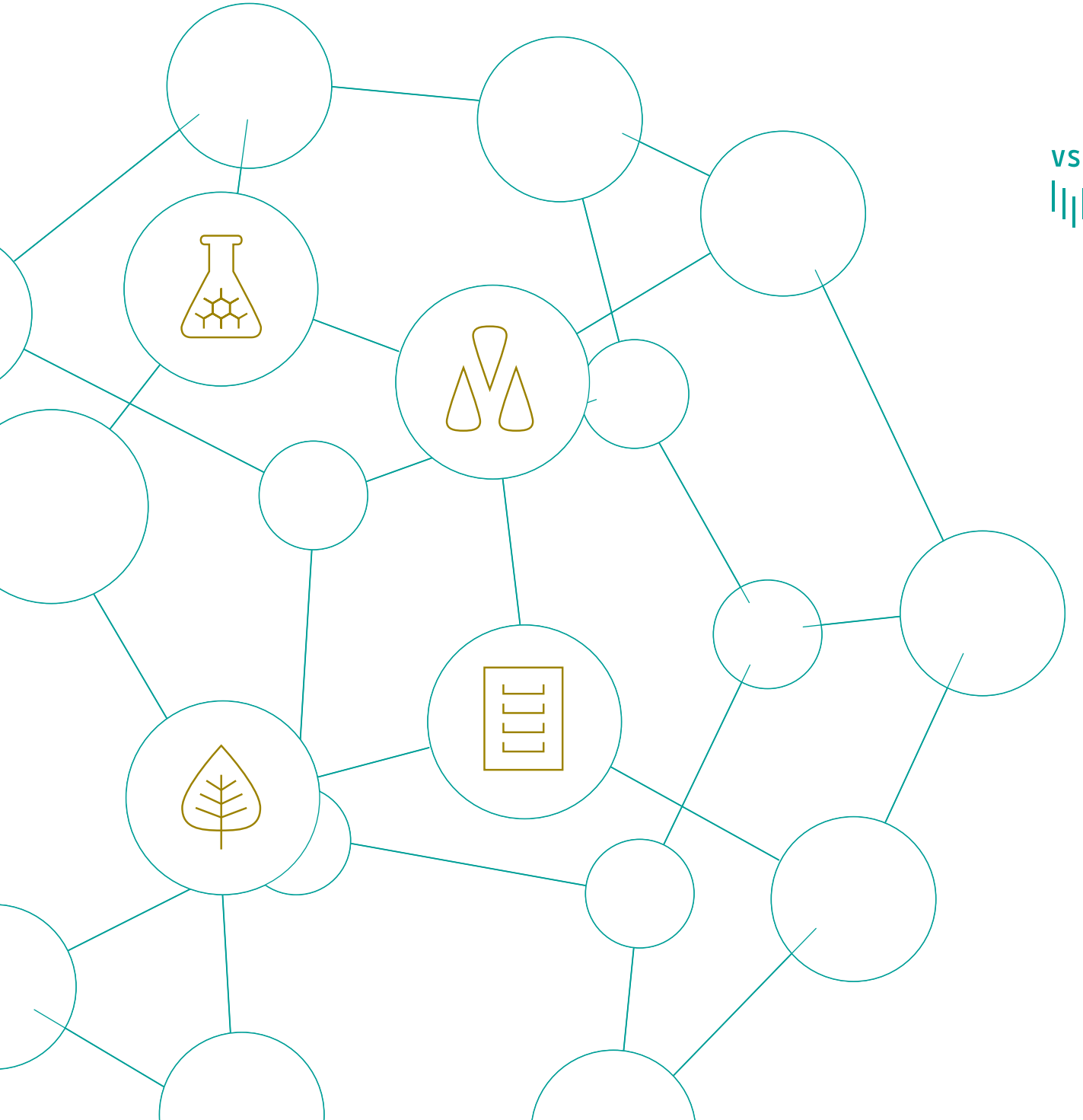
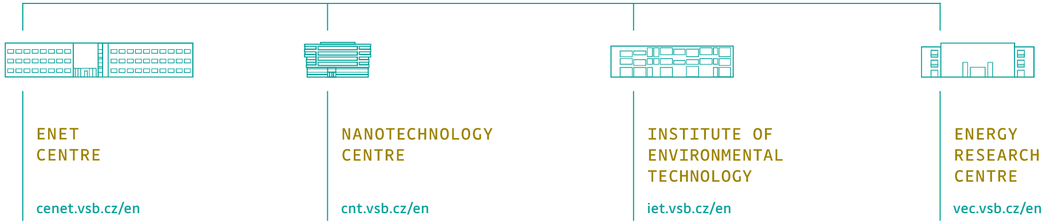


VSB TECHNICAL UNIVERSITY OF OSTRAVA | CENTRE FOR ENERGY AND ENVIRONMENTAL TECHNOLOGIES

2021 ANNUAL REPORT

VSB TECHNICAL UNIVERSITY OF OSTRAVA | CENTRE FOR ENERGY AND ENVIRONMENTAL TECHNOLOGIES

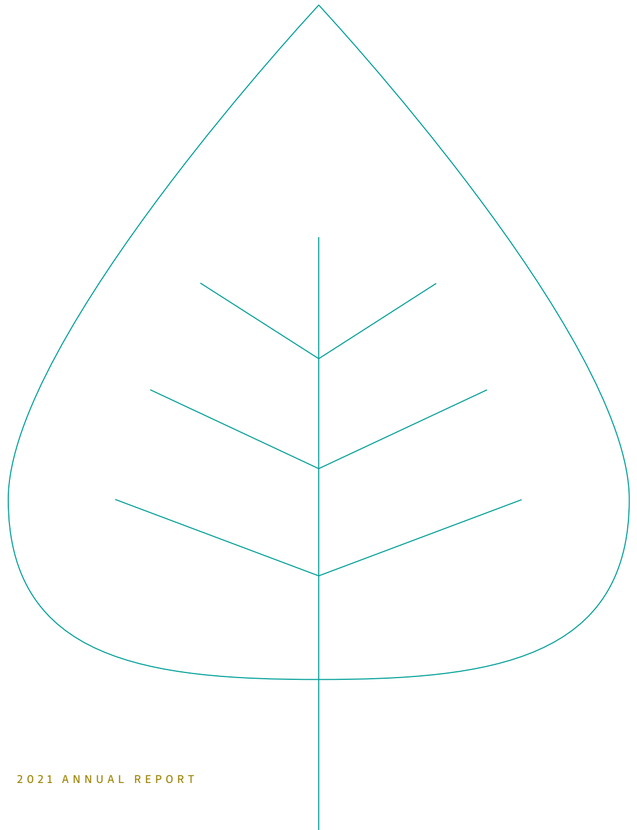


ENET CENTRE
cenet.vsb.cz/en

NANOTECHNOLOGY CENTRE
cnt.vsb.cz/en

INSTITUTE OF ENVIRONMENTAL TECHNOLOGY
iet.vsb.cz/en

ENERGY RESEARCH CENTRE
vec.vsb.cz/en



LETTER FROM THE DIRECTOR

prof. Ing.
Stanislav MIŠÁK, Ph.D.

