



COURSE DESCRIPTION CARD - SYLLABUS

Course name

Energy storages in distribution power systems [S2Elmob1-PAiME>MEEwS]

Course

Field of study

Electromobility

Year/Semester

2/3

Area of study (specialization)

Alternative Fuels and Energy Storage

Profile of study

general academic

Level of study

second-cycle

Course offered in

Polish

Form of study

full-time

Requirements

compulsory

Number of hours

Lecture

15

Laboratory classes

0

Other

0

Tutorials

0

Projects/seminars

0

Number of credit points

1,00

Coordinators

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Lecturers

Prerequisites

A student starting this subject should have basic knowledge of electrical power engineering. He should know the basic principles of the functioning of the electricity market in Poland and in the European Union. Additionally, he should have knowledge of the basics of electrical engineering and electronics at the level of first-cycle studies.

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 presents 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 an 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 assessment. The assessment consists of open questions scored depending on the level of difficulty. The passing threshold is 50% of all possible points. Final exam topics are given to students a few weeks before the exam and discussed during the last lecture.

Programme content

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

Course topics

The following topics are discussed during the lecture:

- 1) legal acts regarding the energy market in the Polish National Power System
- 2) electricity storage technologies: division and features important in the context of cooperation with the power system
- 3) benefits and applications for energy storage in the power system
- 4) the process of selecting energy storage units for specific applications
- 5) optimization methods used to determine the parameters of the energy storage installation
- 6) Power2Gas and Vehicle2Grid

Teaching methods

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.

Bibliography

Basic:

1. UCTE Interconnected Systems Operation Manual: Part 1. Power and Frequency Control, 2004.
2. European Commission: 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/en120916083>
4. Paska, J., Zasobniki energii elektrycznej w systemie elektroenergetycznym - zastosowania i rozwiązania. *Przegląd 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. Act of April 10, 1997, Energy Law, i.e. (Journal of Laws of 2020, items 833, 843, 471, 1086, 1378 and

1565, of 2021, items 234 and 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	28	1,00
Classes requiring direct contact with the teacher	15	0,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	13	0,50