



## COURSE DESCRIPTION CARD - SYLLABUS

Course name

Storage systems and alternative energy sources

### Course

Field of study

Industrial and Renewable Energy

Area of study (specialization)

Gas Technology and Renewable Energy

Level of study

Second-cycle studies

Form of study

part-time

Year/Semester

2/3

Profile of study

general academic

Course offered in

Polish

Requirements

compulsory

### Number of hours

Lecture

30

Laboratory classes

Other (e.g. online)

Tutorials

Projects/seminars

### Number of credit points

2

### Lecturers

Responsible for the course/lecturer:

dr inż. Przemysław Grzymisławski

email:

przemyslaw.grzymislawski@put.poznan.pl

tel. tel. 61 665 2135

Faculty of Environmental Engineering and Energetic

ul. Piotrowo 3 60-965 Poznań

Responsible for the course/lecturer:

mgr inż. Joanna Jójka

email: joanna.jojka@put.poznan.pl

tel. tel. 61 665 2218

Faculty of Environmental Engineering and Energetic

ul. Piotrowo 3 60-965 Poznań



### Prerequisites

**Knowledge:** Student has knowledge about the development trends of energy technologies and renewable energy sources

**Skills:** Student is able to make preliminary economic assessment when formulating and solving engineering task in Power sector

**Social competencies:** Student is ready to critically assess knowledge and received information

### Course objective

The aim of the course is to present and discuss available technologies for the energy storage systems and methods for energy production with alternative sources, their connection with distributed generation (DG) network and impact on environmental and energy strategy. The main objective is expand the knowledge and understanding the fundamental aspects related to the design, construction, implementation and maintenance of energy storage systems and alternative energy generation methods. Secondary objective is to evaluate possibilities of introduction of the energy storage systems and alternative energy sources into the local grid regarding to the demand of energy efficiency increase.

### Course-related learning outcomes

#### Knowledge

Student has expanded knowledge necessary to understand given subjects and specialist knowledge about construction, methods of designing, manufacturing, operating, safety systems as well as impact on the economy, society and the environment in the field of energy storage systems and alternative energy sources including the specialties: 1. Gas Technologies and Renewable Energy, 2 - Thermal energetics

Student knows and understands the fundamental aspects related to the design, construction, implementation and maintenance of energy storage systems and usage of alternative energy sources in the distributed generation network

Student has deep knowledge necessary to understand the issues of energy safety

#### Skills

Student is able to critically analyze the functioning of existing energy storage solutions in the industry and evaluate possibilities of upgrade existing energy generation systems

Student is able to design - in accordance with the given specification - and create simple devices, objects and systems or implement processes for industrial power engineering, using appropriately selected methods, techniques, tools and materials

Student is able to discuss on topics related to energy safety with diverse audiences

#### Social competences

Student is ready to fulfill social obligations as well as inspire and organize activities for the social environment



Student is ready to initiate actions of social interest related to the energy safety in the distributed energy generation

Student is ready to perform responsible professional roles, taking into account changing social needs,

### Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture classes – completing final test, minimum to pass is 51% of total points

### Programme content

The available technologies for the energy storage such as the batteries, superconducting magnetic energy storage, flywheel, electrochemical capacitors, pumped storage power plant, compressed air energy storage, hydrogen storage, and other reported technologies in the literature. Application of energy storage systems in renewable and alternative energy-based distributed generation (DG) systems. The selection of proper alternative energy source and storage systems, including application, size, lifetime, response time, capital, maintenance costs. Definition of the types of alternative energy generation and storage methods, different technologies, as well as the advantages and disadvantages of each system.

### Teaching methods

Informatory lecture with presentation and discussion with students.

### Bibliography

Basic

1. Energy Storage Fundamentals, Materials and Applications, Huggins, Robert
2. Journal of Energy Storage (Open Access Articles)
3. Energy Storage (Wiley Online Library Open Access Journal)

Additional

1. Energy Storage Systems, David Elliott
2. Operation, Planning, and Analysis of Energy Storage Systems in Smart Energy Hubs, Behnam Mohammadi-Ivatloo, Farkhondeh Jabari
3. K. Kuo, Principles of Combustion, 2005
3. Renewable Energy Sources & Energy Storage, Seria wydawnicza (Springer OA)



### Breakdown of average student's workload

	Hours	ECTS
Total workload	60	2,0
Classes requiring direct contact with the teacher	33	1,0
Student's own work (literature studies, preparation for classes, consolidation of new material, preparation to the test) <sup>1</sup>	27	1,0

<sup>1</sup> delete or add other activities as appropriate