Introduction to Energy Systems Modelling

Basic information

Field of study Renewable Energy and Energy Management **Speciality** All **Department** Faculty of Energy and Fuels **Study level** Second-cycle (engineer) programme **Study form** Full-time studies **Education profile** General academic	**Didactic cycle** 2021/2022 **Subject code** EiPEOZS.IIi1S.5ed0a793603b2.21 **Lecture languages** English **Mandatory** Obligatory **Block** Major Modules **Subject related to scientific research** Yes

Subject coordinator	Wojciech Suwała
Lecturer	Wojciech Suwała, Marcin Pluta

Period Semester 1	**Examination** Exam **Activities and hours** Lecture: 15, Project classes: 60	**Number of ECTS points** 7.0

Goals

C1	The aim of this subject is to give basic information on methods used in modeling of fuels and energy systems as well as on the process of modeling and models' structures.

Subject learning outcomes

Code	Outcomes in terms of	Directional learning outcomes	Examination methods

Knowledge – Student knows and understands:			
W1	the methods of building models, understands how the models are built. Understands the role of modelling as a tool for the evaluation and optimization of energy systems development.	EOZ2A_W01, EOZ2A_W02, EOZ2A_W04	Project, Examination, Report, Case study
Skills – Student can:			
U1	describe topology and boundaries of a basic energy system,	EOZ2A_U01, EOZ2A_U04	Project, Report
U2	build basic fuel and energy system model.	EOZ2A_U01, EOZ2A_U02, EOZ2A_U04, EOZ2A_U05, EOZ2A_U07	Project, Report
Social competences – Student is ready to:			
K1	identify interdependencies between the environment, economics and technology in fuels and energy systems. Student knows the role of social issues in the energy systems activity and development.	EOZ2A_K01, EOZ2A_K02	Project, Examination, Report

Programme content that ensure achieving learning outcomes for the module

The content of the programme includes lectures and project classes. During lectures students aquire basic knowledge on energy systems modelling, model building and use of models. Within project classes they work on given assignments, case study, develop own model of basic energy subsystem and use it to analyze the energy system.

Calculation of ECTS points

Activity form	**Average amount of hours* needed to complete each activity form**
Lecture	15
Project classes	60
Contact hours	5
Preparation of project, presentation, essay, report	80
Examination or Final test	2
Preparation for classes	15
Student workload	**Hours** 177
Workload involving teacher	**Hours** 75

* hour means 45 minutes

Study content

No.	**Course content**	**Subject learning outcomes**	**Activities**

1.	Lectures: 1. Role of modelling in the processes of energy systems development and regulation. 2. Systems, system approach in solving problems. 3. Methods of modelling: (a) Mathematical programming, (b) Systems dynamics , (c) Econometrics. 4. Variables and equations in energy systems models. 5. Examples of fuels and energy systems models.	W1, K1	Lecture
2.	Project classes:During project classes student will learn software for building the techno-economic energy model. Then they will work on a given case study in which they will be provided with the characteristics of an existing energy subsystem and relevant model representation. In given assignments, they will check how the change of selected parameters affects the results of the model. Finally, in their project work, students in small groups (ca. 2-3 students) will design and develop a simple model of fuels and energy systems and will conduct an energy system analysis.	U1, U2, K1	Project classes

Course advanced

Teaching methods:

Lectures, Project assignments, Case study, Group work method, Project based learning

Activities	Examination methods	Credit conditions
Lecture	Examination	In order to pass the exam it is necessary to obtain positive partial marks (at least 3.0).
Project classes	Project, Report, Case study	In order to have the project accepted it is necessary to obtain positive partial marks from the case study assignments, project execution and report (at least 3.0).

Requirements and method of completing particular forms of classes

Project classes:
- at most one absence from classes,
- positive grade for the project report,
- positive grade from the assigmnents related to case study,

Lectures:
In order to take the exam, students must get the possitive grade from the project classes.
There three exam dates - first exam and two retakes.

