Lodz University of Technology

Study programme

Faculty:	Faculty of Process and Environmental Engineering
Major:	Energy Systems in the Built Environment (in English)
Level of study:	second-cycle programme (magister inżynier)
Form of study:	full-time studies
Academic year:	2026/27

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Basic information

Name of the field of study:	Energy Systems in the Built Environment (in English)
Level of study:	second-cycle programme (magister inżynier)
Study profile:	general academic
Form of studies:	full-time studies
Duration of studies (number of semesters):	3
The number of ECTS points required to complete studies:	90
Total number of hours of classes:	1130
The number of ECTS points a student obtains as part of classes conducted with the direct participation of academic teachers or other persons conducting classes:	45
Professional title awarded to graduates:	magister inżynier
ISCED code:	0732
Language of study:	English

Assigning the course to the disciplines to which the learning outcomes relate

Discipline	Percentage share
Chemical engineering	51%
Environmental engineering, mining and energy	34%
Automation, electronics and electrical engineering	15%

Learning outcomes (in relation to the PQF)

No.	Learning outcome code	Learning Outcome Content	Reference to the universal characteristics of the first level of PRK	Reference to the second-level characteristics of the PRK, taking into account the second-level characteristics enabling the acquisition of engineering competences
1	**2ESB1**	Has in-depth and integrated knowledge of the physical processes occurring in urban complexes, including energy and environmental quality issues.	P7U_W	P7S_WG
2	**2ESB2**	Knows advanced modelling, simulation and data analysis tools for assessing energy efficiency, indoor environmental quality, life-cycle impacts and system performance under real-world operating conditions.	P7U_W	P7S_WG
3	**2ESB3**	Knows the methods of designing, integrating and optimising complex energy systems as well as the current state of knowledge and the main development trends in the discipline, in particular in the field of energy sources, advanced methods of their generation, distribution and storage.	P7U_W	P7S_WG
4	**2ESB4**	Critically interprets and applies energy regulations, norms, standards and policies at the local, national and international levels to develop solutions that comply with the requirements and principles of industrial property protection and entrepreneurship.	P7U_W	P7S_WG, P7S_WK
5	**2ESB5**	Knows and understands at an advanced level the technical solutions in intelligent buildings and cities of the future.	P7U_W	P7S_WK
6	**2ESB6**	Can analyse and solve complex engineering problems related to energy systems in the built environment by selecting and applying appropriate analytical, numerical and simulation methods.	P7U_U	P7S_UW
7	**2ESB7**	Can communicate professionally and substantively, conduct debates and justify engineering decisions in Polish and a foreign language at least at B2+ level, using specialised terminology, influencing the development of oneself and others.	P7U_U	P7S_UK, P7S_UO, P7S_UU
8	**2ESB8**	Can organize teamwork, assuming various team roles, prepare reports, technical documentation and presentations for various audiences, and apply multi-criteria assessment in the analysis of energy systems and recommending technical solutions.	P7U_U	P7S_UW, P7S_UO
9	**2ESB9**	Is ready to critically evaluate new and innovative technologies related to energy systems in the built environment, taking into account their technical, economic and social justification and feasibility.	P7U_K	P7S_KK, P7S_KR
10	**2ESB10**	Is ready for lifelong learning, self-improvement, responsible development of professional achievements and professional ethics, inspire and organise activities for the benefit of the social environment in line with changing conditions and technological progress, thinking and acting in an entrepreneurial manner.	P7U_K	P7S_KK, P7S_KO, P7S_KR

