – 364 p.*
8. *Sinchuk I.O. Non-traditional and renewable energy sources: Textbook / I.O. Sinchuk, S.M. Boyko, K.I. Losina et al. - Kremenchuk : Publishing House PE Shcherbatykh O.V., 2013. - 192 p.*
9. *Kovalev O.I. Alternative energy sources of Ukraine: textbook. posib. / I.O. Kovalev, O.V. Ratushnyi. – Sumy: View – vo SSU, 2015. – 201 p.*

4.2 Supporting literature

10. *Denisyuk S.P., Kuznetsov V.G., Sychenko V.G. and others. Energy saving and energy management in traction power supply devices : Training. – Dnipropetrovsk, 2015. – 264 p.*
11. *Energyefficiency in the municipal sector: Textbook / A. Maksimov, I. Vakhovich, T. Gutnichenko, etc. – K., LLC "ENTERPRISE "VI EN AY", 2015. – 184 p*
12. *Energy saving in Ukraine: legal aspects and practical implementation. – Rivne: Publisher O.Zen, 2011. – 48 p.*
13. *Verbitsky E.V. Energyconservation and energy efficiency-1: Lecture notes. – K.: NTUU "KPI", 2014. – 106 p.*
14. *Alternative Energy: [teaching postibnik] /M.D. Melnychuk, V.O. Dubrovin, V.G. Myronenko, I.P. Grigoryuk, V.M. Polishchuk, G.A. Golub, V.S. Targonya, S.V. Dragnev, I.V. Svistunova, S.M. Kukharets. – K: "Agrarian Media Group", 2012. – 244 p.*
15. *Energy: history, present and future – [Electronic resource] - http://energetika.in.ua/ua/books.*
16. *Tidal power plants: what is it and how does it work? - [Electronic resource] - https://alternative-energy.com.ua/uk/priplivni-elektrostanczi%D1%97-shho-cze-i-yak-vono-praczyu%D1%94.*
17. *Chuchuy V.P. Alternative energy sources /S.M.Uminsky, S.V. Inyutin. – Odesa: TPP, 2015. – 234 p.*

Information resources on the Internet

1. *Ministry of Environmental Protection and Natural Resources of Ukraine - https://mepr.gov.ua/*
2. *Industrial Ecology. Community of Environmental Specialists - http://www.eco.com.ua/*
3. *Professional Association of Ecologists of Ukraine (PAEU) - https://paeu.com.ua/*
4. *State Agency on Energy Efficiency and Energy Saving of Ukraine - https://saee.gov.ua/uk/ae.*
5. *About alternative energy sources - https://zakon.rada.gov.ua/laws/show/555-15#Text*

Educational content

5. Methods of mastering the discipline (educational component)

Lectures

Lectures are aimed at:

- *provision of modern, holistic, interdependent knowledge of the discipline **"Energy Saving at Industrial and Municipal Facilities"**, the level of which is determined by the target setting for each specific topic;*
- *ensuring in the process of the lecture the creative work of students together with the teacher;*
- *education of students' professional and business qualities and the development of their independent creative thinking;*
- *formation of students' necessary interest and providing direction for independent work;*
- *determining the current level of development of science in the field of the use of alternative energy sources, forecasting its development for the coming years;*
- *reflection of the methodological processing of the material (selection of the main provisions, conclusions, recommendations, clear and adequate to their formulations);*
- *use for demonstration of visual materials, combination, if possible, them with a demonstration of results and samples;*
- *teaching materials in a clear and high-quality language in compliance with structural and logical connections, explaining all newly introduced terms and concepts;*
- *accessibility for perception by this audience.*

No s/n	The title of the topicof lectures and a list of main issues (list of didactic means, references to literature and tasks for the IWS)	Hours
1	***State and directions of energy saving in Ukraine*** *Basic terms and concepts of energy saving. State of energy consumption and energy use in Ukraine. The main directions of energy saving. Energy audit and energy management. Literature: [1.pp.9-28; 5].* *Tasks on the IWS: The essence and importance of energy management in the enterprise[2.c.13-19].*	2
2	***Formation of energy supply strategies*** *Types of energy supply strategies. Economic justification of energy supply strategies. Methods for evaluating investments in strategic energy supply.* *Literature: [2.p.26-56].* *Tasks for the IWS: Comparative analysis of energy consumption in Ukraine and the EU[3.c.25-39].*	2
3	***Directions of energy saving and evaluation of their effectiveness*** *Priority areas of energy saving in industrial sectors. Energy efficiency of heat processing equipment. Indicators of the efficiency of heat engineering equipment. Normalization of energy consumption. Energy balances and their varieties. Energy balances of units and forms of their presentation.* *Literature:[1.p.31-54; 2.pp.82-95].* *Tasks at the IWS: Adaptation of the legislative and regulatory framework in the field of energy efficiency of Ukraine to EU standards [3.p.39-55].*	2