Director

Dear friends and colleagues,

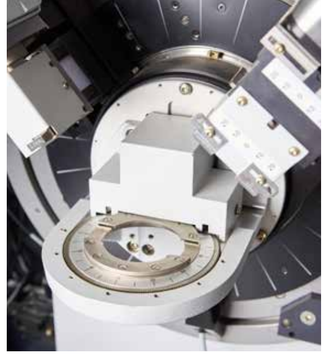
2021 was the first year of the CEET - Centre for Energy and Environmental Technologies operation. The Annual Report provides information on the activities, financial performance, and outputs of our joint work throughout the preceding year. CEET, which was established on January 1, 2021, after a merger of four university research institutes, i.e. the Nanotechnology Centre, the Energy Research Centre, the ENET Centre and the Institute of Environmental Technology, soon after the initial steps aimed at consolidating the new organisational structure, began to fulfil its vision to build a recognised university institute of the VSB-TUO devoted to the development of new technologies and materials for low-carbon and sustainable energy and environmental technologies in line with the principles of the circular economy. Our common denominator is energy transformation, a topic that cuts across all areas of our lives, from transport to industry and the environment. It is a topic of strategic importance, which is manifested by the current situation in the EU energy market, accented by the Russian-Ukrainian war conflict. Through our research, we want to provide advanced technologies and methods that will enable the Czech Republic to complete the energy transformation successfully, i.e. the transition from fossil fuels to clean energy solutions. An extremely important objective of our agenda must therefore be, in addition to the aforementioned transformation, energy self-sufficiency and raw material independence from countries with unstable geo-political environments. In practice, the application of these principles must aim to ensure a balance between policy measures, technological possibilities, and economic expectations. The research team of CEET is unique. It comprises more than 200 scientists dedicated to basic, oriented basic, and applied research who are competent to address energy issues in a truly comprehensive manner. Like the rest of the world, we are looking for emission-free sources. However, another important requirement is to find solutions that do not lead to the creation of additional waste and landfill demand. At the same time, the matter of reducing the pollutants already present in waste gases and air, as well as in water must be addressed. One of the key raw materials that our research activities focus on is hydrogen. Hydrogen solutions will help us, for instance, ensure partial energy self-sufficiency and raw material independence for some of the regions.

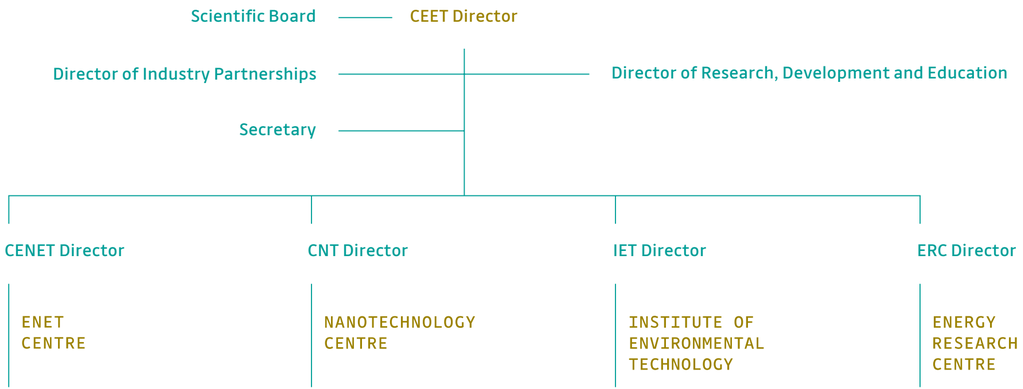
In the past year, we carried out the research projects initiated before the CEET was established, but at the same time, we launched new projects - REFRESH and the National Centre for Energy II (NCE II). Regarding basic research, we grew in the field of nanomaterials or renewable energy research, to name a few. The upcoming REFRESH project represents a great opportunity to focus on giving solutions to technological and societal challenges in the fields of renewable energy, environmental applications, transport and IT, and should be a springboard to transform and revitalize the landscape of the Moravian-Silesian region. The ambitious National Centre for Energy II project, submitted for funding in 2022, builds on the successfully completed NCE I. If accepted, it will enable us to manage a project of national importance over the next six years, based on synergistic cooperation between 9 leading Czech research and university institutions and more than 25 industrial partners on carefully selected sub-projects representing a wide range of current challenges in the field of non-nuclear energy.

The CEETe building (CEET - explorer), the construction of which started in 2021 and is due to be completed in September 2023 means a compelling achievement, but also a major commitment to the future. It will create a unique technological facility on the campus of VSB-TUO with a budget of approx. CZK 350 million designed for research on the conversion of alternative fuels and waste into useful forms of energy and their further usage.The past year of 2021 brought many challenges, in which CEET proved its firm place in the organisational structure of the VSB-TUO owing to the dedicated work of the passionate staff and talented scientists who have contributed to its development and operation. It is thanks to them that CEET had a significant share of more than 25% of the scientific output and stood at the very top in the university-wide comparison. The entire CEET team deserves my great thanks and sincere appreciation. I am convinced that working together under the CEET brand will enable us to achieve further success and the ambitious goals that we envision.

STRUCTURE OF THE MANAGEMENT

The Centre for Energy and Environmental Technologies (CEET) is a university institute of VSB - Technical University of Ostrava which was established on January 1, 2021, after a merger of the Nanotechnology Centre (CNT), the Energy Research Centre (ERC), the ENET Centre (CENET) and the Institute of Environmental Technology (IET).





CEET MANAGEMENT

CEET Director	prof. Ing. Stanislav Mišák, Ph.D.
Director of Research, Development and Education	prof. Ing. Lucie Obalová, Ph.D.
Director of Industry Partnerships	doc. Dr. Ing. Tadeáš Ochodek
Secretary	Mgr. Sylva Krčmářová
Administration Department	Bc. Lenka Nunvářová

CEET Directors (from left)
prof. Mišák / prof. Plachá / prof. Obalová / doc. Ochodek

CEET SCIENTIFIC BOARD

CEET Scientific Board Chairman	prof. Ing. Stanislav Mišák, Ph.D. (VSB-TUO)	
CEET Scientific Board Members	prof. Ing. Libor Čapek, Ph.D. (Univerzita Pardubice)	prof. Ing. Lucie Obalová, Ph.D. (VSB-TUO)
	doc. Dr. Ing. Tadeáš Ochodek (VSB-TUO)	prof. Ing. Daniela Plachá, Ph.D. (VSB-TUO)
	Ing. Petr Salvet (Vyncke s.r.o.)	prof. Ing. Václav Švorčík, DrSc. (VŠCHT Praha)

Research teams and laboratories

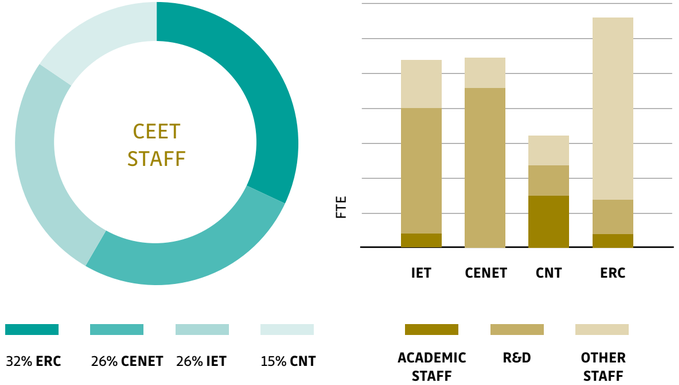
CEET
prof. Ing. Stanislav Mišák, Ph.D.