Method of calculating the final grade

The final grade (FG) is determined on the basis of AGH regulations regarding assessment thresholds and using the following equation:
FG= 0,5*L*R +0,5*P*R
L - grade from lectures,
P - grade from project classes,

R: 1 - for 1st evaluation 0,9 - for 1st retake, 0,8 - for 2nd retake.
The final grade is determined to two decimal places without rounding, in accordance with the following rule depending on the numerical value: 1) from 3.00 verbal rating: sufficient (3.0) 2) from 3.21 verbal mark: plus sufficient (3.5) 3) from 3.71 verbal mark: good (4.0) 4) from 4.21 verbal mark: plus good (4.5) 5) from 4.71 verbal mark: very good (5.0).
Grades indicate that a student (in reference to EIT OLO 6):
5,0 - is able to fully reflect a structure of a basic energy subsystem and all interrelations between its elements in a form of the model,
4,5 - is able to reflect major parts of a structure of a basic energy subsystem and main interrelations between its elements in a form of the model,
4,0 - is able to partly reflect a structure of a given part of a basic energy subsystem and few interrelations between its main elements in a form of the model,
3,5 - show evidence of understanding of a structure of basic energy subsystem and main interrelation between its main elements,
3,0 - show limited evidence of understanding of a structure of a basic energy subsystem and few interrelations between its main elements,
2,0 - no evidence of the Learinig Outcomes shown.

Method and procedure for compensating for missed coursework resulting from student absence from classes

Students are required to independently master the material processed at the time of their absence.

Entry requirements

No specific requirements, mathematics at standard level.

Attendance requirements for particular classes, with indication whether student attendance is compulsory

Lectures are not mandatory.
Students attendance and activity in the project is mandatory.

Literature

Obligatory

1. Labys W. C., Modeling Mineral and Energy Markets, Kluwer Academic Publishers, Boston. 1999
2. The National Energy Modeling System: An Overview 2018, EIA DOE ; https://www.eia.gov/outlooks/aeo/nems/overview/pdf/0581(2018).pdf

Optional

1. Documentation for the TIMES Model Energy Technology Systems Analysis Programme; Documentation for the TIMES Model

Research and publications

Research

1. Modeling of electricity market. Modeling development of power systems

Publications

1. Marcin Pluta, Artur Wyrwa , Wojciech Suwała , Janusz Zyśk , Maciej Raczyński and Stanisław Tokarski ; A Generalized Unit Commitment and Economic Dispatch ; Energies 2020, 13(8), 1952; https://doi.org/10.3390/en13081952Approach for Analysing the Polish Power System under High Renewable Penetration
2. Suwala W., Labys W.C., Market transition and regional adjustments in the Polish coal industry, . Energy Economics, 2002, v. 24, No 3, str. 285-303
3. Suwala W., 2008, Modeling adaptation of the coal industry to sustainability conditions, Energy, Volume: 33, Issue: 7, July, 2008, pp. 1015-1026

Directional learning outcomes

Code	Content
EOZ2A_K01	Is aware of the need to critically assess the information received and knowledge acquired, recognizes the importance of knowledge in addressing cognitive and practical problems, in particular in the field of energy.
EOZ2A_K02	Is aware of responsibility for the tasks performed, is willing to think and act in an entrepreneurial and professional manner, is aware of compliance with the principles of professional ethics and the cultivation and dissemination of appropriate practices, as well as initiation of actions for the benefit of the social community and public interest, including the rational use of energy and provision of the national energy security.
EOZ2A_U01	Is able to use knowledge of basic sciences, thermodynamics, material science and related topics to develop physical and mathematical models of analyzed technical issues in order to solve them using advanced IT tools, crytically analyze and evaluate the solution, verify it experimentally and present information.
EOZ2A_U02	Is able to use knowledge to plan and conduct research on energy processes using various methods, including experimental ones, is able to use available software and create own computer codes for the purpose of analysis of the solution, is able to perform a critical analysis of results and prepare a synthetic compilation presenting the results of conducted research in terms of economic and environmental analysis.
EOZ2A_U04	Is able to create mathematical models of technical issues to solve them, can asses the functioning of energy systems and prepare a forecast and plan for their development at different levels of management.
EOZ2A_U05	Is able to carry out critical, from the technical, economic, environmental and social point of view - analysis of the functioning of any element of the energy system and develop a project of improvement in the construction and operation of renewable and classic energy equipment and installations.
EOZ2A_U07	Is able also to assess the impact of energy systems on the global functioning of civilization, including society, natural environment, economic and social development and related issues, is able to present own point of view to a wide range of audiences, also using a foreign language and presentations illustrating advanced technical and non-technical problems in the field of energy.
EOZ2A_W01	Knows and understands the phenomena described in the basic sciences, methods of their thermodynamic description and modelling in connection with the use of materials in the power industry.
EOZ2A_W02	Knows and understands basic and advanced processes occurring during the operation and functioning of machines, networks and power and electrical systems that use renewable energy sources, the importance of automation and control of their operation, the importance of proper design and selection, forecasting and planning of their development and the impact of energy technologies on the environment.
EOZ2A_W04	Knows and understands dilemmas related to the development of RES: ensuring energy security, environmental protection and sustainable energy development as well as rational utilization of energy and use of energy resources.