

Name of subject	Alternative energy sources in the power supply system (ECTS 8)
Subject/module code	ETTMEM24508
Science taught semester (s).	4 <sup>th</sup> and 5 <sup>th</sup> semesters
Responsible teacher	Suyarov Anvar Olimjon ugli, assistant.
Education language	Uzbek
Connection to the curriculum	Elective
Training hours (this including independent education)	<b>Total hours-240</b> <b>Audience Training hours – 96</b> Lecture training hour – 36 Practical training hour – 60 <b>Independent education -144 hours</b>
ECTS	8
The purpose and tasks of subject / learning outcomes	<p><b>The purpose of teaching the subject</b> is to develop an understanding of renewable energy sources in students, analyze the share of renewable energy sources in the world's electricity generation capacity, develop skills and qualifications in the classification and structural structure of the electric power industry, electricity generation processes, and the effective operation of electrical devices under specific operating conditions.</p> <p><b>The task of the subject</b> is to The role of the electric power industry in the rapid development of the economy is incomparable. Due to the stable operation of the energy system of Uzbekistan, the national economy is provided with uninterrupted and high-quality electric energy. This process, in turn, increases the demand for training highly qualified personnel.</p> <p>This program reflects the goals and objectives, content of the discipline “Alternative energy sources in the power supply system”. In-depth study of the science of alternative energy sources in the power supply system plays an important role in solving the problems of the harmful effects of energy on the environment.</p> <p><b>Learning outcomes:</b></p> <ol style="list-style-type: none"> <li>1. Studies the development, history, and prospects of renewable energy sources and the electric power system.</li> <li>2. The role and socio-economic significance of alternative energy in society.</li> <li>3. State policy in the energy sector and its development trends and prospects in the country and the world.</li> <li>4. Basic concepts in the electric power sector.</li> <li>5. Key performance indicators for various types of transport and opportunities for their improvement.</li> <li>6. Increasing the efficiency of electricity generation equipment.</li> <li>7. Economic assessment of the competitiveness of traditional and unconventional methods of electricity generation.</li> </ol>
Course content (topics)	<p><b>I. Main Theoretical Part (Lecture Sessions)</b></p> <p><b>Topic 1:</b> Introduction. Opportunities for the use of renewable energy sources. Analysis of the opportunities for the use of renewable energy sources in the energy system</p> <p><b>Topic 2:</b> Regulatory and legal framework for the use of renewable energy sources in the energy system of Uzbekistan.</p> <p>History of the development of the energy sector of Uzbekistan. Renewable energy sources, their types and resources. Prospects and stages of development of the use of renewable energy resources in the territory of Uzbekistan.</p> <p><b>Topic 3:</b> The role of renewable energy sources in the transition of the</p>

Republic of Uzbekistan to a "green" economy.

**Topic 4: Hydropower.**

Large natural and artificial subsystems that serve to convert the energy of water flows into electrical energy.

Hydropower plants, their types, principle of operation

**Topic 5:** Hydroelectric power plants and small hydroelectric power plants.

The principle and function of operation of hydroelectric power plants (HPP). HPP operating modes. Small hydroelectric power plants and their operating processes. Advantages of small hydroelectric power plants

**Topic 6: Solar thermal systems**

Conversion of sunlight energy into thermal energy of water. Flat-plate solar collectors. Use of solar thermal systems. Efficient use of solar energy. Parabolic trough solar power plants. High-temperature solar devices. Solar furnaces.

**Topic 7:** Conversion of solar energy into electrical energy.

Photoelectric effect phenomenon. Structural scheme of zones in semiconductors. p-n junction, layout schemes of p-n junctions in a semiconductor crystal. Volt-ampere classifications of semiconductor materials and solar photovoltaic panels. Solar photovoltaic power plants, Solar thermodynamic power plants

**Topic 8.** Wind power plants and power stations

Existing SHES in developed countries. Future prospects of SHES. Wind power plants. Wind energy resources map. Future prospects of wind power plants.

**Topic 9:** Selection and use of wind power equipment

Electric generators and their selection, selection of electric drives, selection of a place for installing a wind electric motor. Analysis of biomass energy resources and their use indicators.

**Topic 10:** Biomass energy sources and their use

General information about biomass sources. Processes of converting biomass into useful energy. Converting biomass into useful energy in thermal and chemical processes.

Modern bioenergy devices, their structure and principle of operation. Scheme of the working process of a biomass device. Methods of pyrolysis, alcohol production. Production of biogas using anaerobic digestion. Biomass energy resources resources.