4	***Management of energy supply processes*** *Basic principles of energy use management. Coordinated planning. Energy load management. Marketing of energy supply.* *Literature: [2.p.56-73].* *Tasks at the IWS:The potential of energy efficiency of economic activities of Ukraine[3.c.56-69].*	**2**
5	***Energy and environment*** *Power supply systems. Basic power plants in power supply systems. Small energy industry. Ecological aspects of basic energy. Environmental aspects of alternative energy and renewable energy sources.* *Literature:[4.c.28-52].* *Tasks at the IWS: Study of the potential of energy efficiency of enterprises [3.p.70-88].*	**2**
6	***General energy saving measures*** *Use of secondary energy resources. Organization of recycling systems. Passive methods of energy saving. Intensification of heat transfer in heat processing plants.* *Literature: [1.p.54-65].* *Tasks at the IWS: European experience in shaping the potential of energy efficiency in everyday life [1.p.89-101].*	**2**
7	***General energy saving measures*** *Use of efficient heat-conducting devices. Integrated use of cold, heat and electricity. Heat accumulators. Heat transformers.* *Literature: [1.c.66-96].* *Tasks on the IWS: Application of SMARTGRIDE[6.c.84-101].*	**2**
8	***Renewable energy sources*** *The intensity of the sun's radiation. Laws of distribution of solar radiation in different parts of the globe. Photoelectric transformation of solar radiation. Block diagram of the conversion of solar radiation into electricity.* *Literature:[6.p.97-101;15.s.61-75].* *Tasks for the IWS: The structure of the Sun and the processes that determine the release of energy. Potential of solar energy in Ukraine [7.p.122-127; 8.pp.40-41].*	**2**
9	***Renewable energy sources*** *Solar heat supply systems. Concentration of solar radiation. The main elements of solar heat systems. Other methods of converting solar radiation.* *Literature: [6.pp.168-198; 7.pp.152-166].* *Tasks for the IWS: Environmental consequences of the development of solar energy [8.p.70-73; 7.pp.287-293].*	**2**
10	***Renewable energy sources*** *Wind formation. Intensity of wind energy on the territory of Ukraine. The principle of operation of the wind turbine goon. Classification of wind turbines according to the principle of operation. Torque and power of the windmill.* *Literature: [6.pp.55-87; 8.pp.86-97; 6.c.79-90; 9.c.85-99].* *Objectives of the IWS: Environmental consequences of the introduction of wind power plants Status and prospects for the development of wind energy in Ukraine [6.p.124-127; 8.pp.101-104;9.p.149-152].*	**2**
11	***Renewable energy sources*** *Classification of usable ocean energy resources. Use of tidal energy. The structure of tidal power plants. Estimation of the power of tidal currents. Conversion of ocean wave energy. Classification of devices for the conversion of wave energy. Efficiency of the introduction of wave power plants. Use of energy of ocean currents. Assessment of the power of the most well-known ocean currents. Conversion of thermal energy of the ocean.* *Literature:[17.c.47-51; 8. pp.155-161: 15. kn.5, ch.1; 8.s.32-34; 9.c.80-*	

	84; 15, kn.5, part 1;17.c.34-47; 15. kn.5, part 1,]. *Tasks for IWS: Impact of tidal power plants on the environment. Hydrogen energy Methods for converting ocean thermal energy[16; 6.c.459-471;17.c.51-71; 8. pp.161-163].*	

