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## A LETTER FROM THE DIRECTOR

Dear colleagues,

Starting an opening statement with information that typically concludes it is not customary. However, considering many unfavourable changes in the world lately, I would like to begin my opening statement with a positive counterpoint to these developments.

We had a successful year, and I dare say a very successful year, as it was full of significant achievements in the scientific field with impact on both, the scientific community, and the general public. The emphasis on a "very successful year" is appropriate, as the accomplishments were reached despite the complications caused by social changes as a result of coming to terms with first the Covid pandemic then the post-Covid period and, unfortunately, the impact of Russia's unprecedented war of aggression against the Ukrainian nation. The changes have had a significant impact on everyday life and have detected all the weak points in the functioning of society, making the need for tools to maintain the societal resilience in a wide range of technical and social sciences all the more apparent. Our university institute is taking on an important challenge that aligns with our vision and mission. Our research in the modern energy

sector is focused on achieving energy self-sufficiency from the regional to nationwide level, which can enhance society's resilience and decrease our reliance on countries with unstable geopolitical situations.

In this situation, the project of the National Centre for Energy II (of which we are a principal investigator and co-founder of two other Centres of Competence for Materials and Environmental Technologies) has been a huge success with excellent timing - thus confirming our professional direction. Our international accomplishments also involve securing the SAN4Fuel project. Together and along with our significant national and international achievements, we have clearly strengthened the position of our institute in the organizational structure of the university. Our institute ranks first in the university's research output metrics evaluation. Additionally, we account for over 65% of the university's overall performance evaluation in terms of cooperation with industry and business sectors.

To achieve our institute's vision and mission, we are developing leading-edge laboratory facilities and infrastructure, particularly



through the REFRESH initiative where in two of the three living laboratories our experts collaborate with top international scientists.

The aforementioned factors lay the groundwork for cutting-edge research that is built on a reliable scientific foundation and embraces the principles of innovation, excellence, and responsibility through collaborative efforts.

Let me conclude by repeating my opening remarks, i.e., we had a very successful year, and it is owing to your unwavering dedication that often transcended personal comfort zones.

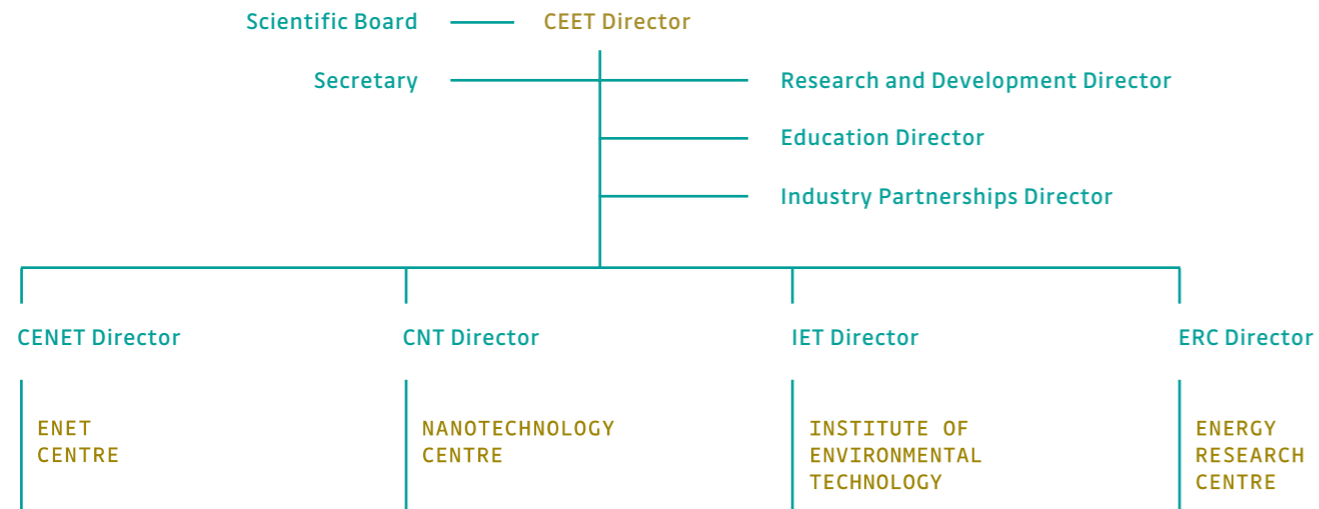
With sincere gratitude and wishes for continued success in the realm of science and good health.

Prof. Stanislav Mišák, PhD

# MANAGEMENT STRUCTURE

Centre for Energy and Environmental Technologies (CEET) is a university institute at the VSB – Technical University Ostrava. We focus on research and development in the field of low-carbon and sustainable energy and environmental technologies in line with the principles of circular economy.

CEET was established on January 1, 2021, after a merger of four university institutes: the Nanotechnology Centre (CNT), the Energy Research Centre (ERC), ENET Centre (CENET) and the Institute of Environmental Technology (IET).



## MANAGEMENT

CEET Director	Prof. Stanislav Mišák, PhD
Research and Development Director	Prof. Lucie Obalová, PhD
Industry Partnerships Director	Assoc. Prof. Tadeáš Ochodek
Education Director	Prof. Daniela Plachá, PhD

## SCIENTIFIC BOARD

Chairman	Prof. Stanislav Mišák, PhD (VSB-TUO)
Members	Prof. Libor Čapek, PhD (University of Pardubice)
	Prof. Lucie Obalová, PhD (VSB-TUO)
	Assoc. Prof. Tadeáš Ochodek (VSB-TUO)
	Prof. Daniela Plachá, PhD (VSB-TUO)
	Petr Salvet (Vyncke s.r.o.)
	Prof. Václav Švorčík, DrSc. (VŠCHT Praha)



## MISSION, VISION AND STRATEGY

### Vision

CEET aims to build a recognized university institute focused on developing new technologies and materials for low-carbon and sustainable energy and environmental technologies in line with the principles of a circular economy which is open to cooperation on current and strategic projects at the national and international level.

### Mission

CEET is a university institute focused on research and development in the field of low-carbon and sustainable energy and environmental technologies in line with the principles of a circular economy. We offer to share our unique laboratory base with established experts for research, development and education of students at all levels of study. We are open to cooperation with partners from the public sector, the application sphere, universities and research organizations at the national and international level.

### Strategy

All CEET activities are coordinated to meet priorities from the regional to the international level in accordance with strategic documents with a strong emphasis on cooperation between the research and application spheres.



