Development strategy
of the Faculty of Environmental Engineering and Energy
of the Cracow University of Technology
for the years 2025–2028

1. Introduction

Guided by the mission and vision of the university, as defined in the Development Strategy of the Tadeusz Kościuszko Cracow University of Technology for 2021–2025, which sets out the Cracow University of Technology's goal of achieving a leading role among technical universities, both in Poland and abroad, by educating specialists at the highest level and contributing to the sustainable development of the economy, the Faculty of Environmental Engineering and Energy, operating within the framework of the of the scientific discipline of environmental engineering, mining and energy:

- educates both Polish and foreign students at the highest level, providing them with theoretical and practical knowledge based on the use of the most modern teaching methods,
- conducts innovative scientific research, contributing to the creation and implementation of new technologies,
- maintains and develops contacts with the socio-economic environment in order to update knowledge about the needs of the labour market, seek inspiration for scientific activity and transfer the results of research work to the economy,
- ensures the continuous development and improvement of the qualifications of academic teachers and non-academic staff
- teaches students to think independently, develops the qualities necessary for university graduates, as engineers, to form the scientific and managerial elite on the national and international labour market and to have a significant impact on setting new development trends in their chosen sectors of the economy and science.

2. Main assumptions of the development strategy of the Faculty of Environmental Engineering and Energy at the Cracow University of Technology

Taking into account the assumptions of the strategy of the Cracow University of Technology and in reference to the priority long-term strategic goals of the university, the strategy of the Faculty of Environmental Engineering and Energy covers three main areas:

1. EDUCATION – activities aimed at ensuring the continuous high quality of education for first and second cycle students nia as well as participants in postgraduate studies and other forms of education provided by the Faculty and its units.
2. RESEARCH – activities related to the Faculty's scientific activities in the field of environmental engineering and energy, as well as interdisciplinary activities, in

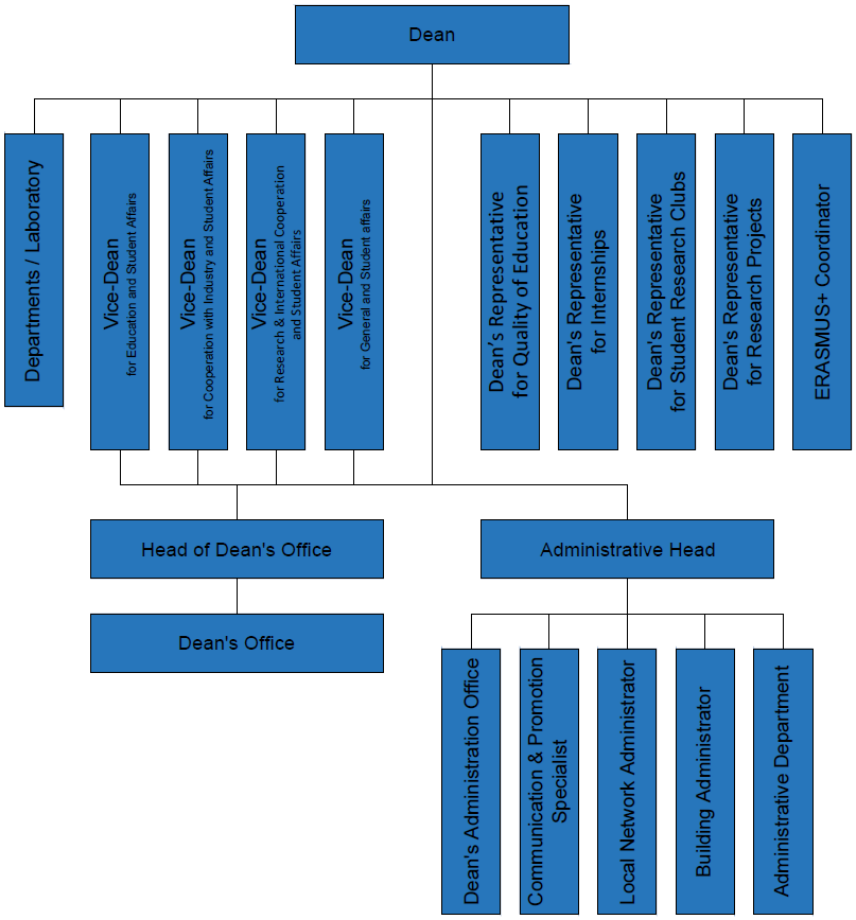
particular those related to the implementation of research projects and the transfer of knowledge to the economy.

