REFRESH

NEWSLETTER_02_24

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2 Nanorobots remove microplastics from water

3 REFRESH will enable the most extensive research to date in excluded localities

> Integrating experts into existing teams is a key step that drives us forward.

Dear REFRESH friends,

We are excited to share the latest edition of our newsletter highlighting the progress achieved by the REFRESH project. Our efforts demonstrate that integrating cutting-edge research, fostering industrial collaboration, and nurturing young talent are essential for transforming our region and tackling global challenges.

From the outset of the project, we have prioritized the participation of excellent researchers from around the world who contribute fresh perspectives and expertise to our teams. We proudly announce that 30 outstanding researchers have joined the project, which is more than three times our initial target. We have welcomed 120 professionals to universities in our region, making up 40 percent of all researchers involved in the project. This achievement represents more than just a figure—it signifies a notable transformation that is enriching not only our teams but also the region as a whole.

Integrating these experts into existing teams is a key step that drives us forward. Nearly half of our publications are now collaboratively created with these new team members. Echoing Václav Snášel, Rector of VŠB-TUO, who stated that „the sustainability of a project begins with its acquisition," we are diligently striving to excel in major international grant competitions. The new staff members are already responsible for a third of the recently secured European grants.

Although we officially received project funding this past February, we have already progressed more than a third of the way through implementation. We seized the opportunity to assess our progress during a recent gathering in Čeladná. Alongside representatives from the Ministry of the Environment, the Confederation of Industry, the management of the Moravian-Silesian Region, and the Statutory City of Ostrava, we reviewed the results to date. The discussion highlighted how crucial is the complementarity of the living laboratories, which gradually compose a complete picture of our project.

The recently acquired infrastructure is also an important pillar of REFRESH. Advanced equipment, including X-ray photoelectron spectroscopy, scanning electron microscopy, and an antenna anechoic chamber, enables us to attain outstanding results and paves the way for enhanced collaboration with both academic and industrial partners.

Alongside our commitment to scientific and technological innovation, we prioritize the needs of our local community. Social research focused on marginalized areas, as well as former miners and steelworkers, provides valuable insights into employment, identity, and sustainable development issues. These studies hold equal importance to our technology initiatives, as they connect science with real-world social challenges.

In this issue, you will find highlights of our accomplishments, such as the development of single-atom engineered antibiotics and nanorobots designed for water purification, as well as the introduction of new initiatives aimed at fostering a green and digital future. We hope this newsletter will inspire you and bring a better understanding of our efforts.

We appreciate your support and enthusiasm for REFRESH and look forward to taking further steps together. Have a great read.

Kind regards,
On behalf of the REFRESH project team,
Igor Ivan

REFRESH - indicators
goals X current status

450 mil. Kč
in total revenue from commercialization activities with companies during the project

50
projects co-developed with the public administration

10
excellent researchers (ERC laureates, H2020 project investigators, Highly Cited Res.)

450
publications in IF journals

106 FTE
new jobs in R&D

15
filed patent applications

15
project applications submitted under European grant schemes

14
project applications submitted under European grant schemes

250 mil. Kč
in total revenue from commercialization activities with companies during the project

47
projects co-developed with the public administration

30
excellent researchers (ERC laureates, H2020 project investigators, Highly Cited Res.)

391
publications in IF journals

62 FTE
new jobs in R&D

4
filed patent applications

Highlights from our gathering in Čeladná

A high success rate in attracting top researchers both domestically and internationally and high-quality outputs across various stages of Technology Readiness Level (TRL), i.e. from excellent basic research to close partnerships with industry. These benefits emerged the most from the presentations of the REFRESH results to date at the retreat in Čeladná, which was attended not only by academics but also by representatives of partner institutions, including the Ministry of the Environment (MoE) of the Czech Republic. The MoE oversees the Operational Programme Just Transition which has provided a grant of CZK 2.5 billion for the largest project to date at VŠB-TUO.

The scientific directors of the four living laboratories presented selected outcomes from the project's initial third, outlining their planned investments and upcoming tasks. Their presentations revealed that the complementary nature of the laboratories is allowing the various aspects of the project's results to come together effectively.

„From the perspective of someone working in the industry on a daily basis, I greatly value the opportunity to bridge the gap between science, industrial realities, and students. I am confident that this connection will lead to achieving the project's objectives," concluded Kateřina Kupková, a member of the REFRESH Board of Directors and Vice President of the Confederation of Industry of the Czech Republic.

Meet our researchers

Václav Snášel

Computer scientist Václav Snášel received a master's degree in numerical mathematics from the Faculty of Science at Palacký University in Olomouc and a PhD in algebra and number theory from Masaryk University in Brno. He completed his habilitation and attained a professorship at VŠB-Technical University of Ostrava, where he has served as Rector since 2017. From 2001 to 2009, he worked as a researcher at the Institute of Computer Science of the Czech Academy of Sciences (CAS), and in 2010-2017 as the Dean of the Faculty of Electrical Engineering and Computer Science at VŠB-TUO. He is currently a full professor at the same faculty.

His research is shaped by over 30 years of experience in both industry and academia. He primarily focuses on the application of artificial intelligence techniques, including neural networks, deep learning, optimization methods, and information retrieval. Within the REFRESH project, he is involved in the Industry 4.0 & Automotive Lab, where he heads the Smart Manufacturing research programme.

According to Web of Science, his h-index stands at 31 (Scopus: 38, Google Scholar: 53). Professor Snášel has supervised 47 PhD students, 22 of whom are from abroad. Over the past five years, he has delivered 17 invited talks, including one on In-Memory Computing Architectures for Big Data and Machine Learning Applications in Vietnam. He also serves on the steering committee for the European University Association (EUA) and the Research and Innovation Strategy Group (RISG).