CNT prof. Ing. Daniela Plachá, Ph.D.	Laboratory of Inorganic Materials	prof. Ing. Jana Seidlerová, CSc.
	Laboratory of Organic and Hybrid Materials	prof. Ing. Daniela Plachá, Ph.D.
	Laboratory of Technology and Structure of Nanomaterials	doc. Ing. Gražyna Simha Martynková, Ph.D.
	Laboratory of Molecular Simulations and Functional Nanostructures	doc. Ing. Jonáš Tokarský, Ph.D.
	Materials-EnviLab	prof. RNDr. Radek Zbořil, Ph.D.
	Laboratory of Nanoparticulate Materials	prof. RNDr. Richard Dvorský, Ph.D.
	Laboratory of Physics of Nanostructures	Ing. Lukáš Halagačka, Ph.D.
CENET prof. Ing. Stanislav Mišák, Ph.D.	Laboratory of Thermochemical and Hydrogen Conversion	Ing. Najser Jan, Ph.D.
	Laboratory for Research of Energy By-products	prof. Ing. Helena Raclavská, CSc.
	Laboratory of Bulk Materials	prof. Ing. Jiří Zegzulka, CSc.
	Smart Grid Laboratory	doc. Ing. Lukáš Prokop, Ph.D.
IET prof. Ing. Lucie Obalová, Ph.D.	Laboratory of Anaerobic Digestion	Ing. Jiří Rusín, Ph.D.
	Laboratory of Heterogeneous Photocatalysis	prof. Ing. Kamila Kočí, Ph.D.
	Laboratory of Preparation of Nanostructured Materials	Ing. Lenka Matějová, Ph.D.
	Laboratory of Air Protection	Ing. Kateřina Pacultová, Ph.D.
	Laboratory of Thermochemical Processes	Ing. Pavel Leštinský, Ph.D.
	Laboratory of Waste Incineration	prof. Ing. Jozef Vlček, Ph.D.
	Laboratory of Water	Mgr. Martina Vráblová. Ph.D.
	Analytical Department	RNDr. Alexandr Martaus, Ph.D.
	Laboratory of Solid Residues	prof. Ing. Jozef Vlček, Ph.D.
ERC doc. Dr. Ing. Tadeáš Ochodek	INEF Centre - Innovation for Efficiency and Environment	doc. Dr. Ing. Tadeáš Ochodek
	Energy Services	Zdeněk Neufinger, MBA
	Operating Measurement	Ing. Karel Borovec, Ph.D.
	Testing Laboratory of Boilers	Ing. Jiří Horák, Ph.D.
	Project Administration	Ing. Jan. Koloničný, Ph.D.

EMPLOYEES

In 2021, the Centre for Energy and Environmental Technologies had a total of 275 employees, corresponding to an average headcount of 206.48 employees (FTE). Regarding the number of employees, CEET-ERC is the largest department constituting 32% of the total FTE, while CEET-CNT has the lowest number of personnel, i.e. 15% of the FTE.

The majority of CEET staff, 49% in total, were researchers. Academic staff accounted for 11% of all employees with the remaining 40% being other staff.



Men comprise 61.1% and women 38.9% of all employees, which is above average in terms of female workforce participation in Czech science. Employees aged 30-40 form the largest group of staff, which suggests that this is a young and progressive team. However, rather high percentage of employees in the age groups of 41-50 and 23-30 indicates an even distribution of potential for development in the coming years.

Employees by age group

23 - 30	13,1%
31 - 40	35,6%
41 - 50	30,5%
51 - 60	11,3%
61 - 70	5,1%
71 +	4,4%
total	100,0%

RESEARCH AND DEVELOPMENT

RESEARCH ACTIVITIES

MATERIALS FOR ENERGY AND ENVIRONMENTAL TECHNOLOGIES

ENERGY UTILISATION OF SECONDARY RAW MATERIALS AND ALTERNATIVE ENERGY SOURCES

ENERGY STORAGE, TRANSFORMATION AND MANAGEMENT

ENVIRONMENTAL ASPECTS AND TECHNOLOGIES

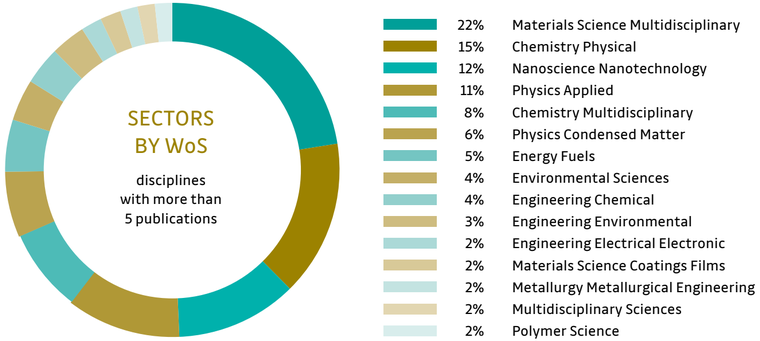
RESEARCH AND DEVELOPMENT OUTPUTS

CEET researchers and academics published a total of 195 peer-reviewed publications indexed in the WoS database in 2021. The distribution of publications by quartile shows that a full 93% of papers were published in journals in the first and second quartiles. The fact that more than 30% 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
195	61 (31,2%)	137 (70,2%)	46 (23,6%)	10 (5,1%)	2 (1,0%)	1,6

Source:
the Web of Science, as of March 8, 2022,
Central Library of VSB-TUO.

Sectors with the best publication record include materials science, physical chemistry, nanoscience and nanotechnology, chemistry, physics, energy and fuels, environmental sciences, chemical engineering and electrical engineering.



A number of papers published in 2021 have been noticed in the scientific community. The following section lists peer-reviewed articles with citations of 20 or more (citations as of April 22, 2022, source WoS).

Authors	Title	Journal title, IF	Citations, field (WoS)
W. Wang, J. Pang, J. Su, F. Li, Q. Li, X. Wang, J. Wang, B. Ibarlucea, X. Liu,Y. Li, W. Zhou, K. Wang, Q. Han, L. Liu, R. Zang, M.H. Rümmeli,Y. Li, H. Liu, H. Hu,G. Cuniberti,	Applications of nanogenerators for biomedical engineering and healthcare systems	InfoMat IF 25,4	98 citations Materials Sciences Multidisciplinary
B. Singh,V. Sharma, R.P. Gaikwad, P. Fornasiero, R. Zbořil, M.B. Gawande	Single-Atom Catalysts: A Sustainable Pathway for the Advanced Catalytic Applications	Small IF 13,281	35 citations Physical Chemistry, Materials Science Multidisciplinary, Applied Physics
Q.T. Shi, J.H. Zhou, S. Ullah, X.Q. Yang, K. Tokarska, B. Trzebicka, H.Q. Ta, M.H. Rümmeli	A review of recent developments in Si/C composite materials for Li-ion batteries	Energy Storage Materials IF 17,789	31 citations Physical Chemistry, Multidisciplinary Materials Science and Nanoscience and Nanotechnology
G. Asimakopoulos, M. Baikousi, C. Salmas, A.B. Bourlinos, R. Zboril, M.A. Karakassides	Advanced Cr(VI) sorption properties of activated carbon produced via pyrolysis of the "Posidonia oceanica" seagrass	Journal of Hazardous Materials IF 10,588	21 citations Environmental Engineering and Environmental Sciences
T. Gonet, B.A. Maher, J. Kukutschová	Source apportionment of magnetite particles in roadside airborne particulate matter	Science of The Total Environment IF 7,963	20 citations Environmental
H. Stančina, M. Šafář, J. Růžičková, H. Mikulčića, H. Raclavská, X. Wang, N. Duića	Co-pyrolysis and synergistic effect analysis of biomass sawdust and polystyrene mixtures for production of high-quality bio-oils	Process Safety and Environmental Protection IF 6,158	20 citations Chemical Engineering, Environmental Engineering

