Subject (course) name: **Renewable energy sources**		
Programme: **Electrical Engineering** Specialty:		Subject code: **E1S_2S_EE**
		Title graduate: **Engineer**
Type of course: **optional**	Course level: **First-cycle studies**	Year: **III** Semester: **V** Semester: **winter**
Form of classes: **Lectures, Classes, Labs, Seminar, Project**	Number of hours per week: **2L, 1C, 0, 1S, 0**	Credit points: **4 ECTS**

GUIDE TO SUBJECT

SUBJECT OBJECTIVES

C1. To introduce students with the issues of renewable energy sources (RES), international documents, the European Union and Polish by regulating their development and support low-carbon economy, environmental problems affecting the decision of RES development.
C2. Provide students with knowledge about the physical processes of creating energy and modern devices and technologies, renewable energy sources (RES), such as hydro, wind, solar, geothermal, based on the use of biomass, etc.
C3. Provide students with knowledge about modern trends in renewable energy technologies using new structural materials in order to increase their efficiency.
C4. Transfer of knowledge about how the selection and evaluation of the economic use of the source (s), depending on the existing natural conditions in the country.
C5. The student obtains the ability of self-execution analysis of the messages on the development of eco-energy, making the right decisions the use of RES.

SUBJECT REQUIREMENTS

1. Knowledge of physics in the theory of liquids and gases, nuclear physics, thermokinetics dynamics.
2. Base knowledge of thermodynamics and electricity generation.
3. Knowledge of mathematics in the field of differential equations and integrals.
4. Knowledge of chemistry and biochemistry.
5. Ability to work independently on a given topic related to the subject of the course.
6. Computer literacy and the use of literature sources and online resource, containing scientific information and the type of catalogue of various companies related to technological solutions devices.
7. Skills to work independently and in a group.

LERNING OUTCOMES

EK 1 - The student defines the basic concepts of ecology, lists the normative documents related thereto, characterized by natural processes in nature, which are the result of physical phenomena on earth associated with the original renewable energy (water rafting, wind energy solar, etc.), used as a source of energy.
EK 2 - Student presents a classic design performance power equipment, processing various types of primary energy from renewable sources, theoretical concepts and models describing the processes of its processing.
EK 3 - The student can indicate a variety of technological and technical solutions using

renewable energy technologies, including hybrid structures (solar tower, a household small wind power plant using photovoltaic panels as a reserve source of energy, accumulating energy systems.).

EK 4 - Student can perform calculations based on simplified models of hydrodynamic, aerodynamic, thermodynamic and thermal balance and material in order to obtain approximate values of energy obtained from natural renewable source of energy and do the analysis period financial return

EK 5 - The student is able to analyse knowledge in the literature, catalogues and other sources and do independent work on a given topic related to the subject classes and present the resulting knowledge.

SUBJECT CONTENT

Form of classes - lectures

Topic	Hours
W1 – Introduction on RES	**1**
W2 – hydropower. Basic concepts, principles of operation, the base theoretical constructs turbines	**2**
W3 – Hydroelectric power stations - construction of power plants, Marine and ocean hydropower. The development of hydropower in Poland in the new economic conditions.	**2**
W4 – Wind energy, theoretical aerodynamics, the coefficient roughness, wind conditions in Poland, measurements of wind speed maps wind	**2**
W5 – Structural performance of wind turbines, Automation, diagnostics and maintenance of wind turbines.	**2**
W6 – Connection and cooperation with grids of large wind farms. Energy problems. Maintenance Supplies. Offshore wind farms, foundations. Other designs. Domestic wind turbines, system components	**2**
W7 – Solar energy, the physical basis (the largest reactor fusion). The balance of the physical and energetic radiation sunlight. Rights of radiation. Poland map sunlight. Passive systems use solar radiation.	**2**
W8 – **Active systems use solar radiation - solar panels. Theoretical basis of heat transfer.**	**2**
W9 – Active systems use solar energy – continuation. Collectors "tracking" the sun, thermodynamic basis of the principle of Sterling engine operation, solar power plants with focused collectors. Hybrid structures-solar chimneys (solar towers)	**2**
W10 – Theoretical principles of photovoltaic elements. Construction materials, construction of photovoltaic panels-flat, mono- and polycrystalline. Technical parameters of photovoltaic cells. Installation components. Assembly and installation of lightning protection and surge. The use of photovoltaic elements. With power photovoltaic cells.	**2**
W11 – Biomass-definition biomass extraction of biomass-source, value opal, humidity, pre-treatment of biomass	**2**
W12 – Conditioning of biomass. Gasification, pyrolysis, co-generation.	**2**
W13 – Geothermal Energy. Geothermal resources Polish. Technology use. Low-temperature thermal energy of the seas. Heat pumps, systems supporting renewable energy technologies	**2**
W14 – Possibilities for the development of renewable energy sources in Poland and performance objectives and agreements Climate Package international.	**2**
Final test	**2**
Total	**30**