**Topic 11:** Geothermal energy sources and their use

Use of geothermal energy. Types of geothermal power plants. Scales of geothermal energy use and their impact on the environment

Installation of hydrothermal power plants in hyperthermal areas. Scheme of heat recovery from dry rock. Heat source from hydrothermal resources.

**Topic 12:** Geothermal power plant using geothermal heat

Cycles for generating electricity from geothermal heat. Scheme of a geothermal power plant with a low boiling point. Geothermal power plant using natural steam directly.

**Topic 13:** Use of ocean wave energy

Ocean wave energy, reactive converters of ocean wave energy, hydroelectric power station on ocean wave energy.

**Topic 14:** Use of tidal energy of seas and oceans

Tidal energy of seas and oceans, wave energy device, wave power station, tidal power station scheme.

**Topic 15:** Environmental aspects of the use of renewable energy sources.

The impact of geothermal energy, solar power plants, wind power plants on the environment. The impact of small hydropower, hydroelectric power plants, biomass energy, ocean energy on the

environment.

## **II. Practical training instructions and recommendations**

The teacher's preparation for a practical training session begins with the study of preliminary documents (curriculum, thematic plan, etc.) and ends with the development of a lesson plan. The teacher should have an idea of the goals and objectives of the practical training session, the amount of work that each student must perform.

Methodological guidelines are the main methodological document of the teacher in preparing and conducting practical training sessions.

The purpose of the practical training session is to understand the theory, acquire skills. It is to consciously apply it in educational and professional activities, and to develop the ability to confidently form one's own point of view.

### **The following topics are recommended for practical training:**

1. Calculation and comparison of the economic efficiency of renewable energy power plants around the world.
2. Calculation of the parameters of a hydroelectric dam and a hydroturbine.
3. Study of the volt-ampere and volt-watt characteristics of a solar cell
4. Series connection of solar cells.
5. Parallel connection of solar cells.
6. Calculation and selection of a photovoltaic module for a solar power plant.
7. Calculation of the type and number of accumulator batteries.
8. Calculation of the prices of selected basic equipment for a solar power plant for an individual house.
9. Study of the structure and principle of operation of a vacuum tube solar collector.
10. Measurement of the parameters of water heated in a flat solar collector and determination of its thermal efficiency.
11. Calculation of a wind power plant. Selection and calculation of a wind power plant generator.
12. Calculation of the volume and heat of a biogas plant reactor.
13. Calculation of thermal power taking into account the use of geothermal heat.

## **III. Independent learning and independent work.**

Independent learning competence serves to support students' independent self-development and increase the effectiveness of professional activities. Students perform independent work on their mobile devices under the guidance of a teacher in a traditional or electronic form.

### **Recommended topics for independent study:**

1. The role and importance of renewable energy in the fuel and energy complex of Uzbekistan.
2. Prospects for the use of renewable energy in the energy sector of the world and Uzbekistan.
3. Trends in the development of renewable energy in Uzbekistan.
4. Use of solar energy in energy supply systems. Technical characteristics of solar installations. Climatic advantages for the construction of solar installations.
5. Main technical schemes of solar installations. Their technical and economic indicators.
6. Production of electricity as a result of the photovoltaic effect.
7. Heliothermal technology for converting solar energy.
8. Wind power. Main directions and technical characteristics of the development of wind power plants.
9. General characteristics and development directions of wind power in