Seyedali Mirjalili

Professor Seyedali Mirjalili, one of the most internationally recognized and highly cited experts in artificial intelligence, has joined the REFRESH project team. In the Industry 4.0 & Automotive Living Lab, he plans to employ machine learning and optimization techniques while working with his colleagues from the Faculty of Electrical Engineering and Computer Science at VŠB-TUO. His research focuses on areas such as optimization, swarm intelligence, evolutionary algorithms, and machine learning. Renowned as one of Australia's leading researchers in bio-inspired optimization algorithms, his work is utilized by specialists at VŠB-TUO and will be further developed through the REFRESH project.

In 2019, Seyedali Mirjalili founded the Centre for Artificial Intelligence Research and Optimization. He is currently a professor of artificial intelligence at Torrens University Australia. He is internationally recognized for his advances in optimization and swarm intelligence, including the first set of algorithms from a synthetic intelligence standpoint - a radical departure from the traditional understanding of natural systems - and a systematic design framework for reliably evaluating and designing computationally inexpensive robust optimization algorithms. He has published more than 600 papers and his h-index stands at 110. He has repeatedly featured in lists of the world's most cited scientists, and in 2021 The Australian named him Australia's top researcher in three areas: artificial intelligence, evolutionary computation, and fuzzy systems.

Viktor Pál

Born in Borsod, Hungary, Viktor Pál has lived and worked in Finland since 2003. He pursued his studies at the University of Tampere and later worked at the University of Helsinki. He has studied in Austria, Belgium, Russia, the USA and the UK.

Professor Viktor Pál is a senior researcher at the Centre for Economic and Social History at the Department of History of the Faculty of Arts, University of Ostrava. His REFRESH - Social Lab project investigates the economic, social, technological, and environmental history of Central and Eastern Europe, placing particular emphasis on industrial regions. He also serves as the principal investigator for the GA CR project titled An Environmental History of Transboundary Rivers in Cold War East-Central Europe, which involves a collaborative team of Czech, Hungarian, Polish, and Slovak researchers examining pollution and regulation issues related to the Oder and Danube rivers. Furthermore, he is one of the editors of the book series Environmental History in Central and Eastern Europe published by Central European University Press.

In line with the University of Ostrava's initiatives to globalize research and education, his team is striving to establish an internationally relevant center for interdisciplinary history.

Flah Aymen

The renowned researcher specializing in electric vehicles, renewable energy, and energy management is a significant asset to the Energy Lab within the REFRESH project. His research primarily focuses on energy efficiency and sustainable technologies, contributing to the development of intelligent energy solutions that merge renewable energy sources with contemporary electrical systems.

Associate Professor Aymen received his PhD in 2012 from the National School of Engineering of Gabes in Tunisia, where he currently heads the Electrical Engineering Department. He collaborates with various research teams worldwide, including those in India, Algeria, IRAQ, Morroco, Pakistan, Saudi Arabia, and Jordan, and is actively engaged in research related to photovoltaics, wind, and geothermal energy. He also serves on the editorial boards of several international journals, including the International Journal of Powertrains, Scientific Reports, Hindawi, and Plos One. He has been a permanent member of the organizing committee for international conferences such as ISAECT since 2018. He is the author of 155 publications that have received more than 1500 citations.

Yazhou Zhou

Yazhou Zhou obtained his master's degree in materials engineering from Jiangsu University in Zhenjiang, China, in 2013. He completed his PhD by the end of 2015 in the group of Professor Xiaonong Cheng at Jiangsu University, and partly in the group of Professor Yuehe Lin at Washington State University (WSU), USA, specializing in developing innovative functional nanomaterials for diverse applications such as electrocatalysts, photocatalysts, and biomaterials. Following this, he worked at Jiangsu University before taking up a position as a visiting postdoctoral fellow at the Max Planck Institute for Polymer Research (MPI-P) in Weimar. Since July 2020, he has served as the administrative project leader in the Department of Synthetic Chemistry at MPI-P and operates as an independent researcher in the field of materials science. His research primarily focuses on electrocatalysts and hydrogen energy devices. He aims to design and synthesize catalysts that do not rely on precious metals, such as heteroatom carbon materials and single-atom catalysts, while also seeking to deepen the understanding of the relationship between the structure, electrocatalytic activity, and applications of these electrocatalysts. In this domain, he is going to enhance the research efforts within the Energy Lab of the REFRESH Project.

Zhou has authored over 80 papers in esteemed journals, including Nature Communications, Journal of the American Chemical Society, Angewandte Chemie, Advanced Materials, Advanced Energy Materials, Advanced Functional Materials, and ACS Energy Letters, amassing over 2,900 citations. According to Web of Science, his h-index stands at 31.

Dawn R. Norris

Dawn R. Norris received her master's and doctoral degrees in sociology from the University of Maryland College Park, where she studied from 2005 to 2012. Previously, she served as a full professor in the Department of Sociology at the University of Wisconsin-La Crosse.

Dawn R. Norris specializes in teaching and researching the intersections of identity, age, work, and mental health. Her notable publication, Job Loss, Identity, and Mental Health (Rutgers University Press, 2016), explores how unemployment can undermine identity and negatively impact mental well-being.

In 2023, she was a Fulbright Scholar at Charles University, focusing on unemployment and mental health issues among the non-manual workforce, while examining the effects of the social changes following 1989 and differing views on work. She has also published numerous academic articles and book chapters in peer-reviewed journals.