## RESEARCH TEAMS AND LABORATORIES

### CENET

#### ENET CENTRE

<b>CENET Director</b>	<b>Prof. Stanislav Mišák, PhD</b>
Laboratory of Thermochemical and Hydrogen Conversion	Jan Najser, PhD
Laboratory of Research of Energy By-products	Prof. Helena Raclavská, CSc.
Laboratory of Bulk Materials	Lucie Jezerská, PhD
Smart Grid Laboratory	Assoc. Prof. Lukáš Prokop

### CNT

#### NANOTECHNOLOGY CENTRE

<b>CNT Director</b>	<b>Prof. Daniela Plachá, PhD</b>
Laboratory of Inorganic Materials	Prof. Jana Seidlerová, CSc.
Laboratory of Organic and Hybrid Materials	Prof. Daniela Plachá, PhD
Laboratory of Technology and Structure of Nanomaterials	Prof. Grażyna Simha Martynková, PhD
Laboratory of Molecular Simulations and Functional Nanostructures	Assoc. Prof. Jonáš Tokarský
Materials-EnviLab	Prof. Radek Zbořil, PhD
Laboratory of Nanoparticulate Materials	Prof. Richard Dvorský, PhD
Laboratory of Physics of Nanostructures	Lukáš Halagačka, PhD

### IET

#### INSTITUTE OF ENVIRONMENTAL TECHNOLOGY

<b>IET Director</b>	<b>Prof. Lucie Obalová, PhD</b>
Waste to Energy	
Laboratory of Waste Incineration	Prof. Jozef Vlček, PhD
Laboratory of Thermochemical Processes	Pavel Leštinský, PhD
Laboratory of Anaerobic Digestion	Jiří Rusín, PhD
Environment Protection, Wastewater Treatment and Solid Residua Utilisation	
Laboratory of Environment Protection	Kateřina Pacultová, PhD
Laboratory of Preparation of Nanostructured Materials	Lenka Matějová, PhD
Laboratory of Heterogeneous Photocatalysis	Prof. Kamila Kočí, PhD
Laboratory of Water	Martina Vráblová, PhD
Laboratory of Solid Residues	Prof. Jozef Vlček, PhD

### ERC

#### ENERGY RESEARCH CENTRE

<b>ERC Director</b>	<b>Assoc. Prof. Tadeáš Ochodek</b>
INEF Centre – Innovation for Efficiency and Environment	Assoc. Prof. Tadeáš Ochodek
Energy Services	Zdeněk Neufinger, MBA
Operating Measurement	Karel Borovec, PhD
Testing Laboratory	Jiří Horák, PhD
Project Administration	Jan Koloničný, PhD

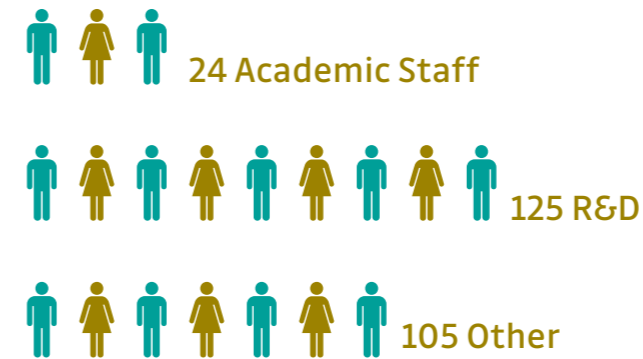
# EMPLOYEES

In 2022, a total of 254 employees worked at the Centre for Energy and Environmental Technologies, which corresponds to an average full time equivalent (FTE) of 198.94 employees. This represents approximately a 4% decrease in comparison with the year 2021. The Energy Research Centre is the largest team within the CEET accounting for 35% of the total FTE, while the lowest number of employees is at the Nanotechnology Centre, which accounts for 16% of the total FTE.

Men comprise 59% and women 41% of all employees, which is above average in terms of female workforce participation in Czech science. Employees aged 40–49 formed the largest group of staff, however, a rather high percentage of employees in the age ranges of 30–39 and 50–59 suggest an evenly distributed potential for further development in the coming years.

**59%**  
MEN  
CEET  
Employees

**41%**  
WOMEN  
CEET  
Employees



CEET STAFF 254

## Employees by age

up to 29 years	11.81%
30 – 39	30.71%
40 – 49	33.86%
50 – 59	12.60%
60 – 69	6.30%
71 +	4.72%

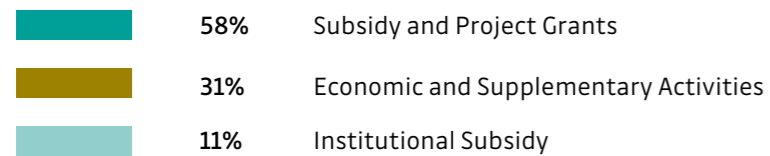
Academic and research staff comprised the bulk of CEET’s employees, accounting for 59% of the total workforce. The remaining 41% constitute other professions of personnel.



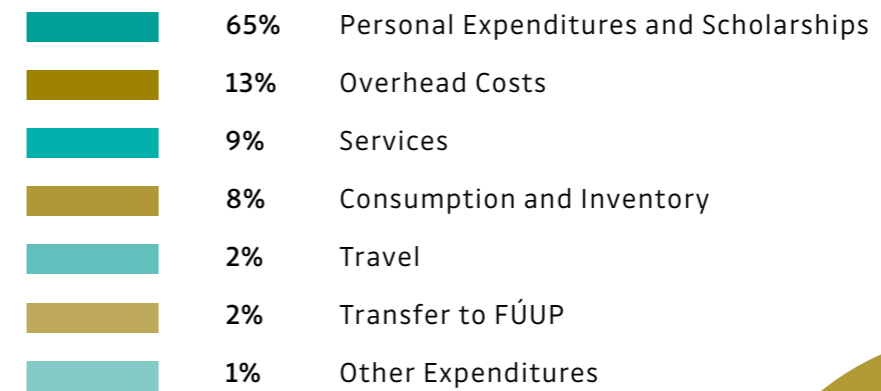
# FINANCIAL OVERVIEW

Financial performance of the Centre for Energy and Environmental Technologies of VSB – Technical University Ostrava in the calendar year 2022 with financial turnover of the total amount of 336.9 Million CZK achieved a positive balance of 38.8 Million CZK with a profit 32.8 Million CZK after tax.

The main financial sources consisted of income from national and international grants, provision of research services and an institutional subsidy.



The total CEET costs of the year 2022 in the total amount 298.2 Million CZK structured according to individual cost groups:



# RESEARCH AND DEVELOPMENT

## A LETTER FROM THE RESEARCH AND DEVELOPMENT DIRECTOR

Research, from basic to applied, is one of the core activities of our institute. CEET boasts a team of multidisciplinary experts across our four centres: the Nanotechnology Centre (CNT), the ENET Centre (CENET), the Institute of Environmental Technology (IET) and the Energy Research Centre (ERC). These professionals specialise in fields such as materials engineering, physical and analytical chemistry, chemical engineering, mechanical engineering, energy and electrical engineering, and that's certainly not a complete list. I was delighted to see that several new interdisciplinary teams were formed in the past year, particularly in relation to the OP ST REFRESH project and the National Centre for Energy II project (NCE II), the acquisition of which was a great achievement for CEET.

Among other things, the preparation of many new projects characterized the year of 2022, including 15 Horizon projects. Amid these, CEET was successful twice. The first Horizon Europe project in the history of CEET was

launched under the title „SAN4Fuel – Single Atom-Based Nanohybrid Photocatalysts for Green Fuels“ in the Twinning programme at two of our centres at the end of 2022. The project is coordinated by Palacky University in Olomouc, and apart from CEET VSB-TUO two foreign universities are involved: University of Trieste (IT) and Friedrich-Alexander-Universität Erlangen-Nürnberg (DE). Another successful project is called „EBEAM – Electron Beam Emergent Additive Manufacturing“ (HE ERA Chairs), which is expected to start at IET in 2023.