3. COOPERATION WITH THE ENVIRONMENT – activities related to the exchange of experience and knowledge with the socio-economic environment, as well as the social responsibility of the university.

The strategy will be implemented in accordance with the adopted organisational structure of the Faculty based on 5 Departments and a Laboratory:

- Department of Geoengineering and Water Management (Ś-1),
- Department of Energy (Ś-2),
- Department of Water Supply, Sewage and Environmental Monitoring (Ś-3),
- Department of Environmental Technologies (Ś-4),
- Department of Thermal Processes, Air Protection and Waste Utilisation (Ś-5),
- Laboratory of Heating, Ventilation, Air Conditioning and Refrigeration (Ś-6)

supported by the faculty administration and the dean's office, in accordance with the following scheme:



The faculty will develop scientific and educational activities in the areas of scientific research related to the scientific disciplines of environmental engineering, mining and energy, in accordance with the scientific profile of its constituent units:

The Department of Geoengineering and Water Management (Ś1) conducts educational and scientific activities in the areas of water management, hydrotechnology, hydraulics, hydrology, hydrogeology, hydrogeophysics, hydroenergy, geodesy and cartography, geoinformatics, geotechnics and engineering geology, meteorology and climatology, and in particular in the field of:

- a comprehensive approach to the problems of floods, droughts, water resources and climate change through the integration of issues in the fields of hydrology, hydraulics, hydrogeology, climatology and meteorology;
- maintenance and renaturation of river and stream beds, and protection and restoration of retention and natural reservoirs;
- principles of water management planning and determining conditions for water use, as well as methodological work for the implementation of the EU Water Framework Directive;
- recognition of the geological centre in the area of hydrotechnical structures through the integration of issues related to geology, geotechnics and hydrogeophysics;
- operation, monitoring (invasive and non-invasive) and repair technologies for hydrotechnical structures;
- hydropower, i.e. the design of hydrotechnical structures that utilise and convert the energy of flowing water;
- geodetic measurements and computer cartography, as well as modern remote sensing and photogrammetric techniques; work is also carried out in the field of Spatial Information Systems (SIP), i.e. the Land Information System (SIT) and the Geographic Information System (GIS);
- geoinformatics, in the field of processing digital geodata (recorded in the lithosphere) and hydrodata (recorded in the hydrosphere), computer data visualisation and comprehensive interpretation using, among others, computer simulations, machine learning, artificial intelligence, image and digital signal analysis, statistics and data mining.

The Department of Energy (Ś-2) conducts scientific and applied research and education in the field of:

- numerical calculations (FEM, FDM) of thermal and strength properties of energy machines and devices;

- mathematical modelling and experimental research of heat exchangers;
- monitoring the operation of pressure components of energy equipment;
- safety and durability assessment of pressure components;
- modelling of boiler superheater dynamics;
- identification of actual operating conditions of thermal equipment, i.e. measurement of temperature, heat flux density, heat penetration and transfer coefficients, thermal stresses, pollutant emissions;
- analysis of the fuel combustion process;
- balancing and optimisation of power equipment;
- calculations and experimental studies of district heating networks;
- thermal calculations for underground high and extra-high voltage power cables;
- modelling and experimental testing of hybrid renewable energy systems;
- modelling and experimental testing of building heating systems.

The Department of Water Supply, Sewage and Environmental Monitoring (Ś3) deals with the following issues:

- water intakes, pumping stations, water reservoirs, water supply networks and installations;
- sewerage networks and installations, retention reservoirs, storm overflows, siphons, sewage pumping stations;
- simulation and operational testing of water supply systems;
- designing protection zones for surface water intakes, studying the effects of area pollution, preparing environmental impact assessments;
- measurements of light pollution levels and identification of its sources.