Currently, she is a senior researcher at the University of Ostrava, where she is participating in the REFRESH project. Her current research within this project centers on individuals who worked in the steel and coal industries in Ostrava, investigating their experience of employment and unemployment, as well as the connection between their identities and work.

Interview →

Radana Leistner Kratochvílová

REFRESH is successfully working towards fulfilling its grand vision

The Operational Programme Just Transition, which has provided the REFRESH project with CZK 2.5 billion in funding, is a newly established programme for the 2021-2027 period. It aims to mitigate the adverse effects of the transition away from coal in the regions most affected. In the Czech Republic, this includes not only the Moravian-Silesian Region but also the Karlovy Vary and Ústí Regions. We spoke to Radana Leistner Kratochvílová, Director of the Department of Support for a Low-Carbon Economy Transition at the Ministry of the Environment of the Czech Republic, about the programme and the REFRESH project.

The operational programme is administered by the Ministry of the Environment. How new is this experience?

It's entirely new for us since this operational programme is allocated from the national level to individual regions, each with its own designated budget. We engage with all three regions to determine how to approach specific calls for proposals; the regions aid us in gathering project ideas and providing essential information. This level of collaboration is unparalleled. Additionally, the programme covers a wide array of themes, ranging from investments in territorial regeneration to softer initiatives like employee training. The scope of assistance is remarkably diverse, and we strive to target nearly the entire region.

The three regions in question are facing similar issues. Are their approaches to addressing the transition aligned?

Each region is pursuing a slightly different path due to its unique starting conditions. Therefore, they must tailor their activities to their specific circumstances, and we adjust the calls accordingly. For instance, the Moravian-Silesian Region benefits from established institutions and regional agencies that assist applicants in refining their projects and spreading information throughout the area. It can also build on local universities that draw in new students and researchers, advancing research and developing new technologies. This is evident in the success of the REFRESH project.

What level of advantage does having multiple universities provide to the Moravian-Silesian Region, especially in contrast to the Karlovy Vary Region, which lacks a university?

The presence of these universities is a significant benefit, evident in the nature of projects that emphasize higher added value. The excellent collaboration between VŠB-TUO and the University of Ostrava, along with the unique role of the Silesian University in Opava, creates a robust foundation for the region. This puts the Moravian-Silesian Region in a prime position to reap considerable benefits and embark on a different path of transformation.

How does the REFRESH project compare to other initiatives? Does it stand out in any way?

Unlike the other projects, REFRESH distinguishes itself with its ambitious vision for the future. It aims to create opportunities for new students and attract top researchers, including those from abroad, fostering an appealing environment and quality job prospects for them. While achieving this is undoubtedly challenging, particularly in keeping skilled human capital once the project concludes, I believe this approach is the alpha and omega of the success of any region. REFRESH embodies a grand vision and is trying its best to fulfill it. There is also a project at Jan Evangelista Purkyně University in the Ústí nad Labem region focused on harnessing human potential and capital, but it does not aim as high as REFRESH.

The idea that people drive transformation is a fundamental principle of the REFRESH project. Do you agree with that perspective?

Definitely. While we can provide a certain structure, the key factor remains the people in the region. They have the deepest understanding of what is necessary for their area and must engage the local community to foster enthusiasm for change. The goal is to cultivate an environment where people choose to stay, find joy in living, and see tangible progress.

What additional strengths of the project would you highlight? On the other hand, do you see any potential risks?

The collaboration among key regional partners is certainly a significant asset and I consider it a foundational element of success. The synergy between the region, the city of Ostrava, and the universities in the Moravian-Silesian Region is extremely beneficial. As for potential risks, any initiative that relies heavily on a strong vision may falter if its visionaries depart. Therefore, it's crucial for the people driving the project to stay involved.

What stage is the Just Transition Operational Programme at now?

The Moravian-Silesian Region is the furthest along, with nearly all strategic projects having received legal approval and entering the implementation phase. Overall, strategic projects in most areas have progressed to the selection committee stage. Within the operational programme, 50 percent of the total funding has already been allocated to projects, which is a significant achievement given that we began a year and a half later than other operational programmes. This progress has been facilitated by well-prepared large strategic projects such as REFRESH.

Can we expect the operational programme to continue in some form beyond 2027?

We strongly hope for continued support. Although we have made progress in overcoming some delays, the transformation of the regions cannot be completed within just seven years. Furthermore, not all projects have reached the implementation stage for various reasons, which means we could prepare them for the next phase. However, this will ultimately depend on the priorities set by the new European Commission, the European Parliament, and the national government. Intense negotiations are expected; 2025 will be a pivotal year for determining future directions.