Form of classes - lectures

Topic	Hours
C1 – Reminder from the earlier subjects: some basic definitions, units, balance equations, checking level of knowledge of students	**1**
C2 – Hydropower.	**1**
C3 – Hydroelectric power stations.	**1**
C4 – Wind energy.	**1**
C5 – Structural performance of wind turbines.	**1**
C6 – Connection and cooperation with grids of large wind farms.	**1**

C7 – Solar energy.	**1**
C8 – **Solar panels**	**1**
C9 – Photovoltaics	**1**
C10 – Biomass	**1**
C11 – Biomass	**1**
C11 – Biofuels	**1**
C13 – Geothermal Energy.	**1**
C14 – Basics of economic evaluation of RES	**1**
Final test	**1**
Total	**30**

Form of classes – Seminar

Topic	Hours
S1 – Are renewable energy sources necessary I discussion	**1**
S2 – Hydropower.	**1**
S3 – Hydroelectric power stations.	**1**
S4 – Wind energy.	**1**
S5 – Structural performance of wind turbines.	**1**
S6 – Connection and cooperation with grids of large wind farms.	**1**
S7 – Solar energy.	**1**
S8 – **Solar panels**	**1**
S9 – Photovoltaics	**1**
S10 – Biomass	**1**
S11 – Biomass	**1**
S11 – Biofuels	**1**
S13 – Geothermal Energy.	**1**
S14 – Basics of economic evaluation of RES	**1**
Final test	**1**
Total	**15**

STUDY METHODS

1. Lectures using multimedia presentations and computer arithmetic tasks
2. Exercise auditorium: problem solving, also using projects, discussion
3. Seminar - discussion, with a multimedia presentation

EDUCATIONAL TOOLS

1. Audiovisual equipment, black(white)board, lectures in electronic version
2. Classes - Black(white)board, Audiovisual equipment
3. Seminar - Black(white)board, Audiovisual equipment, discussion

METHODS OF ASSESMENT (F – Forming, P – Summary)

F1. Final test, points for the activity in lectures, discussion
F2. Grade based on the final test, points for the activity in lectures, discussion
F3. Grade based on participation in seminar classes, the delivered speech
P1. Final test (80%), 10% on the basis of points for the activity and presence at lectures, 10% of the grade for drawing correct the speech
P2. Exercise auditorium-test (90%), for the activity in exercises and discussions (10%)
P3. Final grade - the average of all grades

STUDENT WORKLOAD

Form of activity	Averaged workload (hours)		
	[h]	∑ [h]	ECTS
Participation in class activities lecture	30	60	2
laboratory	15		
consultation	15		
Preparation for tutorials (reading literature)	15	40	2
Preparation for test from lectures	15		
Preparation for test from classes	10		

Total		**100**	**4**

A. BASIC READING

1. **Thomas B. Johansson, Laurie Burnham: Renewable Energy: Sources for Fuels and Electricity, Island Press.**
2. G. N. Tiwari, Rajeev Kumar Mishra: Advanced Renewable Energy Sources, Royal Society of Chemistry, 2011
3. John Twidell, Anthony D. Weir: Renewable Energy Resources, Taylor & Francis, 2006

B. FURTHER READING

1. Goodall Chris: *Ten Technologies to Fix Energy and Climate, Profile Books, 2009*
2. Deploying Renewables 2011, International Energy Agency.
3. Lewandowski W.: Proekologiczne odnawialne źródła energii, Wydaw. Naukowo-Techniczne, Warszawa, 2007, in Polish.

Learning objectives	In relation to the learning outcomes specified for the field of study	Subject objectives	Study methods	Methods of assessment
EK1	KE1A_W02 KE1A_W10	C1, C2	Lecture Classes Seminar	F1,F2,F3, P1,P2,P3
EK2	KE1A_W02 KE1A_W10	C2, C3	Lecture Classes Seminar	F1,F2,F3, P1,P2,P3
EK3	KE1A_W02 KE1A_W10	C2, C3	Lecture Classes Seminar	F1,F2,F3, P1,P2,P3
EK4	KE1A_W02 KE1A_U01 KE1A_K01 KE1A_K02	C3, C4	Lecture Classes Seminar	F1,F2,F3, P1,P2,P3
EK5	KE1A_U01 KE1A_K01 KE1A_K02	C5	Lecture Classes Seminar	F1,F2,F3, P1,P2,P3

