

FACULTY OF ELECTRICAL
ENGINEERING**SUBJECT CARD**

Name in Polish: **Odnawialne Źródła Energii**
 Name in English: **Renewable Energy Sources**
 Main field of study (if applicable): **Electrical Engineering**
 Specialization (if applicable): **Control in Electrical Power Engineering**
 Level and form of studies: **2nd level, full-time**
 Kind of subject: **obligatory**
 Subject code: **ELR052331**
 Group of courses: **NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	30				15
Number of hours of total student workload (CNPS):	60				30
Form of crediting:	examination				crediting with grade
For group of courses mark (X) final course:					
Number of ECTS points:	2				1
including number of ECTS points for practical (P) classes :					1
including number of ECTS points for direct teacher-student contact (BK) classes:	1.40				0.70

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Has a basic knowledge in the field of the theory of electric circuits.
2. Has a basic knowledge of power system operation and electricity generation and transmission techniques.
3. Has sufficient range of language means at his/her disposal to relatively flawlessly speak out (orally and written), formulate and justify opinions, explain his/her position, show advantages and disadvantages of different solutions, participate in discussion and present general, scientific and technical subject matter.
4. Can use basic hardware and software, create and edit a text on basic level, create computer presentations.
5. Understands a need and knows possibilities of continuous education, increasing of professional, personal and social competences.
6. Has awareness of responsibility for own work.

SUBJECT OBJECTIVES

- C1. Getting to know principles of electric energy generation from renewable energy sources.
- C2. Possession a knowledge from range of technical, economic and environmental aspects of renewable energy sources utilization for electric energy generation.
- C3. Getting to know applicable technologies and real solutions for electric energy generation with utilization of renewable energy sources.
- C4. Identification disadvantages and advantages of different renewable energy sources.
- C5. Acquisition of abilities to solve problems connected with renewable energy sources.
- C6. Interpreting processes of electric energy generation with utilization of renewable energy sources.
- C7. Acquisition of abilities to analyze technical, economical and environmental aspects of renewable energy sources utilization for electric energy generation.
- C8. Acquisition of abilities to design systems for electric energy generation with utilization of renewable energy source.

SUBJECT LEARNING OUTCOMES	
<i>relating to knowledge:</i>	
PEU_W01	Knows principles of electric energy generation from renewable energy sources.
PEU_W02	Possesses a knowledge from range of technical, economic and environmental aspects of renewable energy sources utilization for electric energy generation.
PEU_W03	Knows applicable technologies and real solutions for electric energy generation with utilization of renewable energy sources.
<i>relating to skills:</i>	
PEU_U01	Can solve problems connected with renewable energy sources.
PEU_U02	Can interpret processes of electric energy generation with utilization of renewable energy sources.
PEU_U03	Can analyze technical, economical and environmental aspects of renewable energy sources utilization for electric energy generation.
<i>relating to social competences:</i>	
PEU_K01	Can think and act in creative and enterprising way. He/she is able to rank appropriately the priorities needed for realizing the respective task.