Matrix of course modules in relation to learning outcomes and curriculum content

No.	Course name	Program content	2ESB1	2ESB2	2ESB3	2ESB4	2ESB5	2ESB6	2ESB7	2ESB8	2ESB9	2ESB10
1	Advanced Building and Urban Engineering	Physical and structural processes occurring within a building, including heat and mass transfer within the building. Physical processes at the city scale, including heat balance, solar energy, air flow, and water flow at the city scale. Indoor environmental quality at the building scale, including air quality, thermal comfort, daylighting, and acoustics. Microclimate in the urban environment, including aspects related to the heat island effect, air quality, and urban greenery. Issues related to present-day challenges and the development of cities and buildings.	x	x				x				
2	Monitoring, Modelling and Simulation	Methods for assessing the energy efficiency of buildings and energy systems using static and dynamic approaches and energy flow modelling. Principles of energy system monitoring, physical parameter measurements, and the use of sensors and data collection systems. Numerical simulation methods, including system representation, discretization, numerical methods, and model validation and calibration. Analysis and interpretation of simulation results and measurement data using statistical methods.		x			x	x				
3	Conventional and Future Energy Sources	Conventional and future energy sources used to power cities and buildings. Energy generation, trends in energy technology development, and their environmental and economic impact. Analysis of alternative and innovative energy sources, such as solar energy, biofuels, fuel cells, waste heat recovery, thermoelectric effects, and solutions based on advanced materials. Energy storage and its role in power systems for low-energy buildings.			x		x				x	
4	Principles of Sustainable Design	Principles of designing cities and buildings in accordance with the guidelines of sustainable development, taking into account social aspects. Design of comfortable and healthy environments in and around buildings, regardless of climate, and with due regard to sustainability. Green building, biomimicry, low impact or reusing/recycled materials. Environmental indicators and energy rating systems like LEED, BREEAM.	x			x					x	
5	Electrical Power System	Electricity supply systems for cities and buildings, and system control. Intelligent metering systems, smart building and smart city solutions, and the fundamentals of data exchange, including peer-to-peer communication and blockchain technologies. Designing intelligent building infrastructure, integrating renewable energy sources (RES), and interoperability between buildings and external energy services. Analysis of the operation of intelligent energy management systems (BEMS, EMS).										
6	Life Cycle Assessment	Life cycle assessment principles aimed at identifying environmental risks and identifying ways to reduce the environmental burden of a product.				x	x				x	
7	Emerging Solutions in Sustainable Urban Development	Environmental problems in cities, existing and emerging technological solutions, and assessment of emerging solutions from a socio-ecological perspective.				x	x				x	
8	Problem Based Learning	Learning PBL method and their practical use to solve social and humanising issues.										
9	Design Thinking	Learning DT method and their practical use to solve social and humanising issues.							x	x		x

No.	Course name	Program content	2ESB1	2ESB2	2ESB3	2ESB4	2ESB5	2ESB6	2ESB7	2ESB8	2ESB9	2ESB10
10	Building Energy Performance	Using PBL methodology and computer simulation methods to solve advanced design problems on a building scale. Making energy analyses, indoor environmental quality, occupant comfort, renewable energy use, control systems, and sustainability assessment. Implementing a group project to conduct an environmental assessment.										
11	Smart Buildings and Cities	Using DT methodology to solve advanced issues on a city scale from a holistic perspective. Implementing conceptual designs that address urban environmental quality, including air pollution, light and noise pollution, and the urban heat island effect. Conducting analyses of energy supply and the use of local renewable sources, along with elements of intelligent grid and building management.	x					x	x	x	x	x
12	English for Science Communication	Grammatical and linguistic range adequate for writing scientific texts in the relevant field. Preparation and delivery of presentations. Case study. Review article.							x			
13	Best Practice in Building and System Design	Learning about the latest trends and best practices in the area covered by your studies.			x	x		x			x	
14	Seminar & Competency Exam	Learning how to prepare a presentation and the principles of editing a scientific paper, presenting results and discussing them.							x			x
15	Diploma Thesis	Learning the rules of preparing a dissertation under the supervision of a supervisor. Implementing appropriate methodology, including reviewing the literature and formulating hypotheses or specific work objectives. Selecting methods and tools relevant to solving the problem. Analysing the obtained results. Describing the results.			x						x	x

ECTS - subjects

No.	Course name	ECTS	Subjects in the field of humanities and social sciences	Elective subjects	Profile items	Classes in a foreign language
1	Advanced Building and Urban Engineering	5			5	5
2	Monitoring, Modelling and Simulation	5			5	5
3	Conventional and Future Energy Sources	5			5	5
4	Principles of Sustainable Design	4	4			4
5	Electrical Power System	5			5	5
6	Life Cycle Assessment	4		4	4	4
7	Emerging Solutions in Sustainable Urban Development	4		4	4	4
8	Problem Based Learning	2	2	2		2
9	Design Thinking	2	2	2		2
10	Building Energy Performance	14		14	14	14
11	Smart Buildings and Cities	14		14	14	14
12	English for Science Communication	2				2
13	Best Practice in Building and System Design	6			6	6
14	Seminar & Competency Exam	4			4	4
15	Diploma Thesis	20		20	20	20

ECTS indicators

Name	Value
The total number of ECTS credits that a student must obtain through elective courses (amounting to no less than 30% of the total ECTS credits required to obtain the qualification corresponding to the given level of study)	54/90 (60%)
The total number of ECTS credits to be earned by a student through courses in the fields of humanities or social sciences	6
The total number of ECTS credits that a student must obtain from courses related to research conducted at the university, amounting to more than 50% of the total ECTS credits required to graduate from a given level of study	82/90 (91.11%)

Methods of verifying and assessing learning outcomes

The assessment of students' learning outcomes is based on diverse and appropriate assessment methods, tailored to the knowledge, skills, and social competencies covered by these outcomes. The selection of assessment tools takes into account the specific nature of the course and the format of the classes, and the assessment of achieved learning outcomes is conducted in accordance with the principles described in the individual course.

