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|  |  | **Кафедра автоматизації електротехнічних та мехатронних комплексів** |
| **Integrated use of the resource base of traditional and renewable energy**  **Work program of the discipline (Syllabus)** | | |

# Requisites of the academic discipline

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| Degree of higher education | *Second (Master)* |
| Field of study | *14 Electric engineering* |
| Specialty | *141 Electric Power Engineering, Electrotechnics and Electromechanics* |
| Study program  Certificate program | *Engineering of Intellectual Electrotechnical and Mechatronic Complexes*  *Engineering and automation of hydrogen energy systems and technologies* |
| Status of the discipline | *Selective* |
| Form of study | *Full-time/part-time/distance learning* |
| Year of study, semester | *1st year of study/ spring semester* |
| Volume of the discipline | *5 credits 150 hours (36 lectures, 18 practical, 96 SSW)* |
| Semester control/ control activities | *Exam, MCW* |
| Timetable | [*http://rozklad.kpi.ua/*](http://rozklad.kpi.ua/) |
| Language of study | *English* |
| Information about the course leader / teachers | Lecturer: associate professor, PhD, senior researcher, Anna V. Yakovlieva*,*  *tel. +38 063 630 89 59, e-mail: a.v.iakovlieva@lll.kpi.ua[[1]](#footnote-2)*  Practical lessons: *assistant Artmem Khotian,*  *tel. +38 068 546 22 07, email: a.khotian@kpi.ua* |
| Placement of the course | Available on the Google Classroom platform. The access code is provided by the teacher at the first lesson. |
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# Program of the discipline

# Description of the discipline, its purpose, subject matter and learning outcomes

# The transition to alternative energy and power sources has become an integral part of the development of modern society in the context of sustainable development. The main task of bioenergy is to provide humanity with affordable, cheap, inexhaustible and safe energy sources. The use of alternative energy sources at stationary facilities and in transport is a way to reduce energy imports and ensure energy independence of the state.

# The purpose of studying the discipline is to form the student's theoretical knowledge and practical skills in assessing the resource base of traditional and renewable energy in terms of volume and energy intensity, the impact of integrated use of energy resources on the efficiency of energy systems. The study of the material of this discipline is focused on the in-depth mastery of systems of integrated use, conversion and storage of energy.

# The subject of the discipline is resources for conventional and renewable energy production, their properties and potential

# Program learning outcomes:

# Knowledge of the energy capabilities of types and sources of energy resources, integrated approaches to their use, conversion and construction of appropriate systems of electromechanical equipment.

# Ability to quantify comparative assessment of different types and sources of energy resources, systems of their use. Ability to build effective systems for the use of energy resources, determine the capacity of the relevant electromechanical equipment.

###### **2. Prerequisites and post-requisites of the discipline (place in the structural and logical scheme of study in the relevant educational program)**

# The discipline "Integrated Use of the Resource Base of Traditional and Renewable Energy" is taught on the basis of the knowledge and skills acquired by students during the study of credit modules in such disciplines as physics, electrical machines, electric drive, design of electromechanical systems.

# The knowledge and skills acquired in the course of studying the discipline "Integrated Use of the Resource Base of Traditional and Renewable Energy" are necessary for specialists in this specialty who solve engineering problems in the field of electricity and electrical engineering and in the study of the disciplines "Fundamentals of Rational Use of Traditional and Alternative Fuel and Energy Resources", "Technology of Energy Production from Traditional Raw Materials and Alternative Energy Sources", etc.

# 3. Content of the discipline

# Section 1. Introduction to the course "Integrated use of the resource base of traditional and renewable energy":

# Topic 1.1. General concepts of energy resources, classification of the resource base of traditional and alternative energy sources.