A selection of 10 articles from the portfolio of research topics addressed in CEET that have been published in journals in the 1st decile of the field:

Authors	Title	Journal title, IF	Field
J. Ruzickova, S.Koval, H. Raclavska, M. Kucbel, B. Svedova, K. Raclavsky, D. Juchelkova, F. Scala	A comprehensive assessment of potential hazard caused by organic compounds in biochar for agricultural use	Journal of Hazardous Materials IF 10,588	Environmental Engineering, Environmental Sciences
M. Filip Edelmannová, M.M. Ballari, M. Pribyl, K. Kočí	Experimental and modelling studies on the photocatalytic generation of hydrogen during water-splitting over a commercial TiO2 photocatalyst P25	Energy Conversion and Management IF 9,709	Energy & Fuels, Mechanics, Thermodynamics
J. Ruzickova, H. Raclavska, M. Safar, M. Kucbel, B. Svedova, K. Raclavsky, D. Juchelkova, F. Scala, P. Kantor	Environmental risks related to organic compounds from the combustion of paper briquettes in domestic boilers	Journal of Hazardous Materials IF 10,588	Environmental Engineering, Environmental Sciences
D.A. Giannakoudakis, I. Anastopoulos M. Barczak, E. Antoniou, K. Terpilowski, E. Mohammadi, M. Shams, E. Coy, A. Bakandritsos, I.A. Katsoyiannis, J.C. Colmenares, I. Pashalidis	Enhanced uranium removal from acidic wastewater by phosphonate-functionalized ordered mesoporous silica: Surface chemistry matters the most	Journal of Hazardous Materials IF 10,588	Environmental Engineering, Environmental Sciences
P. Basinas, J. Rusin, K. Chamradova	Assessment of high-solid mesophilic and thermophilic anaerobic digestion of mechanically-separated municipal solid waste	Environmental Research IF 6,498	Public, Environmental & Occupational Health
S. Górecka, K. Pacultová, A. Smýkalová, D.Fridrichová, K.Górecki, A. Rokicińska, P.Kuśtrowski, R.Žebrák, L.Obalová	Role of the Cu content and Ce activating effect on catalytic performance of Cu-Mg-Al and Ce/Cu-Mg-Al oxides in ammonia selective catalytic oxidation	Applied Surface Science IF 6,707	Material Sciences, Coatings & Films
R. Škuta, V. Matějka, K. Foniok, A. Smýkalová, D. Cvejn, R. Gabor, M. Kormunda, B. Smetana, V. Novák, P. Praus	On P-doping of graphitic carbon nitride with hexachlorotriphosphazene as a source of phosphorus	Applied Surface Science IF 6,707	Materials Science, Coatings & Films
L. Bardoňová, A. Kotzianová, K. Skuhrovcová, O. Žídek, T. Bártová, J. Kulhánek, T. Hanová, K. Mamulová Kutláková, H. Vágnerová, H., V. Krpatová, M. Knor, J. Starigazdová, P. Holomková, R. Buffa, V. Velebný	Antimicrobial nanofibrous mats with controllable drug release produced from hydrophobized hyaluronan	Carbohydrate Polymers IF 9,381	Polymer Sciences, AppliedChemistry, Organic Chemistry
M. Vojtíšek-Lom, M. Vaculík, M. Pechout, F. Hopan, A. Arul Raj, S. Penumarti, J. Horák, O. Popovicheva, J. Ondráček, B. Doušová	Effects of braking conditions on nanoparticle emissions from passenger car friction brakes	Science of the Total Environment IF 7,963	Environmental Sciences
E. Olšovská, J. Tokarský, J. Michalička, K.Mamulová Kutláková	Simple and fast method for determination of preferred crystallographic orientation of nanoparticles: A study on ZnS/kaolinite nanocomposite	Applied Surface Science IF 6,707	Materials Science, Coatings & Films

In 2021, CEET produced a total of 48 research outputs, including 5 international patent applications:

L. Obal,
J. Korpas,
L. Blahout,

Combined microparticle impactor,

PCT/
CZ2021/050065

L. Zápotocký,
R. Žebrák,
M. Reli,
T. Prostějovský,
K. Kočí,

Method of degradation of volatile organic compounds in waste air,

PCT/
CZ2021/050057

F. Madry,
D. Riemel,
T. Výtisk,
J. Rusín,

A pulse detonation engine and a biogas energy recovery unit,

PCT/
CZ2021/050064

O. Němček,
J. Frantík,
J. Najser,
V. Peer,

A reactor for processing biomass by torrefaction,

PCT/
CZ2021/050110

O. Černý,
S. Honus,

Method for determining an energy consumption for heating or cooling of apartments,

PCT/
CZ2021/050001

Source:
Internal materials of the R&D Commercialisation Unit - Intellectual Property Protection, 2021, as of 9 February 2022.

Patent / application	7
Utility model / application	8
Industrial design / application	3
Specialised maps	2
Software	2
Function sample	8
Verified technology	1
Pilot plant	5
Prototype	12
Total	48

RESEARCH AND DEVELOPMENT PROJECTS

In 2021, a total of 65 national and 17 international research projects and project grants were carried out at individual CEET departments, and the financial support obtained through the funding accounted for 64% of the CEET budget.

NATIONAL CENTRE FOR ENERGY

Project number:
TN01000007

The objective of the National Centre for Energy (NCE) is to stimulate long-term cooperation among the leading research organizations and major application entities in the power industry. This way, unique infrastructures and know-how of expert teams of the existing research centres will be shared through the implementation of applied research sub-projects.

The research agenda of NCE is in line with the National RIS3 Strategy and focuses on Efficiency, reliability and safety of energy units, Alternative sources of energy and waste, and Power grids.

Implementation period: 2019-2022

Provider: Technology Agency, National Centres of Competence, 2018-2022

Principal investigator:
Mišák Stanislav prof.Ing., Ph.D.