Last year was also a successful year in terms of our publishing activities. A total of 188 articles published by our employees in 2022 can be found in the Web of Science (WoS) database. The majority of these publications 94% were published in first and second quartile journals, and our publication output of 1.7 articles/1 FTE places us among the top research institutes globally. This is demonstrated by the high level of interest showed



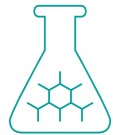
by the scientific community, as evidenced by a 74% increase in citation response compared to the previous year. The information comes from R&D Portal [vsb.cz/en](https://vsb.cz/en), which calculates citation response as the sum of citations as of December 2022 by Scopus considering papers published in 2022, 2021, and 2020.

Prof. Lucie Obalová, PhD

# RESEARCH AREAS

CEET's research activities focused on four areas:

## MATERIALS FOR ENERGY AND ENVIRONMENTAL TECHNOLOGIES



Molecular modelling and design of materials and nanomaterials

Preparation and synthesis of advanced materials and nanomaterials

Characterization of advanced materials, nanomaterials and composite materials

Testing and applications of advanced materials, nanomaterials and composite materials

Impact of nanomaterials and nanotechnologies on the environment

## ENERGY STORAGE, TRANSFORMATION AND MANAGEMENT



Technologies for the conversion of alternative fuels, waste and by-products into usable chemicals and useful forms of energy, their storage and efficient use with the support of digital twin

Electricity distribution networks within energy platforms of municipalities, cities or micro-regions. The use of modern technologies for energy storage in various forms

## ENERGY UTILISATION OF SECONDARY RAW MATERIALS AND ALTERNATIVE ENERGY SOURCES



Plasma gasification technology

Catalytic pyrolysis of waste

Fuel cell issues

Processing of waste and its possible transformation into products usable for energy

## ENVIRONMENTAL ASPECTS AND TECHNOLOGIES



Improvement of existing manufacturing processes to reduce the production of pollutants

Efficiency increase and development of new methods for reducing the emissions of already existing pollutants

## RESEARCH AND DEVELOPMENT OUTPUTS

CEET researchers and academics published a total of 188 peer-reviewed publications indexed in the WoS database in 2022. The distribution of publications by quartile shows that a full 94% of papers were published in journals in the first and second quartiles. The fact that more than 17% of the research papers were published in the first disciplinary decile, together with the high publication performance, places CEET among the successful research institutions both nationally and internationally.

Total	D1	Q1	Q2	Q3	Q4	Number of publications per 1 FTE*
188	32 (17.0%)	110 (58.5%)	67 (35.6%)	10 (5.3%)	1 (0.5%)	1.7

\*1 full-time R&D and academic employee

Source: The Web of Science, as of March 28, 2023, Central Library of VSB-TUO



Peer-reviewed articles published in 2022 with citation counts of 20 and more (number of citations as of April 7, 2023, source WoS).

<b>Authors</b>	Poulose A.C.; Zoppellaro G.; Konidakis I.; Serpetzoglou E.; Stratakis E.; Tomanec O.; Beller M.; <b>Bakandritsos A.</b> ; Zboril R.
<b>Title</b>	Fast and selective reduction of nitroarenes under visible light with an earth-abundant plasmonic photocatalyst
<b>Journal, IF</b>	Nature Nanotechnology IF 40.523
<b>Field</b>	22 citations Materials Science Multidisciplinary, Nanoscience & Nanotechnology
<b>Authors</b>	Sedajova, V.; <b>Bakandritsos, A.</b> ; Blonski, P.; Medved, M.; Langer, R.; Zaoralova, D.; Ugolotti, J.; Dzibelova, J.; Jakubec, P.; Kupka, V.; Otyepka, M.
<b>Title</b>	Nitrogen doped graphene with diamond-like bonds achieves unprecedented energy density at high power in a symmetric sustainable supercapacitor
<b>Journal, IF</b>	Energy Environmental Science IF 39.714
<b>Field</b>	20 citations Environmental Engineering and Environmental Sciences Multidisciplinary Chemistry, Energy & Fuels

Selection of 10 articles from the portfolio of research topics addressed at CEET that have been published in journals in the 1st decile of the field.

<b>Authors</b>	Jayaramulu K; Mukherjee S; Morales D.M.; Dubal Deepak P.; Nanjundan Ashok K.; Schneemann A.; Masa J.; <b>Kment Š.</b> ; Schuhmann W.; Otyepka M.; <b>Zbořil R.</b> ; Fischer R.A.
<b>Title</b>	Graphene-Based Metal-Organic Framework Hybrids for Applications in Catalysis, Environmental, and Energy Technologies
<b>Journal, IF</b>	Chemical Reviews IF 72.087
<b>Field</b>	Multidisciplinary Chemistry
<b>Authors</b>	Poulose A.Ch.; Zoppellaro G.; Konidakis I.; Serpetzoglou E.; Stratakis E.; Tomanec O.; Beller M.; <b>Bakandritsos A.</b> ; <b>Zbořil R.</b>
<b>Title</b>	Fast and selective reduction of nitroarenes under visible light with an earth-abundant plasmonic photocatalyst
<b>Journal, IF</b>	Nature Nanotechnology IF 40.523
<b>Field</b>	Materials Science Multidisciplinary Nanoscience & Nanotechnology
<b>Authors</b>	Sedajova V.; <b>Bakandritsos A.</b> ; Blonski P.; Medved M.; Langer R.; Zaoralova D.; Ugolotti J.; Dzibelova J.; Jakubec P.; Kupka V.; Otyepka M.
<b>Title</b>	Nitrogen doped graphene with diamond-like bonds achieves unprecedented energy density at high power in a symmetric sustainable supercapacitor

<b>Journal, IF</b>	Energy & Environmental Science IF 39.714
<b>Field</b>	Energy & Fuels Chemical Engineering Multidisciplinary Chemistry Environmental Sciences
<b>Authors</b>	Cao X.; Wei Ch.; Zheng X.; Zeng K.; Chen X.; <b>Rummeli M.H.</b> ; Strasser P.; Yang R.
<b>Title</b>	Ru clusters anchored on Magneli phase Ti407 nanofibers enables flexible and highly efficient Li-O <sub>2</sub> batteries
<b>Journal, IF</b>	Energy Storage Materials IF 20.831
<b>Field</b>	Physical Chemistry Materials Science Multidisciplinary Nanoscience & Nanotechnology
<b>Authors</b>	Shi Qi.; Cheng Y.; Wang J.; Zhou J. Ta H.Q.; Lian X.; Kurtyka K.; Trzebicka B.; Gemming T.; <b>Rummeli M.H.</b>
<b>Title</b>	Strain Regulating and Kinetics Accelerating of Micro-Sized Silicon Anodes via Dual-Size Hollow Graphitic Carbons Conductive Additives
<b>Journal, IF</b>	Small IF 15.153
<b>Field</b>	Physical Chemistry Materials Science Multidisciplinary Applied Physics
<b>Authors</b>	<b>Růžičková J.</b> ; <b>Raclavská H.</b> ; Juchelková D.; <b>Kucbel M.</b> ; <b>Raclavský K.</b> ; <b>Švédová B.</b> ; <b>Šafář M.</b> ; Pfeifer Ch.; Hrbek J.

