COURSE DESCRIPTION CARD - SYLLABUS

Course name
Audyting and Energy Management [S2IŚrod2-ZwCKiOP>AiG]

Course

Field of study
Environmental Engineering

Year/Semester
1/2

Area of study (specialization)
Heating, Air Conditioning and Air Protection

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
30

Laboratory classes
0

Other
0

Tutorials
15

Projects/seminars
0

Number of credit points

3,00

Coordinators

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Lecturers

Prerequisites

1.Knowledge: Classification of renewable and non-renewable primary energy sources, evaluation of energy capacity of demand and supply side of energy market; , Principles of energy balancing, economic and ecological evaluation of energy systems in built environment. 2.Skills : Application of energy balance equation in evaluation of energy systems in built environment; Calculation of coefficients of energy, economic and ecolgic efficiency of energy systems in built environment; 3.Social competencies: Awareness of the need to constantly update and supplement knowledge and skills.

Course objective

Widening by the students the knowledge and skills in energy management necessary to solve complex tasks of energy flows occurring in the built and natural environment

Course-related learning outcomes

Knowledge:
1. The student has a theoretical and practical knowledge on the energy and energy balancing of complex energy systems in built environment
2. The student knows and understands the causes of irreversibility of real energy systems in built

environment
3. The student knows principles of reducing the causes of irreversibility of real energy systems in built environment
4. The student knows dynamic methods of economic evaluation in energy management
5. The student knows the principles of energy auditing of buildings and technical equipment of buildings and knows the principles of multicriteria evaluation of energy systems in built environment

Skills:
1. The student can construct evaluation model and energy and exergy balance equations for simple and complex energy systems in built environment
2. The student can calculate energy efficiency of simple and complex energy systems used in built environment
3. The student can calculate exergy efficiency and identify causes of irreversibility of simple and complex energy systems used in built environment
4. The student can calculate net present value (NPV) and internal rate of return (IRR) for elements and energy systems used in built environment
5. The student is able to choose on the basis of multicriteria analysis the recommended scenario of energy management in built environment

Social competences:
1. The student understands the need for teamwork in solving theoretical and practical problems
2. The student is aware of the need to sustainable development in energy management
3. The student sees the need for systematic increasing his skills and competences]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lectures
Written test of competences (10 questions based on case study calculations)
Continuous assessment during lectures (rewarding activity of the students).
Tutorials
Final written colloquium - 3 examples on energy, exergy and economic analysis
Continuous assessment of the students (rewarding students activity

Programme content

Lectures:
Basic knowledge on auditing and energy management: definition of energy management, non-renewable primary energy sources, renewable primary energy sources, upgraded fuels, energy chain, gross and net energy efficiency, coefficient of non-renewable primary energy consumption, coefficient of carbon dioxide emission.
Principles of energy balancing of simple and complex energy systems in built environment, calculation of energy efficiency of complex energy systems in built environment;
Irreversibility of real thermodynamic processes. Gouya-Stodoli Law; the causes of irreversibility of real thermodynamic processes; exergy balance of thermodynamically open system; physical and chemical exergy of substance; exergy efficiency of thermodynamically open system; the measures of limitation of irreversibility of real thermodynamic processes;
Static and dynamic methods of economical evaluation of energy systems in built environment: simple payback time (SPBT), net present value (NPV), internal rate of return (IRR), total operation cost (TOC);
Principles of energy auditing: evaluation of energy use in buildings and technical systems of buildings; identification of technically acceptable scenarios of building?s retrofitting process, evaluation of chosen scenarios using energy, economy and ecological criteria;
Multicriteria methods in evaluation of energy projects in built environment: weighted sum method, outranking method (ELECTRE III/IV);
Tutorials:
1. Energy balancing of complex energy systems in built environment
2. Exergy balancing of complex energy systems in built environment
3. Calculation of economic efficiency of Energy systems in built environment
4. Multicriteria evaluation of energy systems in built environment

Course topics

Irreversibility of thermodynamic processes - case studies; exergy balace of water radiator; exergy balance of water air heater; exergy balance of electric air heater; exergy balance of gas fired air heater; exergy balance of steam turbine; exergy balance of compressor; exergy balance of cogenerated heat and power plant; exergy balance of air handling unit; exergy balance of compressor heat pump; exergy balance of absorption water chiller; exergy balance of geothermal power plant; exergy balance of gas fired microturbine;
Application of weighted sum method in evaluation of energy systems; Application of Electre III/IV method in evaluation of energy systems;

Teaching methods

Lecture: lecture based on a multimedia presentation, interactive analysis of case studies, discussion
Tutorials: interactive solving of computational examples

Bibliography

Basic:
1. Szargut J., Ziębik A.: Termodynamika techniczna. Warszawa, WNT 2001.
2. Marecki J.: Podstawy przemian energetycznych. Warszawa, WNT 2000.
3. Chmielniak T: Technologie energetyczne. Warszawa, WNT 2008.
4. Szargut J., Guzik J.: Programowany zbiór zadań z termodynamiki technicznej. Warszawa, WNT 1980.
5. Rocznik statystyczny Rzeczpospolitej Polskiej 2010. Warszawa, ZWS 2011.
6. Mróz, T.M.: Planowanie modernizacji i rozwoju komunalnych systemów zaopatrzenia w ciepło. Wydawnictwo Politechniki Poznańskiej, seria rozprawy Nr 400, 2006.
7. Mróz, T.M.: Energy Management in Built Environment. Tools and Evaluation Procedures. Wydawnictwo Politechniki Poznańskiej, 2013.

Additional:
1. Kreith, F., West, R.E.: CRC Handbook of Energy Efficiency. CRC Press Inc. 1997

Breakdown of average student's workload

	Hours	ECTS
Total workload	75	3,00
Classes requiring direct contact with the teacher	45	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	30	1,00