12	***Renewable energy sources*** *The main types of hydropower installations. Evaluation of land hydropower in different regions of the world and Ukraine. Development of hydropower resources. Small hydropower and its prospects.* *Literature: [6.c.219-242; 7.s.398-423; 6.p.199-206; 7.s.166-178].* *Tasks for the IWS: The structure of hydroelectric powerplants and the principle of their operation. C.67-80; 6.c.242-244].*	
13	***Renewable energy sources*** *Thermal regime of the earth's crust. Methods of using the thermal energy of the earth's crust. Underground thermal waters and their distribution. The use of geothermal energy to obtain heat and electricity. The principle of operation of the heat pump. Geothermal power plants and systems to provide the population with thermal energy.* *Literature: [6.pp.338-351;8.pp.118-127; 6.pp.326-391; 7.pp.354-373].* *Tasks for the IWS: Thermal energy capacities on the territory of Ukraine. State and prospects of geothermal energy development in Ukraine [9.p.147-149; 6.pp.395-412].*	***2***
14	***Renewable energy sources*** *The concept and classification of biofuels. The use of biomass for the production of electrical and thermal energy. Modern use of biomass and total volumes of its synthesis. Thermal processes of biomass processing. Biomass processing with biogas production. Raw materials for biogas production. Basic properties of biogas and its preparation. Alcohol fermentation and fermentation of biomass. Bioenergy plants.* *Literature: [6.pp.245-260; 7.pp.308-353; 6.pp.273-303; 14.pp.79-115; 6.pp.288-305; 14.pp.125-128]..* *Tasks for the IWS: Energy potential of biomass in Ukraine Processing of solid waste with biogas Production Use of liquid biofuels by mankind [6.p.264-273; 9.pp.155-163; 14.c.121-125, 131 – 132; 14.s.176-213].*	***2***
15	***The need to improve the energy efficiency of existing buildings in Ukraine*** *Dynamics of consumption of basic energy resources in Ukraine. Energy balance of Ukraine. European requirements for energy efficiency facilities. The role of local authorities in improving energy efficiency.* *Literature: [11.p.5-2860].* *Tasks for IWS: Energy management, monitoring of energy consumption. [12.p.36-44].*	***2***
16	***The progress to the thermal modernization of housing and communal services facilities*** *Determination of the list of objects requiring thermal modernization and modernization. Assessment of the technical condition of objects. Group objects into separate projects. General requirements for the development of a list of measures to improve the energy efficiency of facilities.* *Literature: [11.c.34-44].* *Tasks for the IWS: Certification of energy-consuming facilities. c.44-46]*	***2***
17	***Modern approaches to thermal modernization of housing and communal services facilities*** *Thermal modernization of enclosing structures of buildings. Modernization of current engineering networks. Heating and hot water supply systems. Lighting and power supply systems.* *Literature: [11.c.48-97].* *Tasks at the IWS: State control in the field of energy saving [12.p.46-49].*	***2***
18	***Modern approaches to the modernization of heat generation systems.*** *Modernization using natural gas as fuel. Modernization using alternative energy sources. Energy production using unconventional energy sources.*	***2***

	Literature: [11. c. 98 – 127]. *Tasks for the IWS: Norms and standards for the consumption of fuel and energy resources [12.p.27-2 9].*	
	Just	***36***

Practical classes

In the system of professional training of students in this discipline, practical classes occupy 33% of the classroom load. Special terminology, allow you to check knowledge therefore, this type of work is an important means of operational feedback. Practical classes should perform not only cognitive and educational functions, but also contribute to the growth of students as creative workers in the field of environmental protection.

The main objectives of the cycle of practical classes:

- *to help students to systematize, consolidate the knowledge of theoretic character in the field of modern technologies for the generation of clean energy and alternative energy sources;*
- *teach students techniques the solution of practical tasks, contribute to the possession of the skills and skills of performing calculations, graphic and other tasks;*
- *teach them to work with scientific and reference literature and schemes;*
- *to form the ability to learn independently, that is, to dominate methods, methods of self-learning, self-development, and self-control.*

No s/n	***The title of the topic of the practical lesson and the list of main issues (list of didactic support, references to literature and tasks to the IWS)***	***Hours***
1	*Geliosystems for the production of electrical energy. Oblasphemy and apparatuss.* *Literature: [6.p.145-154].* *Tasks on the IWS – Basic algorithms for calculating solar systems for the generation of electrical energy. Parameters of the equipment of solar systems.* *Literature: [https://prel.prom.ua/a282912-poryadok-rozrahunku-geliosistem.html]*	***2***
2	*G eliosystems for obtaining thermal energy.* *Literature: [6.p.168-177].* *Tasks on the IWS – Basic algorithms for calculating solar systems for the generation of thermal energy.* *Literature: [https://prel.prom.ua/a282912-poryadok-rozrahunku-geliosistem.html].*	***2***
3	*In the energy and institutions. Determination of the required capacity of the energy supply system of a private house.* *Literature: [6.pp.111-11 4].* *Tasks on the IWS – Methods for calculating wind power installations. The main design parameters of the equipment.* *Literature: [http://tntu.org.ua/ download/mv_prakroboty_vde.pdf]*	***2***
4	*Selection of the main components from existing elements. Coordination of all components with each other in a single system.* *Literature: [8.c.167-183].* *The task at the IWS is manufacturers of equipment for wind power installations on the territory of Ukraine. [Internet].*	*2*
5	*Calculation of the power of tidal power plants.* *Literature: [17.p.25-34].* *The task at the IWS is to change the power of tidal power plants over time. Cycles of*	*2*