# Topic 1.2. Composition of the Earth's energy system, forms of energy storage.

# Section 2. Raw material base of non-renewable (fossil) energy resources:

# Topic 2.1. Potential for the use of oil raw materials.

# Topic 2.2. Potential for the use of natural gas.

# Topic 2.3. Potential for the use of coal and lignite

# Topic 2.4. Potential for the use of peat and unconventional fossil fuels

# Topic 2.5. Potential for the production and use of nuclear energy.

# Section 3. Raw material base of renewable (alternative) energy resources:

# Topic 3.1. Potential for the use of solar energy.

# Topic 3.2. Potential for the use of wind energy.

# Topic 3.3: Potential for using the energy of the World Ocean.

# Topic 3.4. Potential for the use of hydropower energy.

# Topic 3.5. The potential for the use of geothermal energy.

# Topic 3.6. The potential for the use of biomass energy.

# Topic 3.7. Potential for the use of secondary raw materials.

# Topic 3.8. Potential for the use of hydrogen energy.4. Навчальні матеріали та ресурси

**Basic literature:**

1. Efstathios E. (Stathis) Michaelides. 2012. Alternative Energy Sources. Springer Berlin, Heidelberg, 462 р. [Alternative Energy Sources | SpringerLink](https://link.springer.com/book/10.1007/978-3-642-20951-2#bibliographic-information)

2. Mariano Martín. 2016. Alternative Energy Sources and Technologies. Springer Cham. 512 р. [Alternative Energy Sources and Technologies: Process Design and Operation | SpringerLink](https://link.springer.com/book/10.1007/978-3-319-28752-2#book-header)

### 3. Sharlissa Moore. 2018. **Sustainable Energy Transformations, Power And Politics: Morocco And The Mediterranean (Routledge Studies In Energy Transitions) 1st Edition. 260 р.**

# 4. John Twidell, Tony Weir. 2015. Renewable Energy Resources. Routledge. 784 р. [Renewable Energy Resources: Amazon.co.uk: Twidell, John, Weir, Tony: 9780415584388: Books](https://www.amazon.co.uk/dp/0415584388?linkCode=gs2&tag=smbb0a-21)

# 5. Andrzej L. Wasiak. 2021Alternative Energy Sources. MDPI. 234 р. [Alternative Energy Sources | MDPI Books](https://www.mdpi.com/books/book/3738-alternative-energy-sources)

6. Nicholas Jenkins , Janaka Ekanayake. 2017. Renewable Energy Engineering Cambridge University Press. [Renewable energy engineering | Energy technology | Cambridge University Press](https://www.cambridge.org/sk/universitypress/subjects/engineering/energy-technology/renewable-energy-engineering?format=HB&isbn=9781107028487)

**Additional literature:**

1. Yakovlieva A.V. Modification of jet fuels composition with renewable bio-additives / A.V. Yakovlieva, S.V. Boichenko, K. Lejda, O.O. Vovk. K.: National aviation university, 2019. – 207 p.

5. Fundamentals of Chemmotology [Electronic resource] : manual / S. V. Boichenko, A. V. Yakovlieva, O. O. Vovk, M. M. Radomska, L. M. Cherniak, I. O. Shkilniuk ; National Aviation University. – Kyiv, 2019. – 296 p. <https://ela.kpi.ua/handle/123456789/49653>

# *The literature, the bibliography of which is given with a reference, can be found on the Internet. Literature that does not contain references can be found in the library of Igor Sikorsky Kyiv Polytechnic Institute. Some sections of the basic literature [1]-[5] are required reading. The sections of the basic literature that are required for reading, as well as the relationship of these resources to specific topics of the discipline, are given below in the methodology for mastering the discipline. All other literary sources are optional and are recommended to be read*

# Educational content

# 5. Methods of mastering the discipline (educational component)

Active learning strategies are applied, which are determined by the following methods and technologies: problem-based learning methods (research method); personality-oriented technologies based on such forms and methods of teaching as case technology and project technology; visualization and information and communication technologies, including electronic presentations for lectures. The methodology of teaching the discipline combines visual teaching methods with explanation. Teaching is conducted in the form of lectures, laboratory and practical classes. The problem-solving method is used in the calculation work.