Title	Organic compounds in the char deposits characterising the combustion of unauthorised fuels in residential boilers
Journal, IF	Energy IF 8.857
Field	Thermodynamics
Authors	<b>Tokarský J.</b> ; Scucka J.; Martinec P.; <b>Kutláková Mamulová K.</b> ; <b>Peikertová P.</b> ; Lipina P.
Title	Long-term effect of weather in Dfb climate subtype on properties of hydrophobic coatings on sandstone
Journal, IF	Journal of Building Engineering IF 7.144
Field	Civil Engineering
Authors	<b>Matějová L.</b> ; <b>Bednárek J.</b> ; Tokarský J.; Koutník I.; Sokolová B.; Cruz G. J.F.
Title	Adsorption of the most common non-steroidal analgesics from aquatic environment on agricultural wastes-based activated carbons; experimental adsorption study supported by molecular modeling
Journal, IF	Applied Surface Science IF 7.392
Field	Materials Science, Coatings & Films
Authors	Kaspar V.; Zapletal M.; Samec P.; Komarek J.; Bílek J.; Juran S.
Title	Unmanned aerial systems for modelling air pollution removal by urban greenery

Journal, IF	Urban Forestry & Urban Greening IF 5.766
Field	Forestry Urban Studies
Authors	<b>Škrlová K.</b> ; Rybkova Z.; Stachurova T.; <b>Zágora J.</b> ; Malachova K.; Merinska D.; <b>Gabor R.</b> ; Havlicek M.; Munoz-Bonilla A.; Fernandez-Garcia M.; <b>Plachá D.</b>
Title	Long-term antimicrobial effect of polylactide-based composites suitable for biomedical use
Journal, IF	Polymer Testing IF 4.931
Field	Materials Science, Characterisation & Testing



In 2022, CEET produced  
a total of

47

outputs,  
including

1

international utility model

Vráblová M., Koutník I.  
Vorrichtung zur Messung der Permeabilität von Membranen.  
Equipment designed to measure membrane permeability.  
Utility model 212020000628.8, 2022.

2

SPECIALISED MAP

3

SOFTWARE

14

FUNCTION SAMPLE

6

PATENT  
-  
APPLICATION

10

UTILITY MODEL  
-  
APPLICATION

5

VERIFIED  
TECHNOLOGY

2

PILOT PLANT

5

PROTOTYPE

Source: internal materials of the R&D Commercialisation Unit - Intellectual Property Protection, 2022,  
as of February 21, 2023.

# TECHNOLOGY TRANSFER

## LICENSE AGREEMENTS

### METHODOLOGY

#### Methodology design for detecting the combustion of inappropriate fuels in residential heating systems

At the end of September 2022, a licensing agreement was concluded for methodology design for detecting the combustion of inappropriate fuels in residential heating systems. The licence was purchased by ENSYTRA s.r.o. to facilitate the transfer of this technology.

### PATENTS

#### Method to stabilise the methane level in process gases and apparatus used to implement the technique for single-fuel engines

At the turn of 2021/2022, iO System s.r.o. purchased a licence that allows them to exercise intellectual property rights over a technical solution that stabilises the methane level in process gases and apparatus used to implement this method for single-fuel engines (patent).

### UTILITY MODELS

#### Battery health monitoring device for multiple electric vehicles

In December 2022, a utility model agreement was signed to authorise the use of intellectual property rights for a battery monitoring device for a fleet of electric vehicles. The licence was purchased by ETERNAL ELECTRIC s.r.o. (utility model).





# SIGNIFICANT R&D PROJECTS

## NATIONAL CENTRE FOR ENERGY

**Project number:**  
TN01000007

Following the four-year National Centre for Energy project, which ended in December 2022 and aimed to connect academia with industry in the field of modern energy, the National Centre for Energy II will be undertaken by research teams from 9 leading universities and 25 companies in the energy sector.

Over the course of the NCE I project, a stable consortium was formed and cooperation between researchers and key players in the energy sector was enhanced, resulting in over 30 applied research sub-projects. The research agenda focused on new technologies aimed at improving the efficiency, safety, and reliability of existing energy units, optimizing the deployment and operation of decentralized energy sources, promoting the usage of alternative fuels to ensure raw material independence and energy self-sufficiency for the Czech Republic, and enhancing the safety and reliability of energy networks through the exchange of unique infrastructures and know-how among expert teams.

**Implementation period:** 2019–2022

**Provider:** Technology Agency of the CR, National Centres of Competence, 2018–2022

**Principal investigator:**  
Prof. Stanislav Mišák, PhD

## NATIONAL CENTRE FOR ENERGY II

**Project number:**  
TN02000025

After the very successful completion of the National Centre for Energy (NCE) project, CEET was awarded the follow-up project National Centre for Energy II (NCE II) at the end of 2022. The aim of this project is to develop a comprehensive strategy for modern, low-carbon, sustainable energy to ensure energy and raw material independence of the Czech Republic. The project objectives should be achieved through R&D methods, materials and technologies, including an analysis of the socio-economic impact of the implementation of new scientific knowledge with follow-up recommendations for legislative measures.



The focus of the project is in line with the strategic documents at the national and international level (Green Deal, Fit for 55) to fulfil the Czech Republic's commitments to reduce greenhouse gas emissions. This ambitious goal will be realised in cooperation with research organisations and innovative leaders of the modern energy sector and sharing of the unique laboratory facilities and know-how of expert teams through joint projects.

**Implementation period:** 2023–2028

**Provider:** Technology Agency of the CR, National Centres of Competence, 2018–2028

**Principal investigator:**  
Prof. Stanislav Mišák, PhD

### LARGE RESEARCH INFRASTRUCTURE ENREGAT (VVI ENREGAT)

The ENREGAT research infrastructure represents a unique base for conducting comprehensive research in the field of material and energy recovery of waste using incineration, pyrolysis and anaerobic digestion processes, as well as in the field of purification of the resulting gases by catalytic, sorption and photocatalytic methods. The infrastructure includes 3 pilot plants with technologies for the energy recovery of waste and specialised laboratories equipped with catalytic and photocatalytic units and up-to-date analytical technology. The uniqueness of the ENREGAT



infrastructure lies in the possibility to carry out basic and applied research on various waste management and emission reduction technologies from laboratory to semi-operational scale. Thanks to the support of the MSMT, ENREGAT services are offered free of charge in open access mode to the scientific community and students.

**Implementation period:** 2019–2022

**Provider:** Ministry of Education, Youth and Sports, Large Infrastructure Projects for R&D&I

**Principal investigator:**  
Prof. Lucie Obalová, PhD

### INSTITUTE OF ENVIRONMENTAL TECHNOLOGIES-EXCELLENCE IN RESEARCH

**Project number:**

CZ.02.1.01/0.0/0.0/16\_019/0000853

In 2022, the project of Institute of Environmental Technologies - Excellence in Research was also successfully completed, the aim of which was to promote selected research activities, support and strengthen research teams and develop the infrastructure of the research centre IET, CEET VSB-TUO to increase the competitiveness of the centre and its excellence. One of the key research areas focused on the conversion of waste to energy where

the research aimed at activities in the field of material recovery of technogenic pozzolans, thermal treatment of waste polymeric materials and anaerobic digestion. Another significant area of research aimed at the reduction of pollutants in the environment with focus on the preparation of surfactant materials for environmental applications, the treatment of waste gases by catalytic and sorption processes, photocatalytic removal of pollutants in the gas phase and research on methods for the detection and removal of pollutants from surface and waste waters.