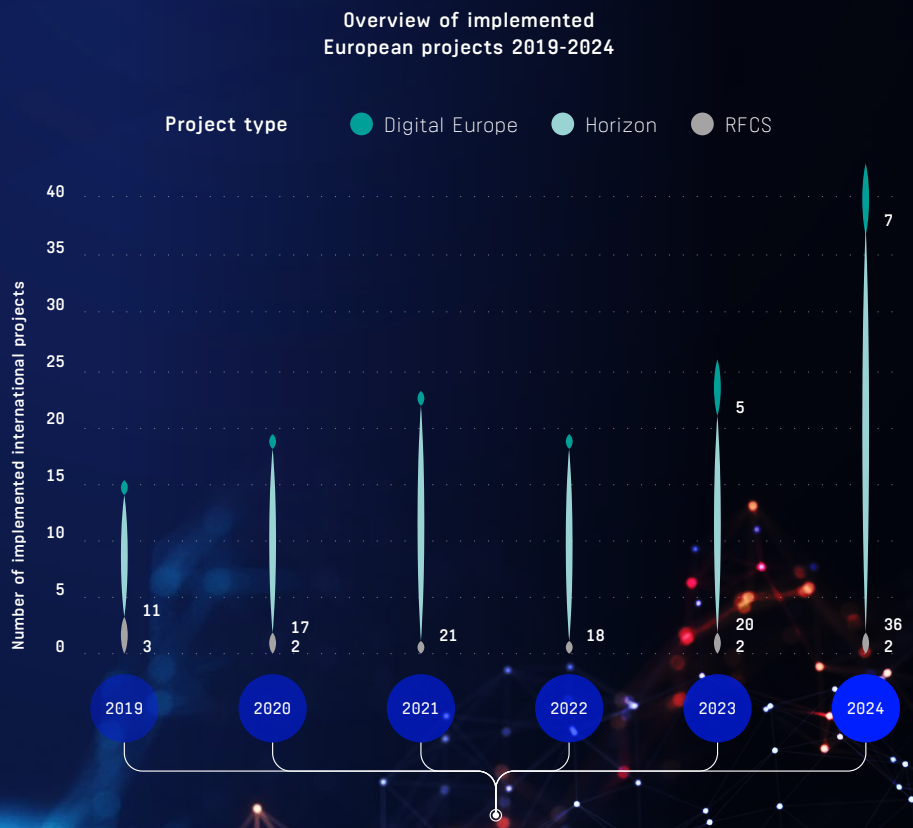
Ing. Radana Leistner Kratochvílová

Radana Leistner Kratochvílová currently works as the Director of the Department of Support for a Low-Carbon Economy Transition at the Ministry of the Environment of the Czech Republic. She focuses on implementing the Just Transition Fund, emphasizing the social, economic, and environmental impacts of transitioning to a climate-neutral economy. She oversees the Operational Programme Just Transition which aims to significantly aid the transformation of coal regions in the Czech Republic, including the Moravian-Silesian Region.

Previously, she led the department responsible for the Regional Development Strategy at the Ministry of Regional Development of the Czech Republic. She holds a degree in international politics and diplomacy from the University of Economics in Prague. Her professional background includes several years at the Ministry of Labour and Social Affairs, where she worked with the Managing Authority of the European Social Fund, as well as experience with the European Commission within DG EMPL. Additionally, she contributed to the government-approved Regional Development Strategy 21+ and its Action Plan, as well as the RESTART Strategy for three restructuring regions with former coal mines, which was developed by the Ministry of Regional Development and the Ministry of Industry and Trade and features a specific programme for the revitalization of brownfields.

Awarded grants

Total funding
23 399 889 EUR



MERGE: Single-atom catalysts for converting biomass into green fuels

The MERGE project, funded by Horizon Europe, aims to develop environmentally friendly, easily recyclable, cost-effective, and efficient single-atom catalysts for converting waste biomass into "green" chemicals and biofuels. This three-year project, led by VŠB-TUO, brings together scientists from Italy's Politecnico di Milano, the Netherlands' Rijksuniversiteit Groningen, and experts from the Greek consultancy firm Q-PLAN International Advisors PC. The European Union has supported the project with €1.5 million in funding.

"MERGE focuses on valorizing renewable carbon materials from waste biomass. Electrocatalytic and photocatalytic processes hold great potential for converting these materials into valuable products. However, the success of these technologies heavily depends on the development of suitable and efficient catalysts – accelerators of chemical reactions. The project aims to bring together the expertise of partners in the field of 2D materials, such as graphene derivatives, carbon nitrides, and photoactive or conductive polymers, which will be used as special metal supports for developing new catalysts through single-atom engineering. This method allows us to precisely control the properties of materials down to the atomic level," explained project coordinator Aristeidis Bakandritsos from the Materials -Envi Lab at the VŠB-TUO Nanotechnology Centre.

The project addresses the critical issue of our dependence on fossil fuels for energy production and key chemicals, which poses a significant threat to energy self-sufficiency and the environment. This has led to a growing demand for alternative, eco-friendly, and sustainable low-carbon energy sources.

Internationally experienced chemist receives prestigious MSCA Postdoctoral Fellowships

Sibi Malayil Gopalan, a chemist specializing in the chemical transformation of lignocellulose—a crucial element of plant biomass—into biofuels and high-value chemicals, has been awarded support for the Bio2SAF project through the MSCA Postdoctoral Fellowships - European Fellowships. Gopalan has chosen the Materials-Envi Lab at the Nanotechnology Centre VŠB-TUO as his host site for the project. The European Union will provide funding exceeding four million crowns to support his two-year research endeavor in Ostrava.

„The chemical conversion of lignocellulose presents significant challenges due to the strong C-O and C-H bonds. Current thermochemical methods necessitate high temperatures, making them energy-intensive, less environmentally friendly, and difficult to manage. In contrast, catalytic conversion holds great promise for producing biofuels. However, the challenge lies in developing appropriate catalysts that can effectively control the chemical conversion process, as multiple competing or sequential reactions occur simultaneously. To address this, the strategic objective of the Bio2SAF project is to create a new multifunctional catalyst utilizing modified graphene infused with individual metal atoms. These single atom catalysts aim to reduce the number of reaction steps and enhance conversion efficiency, all while minimizing energy consumption," explained Radek Zbořil, head of the Materials-Envi Lab and project guarantor.

The Marie Curie Sklodowska Action (MSCA) Individual Postdoctoral Fellowship is regarded as one of the most prestigious research fellowships. „This is a significant milestone in my career. Most importantly, it will give me the opportunity to collaborate with leading scientists at VŠB-TUO," said Sibi Malayil Gopalan, who has previously worked with distinguished research teams in Canada and South Korea, among other countries.