**Lectures**

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| --- | --- |
| No | Title of the lecture topic and a list of key issues (references to literature) |
| 1 | **Lecture 1.** Topic 1.1 Classification of energy sources. Primary and secondary energy resources. Sources of renewable energy resources on the planet. Degrees of processing of energy sources.  **Literature: [1], [2].** |
| 2 | **Lecture 2-3.** Topic 1.2 Composition of the Earth's energy system. Energy systems. Forms of energy storage and conversion.  **Literature: [1], [2].** |
| 3 | **Lecture 4.** Topic 2.1. Potential for the use of oil raw materials. Methods of extraction and processing. Main products of oil refining. Areas of application of petroleum products. Structure of production and use in Ukraine  **Literature: [1], [3].** |
| 4 | **Lecture 5.** Topic 2.2. Potential for the use of natural gas. Methods of extraction and processing. Main areas of application of natural gas and related products. Structure of natural gas production and utilization in Ukraine.  **Literature: [1], [3].** |
| 5 | **Lecture 6:** Topic 2.3. Potential for the use of coal and lignite. Methods of extraction and processing. Main areas of application of hard and brown coal. Structure of production and use of hard and lignite coal in Ukraine.  **Literature: [1], [3].** |
| 6 | **Lecture 7-8.** Topic 2.4. Potential for the use of peat, unconventional fossil fuels (oil shale, biotuminous sands, shale gases, etc.). Methods of extraction and processing. Main areas of application. The structure of production and use in Ukraine and the world.  **Literature: [1], [3].** |
| 7 | **Lecture 9.** Topic 2.5. Nuclear energy. Raw materials for nuclear energy production: Extraction, use and utilization. Potential of nuclear energy production and use in Ukraine. Environmental aspects  **Literature: [1], [2], [5].** |
| 8 | **Lecture 10.** Topic 3.1. Solar energy. Technologies for capturing, accumulating and storing solar energy. Utilization of solar energy. Potential for the production and use of solar energy in Ukraine. Advantages and disadvantages. Environmental aspects  **Literature: [1], [2], [5].** |
| 9 | **Lecture 11.** Topic 3.2. Wind energy. Technologies for capturing, accumulating and storing wind energy. Utilization of wind energy. Potential for the production and use of wind energy in Ukraine. Advantages and disadvantages. Environmental aspects  **Literature: [1], [2], [4].** |
| 10 | **Lecture 12.** Topic 3.3 Energy of the world ocean: tidal energy, sea wave energy, other types of energy potential of the world ocean. The use of ocean energy. Advantages and disadvantages. Environmental aspects  **Literature: [1], [2], [5], [6].** |
| 11 | **Lecture 13:** Topic 3.4. Hydropower. Potential for using the energy of large and small rivers. Technologies for the production and use of water energy. Potential for the production and use of hydropower in Ukraine. Advantages and disadvantages. Environmental aspects  **Literature: [1], [2], [5].** |
| 12 | **Lecture 14.** Topic 3.5. Geothermal energy. Technologies for capturing, accumulating and storing energy from the earth's interior. Use of geothermal energy. Potential for the production and use of geothermal energy in Ukraine. Advantages and disadvantages. Environmental aspects  **Literature: [1], [2], [5].** |
| 13 | **Lecture 15-16.** Topic 3.6. Biomass energy. The range and potential of biomass energy on the planet (plant, animal biomass, organic waste). Properties and composition of biomass. Technologies of accumulation, processing and use of biomass for energy needs. Advantages and disadvantages. Environmental aspects  **Literature: [1], [2], [5], [6].** |
| 14 | **Lecture 17.** Topic 3.7. Secondary raw materials. Associated and potential use of secondary raw materials (household waste, wastewater, rubber and polymer waste). Properties and composition of raw materials. Processing technologies. Advantages and disadvantages. Environmental aspects.  **Literature: [1], [2], [5], [6].** |
| 15 | **Lecture 17.** Topic 3.8. Potential of hydrogen energy. Raw materials and technologies for hydrogen production. Potential for hydrogen production and use. Advantages and disadvantages. Environmental aspects  **Literature: [1], [2]** |