**Implementation period:** 2018–2022

**Provider:** Ministry of Education, Youth and Sports, OP VVV Excellence in Research

**Principal investigator:**  
Prof. Lucie Obalová, PhD

# OVERVIEW OF PROJECTS SORTED BY PROVIDERS

## Technology Agency of the Czech Republic

Microgeneration source using biomass combustion and ORC technologies

Examining Hg distribution in wet flue gas desulfurization process

Reducing the energy consumption and environmental impact of rail transportation through preparing the infrastructure for alternative fuel trains

Low-emission biomass-burning heaters for near-zero energy houses

High-capacity battery storage for houses, industry, electromobility, and community energy with 25,000+cycle lifetime and up to 3C discharge/charge rates

Integrated air quality research, assessment, and control systems

Centre for Energy and Environmental Technologies

Analysing the operation of domestic solid fuels heating installations

Assessing the impact of atmospheric deposition on population health with a focus on PAHs and heavy metals due to transport-related resuspension of particles

Mitigating airborne contamination of asbestos fibres resulting from human activities in rock environment

Research and development of coke oven gas conversion processes for hydrogen and alternative fuel generation

Assessing the environmental impact of coal landfills

Smart energy management system for power grids

Reactor development for algae cultivation via spectral light illumination and CO<sup>2</sup> utilization

ELTRIS – Trichloroethylene elimination in ammonium sulphate production

Exploring hydrogen technologies for low-carbon energy mix and low-emission transport in the Moravian Silesian region

National Centre for Energy

## Ministry of Education, Youth and Sports

Doctoral grant competition at VSB-TUO

Intelligent material development for high performance systems via additive manufacturing

Identification of combustion of undesired substances and a self-diagnostic for solid fuel boilers

ENREGAT - Energy recovery from waste and gas purification

IET - Excellence in research

Promoting cross sectoral cooperation in pollutant reduction and energy recovery from waste

Infrastructural support for scientific education of doctoral students at CNT VSB-TUO

Infrastructural support for the strategic study program of CNT VSB-TUO

Research Centre for Low Carbon Energy Technologies

Multifunctional sp<sup>2</sup> nanocarbons in composites for industrial and medical applications

## Ministry of Industry and Trade

Efficient public transport traction system control

Development of firefighting and quarantine containers for electric vehicle fires including the development of a dry extinguishing method

Technology for water desalination and boron elimination

Solid fuel stove development with ceramic lining and temperature control for Smart Heat baking

Research and development of low emission boiler without an electrical connection based on biomass gasification principle

Research and development of technology for solid alternative fuel production from waste components of car wrecks and electrical equipment or other waste for environmentally friendly combustion in external energy installations

Electricity flow control system between electric vehicle and power unit - critical infrastructure support

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Test unit development for the disposal of sewage sludge

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Scalable control system development for actuator management

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Centre for Energy and Environmental Technologies – Explorer

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Fireplace insert of new design platform with pyrolysis combustion

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Pellet combustion plant with healthy radiant heat accumulation and automatic combustion control

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Technology for optimal thermal treatment of automotive waste

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R-mat separation – environmental applications

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Development of a new type of indoor stove for low-energy and passive houses

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Research and development of an application for SMART business management

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Continuous refining of caprolactam

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Intelligent hybrid heat source up to 100 kW

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Process intelligence optimization of parking system for Smart city

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## Czech Science Foundation (GA CR)

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Factors affecting hydrogenation/ deoxygenation of oxygenate mixtures

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Evaluation of terahertz optical activity of biomolecules

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Conversion of CO<sub>2</sub> to useful chemicals by catalytic and photocatalytic processes with highly active materials

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Heterojunction photocatalysts and TiO<sub>2</sub> photocatalysts simultaneously doped with metals and non-metals for environmental photocatalytic reactions

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Modifying electronic properties of organometallic molecules via non-covalent interactions with solvents, ligands and 2D nano systems

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Challenges and implications of utilising solid alternative fuels

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## Other ministries

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Optimising municipal sewage sludge treatment with respect to its chemical and microbial composition and water retention capacity for safe use on agricultural and forest land

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Comprehensive risk reduction of epidemiological, natural and technical disasters by building resilience at local level

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Innovative approaches to energy sources

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DRONE EXPERT – specialised training for pupils and students

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Innovating energy education programmes

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Professional competences of graduates for cross-border job opportunities in the field of construction (AZBEST)

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## Moravian-Silesian Region

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Intelligent identification system of air pollution sources – analysing the impact of the Hrabová zone on the odour pollution

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Establishing a research infrastructure – Centre for Energy and Environmental Technologies – Explorer

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## International grants

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Impact of transport on air pollution within the TEN-T route Ústí nad Labem – Mělník – Zdíby

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i-AIRPs Identifying air pollution causes on the Czech-Polish border

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Harmonizing reliable test procedures representing real-life air pollution from solid fuel heating appliances

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aLIFEca – Virtual Open Course of Automotive Life Cycle Assessment

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Low carbon technologies

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Enhancing the implementation of air quality programmes in Slovakia by strengthening the capacities and competences of regional and local authorities and supporting air quality measures

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Mobility of joint doctoral studies in the field of ellipsometry of advanced nanostructures

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Joint supervision of doctoral studies by VSB – Technical university of Ostrava and the Norwegian University

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CLear AIR and Climate Adaptation in Ostrava and other cities

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## SELECTED INTERNATIONAL PROJECTS