VŠB-TUO is involved in shaping the future unified architecture of European cars

The focus of the three-year international Horizon project HAL4SDV is to create and test a European software-defined vehicle (SDV) solution for next-generation vehicles expected beyond 2030. This initiative involves collaboration among partners from various European automakers, leading development suppliers, and selected research institutions from 12 countries. Petr Šimoník from the Faculty of Electrical Engineering and Computer Science at VŠB-TUO serves as the national coordinator for the Czech team.

With a total budget of €64.482 million, the project aims to synchronize efforts across Europe to establish a robust SDV ecosystem, leveraging synergies from existing national projects and international research endeavors. The partners are responsible for pioneering innovative methods, technologies, and processes to facilitate the mass production of vehicles set to debut after 2030.

"The innovative concept of the software-defined vehicle enables adaptable customization and expansion of features to meet user requirements. From 2024 to 2027, VŠB-TUO is participating in a completely unique and challenging project focused on developing a future unified architecture for European vehicles. Within the consortium, we are working with partners such as BMW, Mercedes-Benz, Renault, Ford, Cariad, Bosch, Continental, ETAS, Elektrobit, Valeo, ZF, NXP Semiconductors (from both the Czech Republic and Germany), Infineon, STMicroelectronics, Vektor Informatik, the Technical University of Munich, the Technical University of Stuttgart, and others," stated Šimoník.

The VŠB-TUO team is tasked with several responsibilities, including the creation of an experimental demonstration vehicle featuring a new architecture for SDV applications, the development of a virtual SDV within a laboratory simulation model environment, conducting behavioral analyses of autonomous SDV drivers, and preparing educational materials for SDV instruction. Beyond technological advancements, the HAL4SDV project aims to enhance the European automotive industry, ensuring its competitiveness, facilitating green and digital transitions, and fostering collaboration and sustainability across the automotive ecosystem. The total budget for the project amounts to EUR 64.482 million.

Researchers from IT4Innovations are engaged in activities of the SPACE Centre of Excellence

Through collaboration with colleagues from the national supercomputing center IT4Innovations at VŠB-TUO, the Energy Lab of the REFRESH project is involved in the activities of the SPACE initiative (Scalable Parallel Astrophysical Codes for Exascale). This EU-funded project unites researchers, high-performance computing specialists, hardware manufacturers, and software developers, all aiming to re-engineer eight of the most commonly used open-source European HPC codes in astrophysics and cosmology to efficiently exploit the forthcoming computing architectures.

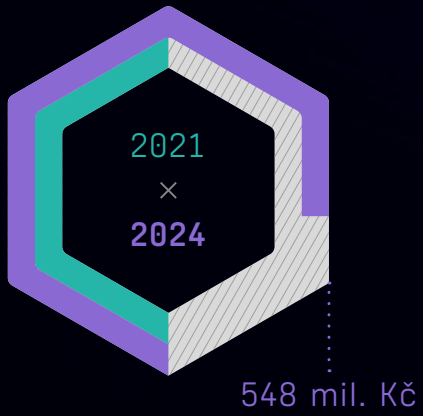
High Performance Computing (HPC)-based numerical simulations are crucial for scientific discoveries in astrophysics and cosmology. Due to the complexity of their tasks, these simulations are vital for modeling, interpreting, and understanding physical processes occurring beyond our observable universe. The primary aim of the SPACE project is to facilitate the use of existing astrophysical and cosmological codes on pre-exascale supercomputers like LUMI (Finland), Leonardo (Italy), and MareNostrum (Spain), which were funded by the European Joint Undertaking EuroHPC and became operational between 2022 and 2023, as well as on future exascale supercomputers such as Jupiter (Germany) and Alice Recoque (France).

„We are working on re-engineering widely used astrophysical and cosmological codes to optimize them for new supercomputer architectures. This includes performance profiling to identify any problematic areas in terms of scalability and power consumption during astrophysical simulations. Additionally, we focus on developing high-quality visualizations of simulation results and actively engage in integrating tools, code deployment to meet specific standards, and providing community support. Furthermore, we work on promoting these codes and organizing specialized training," stated Tomáš Kozubek, who is also affiliated with the Energy Lab.

Income growth in research and development

European projects

In 2024, VŠB-TUO has been involved in a total of 34 European projects, which represents **an increase of 55% compared to 2021.**

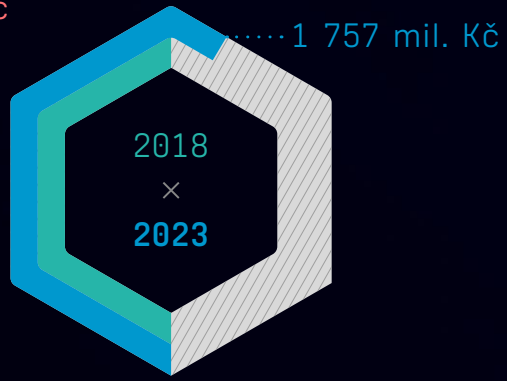


Knowledge transfer

In 2023, VŠB-TUO received a total of CZK 180.5 million from knowledge transfer, which represents **an increase of 25% compared to 2021.**

Total funding for research and development

In 2023, VŠB-TUO received a total of CZK 1.757 billion from domestic and foreign funding as well as supplementary activities for research and development activities. This represents a **9% increase compared to 2021.**



Developing research infrastructure

To date, we have acquired equipment worth over CZK 122 million as part of the project investments. The total expenditure in this sector amounts to nearly CZK 697.7 million.