	tidal power plants. Literature:[15. kn.5, part 1].	
6	*Calculation of the main parameters of hydroelectric power plants of various types. Literature:[17.c.71-76].* *The task at the IWS is the impact of hydroelectric power plants on the environment. Environmental parameters associated with the main possibilities of obtaining energy at hydroelectric power plants. Literature:[8.c.163-167].*	*2*
7	*Calculation of the energy of wave stations and ocean currents. Literature: [17.c.34-51].* *The task of the IWS is the use of a heat pump in the structure of geothermal power plants. The main design parameters of the heat pump. Literature: [7.p. 222-243; 9.c.102-111].*	*2*
8	*Modular tests*	*2*
9	*Test*	*2*
	Just	***18***

6. Independent work of the student

Independent work of students takes 55 % of the time to study the course, also includes preparation for the test. The main task of independent work of students is to master scientific knowledge in the field of environmental protection, which is not included in the list of lecture issues, through personal search for information, the formation of an active interest in a creative approach in educational work. generating and supplying energy to the population and industrial enterprises and, based on calculations, come to their own reasonable conclusions about the effectiveness of the use of alternative sources.

No s/n	*The name of the topic submitted for independent study*	*Number of hours of IWS*
	Section 1. State and directions of energy saving in Ukraine	
1	*The essence and importance of energy management in the enterprise [2.p.13-19].*	*3*
	Section 2. Formation of energy supply strategies	
2	*Comparative analysis of energy consumption in Ukraine and the EU [3.p.25-39].*	*3*
	Section 3. Areas of energy saving and evaluation of their effectiveness	
3	*Adaptation of the legislative and regulatory framework in the field of energy efficiency of Ukraine to EU standards [3.p.39-55].*	*3*
	Section 4. Management of energy supply processes	
4	*The potential of energy efficiency of economic activities of Ukraine [3.c.56-69].*	*3*
	Section 5. Energy and environment	
5	*Research of energy efficiency potential of enterprises [3.p.70-88].*	*4*
	Section 6. General energy saving measures	
6	*Application of SMARTGRIDE [6.p.84-101].*	*6*
	Section 7. Renewable energy sources	
7	*The structure of the Sun and the processes that determine the release of energy. Potential of solar energy in Ukraine [7.p.122-127; 8.pp.40-41]. Environmental consequences of the development of solar energy [8.p.70-73; 7.pp.287-293]. Environmental consequences of the introduction of wind power plants Status and prospects for the development of wind energy in Ukraine [6.p.124-127; 8.pp.101-104;9.p.149-152]. Impact of tidal power plants on the environment. Hydrogen energy Methods for converting ocean thermal energy[16;6.p.459-471;17.c.51-71; 8. P.161-163]. Structure of hydroelectric power plants and the principle of their operation. Influence of small hydroelectric power plants on the environment[7.C.67-80;6.pp.242-244]. Thermal energy capacities on the territory of Ukraine. State and prospects of geothermal energy development in Ukraine[9.p.147-149;6.p.395-412].Energy potential of biomass in Ukraine*	*14*

	Processing of solid waste with biogas Production Use of liquid biofuels by mankind [6.p.264-273; 9.p.155-163; 14.p.121-125, 131-132 ; 14.p.176-213].	
Section 8. Energy efficiency in the municipal sector		
8	*Energy management, monitoring of energy consumption. Energy surveys. [12.pp.36-44]. Certification of energy-consuming objects. Determination of the energy efficiency class of objects [12.p.44-46]. State control in the field of energy saving [12.p.46-49]. Norms and standards for the consumption of fuel and energy resources [12.p.27-29].*	*10*
9	*Preparation for domestication of control works, etc.*	*4*
10	*Execution of OCD*	*10*
11	*Test*	*6*
	Total hours	*66*

Policy and control

7. Policy of the discipline (educational component)

Rules for attending classes and behavior in the classroom

Students are obliged to take an active part in the educational process, not to be late for classes and not to miss them without a good reason, not to interfere with the teacher to conduct classes, not to be distracted by actions that are not related to the educational process.