### **SAN4FUEL - SINGLE ATOM BASED NANOHYBRID PHOTOCATALYSTS FOR GREEN FUELS**

**Programme:**  
Horizon Europe

**Project number:**  
TN01000007

**Implementation period:**  
11/2022 - 10/2025

**Principal investigator:**  
Prof. Radek Zbořil, PhD

### **DESIGN OF NOVEL ANTIMICROBIAL BIOBASED MATERIALS USING SUPERCRITICAL FLUIDS PROCESSES, 2021-2022**

**Programme:**  
iLink, CSIC, Spain

**Project number:**  
iLINK A20364

**Implementation period:**  
January 01, 2021 - December 31, 2022

**Principal investigator:**  
Prof. Daniela Plachá, PhD

### **INNOVATION IN EDUCATIONAL PROGRAMMES IN THE ENERGY FIELD**

**Programme:**  
Interreg V-A SK-CZ

**Project number:**  
304011U698

**Implementation period:**  
January 1, 2020 - March 31, 2022

**Principal investigator:**  
VSB-TUO, CEET (Assoc. Prof. Tadeáš  
Ochodek), University of Zilina

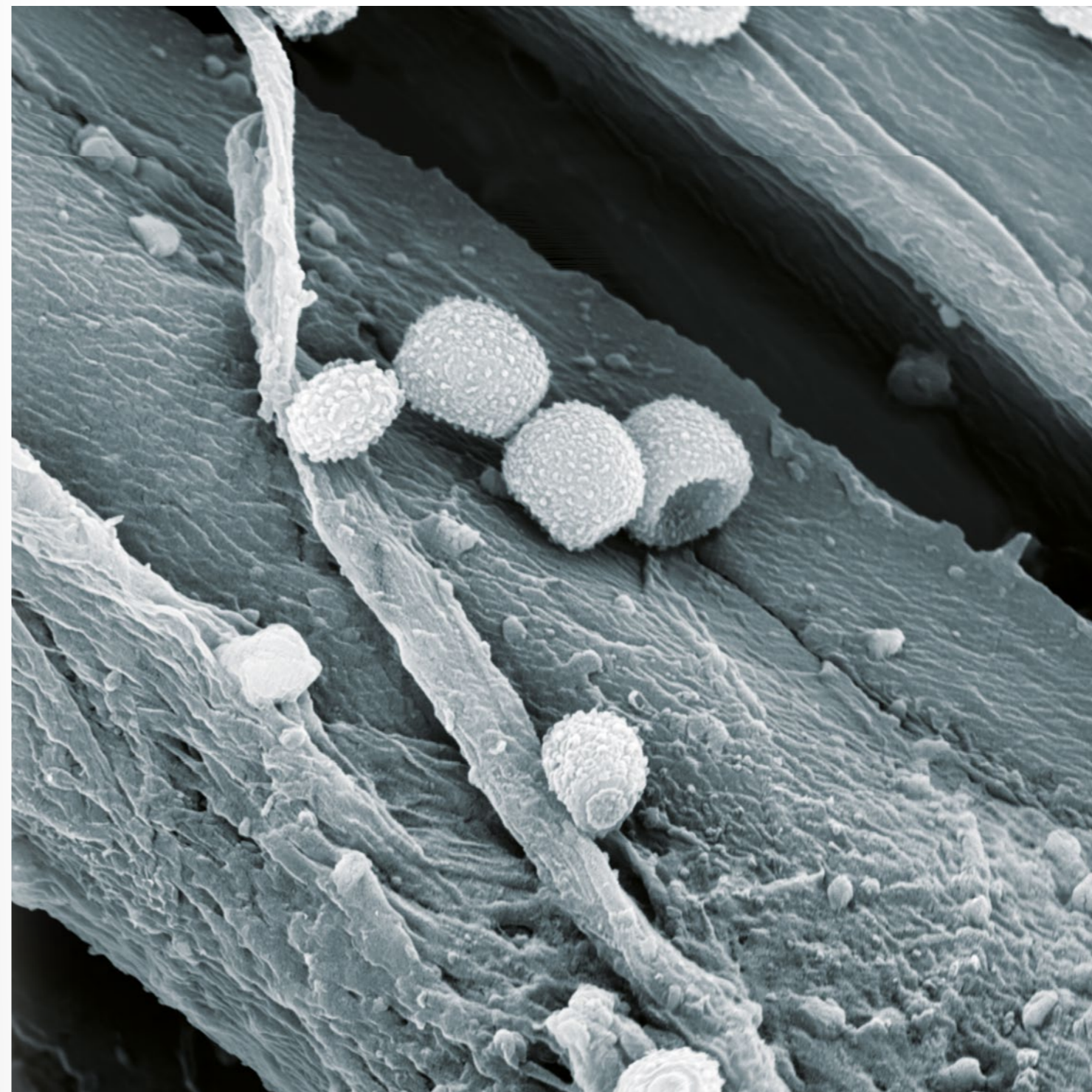
### **ENERGY SOURCES INNOVATION**

**Programme:**  
Interreg V-A SK-CZ

**Project number:**  
304011Y352

**Implementation period:**  
October 1, 2020 - August 31, 2022

**Principal investigator and partners:**  
VSB-TUO, CEET (Jiří Horák, PhD), University  
of Zilina



### ENHANCING THE IMPLEMENTATION OF AIR QUALITY MANAGEMENT PLANS IN SLOVAKIA BY STRENGTHENING CAPACITIES AND COMPETENCIES OF REGIONAL AND LOCAL AUTHORITIES AND PROMOTING AIR QUALITY MEASURES

**Programme:**  
LIFE 2018

**Project number:**  
LIFE18 IPE/SK/000010

**Implementation period:**  
2020–2027

**Principal investigator and partners:**  
Ministry of Environment of the Slovak Republic, Slovak Environment Agency, Bratislava self-governing region, Banská Bystrica Region, Trenčín Region, Trnava Region, Žilina Region, Prešov Region, Košice Region, Slovak Hydrometeorological Institute, PEDAL Consulting, VSB-TUO, CEET (Jiří Horák, PhD), CEPTA – Centre for sustainable alternatives

### CLEAR AIR AND CLIMATE ADAPTATION IN OSTRAVA AND OTHER CITIES (CLAIRO)

**Programme:**  
-

**Project number:**  
UIA03-123

**Implementation period:**  
November 2018–April 2022

**Principal investigator:**  
Municipality of Ostrava

**Partners:**  
VSB-TUO, CEET (Jiří Bílek, PhD), Moravian-Silesian Region, Silesian University in Opava, Palacký University Olomouc, SOBIC Smart & Open Base for Innovations in European Cities and Regions, Regional Association of Territorial Cooperation of Teschen Silesia

### INFLUENCE OF TRAFFIC ON AIR POLLUTION ON THE TEN-T ROUTE ÚSTÍ NAD LABEM – MĚLNÍK – ZDIBY

**Programme:**  
NF Call 2A – 3.2.1.1 Tromsø

**Project number:**  
3202100004

**Implementation period:**  
April 2021 – April 2024

**Principal investigator:**  
VSB-TUO, CEET (Jiří Bílek, PhD)

**Co-investigator:**  
GetBizDone, s.r.o.; SPOLEČNĚ, z.s.; Norsk Energi (Norsko)

### HARMONIZING RELIABLE TEST PROCEDURES REPRESENTING REAL-LIFE AIR POLLUTION FROM SOLID FUEL HEATING APPLIANCES (REAL-LIFE EMISSIONS)

**Programme:**  
LIFE Preparatory Project 2020

**Project number:**  
LIFE 20 PRE/FI/000006

**Implementation period:**  
2021–2024

**Principal investigator and partners:**  
University of Eastern Finland, Finland, Technology and Support Centre in the Centre of Excellence for Renewable Resources, Germany, Institut national de l'environnement industriel et des Risques, France, VSB-TUO, CEET (Jiří Horák, PhD)

### ALIFECA: VIRTUAL OPEN COURSE OF AUTOMOTIVE LIFE CYCLE ASSESSMENT

**Programme:**  
Erasmus+, KA 2 - Cooperation Partnership in Higher Education

**Project number:**  
2021-1-CZ01-KA220-HED-000032222

**Implementation period:**  
November 1, 2021 – October 21, 2023

**Principal investigator and partners:**  
VSB-TUO - coordinator, SPIN 360, SRL (Italy), Scoveco (Czech Republic), University of Žilina (Slovakia), Silesian University of Technology (Poland), Newton University, a.s. (Czech Republic)

# EDUCATIONAL ACTIVITIES

## A LETTER FROM THE EDUCATION DIRECTOR

The CEET pedagogical and educational activities align with the Strategic Plan of VSB-TUO 2021-2027 and effectively contribute to achieving its goals, especially regarding 1 Stabilising student numbers and 2 Increasing graduate employability on the labour market.

The education of students across all three academic levels: bachelor's, master's and doctoral, is carried out in close cooperation with almost all faculties of the University, especially the Faculty of Materials Technology, the Faculty of Mechanical Engineering, the Faculty of Electrical Engineering and Informatics and the Faculty of Safety Engineering. The departments and laboratories of the individual research centres deal with basic and applied research issues. Students are involved in many projects in their theses and dissertation work, either in the area of contract research between the centre and an industrial partners or in major projects at national and international levels. Students benefit from numerous international collaborations across almost all of Europe, including the UK and Northern Ireland, Asia (China, India, Taiwan, Turkey), North

and South America (USA, Peru), as well as meeting international students who come to study at the CEET. The students also benefit significantly from connections to prominent scientific departments at Czech universities (CVUT, MUNI, UK, UP, UPOL, UTB, VSCHT, VUT) and the Academy of Sciences of the Czech Republic.