1 High-resolution scanning electron microscope (HRSEM)

The high-resolution scanning electron microscope is a unique tool for detailed surface and structural analysis of 2D and 3D nanomaterials. This CZK 24.6 million instrument will be utilized in the Materials & Environment Lab to evaluate the size and morphology of the nanomaterials being investigated, leveraging its unique ability to perform combined scanning and transmission electron microscopy (STEM) measurements along with precise chemical mapping. Additionally, it can be integrated with X-ray photoelectron spectroscopy to provide comprehensive insights into the materials' chemical, structural, and morphological characteristics. Gaining insights into the relationship between the synthesis processes and the resulting properties of the materials is vital for optimizing chemical processes. This instrument will serve all living laboratories involved in the REFRESH project and the research groups at VŠB-TUO. Furthermore, it is critical equipment for numerous commercial partners who need detailed size, morphology, and structure characterization of the materials under study.

2 Simultaneous thermal analyzer (TGA/DSC)

The simultaneous thermal analyzer (TGA/DSC) located at the CEET Institute of Environmental Technology (IET) facilitates the observation of mass changes in a sample while assessing its thermal properties under various temperature conditions. This approximately CZK 3 million instrument is crucial for identifying individual polymers within a mixed waste plastic sample, a key aspect in addressing the challenges of chemical recycling as researched by the Energy Lab of the REFRESH project. The simultaneous TGA/DSC capability allows for real-time monitoring of sample weight variations in relation to temperature. Thermal degradation, which entails mass loss when materials are heated, occurs during processes such as pyrolysis, gasification, and incineration. Additionally, the DSC (differential scanning calorimeter) provides insights into endothermic (such as polymer melting and pyrolytic decomposition) and exothermic reactions (including crystallization and oxidation) in materials, enhancing the understanding of processes that may or may not involve mass change. The analyzer is equipped with an FTIR (Fourier transform infrared spectrometer) gas cell, enabling the analysis of specific thermal decomposition products. Furthermore, it can be connected to a reaction cell, allowing for experimentation with corrosive and reactive gases like hydrochloric acid, hydrogen sulfide, or hydrogen.

3 X-ray photoelectron spectroscopy (XPS)

X-ray photoelectron spectroscopy is utilized for the chemical analysis of solid surfaces, powdered materials, and frozen samples. This equipment is primarily tailored for complex chemical analyses, both quantitative and qualitative, as well as for investigating the chemical states of various sample surfaces. XPS will facilitate the characterization of the chemical and structural composition of materials, including the identification of chemical bonds in the developer materials, with the ability to distinguish different functional groups and valence states of individual elements. The instrument can be uniquely paired with a high-resolution scanning electron microscope, allowing for the examination of the chemical and structural properties of a specific area of the sample. Furthermore, it enables dusting part of the surface and detailed, in-depth chemical and structural analysis. Consequently, it is one of the most comprehensive tools for depicting materials' chemical composition and structure. The instrument, valued at approximately CZK 16.5 million, will be employed in the Materials & Environment Lab, other living laboratories within the REFRESH project, and by various research teams at VŠB-TUO. We anticipate significant interest from both domestic and international companies, as well as academic partners.

4 Dynamic mechanical analyzer (DMA)

Researchers at the CEET Centre for Nanotechnology (CNT) can now utilize the dynamic mechanical analyzer (DMA) to characterize the dynamic mechanical properties of solid and powder samples, including polymer films, foils, fibers, foams, and hydrogels, as well as to conduct basic rheological measurements. This rheometer, acquired for approximately CZK 6 million through the REFRESH project, offers a range of options for detailed material analysis. It enables the investigation of material properties in various modes, such as bending, tension, compression, and torsion, along with assessing thermomechanical characteristics and rheological and tribological measurements on samples. A thorough evaluation of materials across different parameters is crucial for research involving polymer and polymer composite materials, as well as various powder fillers and other activities of the Energy Lab within the REFRESH project. Previously, researchers did not have access to such a comprehensive instrument. Moreover, the system's modular design allows for adding new components in the future.

5 Antenna anechoic chamber

The antenna anechoic chamber, designed for testing and measuring the real properties of antennas and other devices utilizing electromagnetic waves in radio communications, radar systems, and mobile technologies, is being constructed at the Faculty of Electrical Engineering and Computer Science (FEI) of VŠB-TUO as part of the REFRESH project. It will facilitate measuring radiation characteristics for electronic components or functional units operating at frequencies up to 44 GHz. This is an area that covers both the currently used technologies and partly millimeter waves, which are expected to be used more significantly in mobile networks.