Achievement of the intended learning outcomes is assessed using, among others, the following methods, appropriate to the format of the classes:

• Lectures: written test, open-ended test, multiple-choice test. For courses culminating in an examination: written and/or oral examination;

• Exercises: discussion, assessment of student activity during classes;

• Laboratories: assessment of student knowledge and skills (oral and/or written), assessment of laboratory reports, assessment of student activity during classes;

• Projects: assessment of completed projects (in the case of group projects, assessment of individual tasks), assessment of final project presentations, assessment of student activity during classes, self-assessment within the team, assessment of the entire team's work; • Seminars: evaluation of seminar presentations, assessment of preparation, activity during classes, and the substantive level of discussion participants;

• Competency exam and diploma exam.

Assessment of learning outcomes can be formative (conducted in stages throughout the semester) and/or summative (constituting the basis for the final grade). The final assessment result is determined according to the applicable grading scale.

For each course included in the study plan, a course card is developed, which includes, in particular:

• learning outcomes with indicators of their achievement, relating to knowledge, skills, and social competencies,

• methods for verifying indicators of learning outcome achievement, appropriately selected for their categories,

• field-specific learning outcomes, knowledge/skills/social competencies defined for the entire course, the achievement of which is confirmed by indicators,

• forms and conditions for passing the course.

Professional internships

not applicable

Characteristics of the course

Graduate profile

Graduates of the Energy Systems in the Built Environment study are interdisciplinary specialists in energy and building performance. Their professional activities stem from acquired expertise and are primarily focused on the built environment, including single buildings, building complexes, housing estates, and entire cities, with integrated energy infrastructure. During their studies, students acquire advanced, interdisciplinary knowledge of the engineering of physical processes in the built environment, enabling them to analyse, assess, and improve energy efficiency towards reduce environmental impact. They are familiar with modern methods for assessing building energy efficiency (building performance), techniques and tools for analysing cities, buildings, and building technical systems (building performance simulation), city and building solutions (smart cities and sustainable buildings), and broadly defined energy management methods in the built environment (energy management). They possess the skills to apply advanced methods and tools, including programs for building performance simulation and interactions in the built environment. They can pursue professional careers in areas related to energy efficiency, environmental certification, and environmental

protection, requiring knowledge of simulation tools, the latest technologies, and environmental assessment methods. They can serve as energy experts, advisors and coordinators for all types of engineering projects, requiring knowledge of process engineering, environmental engineering, building physics, electrical engineering, and automation. Graduates are prepared to work in industry, public administration, consulting companies, design offices, and any field of the modern energy sector. They can also work as independent energy specialists, serving as consultants, auditors, or certification experts in the broadly defined construction industries.

The relationship between the field of study and the university's strategy

The ESBE program aligns with selected areas defined in the Lodz University of Technology Strategy for 2025-2030, through the implementation of specific objectives. These include:

IMPACT, specific objective 2. This objective is achieved through close collaboration with the Association of Energy Auditors (ZAE) and the International Building Performance Simulation Association - chapter Poland (IBPSA-PL), which involves the exchange of knowledge, experiences, and attitude development.

INTERNATIONALIZATION, specific objective 4. Student exchanges with foreign institutions (universities) are implemented as part of each edition. Visiting professors are invited for short-term visits, and they are financed by grants from the Faculty's own funds, the ERASMUS+KA171 program, and others.

INNOVATION, specific objective 1. Selected students are engaged in the Faculty's scientific activities by completing their diploma thesis under R&D grants. The selected students' works were developed as part of the following projects (the acronyms): SOLTREN and En-ActivETICS.

SCIENCE, specific objective 1. By engaging students in research, they are also encouraged to publish the results of their work, both individually and in teams, and in highly indexed journals.

INFASTRUCTURE, specific objective 1. Teaching is conducted using state-of-the-art equipment, including new experimental set-ups developed and constructed under research grants.

TALENTS, specific objective 3. By encouraging and creating opportunities for scientific development, including continuing education at the doctoral level.