The CEET team members not only oversee student's work, but also serve as supervisors, lecturers and professionals sharing their first-hand experience and accomplishments with students. In teaching and supervising students, emphasis is placed on an open and friendly approach which fosters a friendly atmosphere and mutual trust between students and CEET staff and creates a very inspiring and creative environment that produces many high-quality outcomes of research and development such as patents, utility models, etc.

The guidance provided by our knowledgeable staff translates into a successful integration into workforce for students who are highly sought after by both scientific departments (also outside the VSB-TUO) and industry partners.

The constant development of individual departments within the centres requires the participation of enthusiastic young individuals who are passionate about science. That is why we take part in almost every popularisation event organized by VSB-TUO, e.g., Chemistry at the Castle, Night of Scientists, Art & Science, etc.

With the implementation of new strategic projects, we will be even more open to collaborating with faculties, recent graduates from various disciplines, and new PhD students. To further our goal of internationalisation we aim to recruit students not only from VSB-TUO and other domestic universities, but also international PhD students. International teams formed this way have a much better chance of successfully breaking into excellent research teams on a European or global scale.

One of the goals of the CEET institute is to contribute to the education of high-quality graduates of the VSB-TUO, thus increasing the prestige of the university as a whole on a national and international scale. By integrating teaching and student participation in an international environment, we hope to attract more students to study at VSB-TUO and subsequently develop their careers in the Moravian-Silesian Region. This will contribute significantly to the planned transformation of the region and the development of excellent research in our area.

Prof. Daniela Plachá, PhD



## EDUCATION AND TEACHING

While CEET's primary focus lies on scientific and contract research with industry partners, education and training for students and young scientists are also key components of the organisation's activities. Collaboration with various faculties of VSB-TUO, including the Faculty of Electrical Engineering and Computer Science, Faculty of Materials Science and Technology, Faculty of Mechanical Engineering, but also with the Faculty of Safety Engineering, Faculty of Civil Engineering and Faculty of Mining and Geology, is integral to CEET's initiatives. CEET's academic and scientific staff teach courses across Bachelor, Master and Doctoral degree programmes, e.g., Chemical and Environmental Engineering (FMST), Nanotechnology (FMST), Thermal Engineering and Fuels in Industry (FMST), Electrical Power Engineering (FEECS), Safety

Engineering (FSE), Operation of Power Units (FME), Environmental Engineering (FME), etc.

Students often spend their time in the laboratories of the various research centres. The experience and knowledge gained by CEET staff in research is directly translated into teaching so that students can apply theoretical concepts to real-world tasks, including collaborations with industry partners and participation in national and international projects. CEET offers access to international contacts for professional development and students can also meet many foreign scientists and students at the research centres. CEET staff actively participate in popularisation events of the VSB-TUO in order to inform the public and potential students about research directions and achievements.

### Number of CEET employees involved in teaching and supervising bachelor's and master's theses in 2022

Faculties of VSB-TUO	CEET employees involved in teaching	CEET employees supervising bachelor's and master's theses
FEECS	7	4
FMST	28	17
FME	11	1
FMG	5	4
<b>Total</b>	<b>51</b>	<b>26</b>





In 2022, a total of 31 bachelor's and master's theses produced at CEET were defended at the FECS within the study programmes of Electrical Engineering and Computer Science, FMST within the study programmes of Chemical and Environmental Engineering and Nanotechnology, and FME within the study programmes of Mechanical Engineering and Energy and Environment. 9 CEET employees were part of the Final State Examination Committees at FECS (Electrical Power Engineering), FMST (Chemical and Process Engineering, Nanotechnology), and FME (Power Engineering Machinery and Equipment).

Additionally, 32 PhD students worked on their dissertations under the supervision of CEET researchers and academics at CENET, CNT, IET and ERC (in three cases, these were supervisors from FMST/NCT and FMST/IET). The students were supported, inter alia, by the OP VVV project CZ.02.2.69/0.0/0.0/19\_073/0016945 Doctoral Grant Competition.

CEET staff actively supervise dissertations in the study programmes Chemical and Environmental Engineering (FMST), Nanotechnology (FMST/USP), Process Engineering (FMST) and Thermal Engineering and Fuels in Industry (FMST).

In 2022, the dissertation „System for optimizing the operation of the electrical distribution network“ was defended by Jan Vysocký, PhD under the supervision of Prof. Stanislav Mišák, PhD and was awarded the prestigious prize „Werner von Siemens Prize: 1st place - best dissertation category.“

A total of 98 students from bachelor, master and degree courses worked at the CEET research centres, focusing on research directions of the individual CEET research centres and contributing to projects carried out at CEET.

### Overview of the total number of students working at CEET in 2022

CEET research centre/ faculty	FMST	FSE	FECS	FME	FMG	USP	Total
CENET	1	-	10	2	-	-	13
CNT	29	-	-	-	-	3	32
IET	36	-	-	-	1	-	37
VEC	-	8	-	8	-	-	16
<b>Total</b>	<b>66</b>	<b>8</b>	<b>10</b>	<b>10</b>	<b>1</b>	<b>3</b>	<b>98</b>

### In 2022, the following awards were bestowed:

1st place in the best dissertation category went to the dissertation of Ing. Jan Vysocky, Ph.D. „System for optimizing the operation of the electrical distribution network“ under the supervision of Prof. Stanislav Mišák, PhD, the Werner von Siemens Prize,

1st place for the best one-year project of the Doctoral Grant Competition (DGC) evaluated within the DGC workshop was awarded to the team of Zuzana Vilamová (CNT/FMST) and Sergej Kiselev (FMST),

Two teams of PhD students working at CEET research centres were awarded at the Scientific Writing Camp organised by the PhD Academy of VSB-TUO on 13 and 14 December 2022 in the university auditorium. Jiří Ryšavý, Jakub Čespiva, Jan Diviš and Rostislav Prokeš from ERC and CENET claimed first place, while students of CNT and IET Pavel Czernek, Tereza Motúzová, Rudolf Ricka, Adéla Šlachtová, Zuzana Vilamová and Jakub Zágora collectively secured second place.

CEET also prioritizes student mobility and partnerships with international institutions, supporting 10 students to travel abroad and receiving visits from 13 foreign students in 2022.

### Overview of students travelling abroad and coming from foreign countries

CEET research centres	Number of students travelling abroad	Number of students coming from foreign countries
CNT	2	3
IET	5	7
ERC	3	3
<b>Total</b>	<b>10</b>	<b>13</b>

## PARTNERSHIPS

CEET engages in collaborative efforts with industries, municipalities and other organisations to supplement its work. In its implementation it is possible to use the scientific potential of research teams and also fill the capacity of instrumentation and technological equipment of research centres. The first part of the cooperation consists of joint scientific research projects funded by research agencies. The second part is in the area of contract research which includes product and technology development, accredited laboratories, consultancy and expert activities. This area is fully financed from the client's own resources. The broad and comprehensive concept of the implementation of complementary activities at CEET enhances chances for success in the future in the competition of many renowned entities that are active on the domestic and foreign market and operate in the same areas as CEET.