**Practical lessons**

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| --- | --- |
| No | Tasks to be assigned for practical classes |
| **Practical lesson 1** | Comparative characteristics of the use of alternative and traditional energy sources |
| **Practical lesson 2** | Calculation of geothermal energy sources |
| **Practical lesson 3** | Calculation of wind turbine parameters |
| **Practical lesson 4** | Calculation of the solar collector |
| **Practical lesson 5** | Calculation of ocean energy by type |
| **Practical lesson 6** | Calculation of parameters of biogas plants |
| **Practical lesson 7** | Calculation of parameters of micro and small hydropower plants |
| **Practical lesson 8** | Calculating the use of secondary energy resources |
| **Practical lesson 9** | Modular control work |

# 6. Student's self-study

*Student’s self-study include:*

*Preparation for classroom lessons - 70 hours;*

*Preparation to module control work – 2 hours;*

*Preparation to exam – 24 hours.*

# Policy and control

# 7. Policy of the academic discipline (educational component)

At the time of each lesson, both lecture and practical, the student must have the Google meet application installed on the device from which he or she is working (in the case of distance learning), and the course "Integrated use of the resource base of traditional and renewable energy" on the Sikorsky platform (the access code to the course is provided at the first lesson according to the schedule). Syllabus; lecture material; assignments for each practical lesson; variants of the module test; guidelines for practical work and calculation and graphic work; variants of the final test are available on the Sikorsky platform and in the KPI Electronic Campus system.

While taking the course "Integrated use of the resource base of traditional and renewable energy", students are obliged to adhere to the general moral principles and rules of ethical behavior specified in the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

The deadlines for each assignment are specified in the course "Integrated use of the resource base of traditional and renewable energy" on the Sikorsky platform.

All students, without exception, are obliged to comply with the requirements of the Regulations on the system of prevention of academic plagiarism at the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute".

For participating in the All-Ukrainian Olympiad (research paper competition), a student is awarded 5 (I round) or 10 (II round) points. For writing an article and publishing it, a student is awarded 10 points (a publication included in Scopus or Web of Science) or 6 points (a professional publication of Ukraine). For publishing abstracts at a scientific conference, 3 points are awarded. The total amount of incentive points cannot exceed 10 points.

# 8. Types of control and rating system for assessing learning outcomes (RSA)

**Current control:** assignments within the framework of practical classes (9 practical classes × 5 points = 45 points), MCW (conducted directly at the practical class, in the presence of the teacher, 15 points). At the end of the lesson, the test is closed and cannot be rewritten or completed at home. The test contains thirty questions and several answers to each of them, one of which is correct. Each correct answer is worth 0.5 points.

The tasks within the practical and laboratory classes are evaluated in 5 points according to the following criteria:

* "excellent" - a complete answer (at least 90% of the required information), appropriate justifications and personal opinion are provided - 10 points;
* "good" - a sufficiently complete answer (at least 75% of the required information), which is performed in accordance with the requirements for the "skills" level or contains minor inaccuracies – 9-8 points;
* "satisfactory" - an incomplete answer (at least 60% of the required information), performed in accordance with the requirements for the "stereotypical" level and containing some errors – 7-5 points;
* "unsatisfactory" - unsatisfactory answer - 0-2 points.

**Calendar control:** is conducted twice a semester as a monitoring of the current state of fulfillment of the requirements of the sila-bus. The condition for a positive first and second calendar control is to obtain at least 50% of the maximum possible rating at the time of the relevant calendar control.