Rules for assigning incentive and penalty points

- *Incentive points can be awarded by the teacher solely for performing creative work in the discipline or additional completion of online specialized courses with the receipt of the appropriate certificate:*
- *https://www.coursera.org/specializations/renewable-energy*
- *https://www.coursera.org/learn/solar-energy-basics;*
- *https://www.coursera.org/specializations/solar-energy;*
- *https://www.coursera.org/learn/renewable-energy-technology-fundamentals.*

But their amount cannot exceed 10% of the rating scale.

The ethics of deadlines and rescheduling

In case of debts in the discipline or any force majeure circumstances, students should contact the teacher through the available (provided by the teacher) communication channels to solve problematic issues and agree on an algorithm of actions for working out.

Academic Integrity Policy

Plagiarism and other forms of dishonest work are unacceptable. Plagiarism includes the lack of links when using printed and electronic materials, quotes, opinions of other authors. Unacceptable hints and write-offs when writing tests, conducting classes; passing the exam for another student; copying materials protected by the copyright system without the permission of the author of the work.
The policy and principles of academic integrity are defined in Chapter 3 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute". Read more: https://kpi.ua/code

Academic Conduct and Ethics Policy

Students should be tolerant, respect the opinions of others, formulate objections in the correct form, constructively maintain feedback in the classroom.
The norms of ethical behavior of students and employees are defined in Chapter 2 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute". Read more: https://kpi.ua/code

8. Types of control and rating system for evaluating learning outcomes (RSO)

Distribution of study time by types of classes and tasks in the discipline in accordance with the working curriculum:

Semester	Study time		Distribution of study hours				Control measures		
	Loans	acad. H.	Lecture	Practical	Lab. Rob.	IWS	MCT	HCW	Semester control
2	4	120	36	18	–	66	1	1	Test

The student's rating on the discipline consists of points that he receives for:

1 - two tests (planned according to the work plan of the MKR is divided into 2 works lasting 45 minutes each);

2 - work in practical classes;

3 – express questioning at lectures;

4 – HCW.

The system of rating (weight) points and evaluation criterion

1. Express survey at lectures:

Weight score –5.

The maximum number of points in the survey at the lecture classes of at least 7 students is 5×5 = 25 points

Criteria for assessing students' knowledge:

Completeness and signs of response	***Points***
Clear and complete answer to the question	*5*
The answer made some inaccuracies or errors	*4... 3*
The answer does not contain the wording of terms, laws and formulas	*2... 1*
Answer not credited	*0*

2. Modular control (R_m)

Weight score – 10. The maximum number of points for all tests is: 10 points x 2 works = 20 points

Criteria for evaluating tests

Mark	*Completeness of the answer*
9...10	*"excellent", creative disclosure of one of the issues, fluency in the material*
6...8	*"good", incomplete disclosure of one of the questions or full answer with minor inaccuracies*
4...5	*"satisfactory", Incomplete disclosure of the issue (at least 60% of the information required) and minor errors*
1...3	*Unsatisfactory work (does not meet the requirements for 3 points)*
0	*Lack of work.*

3. Practical work:

Weight score – 5. The maximum number of points for all practical work is equal to:

5 points × 7 p/p = 35 points.

Criteria for assessing students' knowledge:

Completeness and signs of response	*Points*
Clear and timely execution and design of work	*5*
Minor inaccuracies were made in the response	*4*
Mistakes have been made in the work that distort the result	*3*
Late execution of work, deficiencies in the design	*1-2*
Failure to do practical work	*0*

4 Home test is estimated at 20 points according to the following criteria:

Mark	Completeness of the answer
17... 20	"excellent", creative disclosure of one of the issues, fluency in the material
13...16	"good", incomplete disclosure of one of the questions or full answer with minor inaccuracies
10...12	"satisfactory", Incomplete disclosure of the issue (at least 60% of the information required) and minor errors
1...9	Unsatisfactory work (does not meet the requirements for 3 points)
0	Lack of work.

Calculation of the scale (R) of the rating:

Thus, the rating scale for the discipline is:

$$R=25+20+35+20=100 \text{ points}$$

According to the results of educational work in the first 7 weeks, the "ideal student" should score 40 points. At the first certification (8th week), a student receives "enrolled" if his current rating is at least 20 points.

According to the results of educational work for 13 weeks of study, the "ideal student" should score 90 points. At the second certification (14th week), a student receives "enrolled" if his current rating is at least 45 points.

The maximum amount of points is 100. To receive credit from the credit module "automatic" you need to have a rating of at least 60 points.