In 2022, the success of complementary activities at the institute resulted in an increase in total financial volume and profit, expansion into new research domains, and recognition of CEET as a leading institute in this field at the University. The fact that complementary activities are also provided abroad is significant. It remarkably increases the prestige of the Centre compared to competing companies operating only in the domestic market.

The institute's research centres engage in various activities within supplementary work; however, the most important are:

Development of heating equipment including technologies to improve environmental impact, projects of technologies that involve the production of heat and electricity using renewable energy sources, projects for application of hydrogen technologies, reduction of emissions from energy sources, development of technologies for energy and material utilization of waste, thermochemical conversion of biomass and alternative fuels, waste heat recovery in industry, diagnostics and optimisation of electrical networks, research on vehicles with alternative drives, testing of materials in hydrogen atmosphere, research on protective coatings of spectacle lenses, evaluation of surface impurities and oxide layers on aluminium alloys and topographic analysis of nitride layers deposited by PVD.

Within CEET there are two accredited laboratories that analyse fuels, wastes and emissions and test explosion properties of gases, liquids and their mixtures. Cooperation with municipalities is carried out in the form of studies and consultancy and expert activities.

CEET works closely with municipalities and regions to provide expert advice on conceptual



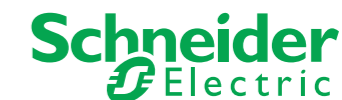
solutions for energy management and conduct studies to explore the potential of hydrogen as a fuel for transportation and the feasibility of expanding the utilisation of renewable energy sources in heat and electricity generation. Consultancy services to ministries and financial institutions also represent a significant part of the CEET's work.

CEET earned revenues of thousand CZK 103,951 without VAT in 2022, accounting for 46.65% of the University's total complementary activity revenues of thousand CZK 222,832 without VAT.

### Complementary activity revenues

CEET complementary activity in 2022 (thousands CZK, without VAT)			
Centre	Contract research	Other	Total
CNT	778	0	778
CENET	4,969	72	5,041
IET	2,775	0	2,775
ERC	89,496	5,861	95,357
<b>CEET Total</b>	<b>98,018</b>	<b>5,933</b>	<b>103,951</b>

## PARTNERSHIPS



## SIGNIFICANT EVENTS

### Workshop CEET

December 7, 2022

#### VSB-TUO University Auditorium

The VSB-TUO University Auditorium hosted the second CEET workshop which built on the success of the first edition held online amidst the pandemic. The interactive format of this year's event allowed all CEET employees to convene in person and provided ample room for collaborative discussions. The research teams showcased their top research and development outcomes from the previous year, fostering inspiration and the exploration of new avenues for even more fruitful partnerships and prospects for the CEET university institute.

### Ceremonial tapping of the foundation stone of the new CEETe polygon

February 18, 2022

The ceremonial tapping of the foundation stone of the new CEET - explorer polygon took place on Friday, 18 February 2022 at 10 a.m. in the area behind the IET building, with the participation of Deputy Minister of Industry and Trade Marian Piecha,

Governor of the Moravian-Silesian Region Ivo Vondrák, Mayor of Ostrava Tomáš Macu-  
ra, Rector of VSB-TUO Václav Snášel, Director of CEET Stanislav Mišák and other guests.

### 1st workshop for Doctoral Grant Competition

February 9—10, 2022

#### VSB-TUO University Auditorium

##### Expert guarantor:

Prof. Daniela Plachá, PhD

The first workshop for the Doctoral Grant Competition (DGC), arranged under the guidance of Prof. Jana Kukutschová, PhD, Vice-Rector for Science and Research, took place on February the 9th and 10th, 2022 at University Auditorium. On this occasion, the students presented their research findings from their individual grants, which were scrutinised by a team of experts. The workshop also encompassed a contest for the best one-year project.

### Visit of Korean Delegation

April 5, 2023

### DOV, Ostrava

The purpose of the Korean visit to VSB-TUO was to introduce the Ostrava Technology Centre and the Centre ENET, as well as to share information about the KSP project „Resilience of Smart System“, updated research plans, and to establish deeper mutual understanding. The delegates also participated in a seminar where they discussed topics such as „Analysis of Electric Power System Technology in Korea and Suggestions for Application of Czech Republic Power Systems“ and „Development of Smart System through Introduction of Vehicle-to-Grid“.

### CzePoCat 2022

April 29, 2022

Several dozen students and experts in the field of catalysis and photocatalysis from Czech and Polish universities attended the 10th annual symposium, which was held at the Institute of Environmental Technologies for the tenth time. The main aim of the seminar was to present and discuss the results of research carried out at the individual universities.

### Reducing pollutants in the Environment Seminar

May 10, 2022

Expert seminar on the topic of Pollutant Reduction in the Environment took place at the Institute of Environmental Technologies within the framework of the OP VVV project „COOPERATION“, registration number CZ.02.1.01./0.0/0.0/17\_049/0008419 and with the financial support of the Czech Chemical Society - Ostrava Branch. The aim of the seminar was to present the research outputs of the IET research teams and industrial partners involved in this project.

### Interim Reporting and Practitioners Workshop

June 19—24, 2022

#### Seoul, Republic of Korea

Prof. Mišák and Assoc. Prof. Prokop visited a workshop in Seoul called Interim Reporting and Practitioners. The aim of the visit was to strengthen the intergovernmental cooperation between the Czech Republic and South Korea in the field of development of critical energy infrastructure with the aid of low-carbon technologies.

### Decarbonisation Options – Hydrogen in Chemistry and Energy

June 23, 2022

Lecturer: Prof. Kamil Wichterle, DrSc.

The lecture on Decarbonisation Options – Hydrogen in Chemistry and Energy,

the aim of which was to critically evaluate the possibilities of using hydrogen technologies in industry and energy, was hosted by Prof. Lucie Obalová, PhD, Director of the Institute of Environmental Technologies, and conducted by prof. Kamil Wichterle.

### **Dominika Zabiegaj's (Northumbria University) Internship**

July 2022

Dr. Dominika Zabiegaj from Northumbria University, Newcastle upon Tyne, UK, who was completing her internship at the Centre for Nanotechnology conducted extensive research on carbon foam-based sorbents modified with suitable nanoparticles. She also presented her research during a specialised lecture to CNT staff and students of the Nanotechnology programme.

### **Visit at the Institute of Polymer Science and Technology in Madrid**

November 2022

Madrid, Spain

The aim of the visit at the Institute of Polymer Science and Technology in Madrid, with whom CNT had existing cooperation, was to strengthen the partnership between the two institutions. During their stay Dr. Alexandra Muñoz-Bonilla, Dr. Marta Fernández-

-García, and student Victor Hevilla Talavera offered valuable insights to the students and researchers of CNT, aiding their knowledge development. Dr. Fernández-García and Dr. Muñoz-Bonilla specialise in macromolecular engineering, particularly in the creation and design of polymers with intricate nanostructures.

Jakub Zágora, a doctoral student of Nanotechnology programme (FMST), visited the Institute in Madrid during his study internship.





## ANNUAL REPORT 2022

VSB – Technical University of Ostrava

CENTRE FOR ENERGY AND ENVIRONMENTAL TECHNOLOGIES

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The CEET Annual Report was approved by the CEET Scientific Board on May 4, 2023. It is available electronically on the CEET website.

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