The Department of Environmental Technologies (Ś4) focuses its scientific and educational activities mainly on the following areas:

- modern technologies related to water and wastewater treatment;
- remediation of the water and soil environment;
- treatment of sewage sludge and municipal waste;
- physicochemical and microbiological testing of water, sewage and sewage sludge;
- construction and operation of sewage treatment plants;

- modelling of phenomena occurring in sewage treatment plants;
- water and sewage technology;
- sustainable waste management and circular economy.

The Department of Thermal Processes, Air Protection and Waste Utilisation (Ś5) focuses its scientific and educational activities in particular on the following issues:

- the use of fluid technology in combustion processes;
- thermal measurements, automation and control;
- construction of machines and devices used in thermal engineering;
- modelling of the thermophysical properties of thermodynamic factors, their mixtures and the creation of utility software;
- mathematical modelling of flow and heat processes in devices and equipment, heat exchange methods and fluid mechanics;
- mathematical modelling and experimental testing of heat exchangers, including design selection analyses, heat transfer intensification and model validation in laboratory settings;
- use of waste heat in energy and industrial systems, including the design and optimisation of recovery cycles (ORC, heat pumps, recuperation) and energy flow balancing;
- thermal and strength calculations for energy machines and equipment, including CFD/FEM coupled analyses and low-cycle fatigue and creep assessments;
- energy storage in the form of compressed air (CAES) and hydrogen, including assessment of efficiency, safety, integration with the National Power System (KSE) and material and operational aspects;
- modelling of power plants and combined heat and power plants, including models of coal, gas and hybrid (CHP) units, analysis of operation under variable load conditions and system services;
- measurement of transient temperatures of high-temperature and high-pressure fluids;
- development of computer systems supporting the control and optimisation of thermal processes.

Issues related to the use of solar energy (solar and photovoltaic installations), wind and nuclear energy, as well as their integration with energy storage and waste heat recovery systems, are playing an increasingly important role in the Department's activities.

The Heating, Ventilation, Air Conditioning and Refrigeration Laboratory (Ś6) conducts scientific and educational activities in the field of:

- efficient and environmentally friendly heating and ventilation systems;
- optimisation of air conditioning and refrigeration systems;
- energy audits and assessments of building heating systems;
- introduction of environmentally friendly solutions in refrigeration and air conditioning;
- modelling and measuring heat exchange processes in building components;
- use of renewable energy in heating and heating systems;
- research on ventilation and air conditioning processes, including the use of heat accumulation through the use of phase change materials (PCM);
- research on modern and environmentally acceptable refrigerant mixtures.

The Faculty will continue to actively participate in the university's staff development activities, implementing the HR Excellence in Research principles and the OTM-R policy, ensuring open, transparent and competence-based HR processes.

3. Main assumptions of the development strategy of the Faculty of Environmental Engineering and Energy at the Krakow University of Technology

3.1. Area: EDUCATION

The Faculty of Environmental Engineering and Energy is clearly and consistently developing its educational offer to comprehensively meet the high market demand for specialists responsible for the development of urbanisation and metropolisation. Currently, it is focused on shaping and implementing SMART solutions that skilfully combine intelligent solutions in the field of infrastructure management and development with improving the quality of space, residents' lives and access to natural resources, taking into account the principles of sustainable development.

The decline in student numbers resulting from, among other things, demographic factors and the perception of engineering courses as difficult, which could potentially hamper the Faculty's development, requires even more thorough analysis and adaptation of educational programmes to the dynamically changing requirements of the labour market.

Objective 1. Modification of educational programmes for all fields of study, taking into account current educational trends and labour market requirements

The Faculty offers first- and second-cycle programmes in a wide range of competences in the disciplines of environmental engineering, mining and energy, in the following fields:

- *Eco-technologies for sustainable development (first-cycle studies);*
- *Energy (first- and second-cycle studies);*
- *Nuclear Energy (second-cycle studies);*
- *Geoinformatics (first- and second-cycle studies);*
- *Water Engineering and Management (first- and second-cycle studies);*
- *Environmental Engineering (first- and second-cycle studies);*
- *Renewable Energy Sources and Municipal Infrastructure (first- and second-cycle studies)*

  and the inter-faculty programme Spatial Management, run jointly with the Faculty of Architecture and the Faculty of Civil Engineering at the CUT.