Students who have a rating of less than 60 points at the end of the semester, as well as those who want to improve their grade in the ECTS system, perform a test paper. The task of the test consists of four questions of different sections of the work program from the list provided in the guidelines for mastering the credit module.

Each test question (r_1, r_2, r_3, r_4) is estimated at 25 points according to the grading system:

- "excellent", complete answer (at least 95% of the necessary information) – 25 - 24 points;
- "very good", a sufficiently complete answer (at least 85% of the necessary information or minor inaccuracies) – 23 - 20 points;
- "good", sufficiently complete answer (at least 75% of the necessary information or minor inaccuracies) – 19 - 17 points;
- "satisfactory", incomplete answer (at least 65% of the necessary information and some errors) – 16 - 13 points;
- "enough", incomplete answer (at least 60% of the necessary information and some errors) – 13 - 10 points;
- "unsatisfactory", unsatisfactory answer – 9 - 0 points.

The sum of points for a non-four test questions is transferred to the test score according to the table.

Rating scale in the discipline

$R= r_1+r_2+r_3+r_4$	University scale
95... 100 points	Perfectly
85... 94 points	Very good
75...84 points	Well
65... 74 points	Satisfactory
60...64 points	Enough
R<60 points	Disappointing
If r_c<40 points or other conditions for admission to the test are not met	Not allowed

9. Additional information on the discipline (educational component)

An approximate list of questions that are submitted for semester control

1. *Basic terms and concepts of energy saving.*
2. *State of energy consumption and energy use in Ukraine.*
3. *The main directions of energy saving.*
4. *Energy audit and energy management.*
5. *Types of energy supply strategies.*
6. *Economic justification of energy supply strategies.*
7. *Methods for evaluating investments in strategic energy supply.*
8. *Describe the reserves and dynamics of energy consumption in the world.*
9. *Priority areas of energy saving in industrial sectors.*
10. *Energy efficiency of heat processing equipment.*
11. *Indicators of the efficiency of heat engineering equipment.*
12. *Basic principles of energy use management.*
13. *Coordinated planning.*
14. *Energy load management.*
15. *Marketing of energy supply.*
16. *Power supply systems.*
17. *Basic power plants in power supply systems.*
18. *Small energy industry.*
19. *Ecological aspects of basic energy.*
20. *Use of secondary energy resources.*
21. *Organization of recycling systems.*
22. *Passive methods of energy saving.*
23. *Intensification of heat transfer in heat processing plants.*
24. *Use of efficient heat-conducting devices.*
25. *Integrated use of cold, heat and electricity.*
26. *Heat accumulators.*
27. *Heat transformers.*
28. *The intensity of solar radiation.*
29. *The main parameters of solar radiation.*
30. *The laws of the spread of solar radiation in different parts of the globe.*
31. *Classification of solar systems.*
32. *Photovoltaic conversion of solar radiation.*
33. *Materials and designs of solar cells.*
34. *Block diagram of the conversion of solar radiation into electricity.*
35. *Solar heat supply systems.*
36. *Concentration of solar radiation.*
37. *The main elements of solar heat systems.*
38. *Other methods of converting solar radiation.*
39. *Wind formation.*
40. *Intensity of wind energy on the territory of Ukraine.*
41. *The principle of operation of the wind turbine.*
42. *The concept of an ideal windmill.*
43. *Classification of wind turbines according to the principle of operation.*
44. *The torque and power of the windmill.*
45. *Block diagram of the wind power plant.*
46. *Classification of usable ocean energy resources.*
47. *Use of tidal energy.*
48. *The structure of tidal power plants.*
49. *Estimation of the power of tidal currents.*
50. *The energy transformation of ocean waves.*

51. *Classification of devices for converting wave energy.*
52. *Efficiency of implementation of wave power plants.*
53. *The use of the energy of ocean currents.*
54. *Assessment of the power of the most well-known ocean currents.*
55. *Transformation of ocean thermal energy.*
56. *The main types of hydropower installations.*
57. *Evaluation of land hydropower in different regions of the world and Ukraine.*
58. *Development of hydropower resources.*
59. *Small hydropower and its prospects.*
60. *The main types of devices for the selection of energy of rivers at low cost.*
61. *Thermal regime of the earth's crust.*
62. *Methods of using the thermal energy of the earth's crust.*
63. *Underground thermal waters and their distribution.*
64. *The use of geothermal energy to obtain heat and electricity.*
65. *The principle of operation of the heat pump.*
66. *Geothermal power plants and systems to provide the population with thermal energy.*
67. *The concept and classification of biofuels.*
68. *The use of biomass for the production of electrical and thermal energy.*
69. *Modern use of biomass and total volumes of its synthesis.*
70. *Thermal processes of biomass processing.*
71. *Biomass processing with biogas production.*
72. *Raw materials for biogas production.*
73. *The main properties of biogas and its preparation.*
74. *Alcohol fermentation and fermentation of biomass.*
75. *Bioenergy installations.*
76. *The need to improve the energy efficiency of existing buildings in Ukraine.*
77. *Approaches to thermal modernization of housing and communal services facilities.*
78. *Development of measures to improve the energy efficiency of housing and communal services.*
79. *Modern approaches to thermal modernization of housing and communal services facilities.*
80. *Modern approaches to the modernization of heat generation systems.*