	<p>Uzbekistan.</p> <p>10. Bioenergy. Main technical schemes of bioenergy plants.</p> <p>11. Main directions of the development of bioenergy in Uzbekistan.</p> <p>12. Technical, socio-economic and environmental problems in the system of waste processing technologies.</p> <p>13. Geothermal energy. The main technical and economic conditions for its development.</p> <p>14. Small hydropower plants. Prospects for the construction of small hydropower plants. General description of energy sources and the main technical solutions for their development.</p> <p>15. Energy of the seas and oceans. General description of energy potential and technical possibilities for its development.</p> <p>16. Wave and tidal devices. Basic technical characteristics, development prospects.</p> <p>17. Thermal energy of the seas and oceans. Energy of ocean currents.</p> <p>18. What problems can be solved in our country using renewable energy?</p> <p>19. Current status and prospects for the use of renewable energy sources.</p> <p>20. The role of small hydropower in the development of certain regions of Uzbekistan.</p> <p>21. The status of renewable energy in Uzbekistan, problems and solutions.</p>
Exam form	Written
Teaching/learning and examination requirements	<p>Complete mastery of theoretical and methodological concepts and practical knowledge of the discipline, the ability to correctly reflect the results of analysis, independently reason about the processes being studied and carry out tasks in the current, intermediate forms of control and independent work, pass written work on the final control.</p> <p>When drawing up final exam questions, deviations from the content of the discipline program are not allowed. The bank of final exam questions for each discipline is discussed at the meeting and approved by the head of the department.</p> <p>No later than 1 week before the start of the final control, tickets signed by the head of the department, enclosed in an envelope, are sealed by the Dean's office and opened 5 minutes before the start of the exam in the presence of students. Final exam duration is 80 minutes. Answers to final exam questions are recorded in copybooks with the seal of the Dean's office. After completion of the final work, the work is immediately encrypted by a representative of the Dean's office, and the copybooks are handed over to the commission for verification. From the moment of completion of the final exam, a period of 72 hours is allotted for checking and posting the results on the electronic platform.</p> <p>The teacher who taught the students in this discipline is not involved in the process of conducting the exam and checking the students' answers.</p> <p>Student(s) who are dissatisfied with the final exam results may submit a written or oral appeal within 24 hours of the publication of the final exam results. Complaints submitted after 24 hours from the publication of the final exam results will not be accepted.</p>
Scope of assessment criteria and procedure	<p><b>CURRENT CONTROL</b></p> <p>Purpose: Determining and assessing the student's level of knowledge, practical skills, and competencies on course topics.</p> <p>Instructions: The student's activity in daily classes is assessed through the student's mastery of course topics, as well as constructively interpreting and analyzing the educational material, developing module-specific skills, acquiring practical skills (in terms of quality and the specified number) and competencies, solving problem situations aimed at applying professional practical skills, working in a team, preparing</p>

presentations, etc.

Current control form: Activity in lessons Preparing educational materials Working with sources within the subject Using educational technologies Working in a team Preparing presentations Working with projects.

#### MIDTERM CONTROL

Purpose: Assessing the student's knowledge and practical skills and level of mastery of lecture material after completing the relevant section of the course.

Form and procedure of intermediate control: Midterm examination is held during the semester during the training sessions after the completion of the relevant module of the curriculum of the subject. Midterm examination is held once in written form within the framework of this subject. Midterm examination questions cover all topics of the subject.

#### INDEPENDENT LEARNING

Purpose: Independent learning is aimed at fully covering the content of this course, expanding the theoretical knowledge acquired, and establishing independent learning activities for students.

Form and procedure of independent education: independent work assignments are completed in the form of an educational project, presentation, case study, problem solving, information search, digest, colloquium, essay, article, abstract, etc. Completed assignments for independent study are placed in the electronic system and checked based on the anti-plagiarism program and evaluated by the subject teacher.

In this case, the uniqueness of the completed assignment should not be less than 60%, otherwise the assignment will not be accepted for assessment. The number of independent work assignments, depending on the nature of the subject, should not be less than 3 for one subject (module). Independent work assignments account for 60% of the points allocated for current and intermediate control.

#### FINAL CONTROL

Purpose: The final examination is held at the end of the semester to determine the level of mastery of the student's theoretical knowledge and practical skills in the relevant subject. The final examination is held at a specified time according to the examination schedule created by the Registrar's Office on the electronic platform.

Requirements: The student must have passed the current control, intermediate control and independent learning assignments by the deadline for the final control type in the relevant subject. A student who has not passed the current control, intermediate control and independent learning assignments, as well as who has received a score in the range of "0-29.9" for these assignments and control types, is not included in the final control type. Also, a student who has missed 25 percent or more of the classroom hours allocated to a subject without a reason is excluded from this subject and is not included in the final control type and is considered not to have mastered the relevant credits in this subject. A student who has not passed or was not included in the final control type and has received a score in the range of "0-29.9" for this type of control is considered to be an academic debtor.

Final control form: The final examination in this subject will be conducted in written form. If the final examination is conducted in written form, the requirements for assessment must also be reflected.

Criteria for assessing student knowledge	5 grade	100 points		Assessment criteria
	5	90-100	Excellent	When a student is considered to be able to make independent conclusions and decisions, think creatively, observe independently, apply the knowledge he