This objective is related to the need to ensure that studies are modern and practical in the face of a declining number of candidates and fierce competition in the education market. It will be achieved by introducing changes to the curriculum, including:

- increasing the share of practical classes (exercises, projects, laboratories, computer laboratories, seminars) to approx. 60-70%;
- implementing subjects related to project-based learning (PBL) in all fields and levels of study, enabling students to carry out project activities, including interdisciplinary projects available at CUT
- the inclusion of the latest technological and technical issues in the study programmes, not only in the fields of study, but also related to AI, cybersecurity and the development of soft skills.

Objective 2. Expanding the range of courses offered in English

Currently, the Faculty offers education in English ( ) only at the second cycle of studies. Based on a framework cooperation agreement between the Cracow University of Technology and the Universita degli Studi di Cagliari (UNICA) in Italy, signed on 13 April 2018 on the initiative of the Faculty of Environmental Engineering of the Cracow University of Technology, a double degree programme is being implemented at the second-cycle level in Environmental and Land Engineering by the Faculty of Environmental Engineering of the Krakow University of Technology and the Faculty of Engineering and Architecture of UNICA. The programme allows students to obtain an Italian Master's degree in Environmental and Land Engineering and a Polish Master's degree in Engineering in this field. The Faculty also offers an English-language specialisation in the second-cycle programme in Energy.

The objective will be achieved through:

- successively strengthening the current English-language education elements in the second-cycle programme,
- expanding the educational offer at the second-cycle level with a joint programme created on the basis of the STARS EU alliance,
- creating an educational offer for first-cycle students based on cooperation with other CUT faculties, in particular the Faculties of Chemical Engineering and Technology and the Faculty of Materials Science and Engineering in the field of innovative technologies and materials.

Objective 3. Increasing support for students' research and development activities

The objective will be achieved by:

- increasing funding for activities within research clubs, as well as implementing bonus systems for above-standard activities within clubs, both for students and supervisors,
- implementing an incentive system to increase student participation in research projects and work for the socio-economic environment,
- strengthening project-based learning elements in study programmes, allowing students to engage in above-standard activities, including interdisciplinary projects,
- strengthening the role of student club conferences and competitions for students' scientific activities.

Objective 4. Improving the quality and flexibility of education by implementing UDL (Universal Design for Learning) principles

As part of the development of education, emphasis will be placed on implementing UDL (Universal Design for Learning) principles, which ensure flexible, accessible and diverse forms of education. The aim is to improve the quality of the educational process by adapting content, methods and forms of assessment to the diverse needs of students.

The implementation of UDL will increase the accessibility of studies for people with different educational needs, while at the same time increasing the attractiveness and competitiveness of the Faculty's educational offer on the domestic and international market.

The objective will be achieved through:

- developing a support system for students with different educational needs (including persons with disabilities and foreign students),

- developing and implementing teaching materials in various forms (text, graphics, multimedia),
- using diverse forms of engaging and motivating students to actively participate in the educational process, taking into account individual needs, learning styles and interests,
- introducing a variety of activation methods (team projects, laboratory work, digital tools) that support the development of competences and strengthen student engagement,
- training for academic staff in the field of universal education design,
- close cooperation with the CUT Accessibility Centre and the CUT International Cooperation Department.

3.2. Area of SCIENTIFIC RESEARCH

The Faculty of Environmental Engineering and Energy is authorised to award doctoral and postdoctoral degrees and has been awarded category A in the parametric evaluation of scientific units for the years 2017-2021.

The Faculty has the appropriate human and infrastructure resources to carry out scientific research, enabling further scientific development of the discipline, with intensified efforts to obtain grants and increase the internationalisation of scientific research.

