COURSE DESCRIPTION CARD - SYLLABUS

Course name

Energy storage in the power system

Course

Field of study	Year/Semester
Electrical power engineering	2/3
Area of study (specialization)	Profile of study
Renewable sources and storage of energy	general academic
Level of study	Course offered in
Second-cycle studies	polish
Form of study	Requirements
full-time	compulsory

Number of hours

Lecture	Laboratory classes	Other (e.g. online)
15	0	0
Tutorials	Projects/seminars	
0	15	

Number of credit points

2

Lecturers

Responsible for the course/lecturer:

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Responsible for the course/lecturer:

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Prerequisites

Student at the beginning of the course shoule have basic knowledge in field of Physics, equations system solving and electrcal circuits in steady states analysis. Furthermore, he should know the structure of power systems and its components.

Course objective

Familiarization with the principles of cooperation between energy storage and power system in term of legal and engineering. Understanding the impact of installing energy in the power system. Getting to know presentes in the classes methods of modeling energy storage, the power system and its components.

Course-related learning outcomes

Knowledge

1. Student has a extended knowledge about the processing and transformation of electricity.

2. Understands the importance and impact of energy storage technology on the problem of energy reliability in local and global terms.

3. Learns the principle of cooperation between energy storage facilities in accordance with the Polish Law and the principles of operation of the energy market

Skills

1. He is able to evaluate and compare various solutions in the field of energy storage.

2. He is able to create ana analytical model of energy storage installation, analyze the cooperation of this installation with the power system and optimize its parameters.

Social competences

1. He understands the importance of the power industry for the country and society.

2. He understands the need to develop new technologies in order to ensure energy supplies in line with the environmental protection requirements.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

The knowledge acquired during the lecture is verified during a written exam at the examination session. The exam consists of open questions, scored depending on the level its difficulty. The pass mark is 50% of all points available. Exam issues are given to students a few weeks before the exam and the are discussed during the last lecture.

The skills acquired during project classes are verified on the basis of tasks that can be done independently at home or during classes. The topic of each task is a variation of the issues discussed during the project classes. Each task is scored. The final grade is determined on the basis of the total number of points obtained and activity during the project classes.

Programme content

Lecture:

Overview of current trends and technical problems of connecting energy storage systems to the power system. Energy storage in the Energy Law in Poland and other EU countries. Description of the use control strategies and related to them algorithms for controlling energy storage cooperating with the power grid. Possibilities of using energy storage in prosumer installations to actively participate in the purchase and sale of energy. Modern technologies of energy storage such as: Power2Gas, Vehicle2Grid and their impact on the operation of the power system. Economic analysis of the use of energy storage in the power system.

Project:

Overview of tools used in class for modeling and analysis of the power system and connected to its energy stores. Analysis of the power system operation in a steady state. Discussion of the mathematical model of energy storage. Presentation of example storage control algorithms allowing for the operation of an energy storage as e.g.: a power filter, a load leveling system, a network overload limiting system, and voltage support system. Reliability analysis for small systems. Overview of exemplary methods of optimizing the distribution of energy storage in the EL-EN system.

Teaching methods

Lecture: multimedia presentation supplemented with simulation and calculation examples. Taking into account various aspects of the presented issues, including economic, ecological, legal and social. Encouraging students to participate in a substantive discussion on technical, social and environmental aspects of the solutions presented during classes. Additional materials such as links to the necessary literature, transcripts of the lectures held, available on the elearning platform.

Project: multimedia presentations introducing the topics of individual classes. Project tasks carried out in conjunction with the teacher in the classroom. Tasks for self-completion, performed using the Virtual Programming Laboratory (VPL) on the university's e-learning platform.

Bibliography

Basic

1. Instrukcja Pracy Systemów Połączonych UCTE: Część 1. Regulacja mocy i częstotliwości, 2004.

2. Komisja Europejska,: Energy storage - the role of electricity, February, 2017

3. Kim, H.T., Jin, Y.G., Yoon, Y.T., An Economic Analysis of Load Leveling with Battery Energy Storage Systems (BESS) in an Electricity Market Environment: The Korean Case. Energies 12, 2019. https://doi.org/10.3390/en12091608

4. Paska, J., Zasobniki energii elektrycznej w systemie elektroenergetycznym - zastosowania i rozwiązania. Przeglad Elektrotechniczny 2012, pp. 50-56

5. Swain, A., Salkuti, S.R., Swain, K., An Optimized and Decentralized Energy Provision System for Smart Cities. Energies 14, 2021. https://doi.org/10.3390/en14051451

6. Ustawa z dnia 10 kwietnia 1997 r. Prawo energetyczne tj. (Dz. U. z 2020 r. poz. 833, 843,471, 1086, 1378 i 1565, z 2021 r. poz. 234 i 255), 1997.

Additional

1. Bednarek, K., Kasprzyk, L., Hłasko, E., Modele funkcjonowania zasobników energii stosowanych w układach mobilnych. Electrical Engineering 277–289, 2016

2. Tomczewski, A., Kasprzyk, L., Optimisation of the Structure of a Wind Farm—Kinetic Energy Storage for Improving the Reliability of Electricity Supplies. Applied Sciences 8, 2018. https://doi.org/10.3390/app8091439

3. Yan, Z., Zhang, X.-P., General Energy Filters for Power Smoothing, Tracking and Processing Using Energy Storage. IEEE Access 5, 2017. https://doi.org/10.1109/ACCESS.2017.2737547

Breakdown of average student's workload

	Hours	ECTS
Total workload	55	2,0
Classes requiring direct contact with the teacher	30	1,0
Student's own work (literature studies, reports preparation, project preparation, preparation of final essay, preparation for test, preparation for exam) [1]	25	1,0

[1] delete or add other activities as appropriate