SUSTAINABILITY, specific objective 1. Due to the specific nature and scope of the studies, the curriculum content fully aligns with the Sustainable Development Goals of Lodz University of Technology.

EDUCATION, all specific objectives. Teaching staff receive regular training in modern teaching methods. They have access to the current state of knowledge, technological developments, and trends in science. The program is constantly improved based on consultations with the socio-economic environment. The curriculum allows for the full individualisation of student learning paths and supports an interdisciplinary approach to education. Students are engaged in scientific research, primarily conducted through international collaboration.

STUDENTS, specific objective 1. Through active collaboration with the economic environment and involving representatives of companies (e.g., NAPE) and enterprises (e.g., VEOLIA), including international corporations (e.g., Buro Happold, SWEGON), in the implementation of classes.

Educational objectives and employment and continuing education opportunities

The ESBE study aims to prepare graduates for professional careers in industries implementing future energy policy, particularly those focused on improving energy efficiency in the economy. The primary focus of knowledge, skills, and competencies acquired during the studies is on the built environment, focused on cities and buildings. ESBE programs align with the current and crucial national goal of educating personnel for the modernisation of the building stock and the development of new, energy-efficient buildings. Graduates acquire advanced and specialised knowledge in monitoring, modelling, and computer simulations, urban and building physics, traditional and alternative energy sources and power systems, along with supply- and demand-side management. Using Problem-Based Learning and Design Thinking methodology, they can analyse, evaluate, modernise, and design in accordance with the principles of sustainable development. Graduates of this program can pursue professional careers in areas related to energy efficiency, energy auditing, environmental certification, and environmental protection (including industry, public administration, local government units, institutions supporting energy transition, consulting firms, design offices, and the modern energy sector). Graduates also gain qualifications to work as independent energy performance specialists, thus enabling them to run their own businesses. Graduates of the eighteen-month program receive a professional Master of Science degree and can successfully continue their education in doctoral programs.

Description of the process and outcome of consultations on the proposed study program with the socio-economic environment

Consultations with the socio-economic environment are conducted on an ongoing basis through the exchange of information with representatives of companies and organisations operating in the graduate's professional areas. A summary and conclusions from the consultations are published in annual reports on the quality of education.

Description of competencies expected from a candidate applying for admission to studies

Completed any engineering studies at the bachelor's or master's level.

The unit organizing education

Faculty of Process and Environmental Engineering

Education program

Semester 1

Course	Number of hours	ECTS points	Form of verification	Obligatory
Advanced Building and Urban Engineering	Tutorials: 15 Laboratory classes: 30 Lecture: 15	5	Exam	Obligatory
Monitoring, Modelling and Simulation	Tutorials: 15 Laboratory classes: 30 Lecture: 15	5	Exam	Obligatory
Conventional and Future Energy Sources	Tutorials: 15 Laboratory classes: 30 Lecture: 15	5	Graded assignment	Obligatory
Principles of Sustainable Design	Tutorials: 30 Lecture: 15	4	Graded assignment	Obligatory
Electrical Power System	Tutorials: 15 Laboratory classes: 30 Lecture: 15	5	Graded assignment	Obligatory
Elective Course 1		4	Graded assignment	Obligatory group
The student chooses 1 course from the group.				
Life Cycle Assessment	Tutorials: 30 Lecture: 10	4	Graded assignment	Optional
Emerging Solutions in Sustainable Urban Development	Tutorials: 30 Lecture: 10	4	Graded assignment	Optional
Elective Course 2		2	Graded assignment	Obligatory group
The student chooses 1 course from the group.				
Problem Based Learning	Tutorials: 20	2	Graded assignment	Optional
Design Thinking	Tutorials: 20	2	Graded assignment	Optional
Sum	**345**	**30**		

Semester 2

Course	Number of hours	ECTS points	Form of verification	Obligatory
Building Energy Performance	Project work: 150	14	Graded assignment	Obligatory subjects to choose from
Smart Buildings and Cities	Project work: 150	14	Graded assignment	Obligatory subjects to choose from
English for Science Communication	Tutorials: 45	2	Graded assignment	Obligatory
Sum	**345**	**30**		

Semester 3

Course	Number of hours	ECTS points	Form of verification	Obligatory
Best Practice in Building and System Design	Seminar: 30 Project work: 45	6	Graded assignment	Obligatory
Seminar & Competency Exam	Seminar: 15	4	Graded assignment + exam	Obligatory
Diploma Thesis	Diploma Thesis: 0	20	Pass	Obligatory subjects to choose from
Sum	**90**	**30**		