Objective 1. Improving and enhancing the effectiveness of scientific research

The faculty is characterised by high publication activity among its staff, with a significant proportion of publications in the highest-scoring journals (200 and 140 points of the Ministry of Science and Higher Education of Poland), which was reflected in the latest scientific evaluation. At the same time, there is a low level of activity in applying for and obtaining research projects, as well as in the field of patents and commercialisation of research results.

The objective will be achieved by:

- rewarding publication activity in highly rated journals in order to maintain a high level of publication activity, while continuously increasing the share of publications in the most significant journals,
- intensifying the acquisition of research projects by increasing substantive and organisational support for employees applying in competitions, in particular young scientists,
- creating research teams around priority issues with a structure that ensures a mentoring role, supporting the development of young scientists,

- undertaking effective research cooperation with other disciplines within the university and beyond.

Objective 2. Increasing the level of internationalisation of scientific research

This objective will be achieved by:

- increasing the role of visiting professors from leading foreign centres in the development activities of the discipline at CUT, including taking measures to attract scientists of high international renown,
- developing research cooperation within the universities grouped in the STARS EU alliance, in particular in the area of applications for international research projects,
- developing existing and establishing new research relationships with significant foreign centres,
- intensifying activities in the field of organising international conferences.
- intensifying the mobility of academic staff.

Objective 3. Improving infrastructure and equipment to increase the efficiency of scientific research

- creation of an equipment base to optimise the use of available equipment,
- implementation of uniform rules for the use and sharing of existing equipment,
- intensification of activities aimed at acquiring modern research equipment by obtaining equipment and infrastructure grants,
- developing existing and establishing new research relationships with significant foreign centres.

3.3. Area: COOPERATION WITH THE ENVIRONMENT

The Faculty conducts joint activities with the business community, focused on the implementation of design and technological solutions in the field of energy and environmental engineering, related in particular to new technical and technological solutions in the context of the intensive development of urban agglomerations and the negative effects of climate change. This applies in particular to cities and areas in southern Poland, where cooperation with local government structures is carried out under independent agreements. The main partners of WIŚiE include:

- Krakow Municipal Holding Company,
- Krakow Waterworks S.A,
- Municipal Sanitation Company Sp. z o.o. in Krakow,

- Municipal Heat Energy Company in Krakow,
- Grupa Azoty S.A.
- Nowy Sącz Waterworks Sp. z o.o.,
- National Water Management Authority (KZGW),
- State Water Management Authority "Wody Polskie",
- KGHM Polska Miedź S.A.,
- Czatkowice Limestone Mine,
- Wieliczka Salt Mine,
- FAKRO and VELUX window factories,
- Połaniec Power Plant S.A., Skawina Power Plant S.A. and Opole Power Plant S.A.,
- Siekierki Combined Heat and Power Plant in Warsaw,
- Petrochemia Płock,
- Rzeszów Heat and Power Plant,
- Racibórz Boiler Factory - Rafako S.A.,
- Boiler Factory - Sefako S.A.,
- Energy Repair Plant S.A. in Katowice.

Objective 1. Maintaining and continuously strengthening the Faculty's position as an expert in the field of education, infrastructure and technology at the regional and national level.

The objective will be achieved by:

- creating a Business Council at the Faculty, consisting of representatives of leading companies in the region, allowing for the exchange of experiences and joint planning of strategic activities,
- participating in promotional and educational initiatives in cooperation with local authorities,
- expanding cooperation with regional educational institutions.

Objective 2. Increasing the role of representatives of the business community in shaping study programmes.

The Faculty's policy in this area has so far focused on the presence of representatives of the business community in Programme Councils, without taking into account a permanent group of stakeholders supporting the process of education and the development of study programmes on an ongoing basis.

The objective will be achieved by:

- creating a Business Council at the Faculty (compatible with objective 2),
- ongoing programme consultations, also outside the Business Council,

- expanding the range of thesis topics carried out in cooperation with enterprises,
- involving an increasing number of experts from the business community in teaching.

Objective 3. Increasing revenues from work carried out for the socio-economic environment.