				has gained in practice, understand, know, express, and narrate the essence of the subject, and have an idea about the subject.	
	4	70-89,9	Good	When the student is considered to be able to observe independently, apply the knowledge he has gained in practice, understand, know, express, and narrate the essence of the subject, and has an idea about the subject.	
	3	60-69,9	Satisfactory	When the student is found to be able to apply the knowledge he has gained in practice, understands, knows, can express, and narrate the essence of the subject, and has an idea about the subject.	
	2	0-59,9	Unsatisfactory	When it is determined that the student has not mastered the science program, does not understand the essence of the subject, and does not have an idea about the science.	
Course assessment criteria and procedure	Assessment type	Total points allocated	Control (task) form	Distribution of points	Qualifying score
	Current assessment	30 points	System tasks	20 points (divided by the number of tasks)	18 points
			Student activity (in seminars, practical, laboratory classes)	10 points	
	Midterm assessment	20 points	Supervision: Written work	10 points	12 points
			System tasks	10 points (divided by the number of tasks)	
	Final assessment	50 points	Written assignment (5 questions)	50 points (10 points per question)	30 points
	* Note: 60% of the points allocated for current and intermediate control are allocated to independent work assignments. Independent work assignments are evaluated as system assignments through the electronic platform.				
Recommended Literature	<b>Main literature:</b> <ol style="list-style-type: none"> <li>21.05.2019 -yildagi “Qayta tiklanuvchi energiya manbalaridan foydalanish to‘g‘risida”gi O‘zbekiston Respublikasining Qonuni.</li> <li>O‘zbekiston Respublikasi Prezidentining 04.10.2019-yildagi “2019 — 2030-yillar davrida O‘zbekiston respublikasining “yashil” iqtisodiyotga o‘tish strategiyasini tasdiqlash to‘g‘risida”gi PQ-4477-sonli Qarori</li> <li>O‘zbekiston Respublikasi Prezidentining 26.05.2017-yildagi “2017-2021 yillarda qayta tiklanuvchi energetikani yanada rivojlantirish, iqtisodiyot tarmoqlari va ijtimoiy sohada energiya samaradorligini oshirish chora-tadbirlari dasturi to‘g‘risida”gi PQ-3012-sonli Qarori.</li> <li>O‘zbekiston Respublikasi Prezidentining 22.08.2019-yildagi “Iqtisodiyot tarmoqlari va ijtimoiy sohaning energiya samaradorligini oshirish, energiya tejovchi texnologiyalarni joriy etish va qayta</li> </ol>				

tiklanuvchi energiya manbalarini rivojlantirishning tezkor chora-tadbirlari to'g'risida"gi PQ-4422-sonli Qarori.

5. Majidov T.Sh. Noan'anaviy va qayta tiklanuvchi energiya manbalari // Toshkent. 2014.

6. John Twidell and Tony Weir. Renewable Energy Resources // Taylor and Francis Group. LONDON AND NEW YORK, 2006.

7. Renewable Energy // ICAR e-Course For B.Sc (Agriculture) and B.Tech (Agriculture)

8. Риполь-Сарагоси Т.Л., Кууск А.Б. Возобновляемые и нетрадиционные источники энергии. Учебно-методическое пособие // Ростов-на-Дону, 2019. – 122 с.

9. Badalov A.S., Zenkova V.A., Uralov B.R., Shaazizov F.Sh. Hidroelektrostansiyalar. O'quv qo'llanma // Toshkent – 2009.

10. М.М. Мухаммадиев, Б.У. Уришев, Э.К. Мамадиёров, К.С. Джураев Энергетические установки малой мощности на базе возобновляемых источников энергии // Ташкент. ТашГТУ, 2015.- С.161

11. Faleev D.S Osnovnye karakteristiki solnechnykh moduley // Metodicheskaya ukazaniya. Xabarovsk. 2013. – Izdatelstvo DVGUPS. – S.28

12. Gremenok V.F., Tivanov M. S., Zaleski V.B Solar cells based semiconductor materials// International Scientific Journal for Alternative Energy and Ecology – 2009 – Vol.69. №1. – P. 59-124.

#### **Additional literature:**

13. Mirziyoev SH.M. Buyuk kelajagimizni mard va olijanob xalqimiz bilan birga quramiz. - T.: "O'zbekiston" NMIU, 2017. – 488 b.

14. O'zbekiston Respublikasini yanada rivojlantirish bo'yicha Harakatlar strategiyasi to'g'risida. - T.:2017 yil 7 fevral, PF-4947-sonli Farmoni.

15. O'zbekiston Respublikasini «Energiyadan ratsional foydalanish haqidagi» qonuni 29 aprel 1997yil.

Афанасев В. П., Теруков Э. И., Шерченков А. А Тонкопленочные солнечные элементы на основе кремния // Санкт-Петербург. Издательство СПбГЕТУ «ЛЕТИ» 2011

#### **Internet resources:**

13. [www.gov.uz](http://www.gov.uz) – O'zbekiston Respublikasining hukumat portali.

14. [www.ziyonet.uz](http://www.ziyonet.uz)– milliy o'quv materiallarining qidiruv sayti.

15. [www.lex.uz](http://www.lex.uz)– 'zbekiston Respublikasining Qonun hujjatlari ma'lumotlari milliy bazasi