Questions for tests

MKR 1

№1

1. Characteristics of the problem of effective energy use.
2. Integrated resource planning (IRP) of energy supply and energy use.
3. Long-term strategies for the development of energy supply and their analysis.
4. Define the economic efficiency of organizational and technical measures.
5. The main factors for the need to implement the ADE.
6. The main types of ADE.
7. The concept of breezes.
8. Classification of wind potential of localities by the nature of inequalities.
9. Drum wind turbines.
10. Use of wind turbines.
9. The work of the wind wheel of the impeller wind turbine.
10. The main disadvantages of wind turbines.

№2

1. *What factors are the reasons for the problem of managing the use of energy?*
2. *The main differences between IRP and traditional planning.*
3. *What components are included in the cost balancing process?*
4. *What are the energy saving measures?*
5. *The concept of monsoons.*
6. *Change in wind speed in height above the surface of the territory.*
7. *Schematic diagram of the wind turbine.*

8. *Functional separation of wind turbines.*
9. *The concept of an ideal windmill.*
10. *Potential and actual use of biomass in Ukraine.*

№3

1. Formulate and substantiate the hypothesis of a systematic solution to the energy use control problem.
2. The purpose of efficient power consumption.
3. Alternatives to load management. Direct and indirect control.
4. What measures of the technological direction are organizational and technical and make their analysis?
5. General circulation of the earth's atmosphere.
6. The concept of speed of wind turbines.
7. Classification of wind turbines by power.
8. Wind turbines for the production of mechanical energy.
9. Change in speed and pressure in the course of air flow through the wind turbine.
10. Efficiency of wind use by drum wind turbines.

№4

1. Analyze the main tasks that are the content of the problem of managing energy use
2. The purpose of managing energy use.
3. Energy accumulation and decentralized generation.
4. Analyze the factors that positively affect the results of the enterprise's activity in case of adoption of organizational and technical measures for energy conservation.
5. The main areas of wind energy in Ukraine.
6. The main classes of wind turbines.
7. Approximate service life and payback periods of wind turbines.
8. Wind turbines that operate on the power grid.
9. The coefficient of energy use of an ideal windmill.
10. The concept of breezes.

№5

1. Define the load factor and analyze its greatness.
2. Motivating procedures for load management.
3. Conditions for effective control of electric load in Ukraine and their analysis.
4. Analyze the factors that negatively affect the results of the activity of the enterprise.
5. Kinetic energy of the wind flow.
6. Winged wind turbines.
7. Stimulating the use of wind energy in different countries.
8. Autonomous wind turbines.
9. Losses of wind turbines.
10. The concept of monsoons.

№6

1. Power plants and their types, operational features.
2. Forced load management procedures.
3. Types of economic impact on energy consumers.
4. Methodology for assessing the economic efficiency of energy saving measures and its components.
5. Wind flow power.
6. Carousel and rotary wind turbines.
7. Changes in the capacity and cost of electricity of wind turbines in recent years.
8. The effectiveness of the use of wind drum wind turbines.
9. The main disadvantages of wind turbines.
10. Classification of wind turbines by power.

MKR 2

№1

1. *Dynamics of consumption of the main types of energy resources in the country.*
2. *Strategic prospects for the development of Ukraine.*

3. *Hierarchical energy efficiency management system in Ukraine.*
4. *Group objects into separate projects.*
5. *Characteristics of various heating control systems*
6. *The structure of the Sun.*
7. *Passive solar heating system.*
8. *Kinetic and potential wave energy.*
9. *Scheme of OTPP with a closed cycle.*
10. *Hydrotherms and their classification.*