II. EVALUATION

Grade	Outcome
EK1	The student defines the basic concepts of ecology, lists the normative documents related thereto, characterized by natural processes in nature, which are the result of physical phenomena on earth associated with the original renewable energy (water rafting, wind energy solar, etc.), used as a source of energy.
2 (F)	The student is not able to characterize environmental problems, replace the basic normative documents, renewable energy sources (hydro, wind solar etc.), natural processes conducive to its formation, he can not make an assessment this energy resource
3 (E)	Student incomplete characterize environmental problems and mentions only a few basic normative documents, renewable energy sources (hydro, wind solar, etc.), natural processes conducive to its formation, draw an incomplete assessment of the energy resources
4 (C)	The student can well characterize environmental problems and documents governing the development of renewable energy sources (hydro, wind solar, etc.) natural processes conducive to its formation, draw up an assessment of the energy resources, lists the parts of factors affecting energy resources
5 (A)	Student is able to fully comprehensively characterize the ecological problems of the related normative documents supporting the development of renewable energy, sources of primary energy (water, wind, solar, etc.), natural processes conducive to its formation, draw up an assessment of the energy resources, exhaustive list of factors affecting energy resources, provides solutions that affect the increase in efficiency
EK2	Student presents a classic design performance power equipment, processing various types of

	primary energy from renewable sources, theoretical concepts and models describing the processes of its processing.
2 (F)	A student can not: provide a classic design performance of devices energy, processing various types of primary energy sources renewable, does not present the theoretical concepts and models describing the process of its processing.
3 (E)	Student not completely distinguish between classical design execution devices energy, processing various types of primary energy sources renewable, does not present the theoretical concepts and models describing the processes it processing for some sources.
4 (C)	Student shows satisfactory performance classic construction equipment energy, processing various types of primary energy sources energy, also gives satisfactory theoretical concepts and models describing the its processing processes.
5 (A)	Student distinguishes a classic design performance power equipment, processing different types of primary energy from renewable sources, gives comprehensively theoretical concepts and models describing the process of its processing.
EK3	The student can indicate a variety of technological and technical solutions using renewable energy technologies, including hybrid structures (solar tower, a household small wind power plant using photovoltaic panels as a reserve source of energy, accumulating energy systems.).
2 (F)	The student is not able to indicate a variety of technological and technical solutions using renewable energy technologies, also does not mention hybrid structures (solar tower, a household small wind turbine using eg photovoltaic panels as a reserve source of energy, the energy-storing systems, etc.).
3 (E)	The student can indicate a fractionally different technological and technical solutions using RES technologies and hybrid structures (solar tower, Domestic small wind turbine using eg photovoltaic panels as a reserve source of energy, the energy-storing systems, etc.).
4 (C)	Student is able to point out the most technological and technical solutions using renewable energy technologies, and some hybrid structures (solar tower, a household small wind turbine using eg photovoltaic panels as a reserve source of energy, the energy-storing systems etc.).
5 (A)	Student is able to fully replace the various technological and technical solutions using renewable energy technologies, including hybrid structures (solar tower, a household small wind turbine using eg photovoltaic panels as a reserve source of energy, the energy-storing systems, etc.).
EK4	Student can perform calculations based on simplified models of hydrodynamic, aerodynamic, thermodynamic and thermal balance and material in order to obtain approximate values of energy obtained from natural renewable source of energy and do the analysis period financial return
2 (F)	The student is not able to perform calculations for the simplified formulas hydrodynamic, aerodynamic, thermodynamic, and thermokinetic heat and material balance in order to obtain approximate values of the energy obtained from natural renewable energy sources
3 (E)	Student fractionally can perform calculations by the simplified formulas hydrodynamic, aerodynamic, thermodynamic, and thermokinetic heat and material balance in order to obtain approximate values of the energy obtained from natural renewable energy sources
4 (C)	Student increasingly able to perform calculations for the simplified formulas hydrodynamic, aerodynamic, thermodynamic, and thermokinetic heat and material balance in order to obtain approximate values of the energy obtained from natural renewable energy sources
5 (A)	The student can perform calculations by simplified hydrodynamic models, aerodynamic, thermodynamic, thermokinetic and thermal balance and material in order to obtain approximate values of energy obtained from natural renewable source of energy and perform an analysis of the payback period funding
EK5	The student is able to analyse knowledge in the literature, catalogues and other sources and do independent work on a given topic related to the subject classes and present the resulting knowledge
2 (F)	The student is not able to analyse the knowledge of literature,, catalogues and other sources related to the topic of RES can not do independent work on a given topic related to the subject classes.
3 (E)	The student can not fully properly analyse the knowledge of literature, directories and other sources and do independent work on a given topic related topics, presents an incomplete knowledge.
4 (C)	The student can as well analyse the knowledge of literature, catalogues and other sources and do independent work on a given topic related topics classes and present the resulting knowledge.
5 (A)	The student can very well analyse the knowledge of literature, catalogues and other sources and do independent work on a given topic related topics classes and present the resulting knowledge.

III. OTHER USEFUL INFORMATION

1. All information for students on the schedule are available on the notice board and on the website: www.el.pcz.pl
2. Information on the consultation shall be provided to students during the first lecture and

will be placed on the website www.el.pcz.pl

3. Terms and conditions of credit courses will be provided to students during the first lecture