Meeting of project researchers with representatives of the application sphere and TA CR, 5 October 2021 at the campus of VSB-TUO. Photo: T. Sláma

ENREGAT - ENERGY WASTE RECOVERY AND GAS TREATMENT

Project number: LM2018098

ENREGAT represents a unique base for the implementation of comprehensive research in the field of material and energy recovery of waste by means of combustion, pyrolysis and anaerobic processes, as well as in the field of catalytic, sorption and photocatalytic cleaning of the resulting gases. In addition, ENREGAT also allows research in related areas, for example the resistance of refractory materials used in waste incineration, material utilization of slag and fly ash, possibilities of using pyrolysis products and analytical services.The uniqueness of ENREGAT infrastructure lies in the ability to perform basic and applied research focused on several waste-to-energy technologies from the laboratory up to pilot plant scale for a wide range of waste and thus to assess the suitability of the technology for the selected type of waste. Additionally, it allows research on a number of technologies for the abatement of different gaseous pollutants (e.g. nitrogen oxides, carbon dioxide, organic substances) through laboratory tests up to pilot scale verification for waste incineration, which is available here. In December 2018, the Czech government endorsed the including of ENREGAT in the Czech Roadmap of Large Infrastructures for Research, development and Innovation. Thanks to the targeted support of large infrastructures by the Ministry of Education, Youth and Sports, ENREGAT RI is available in open access mode for wide scientific community since 2019.

Implementation period: 2019-2022

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

Principal investigator:
Obalová Lucie prof. Ing., Ph.D.

RESEARCH ON THE IDENTIFICATION OF COMBUSTION OF UNSUITABLE FUELS AND SYSTEM OF SELF-DIAGNOSTICS OF BOILERS COMBUSTING SOLID FUELS FOR DOMESTIC HEATING

Project number:
CZ.02.1.01/0.0/0.0/18_069/0010049

The project examines solid pollutant emissions from small combustion plants (mainly up to 30 kW) intended for household heating. The aim of the project is to carry out the research on measures (technical and organisational) to reduce dust emissions through an effective mechanism to control the combustion of unsuitable fuels (research objective 1) and appropriate boiler self-diagnostics to monitor the correct combustion process (research objective 2). A team of researchers and technicians from three R&D centres of VSB-TUO will contribute to achieve the objectives. An integral part of the project is cooperation with the application sphere in order to obtain incentives for better applicability of the project outputs in practice, providing feedback from experimental verification, mutual knowledge transfer and future commercialization of the achieved outputs.

Implementation period: 2019-2022

Provider: the Ministry of Education, Youth and Sports, OP VVV Excellent Research

Principal investigator:
Ochodek Tadeáš doc. Dr. Ing.

RESEARCH CENTRE FOR LOW-CARBON ENERGY TECHNOLOGIES

Project number:
CZ.02.1.01/0.0/0.0/16_019/0000753

The key aspect of the project is to exploit the potential of the research centre to achieve internationally competitive research quality. The research aims at CO_2 capture from combustion processes (CCS-carbon capture and storage) with the biomass usage - the so-called Bio-CCS, or the utilisation of captured CO_2, the so-called Bio-CCU. The research investigates oxyfuel combustion of different types of biofuels in fluidised bed, which appears to be the most promising regarding new devices, and the entire technological chain associated with the process, including oxygen production. Another significant research direction is the oxy- gasification of biomass. The project also examines technologies for the utilisation of captured CO_2 for liquid fuel production.

Implementation period: 2018-2022

Provider: the Ministry of Education, Youthand Sports, OP VVV Excellent Research

Principal investigator:
Čech Bohumír doc. Dr.Ing.

INSTITUTE OF ENVIRONMENTAL TECHNOLOGIES

Project number:
CZ.02.1.01/0.0/0.0/16_019/0000853

The aim of the project is to promote selected research activities, support and strengthen research teams, and develop the infrastructure of the IET Research Centre in order to increase its competitiveness and excellence. The key focus lies on the waste to energy process, where the research aims 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 is the pollutant reduction in the environment which focuses on the preparation of surfactant materials for environmental applications, the purification of waste gases by catalytic and sorption processes, the photocatalytic removal of pollutants in the gas phase, and the investigation of methods for the detection and removal of pollutants from surface and wastewaters.

Implementation period: 2018-2022

Provider: the Ministry of Education, Youth and Sports, OP VVV Excellent Research

Principal investigator:
prof. Ing. Prof. Lucie Obalová, Ph.D.

CONTROL OF ELECTRONIC PROPERTIES OF METAL-CONTAINING MOLECULES THROUGH THEIR NONCOVALENT INTERACTIONS WITH SOLVENTS, LIGANDS AND 2D NANOSYSTEMS

Project number: GX19-27454X

The project focuses on the development of new materials that, through noncovalent interactions with metal-containing molecules, allow to control and modify their structural and electronic properties. Modifications include (i) physisorption of transition metal molecules onto 2D nanostructures (graphene and N, B and S atom doped graphene), (ii) interaction with different polar solvents, and (iii) interaction with different ligands. Each of the options, as well as their combination will enable the targeted design of new molecular systems suitable for applications.The usage of 2D surfaces, solvents, and various ligands that can control the electrical, magnetic, and optical properties of small molecules through noncovalent interactions represents an unexplored area of material chemistry and an alternative to existing methods based on the utilisation of strong erexternal influences such as temperature, pressure, and UV radiation. The nature of the processes that lead to spin changes due to physisorption, interaction with solvents, and various ligands will be studied simultaneously using advanced theoretical and experimental methods.

Implementation period: 1.1.2019-31.12.2023

Provider: the Grant Agency of the Czech Republic

Principal investigator:
prof. RNDr. Radek Zbořil, Ph.D.

Projects implemented in 2021

TECHNOLOGY AGENCY OF THE CZECH REPUBLIC

- Reaction Vessel Development for Cultivation Algae with grow light LED using Carbon Dioxide from Biogas.
- Elimination of trichlorethylene from production of ammonium sulphate.
- Non-contact partial discharge detector for HV distribution lines
- Optimization of the electrical distribution system operating parameters using artificial intelligence
- Identification of dust particles in street dust and technological measures to reduce emitted street dust in the cities
- Research and optimization of production process and mechanical properties of raw materials in magnetic hard ferrites production.
- Problems and impacts of the use of solid alternative fuels
- Research on the potential of hydrogen technologies for transformation of energy mix of Moravian-silesian region (MSK), low-carbon energy and development of low-emission mobilityResearch on the potential of hydrogen technologies for transformation of energy mix of Moravian-silesian region (MSK), low-carbon energy and development of low-emission mobility
- Research and realization of prototype of a multifunctional mobile autonomous hybrid energy container of heat pumps air / water - water , with progressive autonomous energy management
- Energy System for Grids
- Centre for Energy and Environmental Technologies
- Research and development of processes of coke oven gas conversion to hydrogen and alternative fuel
- National Centre for Energy

MINISTRY OF EDUCATION, YOUTH AND SPORTS

- Infrastructure support of scientific education of doctoral students at CNT VSB-TUO
- Infrastructure support of strategic studying programme at CNT VSB-TUO
- Professional competences of graduates as an opportunity to work in the construction sector on the cross-border labor market (AZBEST)
- DRONE EXPERT - specialized training for students
- SUWAT: Cross-border cooperation in the monitoring of chemical and radiation contamination of surface waters by mine waters.
- Research centre for low-carbon energy technologies
- IET-Excellent research
- Advanced Mechatronic Systems Research Centre
- Support of cross-sectoral cooperation in the field of environmental pollutants reduction and waste recovery
- Research on the identification of combustion of unsuitable fuels and systems of self-diagnostics of boilers combusting solid fuels for domestic heating
- Doctoral grant competition VSB-TUO
- Energy Waste Recovery and Gas Treatment - ENREGA
- Innovation of educational programs in the field of power engineering
- Innovation for energy sources
- Experimental study of chemical syntheses
- Use of catalysts to reduce emissions from the combustion of waste biomass
- Development of photocatalysts based on nanostructured layered double hydroxides for photocatalytic reduction of carbon dioxide in the presence of UV (UVC UVA) radiation
- Development of smart materials with the additive manufacturing for high-performance systems
- ERC Excellent team
- Scientific - research cooperation on development of eco-transport in Czech-Polish cross boarder area