PROGRAMME CONTENT		
Form of classes - lecture		Number of hours:
Lec 1	Renewable energy sources - introduction, the fundamentals, definitions, glossary, classifications, the potential of renewable energy, development of renewable energy, scientific principles of renewable energy, technical implications.	2
Lec 2	Wind energy - introduction, the potential and energy of wind, parameters of wind, measurements of wind, mathematical models of wind, analysis of wind conditions.	2
Lec 3	Wind energy - wind turbines (construction, operation principle, basic technical parameters, example calculations, review of solutions), optimising wind farm, connection of wind power plant to the electric power grid.	2
Lec 4	Wind energy - assessment of wind power plant impact on the Environment, economic aspects of wind energy, account of costs, tariffs, example economical calculations.	2
Lec 5	Wind energy - design of wind plant, examples of solutions of small and medium wind power plant, medium wind power plant, examples of wind farm in Poland and Germany, wind energy market, future of wind energy.	2
Lec 6	Solar Energy - introduction, current PV technology, principles of PV cells work; PV cells, modules and arrays; PV systems (classifications, construction, operation principles, production).	2
Lec 7	Solar Energy - PV systems (installation, exploitation, standards, review of solutions), connection of PV systems to the electric power grid.	2
Lec 8	Solar Energy - solar house, solar energy collectors, systems of solar energy collectors (construction, review of solar energy collectors use, design).	2
Lec 9	Hydro energy - introduction, definitions, hydro electric power plants (construction, classifications, operation principles), advantages and disadvantages of hydropower, hydropower resource potential in Poland.	2
Lec 10	Biogas energy - introduction, definitions, biogas (kinds, sources, the potential), converting biogas to energy, biogas technologies.	2
Lec 11	Biogas energy - applications, review of solutions, environmental aspects, economical aspects of biogas utilization, advantages and disadvantages, future of biogas.	2
Lec 12	Biomass energy - introduction, definitions, biomass (kinds, sources, the potential), converting biomass to energy, biomass technologies.	2
Lec 13	Biomass energy - applications, review of solutions, environmental aspects, economical aspects of biomass utilization, advantages and disadvantages, future of biomass.	2
Lec 14	Geothermal energy - introduction, the potential, kinds of geothermal energy sources, review of geothermal sources utilization to electric energy production, examples of real solutions, economical aspects of geothermal energy utilization.	2
Lec 15	Wave energy - introduction, principles of wave energy conversion, advantages and disadvantages, market barriers, impact on the Environment, technology, review of real solutions of sea waves utilization to electric energy production.	2
Total hours:		30

Form of classes - seminar		Number of hours:
Sem 1	Analysis of wind, geographical, technical, economical and legal conditions for wind power plant. Perspectives of development of wind energy and other renewable energy sources.	2
Sem 2	Review of applied wind turbines in Europe. Analysis of possibility of wind farm connection to the electric power grid.	2
Sem 3	Analysis of costs for wind power plant. Some aspects of wind farm project. Schedule of investor's procedure at build wind power plant.	2
Sem 4	Design of photovoltaic systems. Review of current solutions of photovoltaic systems.	2
Sem 5	Review of solar heating systems. Selected aspects of solar house project.	2
Sem 6	Analysis of small-scale and large hydro electric power plant. Review of solutions of sea waves energy utilization.	2
Sem 7	Review of current solutions in range of biomass energy utilization to electric energy production. Case study of biomass utilization in energy project.	2
Sem 8	Analysis of costs for geothermal power solutions Review of projects of geothermal energy utilization.	1
Total hours:		15

TEACHING TOOLS USED

- N1. Lecture with the use of audiovisual techniques, multimedia presentations.
 N2. Multimedia presentation.
 N3. Problem discussion.
 N4. Case study.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation <i>F – forming (during semester)</i> <i>P – concluding (at semester end)</i>	Educational effect number	Way of evaluating educational effect achievement
F1(w)	PEU_W01 PEU_W02 PEU_W03 PEU_K01	Test.
P(w)	P=F1	
F1(s)	PEU_U01 PEU_U02 PEU_U03	Activity on seminar classes.
F2(s)	PEU_U01 PEU_U02 PEU_U03	Preparing and presenting a presentation.
P(s)	$P=0.2 \cdot F1 + 0.8 \cdot F2$	

PRIMARY AND SECONDARY LITERATURE**PRIMARY LITERATURE:**

- [1] Boyle G., Renewable Energy – Power for a sustainable future, Second Edition, Oxford University Press Inc. New York, 2004.
 [2] Twidell J., Weir T., Renewable Energy Resources, Seventh Edition, Spon Press, London, 2005.
 [3] Burton T., Sharpe D., Jenkins N., Bossanyi E., Wind Energy Handbook, John Wiley and Sons Ltd. Chichester, England, 2001.
 [4] Luque A., Hegedus S., Handbook of photovoltaic science and engineering, John Wiley and Sons Ltd. Chichester, England, 2003.

SECONDARY LITERATURE:

- [1] Manwell J.F., McGowan J.G., Rogers A.L., Wind Energy Explained: Theory, Design and Application, John Wiley and Sons Ltd. Chichester, England, 2002.
 [2] Markvart T.: Solar electricity, Second Edition, UNESCO, John Wiley and Sons Ltd. New York, 2000.

SUBJECT SUPERVISOR

Waldemar Dołęga, waldemar.dolega@pwr.edu.pl