The specialized equipment will facilitate collaboration with companies working on developing antenna systems for a range of electronic devices. Furthermore, it is anticipated that researchers from the Industry 4.0 & Automotive Lab, as well as other teams, will participate in national and international projects. Set to be fully operational by early 2025, the chamber will play a vital role in IoT and 5/6G network research. The CZK 17 million anechoic chamber will measure eight meters in length and 3.5 meters in height. In addition, the new laboratory, unique in the country, will be outfitted with advanced technological equipment for measuring electromagnetic compatibility (EMC).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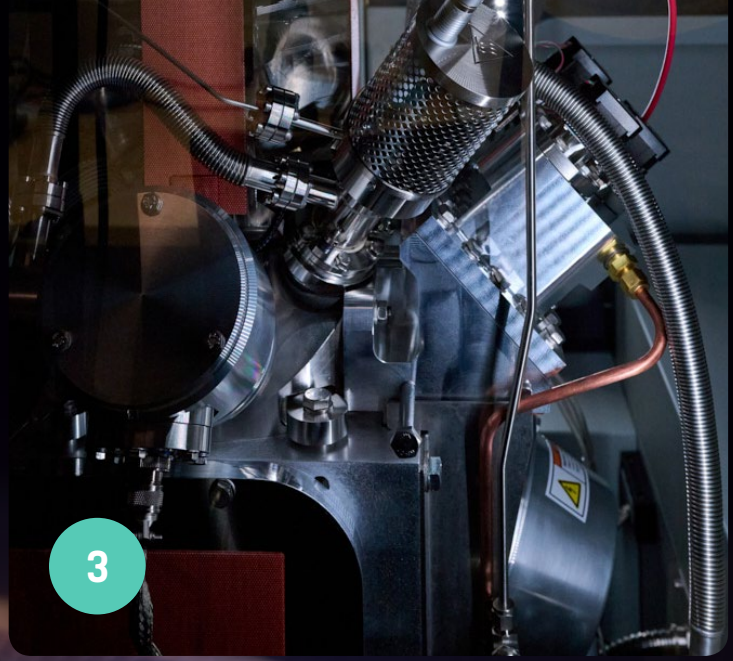
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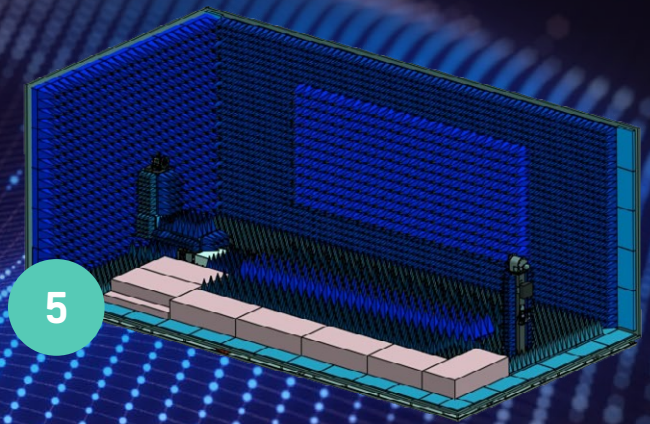
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Single-atom-engineered antibiotics can combat bacterial resistance

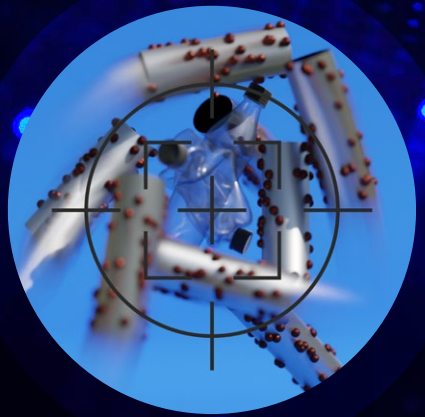
Researchers from VŠB-TUO involved in the REFRESH project have contributed to developing a new class of antibiotics that are effective against even the most resistant strains of bacteria and can help combat bacterial resistance. Collaborating with colleagues from Palacký engineered University and researchers in China, they have engineered manganese—a trace element vital to human health—into a potent antibiotic by integrating it into a structure of chemically modified graphene using single-atom engineering techniques. This breakthrough has been published in the prestigious journal Advanced Materials, and the team has filed a European patent to protect the invention.

"The material we've developed can effectively kill and inhibit the growth of all bacteria we have tested, including difficult-to-treat pathogens. It operates at low concentrations that pose no harm to human cells. Furthermore, bacteria cannot develop resistance to it, addressing one of the significant challenges in modern medicine. These findings provide a strong foundation for the practical application of single-atom engineered antibiotics," remarked Radek Zbořil, the lead researcher and scientific director of the Materials & Environment Lab within the REFRESH project. He emphasized the critical role of the graphene carrier, which facilitates the transfer of manganese ions to bacterial surfaces, allowing them to effectively target carbohydrate molecules. This research initiative also involved researchers from the national supercomputing center IT4Innovations and the Centre for Energy and Environmental Technologies at VŠB-TUO.

Nanorobots remove microplastics from water

Researchers from VŠB-TUO, in cooperation with colleagues from CATRIN at Palacký University in Olomouc and CEITEC-VUT in Brno, have developed titanium dioxide nanotubes powered by UV radiation and fueled by hydrogen peroxide. Employing defect and single-atom engineering, these nanorobots are capable of capturing microplastics present in water. This research, part of the REFRESH project, paves the way for novel applications of light-driven nanorobots in water purification technologies.

In a study published in Advanced Functional Materials, the researchers demonstrated that these nanorobots can irreversibly capture microplastics in contaminated water in just seconds. They used polystyrene spheres approximately five micrometers in diameter as a model for microplastics. By utilizing defect and single-atom engineering, the team was able to manipulate the movement direction and speed of the nanorobots in water, which opens up various avenues for their application in environmental, chemical, and biomedical fields. The nanotubes, around 250 nanometers wide and several micrometers long, were synthesized through electrochemical anodization. Oxygen defects were created in the titanium dioxide structure by annealing in a hydrogen atmosphere. Platinum atoms were incorporated into the defect structure using deposition techniques.



Czech cities experience significant socio-ecological injustice

Achieving a just sustainable transition requires a shift in how we approach sustainability. Consequently, researchers from the University of Ostrava focused on the idea of social-ecological justice (SEJ), which redirects sustainability toward meeting both social and environmental objectives. In an article published in Environmental Science & Policy, they contributed to the advancement of the socio-ecological justice concept.

This framework underscores that equitable and sustainable solutions to pressing global issues like climate change and natural resource depletion must prioritize both environmental protection and human rights alongside social equity. The article aimed to promote the development of SEJ at three levels. Conceptually, SEJ was associated with the repurposing of underutilized urban spaces, and the experts explored the recognition, process, and distributive dimensions of SEJ. At the applied level, they proposed a context-sensitive strategy to integrate SEJ into policies concerning the reuse of underutilized areas (including demolition, temporary use of buildings and land, land development, and redevelopment), using a case study from the Czech Republic. Methodologically, the authors outlined how the normative framework of SEJ was applied in research that combined both quantitative and qualitative methods.