MINISTRY OF INDUSTRY AND TRADE

- New construction platform of fireplace insert with pyrolysis combustion
- Methodology and system solution when applying the standard ISO 50001
- Development of a new type of interior stoves in low energy and passive houses
- Pellet stove with a healthy radiant heat storage function and automatic combustion control
- Technology for optimal thermal treatment of automotive waste
- Separation of RAP - ekological application
- Centre for Energy and Environmental Technologies - Explorer
- Development of a solid fuel stove with ceramic lining and temperature control for baking Smart HeatDevelopment of a solid fuel stove with ceramic lining and temperature control for baking Smart HeatDevelopment of a solid fuel stove with ceramic lining and temperature control for baking Smart Heat
- Research and development of a low-emission boiler without electrical connection working on the principle of biomass gasification
- Research and development of technology for the production of solid alternative fuel (TAP) from waste components of car wrecks and electrical equipment, or other wastes for ecological combustion in external energy installations
- Control system for bi-directional power flow between battery electric vehicle and microgrid - critical infrastructure support
- Development of a test unit for the disposal of sewage sludge
- Small-scale ORC unit with special expanders
- Research and Development of SMART business management Apllication
- Common Actuator Controller
- Photonic structures in safety holograms (Modelling and design of photonic structures for safety holograms)
- Continual purification of crude Caprolactam
- Intelligent hybrid heat source with an output of up to 100 kW
- Optimization of process intelligence of parking system for Smart City
- Electromobility in ERC

GRANT AGENCY OF THE CZECH REPUBLIC

- Non-metal doped nanostructures of graphitic carbon nitride for photocatalytic reactions
- Heterojunction photocatalysts and simultaneously metal and non-metal doped TiO2 photocatalysts for environmental photocatalytic reactions
- Control of electronic properties of metal-containing molecules through their noncovalent interactions with solvents, ligands and 2D nanosystems
- CO_2 transformation to valuable chemicals by catalytic and photocatalytic ways over highly active materials

OTHER MINISTRIES

- Optimization of sludge treatment technology from municipal wastewater treatment plants with regard to their chemical and microbial composition and ability to retain water with the aim of their safe use on agricultural and forest land
- Modern ecological transport at the ERC
- Comprehensive risk reduction of disasters of epidemiological, natural and technical character by building resilience at the local level

MORAVIAN-SILESIAN REGION

- Operation of IIS - Intelligent Identification System of Air Pollution Sources
- Research Infrastructure - Centre for Energy and Environmental Technologies - Explorer

INTERNATIONAL GRANTS

- Joint supervision of doctoral studies by VSB-Technical university of Ostrava and the Norwegian University
- Mobility of joint doctoral studies in the field of ellipsometry of advanced nanostructures
- 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
- Harmonizing reliable test procedures representing real-LIFE air pollution from solid fuel heating appliances
- Environmental Safety of Biosolids in the Circular Economy - EnviSafeBio
- i-AIRPs Identification of causes of air pollution on the Czech-Polish border
- CLear AIR and Climate Adaptation in Ostrava and other cities
- aLIFEca - Virtual Open Course of Automotive Life Cycle Assessment
- Low carbon technologies
- The impact of traffic on air pollution within the TEN-T route Ústí nad Labem - Mělník - Zdiby

SELECTED INTERNATIONAL R&D PROJECTS

ENVIRONMENTAL SAFETY OF BIOSOLIDS IN THE CIRCULAR ECONOMY -ENVISAFEBIO

Programme:
NAWA (THE POLISH NATIONAL AGENCY FOR ACADEMIC EXCHANGE)
Project number: PDI/APM/2018/1/00029/U/001
Implementation period: 01/02/2019 -31/12/2021
Principal investigator:
prof. Ing. Prof. Helena Raclavská, CSc.

I-AIRP'S IDENTIFICATION OF CAUSES OF AIR POLLUTION ON THE CZECH-POLISH BORDER

Programme:
FM EEA/Norway (NF Call 2A - 3.2.1.1, Call: Tromso - Air quality monitoring, source identification and development of action plans)
Project number:
SFZP 016204/2021
Implementation period:
1/4/2021-30/4/2024
Principal investigator:
Mgr. Jiří Bílek, Ph.D.

LOW CARBON TECHNOLOGIES

Programme:
International Visegrad FundGrant No. 22030137
Project number: 22030137
Implementation period:
1/2/2021 - 1/2/2022
Principal investigator:
Ing. Jan Najser, Ph.D.

SUWAT: CROSS-BORDER COOPERATION IN MONITORING CHEMICAL AND RADIATION CONTAMINATION OF SURFACE WATER BY MINE WATER

Programme:
INTERREG V-A Czech Republic - Poland
Project Number:
CZ.11.4.120/0.0/0.0/17_028 /0001633
Implementation period:
2019-2021
Principal investigator:
doc. RNDr. Václav Dombek, CSc.

JOINT SUPERVISION OF DOCTORAL STUDIES BY VSB-TECHNICAL UNIVERSITY OF OSTRAVA AND THE NORWEGIAN UNIVERSITY

Programme:
Project Aktion
Project number:
EHP-EN-ICP-1-013
Implementation period:
2019-2021
Principal investigator:
doc. Dr. Mgr. Kamil Postava

MOBILITY OF JOINT DOCTORAL STUDIES IN THE FIELD OF ELLIPSOMETRY OF ADVANCED NANOSTRUCTURES

Programme:
Aktion Project
Project number: EHP-EN-MOP-2-013
Implementation period:2020-2021
Principal investigator:
doc. Dr. Mgr. Kamil Postava

DESIGN OF NOVEL ANTIMICROBIAL BIOBASED MATERIALS USING SUPERCRITICAL FLUIDS PROCESSES

Programme:
CSIC Programme i-LINK+ 2020
Project number: LINKA2036
Implementation period:
2021-2022
Principal investigator:
prof.Ing. Daniela Plachá, Ph.D.

HARMONISING RELIABLE TEST PROCEDURES REPRESENTING REAL-LIFE AIR POLLUTION FROM SOLID FUEL HEATING APPLIANCES

Program:
EU - Programme, LIFE sub- programme: Support for testing procedures for air pollutants from solid fuel heating appliances
Project number:
LIFE20PRE/ FI/000006
Implementation period:
01/05/2021 - 30/04/2024
Principal investigators:
UEF - University of Eastern Finland, TFZ - Technology and Support Centre in the Centre, VSB - Technical University of Ostrava, INERIS - Institut national de l'environnement industriel et des Risques

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

Project Number:
UIA03-123
Implementation period:
11/2018 - 4/2022
Principal investigator:
the Statutory City of Ostrava
Partners: VSB-TUO, IET (Mgr. Jiří Bílek, Ph.D.), Moravian-Silesian Region, Silesian University in Opava, Palacký University, Regional Association of Territorial Cooperation of Těšín Silesia, SOBIC Smart & Open Base for Innovations in European Cities and Regions, z.ú.