**Semester control:** credit.Conditions for admission to the semester control: completed and credited practical works and MCW. Students who have fulfilled all the conditions for admission to the test and have a rating score of 60 or more points receive a grade corresponding to the rating without additional tests. The sum of the rating points received by the student during the semester is transferred to the final grade according to the table. If the sum of points is less than 60, but practical works and ICR are completed and credited, the student performs a test work. In this case, the sum of points for practical, ICR and test work is transferred to the final grade according to the table. A student who has received more than 60 points in a semester but wishes to improve his or her result may take part in the test work. In this case, the final result consists of the points obtained in the test work and the points for practical and internship work.

The test is worth 40 points. The test task of this paper consists of three theoretical questions from the list provided in the appendix to the syllabus.

Each question and task is worth 13 points (if you get 39 points for each question, 1 point is added to the grade) according to the following criteria

- "excellent" - a complete answer (at least 90% of the required information), appropriate justifications and personal opinion are provided - 13 - 11 points;

- "good" - a sufficiently complete answer (at least 75% of the required information), which is made in accordance with the requirements for the "skills" level or contains minor inaccuracies - 12 - 10 points;

- "satisfactory" - an incomplete answer (at least 60% of the required information), performed in accordance with the requirements for the "stereotypical" level and containing some errors - 9 - 7 points;

- "unsatisfactory" - unsatisfactory answer - 0 points.

Table of correspondence between rating points and grades on the university scale:

|  |  |
| --- | --- |
| Number of points | Grade |
| 100-95 | Excellent |
| 94-85 | Very good |
| 84-75 | Good |
| 74-65 | Satisfactory |
| 64-60 | Sufficient |
| Below 60 | Non-satisfactory |
| The conditions for admission are not met | Not admitted |

# 9. Additional information on the discipline (educational component)

The list of questions submitted for semester control is given in the appendix to the syllabus.

A higher education applicant has the opportunity to take an online course(s) on one or more topics provided by the work program of the discipline. An applicant can choose an online course independently or on the recommendation of a teacher. 1 hour of the course is evaluated at 0.83 points. The maximum number of hours that can be credited for the results of non-formal education is 12 hours, respectively, the maximum number of points for such results is 10 points.

**Work program of the discipline (Syllabus):**

**Developed by** associate professor, PhD, senior researcher, Anna V. Yakovlieva

**Approved by** the department of automaton of eletrotechnic and mechatronic complexes, minutes No 17 from 31.05.23р.

**Approved by** methodic council of the ES IESEM, minutes No 9 from 22.06.23 р.

**Appendix to the syllabus of the educational component**

**"Integrated use of the resource base of traditional and renewable energy"**

**List of tasks to be submitted for semester control**

1. Give reasons for the transition of modern society to alternative energy sources.
2. What is the energy potential of renewable energy sources?
3. Give the classification of energy resources according to the degree of processing.
4. What are the primary and secondary energy resources?
5. What energy resources are not renewable energy sources? Describe them.
6. What types of renewable energy are the result of energy radiation
7. Give the definition of "solar energy".
8. What is the principle of photovoltaic solar power plant?
9. What is the principle of thermodynamic solar power plant?
10. Give the main advantages and disadvantages of solar energy.
11. Give the definition of "wind power".
12. What you know the design of wind turbines? What is their difference?
13. Give the definition of "hydropower"
14. What is the difference between the principle of operation of traditional hydroelectric power plants and PSPP?
15. What are the determining factors of the energy potential of hydropower?
16. Give a definition of "ocean energy"
17. Give the main advantages and disadvantages of nuclear power.
18. Give the definition of "geothermal energy"
19. What is the difference between primary and secondary biomass?
20. Give a definition of "biogas". What is its average chemical composition? Describe the principle of operation of the biogas plant.
21. What do you know ways to produce hydrogen?
22. Describe the main areas of use of hydrogen fuel.
23. Describe the main resources of polymeric raw materials for alternative fuels.

1. The teacher's e-mail or other contacts for feedback, it is possible to specify office hours or hours for communication in case of contact numbers. For a syllabus of a discipline taught by many teachers (for example, history, philosophy, etc.), you can specify a page on the website where contact information for the teachers for the relevant groups, faculties, institutes is provided. [↑](#footnote-ref-2)