№2

1. *Energy balance of Ukraine*
2. *The main directions in the implementation of energy-efficient technologies and equipment in Ukraine.*
3. *Characteristics of it lovo-communal farms in Ukraine.*
4. *Andnzh enerno-technical and measures to improve the energy efficiency of the facility.*
5. *Problems of operation of communal facilities.*
6. *Proton-proton solar cycle.*
7. *Concentrating helio receivers.*
8. *Balance ocean energy.*
9. *Underwater ocean energy selection devices.*
10. *OtPP scheme with an open cycle.*

№3

1. *Compliance of the energy balance with the available energy reserves in Ukraine.*
2. *Tepl expenses of residential public buildings.*
3. *The structure of thermal energy losses by the building.*
4. *Thermomodernization of enclosing structures.*
5. Lighting systems for constructions.
6. *Solar radiation on the territory of Ukraine.*
7. *Liquid combined double-circuit solar heating system with parabolic concentrator.*
8. *The concept of tides and their characteristics.*
9. *Scheme of the Arctic OTPP on the water-air difference.*
10. *Reserves and distribution of thermal waters in Ukraine.*

№4

1. *On the latest EU documents in the field of energy efficiency.*
2. *Classification of houses by energy efficiency.*
3. *Assessment of the technical condition of buildings and structures.*
4. *Thermodernization I have external walls.*
5. *Obtaining of heat generation systems using gas as fuel.*
6. *The concept and meaning of solar constant.*
7. *The structure of a flat solar collector.*
8. *Characteristic features of surface waves in deep water.*
9. *The main disadvantages of tidal energy.*
10. *Direct conversion of ocean thermal energy.*

№5

1. From the east and the EU to improve energy efficiency.
2. Comparison of requirements for heat transfer resistance in Ukraine with the requirements of other countries.
3. D and agnostic procedures for the technical condition of buildings.
4. Thermal modernization I cover houses.
5. Obtaining using alternative energy source sand the main factors influencing the intensity of solar radiation.
6. Active and passive solar systems.
7. Water low-temperature solar heating system with a flat collector.
8. The concept of "waves in deep water"
9. Ocean thermal energy resources.

10. The concept of a geothermal step.

№6

1. *Principles of "green standards" .*
2. *With the aconodative base of Ukraine in the field of energy saving.*
3. *Report on the technical condition of the building (structure)*
4. *With heating control system*
5. *To complex engineering energy-saving solutions .*
6. *The balance of solar energy.*

7. Classification of solar systems.
8. Solar heating system with collector and heat pump.
9. The main characteristics of the wave.
10. Change in the temperature of rocks with depth.

Individual task to perform home test work

1. Describe the principle of operation, calculation option and select the necessary equipment for the following types of alternative energy sources:

Source datasheet for home test

n	*Installation type*	*Type of energy*	*Power*	*Od. vym.*
1	Solar system	Electricity	1,93	Kw
2	Solar system	Thermal	$9 \cdot 10^{-8}$	Gcal
3	Wind	Electricity	3	Kw
4	Geoustnovka	Thermal	$12 \cdot 10^{-9}$	Gcal
5	Solar system	Electricity	2,03	Kw
6	Solar system	Thermal	$4 \cdot 10^{-7}$	Gcal
7	Wind	Electricity	5	Kw
8	Geoustnovka	Thermal	$7 \cdot 10^{-8}$	Gcal
9	Solar system	Electricity	3,33	Kw
10	Solar system	Thermal	$3 \cdot 10^{-7}$	Gcal
11	Wind	Electricity	4	Kw
12	Geoustnovka	Thermal	$1,1 \cdot 10^{-7}$	Gcal
13	Solar system	Electricity	4,03	Kw
14	Solar system	Thermal	$2 \cdot 10^{-7}$	Gcal
15	Wind	Electricity	6	Kw
16	Geoustnovka	Thermal	$2 \cdot 10^{-8}$	Gcal
17	Solar system	Electricity	4,93	Kw
18	Solar system	Thermal	$6 \cdot 10^{-8}$	Gcal
19	Wind	Electricity	6	Kw
20	Geoustnovka	Thermal	$2 \cdot 10^{-9}$	Gcal
21	Solar system	Electricity	7,12	Kw
22	Solar system	Thermal	$2 \cdot 10^{-7}$	Gcal
23	Wind	Electricity	9	Kw
24	Geoustnovka	Thermal	$15 \cdot 10^{-8}$	Gcal
25	Solar system	Electricity	7,33	Kw

Work program of the discipline (syllabus):
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Approved *by the Department ___E and PPT___ (protocol No. 14 of 8.06.2022)*
Approved *by the FCE Methodical Commission (Protocol No. 10 of 24.06.2022)*