ADVANCED ENGINEERING AND RESEARCH OF AERO-GELS FOR ENVIRONMENT AND LIFE SCIENCES

Programme:
COST
Project Number: CA18125
Implementation period:
4/2019 - 4/2023
Principal investigator(s):
Dr. Carlos and Garcia Gonzalez - Universidad de Santiago de Compostela, prof. Ing. Kamila Kočí, Ph.D. (VSB- TUO)

AMMONIA AND GREENHOUSE GASES EMISSIONS FROM PRODUCTION BUILDING

Programme:
COST
Project Number: CA16106
Implementation period:
3/2017 - 9/2021
Principal investigators:
Dr. Guoqiang Zhang, Aarhus University, Denmark, prof. Ing. Prof. Kamila Kočí, Ph.D. (VSB-TUO)

SYNTHESIS OF CARBON QUANTUM DOTS FROM AGRO-INDUSTRIAL RESIDUAL BIOMASS BY HYDROTHERMAL CARBONIZATION AND/OR MICROWAVE RADIATION USING TECHNICALPROPERTIES SUITABLE FOR BIOMOLECULE TRANSPORT

Program:
FONDECYT
Project Number: 398-2019
Implementation period:1/2020 - 4/2022
Principal investigator:
prof. Carlos A. Canepa La Cotera - National University of Tumbes, Peru
Co-investigator: Ing. Lenka Matějová, Ph.D. - VSB-TUO, Prof. J.L.Solis - National University of Engineering in Lima, Peru, INCA BIOTEC S.A.C., Peru, Dr. F.V. Samanamud - National University of Trujillo, Peru

EDUCATION

The academic and scientific staff of CEET maintain long- term teaching cooperation with the Faculty of Mining and Geology (HGF), Faculty of Safety Engineering (FBI), Faculty of Electrical Engineering and Informatics (FEI), Faculty of Materials Technology (FMT) and Faculty of Engineering (FS). They provide lectures, tutorials and laboratory exercises in bachelor's, master's and doctoral degree study programmes, e.g. Chemical and Environmental Engineering (FMT), Nanotechnology (FMT), Thermal Engineering and Fuels in Industry (FMT), Electrical Power Engineering (FMT), and (FEI), Safety Engineering (FBI), Operation of Power Equipment (FS), Environmental Engineering (FS), etc. In 2021, the Nanotechnology Centre provided its own University Study Programmes (USP) for all three types of degree programmes. At the end of 2021, the bachelor's and master's degree study programmes in Nanotechnology were definitively discontinued, they will be further conducted at the FMT in collaboration with the CNT. In 2021, most CEET staff were involved in teaching at the FMT and within the USP.

CEET staff involved in teaching and supervising final theses of students of bachelor's and master's degree study programmes in 2021:

Faculty of VSB-TUO	CEET employees involved in teaching	CEET employees supervising theses
HGF	5	2
FBI	2	3
FEI	6	4
FMT	17	22
FS	6	8
University study programmes	9	2

In 2021, a total of 20 bachelor's and master's theses were submitted successfully at CEET, of which 7 at the FMT, 4 at the FS and 3 theses, 9 in total, passed the defence at the HGF, FEI and CNT (USP). CEET also provides education for young scientists - students of doctoral studies.

A total of 33 doctoral students worked on their dissertations under the supervision of CEET researchers and academic staff. The students are supported by, for instance, the project OP VVV CZ.02.2.69/0.0/0.0/19_073/0016945, Doctoral Grant Competition. A total of 4 students passed their dissertations under the supervision of CEET staff.

Dissertations supervised by CEET staff in 2021:

Student	Supervisor	Thesis title	Defence	Workplace
Ing. Kateřina Škrlová, Ph.D.	prof. Ing. Daniela Plachá, Ph.D.	Biodegradable polymeric materials with antimicrobial effects suitable for medical applications	12.01.2021	CNT
Ing. Aleš Richter	doc. Dr. Ing. Tadeáš Ochodek	Decentralized system of electricity production with accumulation	24.02.2021	ERC
Ing. Oleksandr Molchanov	doc.Dr. Ing. Tadeáš Ochodek	Reduction of emissions of solid pollutants from heating units by electrostatic method	24.02.2021	ERC
Ing. Ibrahim Salem Jahan	prof. Ing. Stanislav Mišák, Ph.D.	Control system for electrical power grids with renewables using artificial intelligence methods	16.06.2021	CENET

In total, 89 students worked at CEET in 2021, addressing their bachelor's, master's and dissertation theses, the topics of which were focused on the research topics of the individual CEET research centres and were part of the projects carried out at CEET. Overview of the number of students working at CEET centres in 2021:

CEET Departments/Faculties	FMT	FEI	FS	HGF	USP	Total
CENET	1	2	4	6		13
CNT	24				4	28
IET	37			3		40
ERC			8			8
Total	62	2	12	9	4	89

Werner von Siemens Prizes

In 2021, two students of VSB-TUO received the Werner von Siemens Prize for their diploma theses, both of which were processed at CEET

Student	Supervisor	Location	Title of thesis	Type of thesis	Award
Ing. Martin Kosinka	Ing. Zdeněk Slanina, Ph.D.	CENET	V2H (Vehicle toHome) control system	Diploma thesis	2nd place, Werner von Siemens Prize
Ing. Lenka Bardoňová	doc. Mgr. Kateřina Mamulová Kutláková	CNT	Nanofibrous layer containing clay minerals preparation by electrostatic softening	Diploma thesis	3rd place, Werner von Siemens Prize

CEET also promotes student mobility and cooperation with institutions abroad. Four students were supported in 2021.

Student	Workplace	Internship period	Location
Daniel Vala	CNT	Jan-Feb 2021	University Trondheim, Norway
Zuzana Vilamová	CNT	Jul 2021	University of Porto, Portugal
Jakub Zágora	CNT	Sep-Dec 2021	ICTP-CSIC Madrid, Spain
Ing. Filip Kovár	IET	Sep 2021	Institute of Materials Research at the Slovak Academy of Sciences, Košice, Slovak Republic

COOPERATION

Science - industry cooperation and collaboration with municipalities and other organisations can be divided into two categories. The first level of collaboration consists of joint research and development projects - the list of which is provided in the chapter on Research and Development Projects and is funded by grant agencies. The second level of cooperation comprises contract research and other services (e.g. activities of accredited laboratories, consultancy and expert activities, etc.). These activities are carried out based on contracts for work and are financed directly by contracting companies, municipalities, and other entities (e.g. banks). Through cooperation with the public sector and industrial partners in various fields, mainly through contract research and joint research projects, the potential of the research teams, technological facilities, and equipment of CEET were efficiently exploited in 2021, thus ensuring the desired technology transfer from the scientific to the commercial sphere.

In the matter of contract research, thanks to long-term cooperation with individual industrial partners, CEET as a whole is very successful and the funds raised allow us to develop human resources, supplement instrumentation and maintain technical infrastructure. The current requirements and needs of industrial partners and associates in many areas exceed the Institute's capacity. In the pursuit to meet their needs, we are facing a shortage of employees not only at the workplaces of individual research centres, but also in the labour market in general.

The dominant aspects of cooperation include the development of new technologies and products for electricity and heat production, specialized measurements and tests, efficient storage including energy flow control, electromobility, power grid issues, safety in the energy sector, design activities, analytical work, and others. Cooperation with external entities within the contract research and additional activities accounted for a total of CZK 87.57 million, representing almost a quarter of the CEET total annual budget.

* Amounts in mill. CZK

Research Centre	Contract Research	Other Activities	Total
CENET	13,68	0,88	14,56
CNT	0,70	1,29	1,99
IET	3,74	0,00	3,74
ERC	61,66	5,61	67,27
Total CEET	79,78	7,79	87,57

RESEARCH AND ACTIVITIES CARRIED OUT IN DIFFERENT FIELDS ACCORDING TO THE FOCUS OF RESEARCH CENTRES

Research Centre	Fields
CENET	Analyses, studies, specialised measurements and tests focused on the efficient deployment and operation of decentralised energy sources, the use of alternative fuels or waste, efficient energy storage and flow control, alternative fuel vehicles, etc.
CNT	Activities of accredited laboratory, research in the field of batteries, strength testing in hydrogen environment, material research
IET	Analytical work, tests on process apparatus, consulting and expert activities, activities of accredited laboratory.
ERC	Activities of accredited laboratory, development of products for heating, design activities, authorized emission measurements,consulting and expert activities, paid educational programmes.

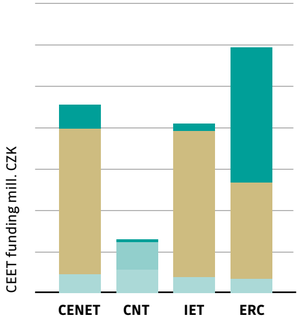
In 2021, the topic of hydrogen, its production methods and possibilities of utilisation in industry and transport came to the forefront of interest of companies, regions, and municipalities. Not only for this reason, hydrogen is the subject of CEET's joint research activities. The attractiveness of this topic is evidenced by the Memorandum of Mutual Cooperation on the Development of Hydrogen Technologies signed in 2021 between CEET and Veolia, through which CEET will participate in research projects related to the production of green hydrogen in Veolia's heating plants, or cooperation with the Moravian-Silesian Region on joint projects in the field of hydrogen technology research.

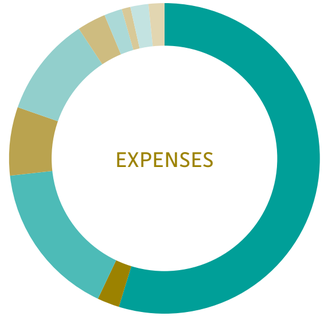
FINANCIAL PERFORMANCE

The income of CEET comprises funding from national and international grants, contract research, and institutional sources.

- Subsidies and grant funding
- Income from supplementary activities, own resources
- Long-term conceptual development of the research organization (LCDRO)

	mill. CZK
Subsidies and grant funding	220,2
Income from supplementary activities, own resources	83,4
LCDRO	38,9
Total	**342,5**





Individual cost items:

55%	Personal costs
2%	Scholarships
16%	Services, subcontracting
7%	Consumption, material costs
10%	Overhead costs
3%	Investments
2%	Maintenance
1%	Travel
2%	Other
2%	Transfer to funds

SIGNIFICANT EVENTS

CEET organised a number of events in 2021:

CEET WORKSHOP

January 16, 2021

VSB-TUO Campus

Held online

Number of participants: 190 online

The main objective of the CEET workshop was to bring together all associates within the individual CEET research centres and research teams, to get to know each other, and to present their laboratories, research activities, and outputs to date.

NANOOSTRAVA 2021

May 17-20, 2021

International conference

Held online

Organisers: doc. Simha Martynková, Ph.D., prof. Ing. Daniela Plachá, PhD., Ing Čech Barabaszová, Ph.D., Ing. Sylva Holešová, Ph.D.

Number of participants: 120+

Participants: experts, academics, students and young researchers.

LECTURE SERIES ON ENERGY STORAGE BY DOC.TUGRUL CETIKAYA

November 9, 2021
November 16, 2021
November 23, 2021

Bilateral seminars for experts, academics, students and young researchers facilitating the option of own material evaluation.

1. Introduction to Energy Storage and Lithium-Ion Batteries
2. Nanocomposite Electrodes for Lithium-Ion and Li-S Batteries
3. Nanocomposite Electrodes for Lithium-Air battery and Supercapacitors

Held online

Organisers: doc. Simha Martynková, Ph.D., prof. Ing. Daniela Plachá, PhD.

MISCANTHUS WASTE CONVERSION FOR SMALL AND MEDIUM-SIZED ENTERPRISES

May 26, 2021

VSB-TUO Campus

International workshop

LOW CARBON TECHNOLOGIES

June 28-30, 2021

Hrubá voda, Czech Republic

International conference

Organisers: VSB-TUO (CZ), University of Žilina (SK), Institute for Chemical Processing of Coal (PL), University of Miskolc (HU)

WORKSHOP ON SMART ENERGY MANAGEMENT SYSTEM FOR POWER GRIDS

October 19-20, 2021

Pension Jurášek, Kunčice pod Ondřejníkem

JUNIOR RESEARCHERS MEETING

October 13, 2021

VSB-TUO Campus

Junior Researchers Workshop provided presentations on the scientific portfolio and outcomes regarding publications, R&D project involvement, or collaboration on contract research.

ADVANCED WASTE TREATMENT

November 11, 2021

VSB-TUO Campus

National workshop under the project of Environmental Research and Development Information Centre of the Czech Republic (EVVIC)

MSK - HYDROGEN REGION

December 9, 2021

VSB-TUO Campus Expert seminar within the project of Research on the potential of hydrogen technologies for transformation of the MSK energy mix, low-carbon energy, and low-emission transport.

RESEARCH ON IDENTIFICATION OF COMBUSTION OF UNSUITABLE FUELS AND SYSTEM OF SELF-DIAGNOSTICS OF BOILERS COMBUSTING SOLID FUELS FOR DOMESTIC HEATING

Second part of the project seminar series

May 11, 2021

Seminar to inform the professional public, especially air protection officials about the outcomes of the project.

WORKSHOP ON THE CLAIRO PROJECT

October 26-27, 2021

VSB-TUO Auditorium

SEMINAR ON ANAEROBIC DIGESTIONOF BIOMASS AND BIOWASTE

November 26, 2021

IET

STRATEGIES FOR CARBON NEUTRALITY

October 22, 2021

VSB-TUO Campus

More than three dozen energy experts from key companies in the market discussed the future direction of Europe in the field of energy along with the SMOKEMAN's educational show.

2021 ANNUAL REPORT

VSB - Technical University Ostrava

CENTRE FOR ENERGY AND ENVIRONMENTAL TECHNOLOGIES

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The CEET 2021 Annual Report was approved by the CEET SCIENTIFIC BOARD on May 4, 2022 and is available electronically on the CEET website.

ceet.vsb.cz/en

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