Researchers test metal hydrides for safe and efficient hydrogen storage

Enhancing technologies for secure and efficient hydrogen storage is a primary objective of the REFRESH project and its Energy Lab. Researchers at CEET focus on technology that utilizes metal hydrides—compounds where hydrogen is bonded to a metal element or alloy. Their efforts are directed toward addressing a critical challenge of this technology: thermal management.

"Controlling temperature is crucial for optimizing hydrogen absorption and desorption processes. Absorption releases heat, making it an exothermic process, whereas desorption consumes heat, classifying it as an endothermic process. Effective temperature management can significantly speed up both of these processes," explained Ľubomíra Drozdová from CEET.

The team is conducting tests on MyH2 2000 metal hydrides provided by H2 Planet. This innovative low-pressure refillable hydrogen tank is engineered for safe and efficient hydrogen storage. It employs a metal powder that can repeatedly absorb and release hydrogen as required, enabling storage at relatively low pressures (up to 30 bar), which enhances system safety. During the absorption phase, the tank is cooled to avoid overheating, and it is heated during desorption, optimizing the overall process. "This system is perfect for storing pure hydrogen gas, which can subsequently be used to generate electricity via fuel cells. The entire process supports sustainable energy solutions," Drozdová added.

Researchers describe the mechanism of synthesizing boron-doped graphitic carbon nitride

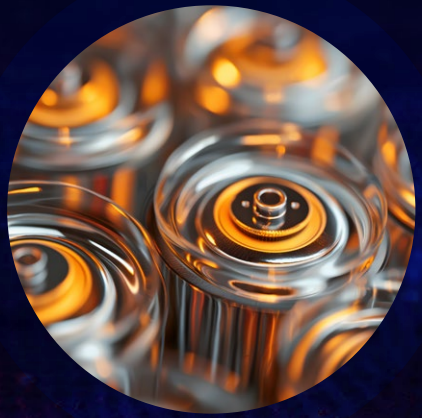
Researchers from VŠB-TUO have outlined the synthesis mechanism for boron-doped graphitic carbon nitride in a study published in Materials Today Chemistry. A team of experts, led by Professor Petr Praus, examined the impact of chemical mechanisms involved in B-doping on the structure and characteristics of these materials, which is essential for their optimization for practical applications.

"Graphitic carbon nitride is a fascinating material. Despite being composed solely of common elements like carbon and nitrogen, their combination results in a substance with numerous potential applications in semiconductor technology, energy storage, and as a catalyst for chemical reactions. To further enhance its properties, it is often enriched with other elements that enhance its applications. Boron is one such element that our study focuses on," said Daniel Cvejn, the paper's lead author from the Centre for Energy and Environmental Technologies. The study demonstrates how the co-calcination of a CN precursor and a B-dopant (boric acid) leads to the formation of B-doped graphitic carbon nitrides. Using various analytical techniques such as X-ray diffraction, XPS, FTIR, or NMR, a new structure of these materials was derived, considering the different ratios between precursor and dopant. Thus, the paper contributes to the knowledge of how to efficiently dope graphitic carbon nitrides, potentially paving the way for developing new materials with enhanced properties for a range of technological applications.

REFRESH will enable the most extensive research to date in excluded localities

Researchers from the Faculty of Social Studies and the Faculty of Education at the University of Ostrava have initiated a systematic study focused on the life opportunities of residents in Ostrava's excluded localities. The objective is to identify non-financial strategies that can lead to a sustainable improvement in the living standards of the most disadvantaged citizens and prevent their social exclusion or segregation.

"We currently lack knowledge about this population, yet marginalized groups are often the first to bear the brunt of significant social changes. They serve as a visible indicator of societal dynamics and potential future challenges for other social groups. These people act as buffers against change," explains Petr Kupka from the Department of Social Work at the University of Ostrava. His research team will also conduct a study on residential mobility within socially excluded neighborhoods, examining how frequently people relocate in these areas and the underlying reasons for their moves. The number of citizens experiencing some form of poverty is on the rise, extending beyond socially excluded localities to include more elderly individuals and single parents. In the Ostrava region alone, nearly 3,000 households are grappling with energy poverty. The Moravian-Silesian Region currently faces the highest level of housing need, indicating a potential increase in the number of people unable to secure adequate housing. The REFRESH project will enable experts to identify protective measures aimed at curbing the growth of populations in excluded localities.



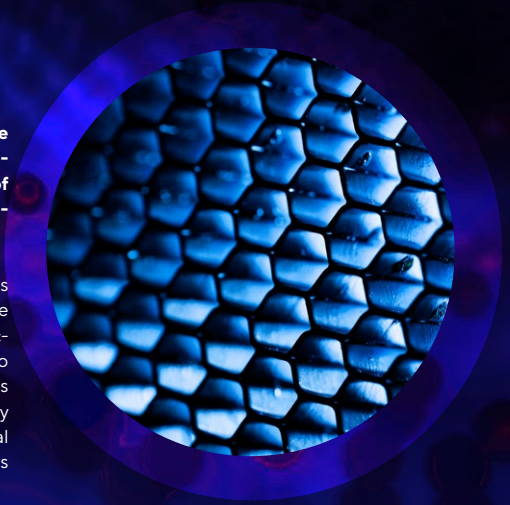
Researchers have developed a new method for producing battery electrodes

Researchers have introduced an innovative method for producing battery electrodes using organic materials that demonstrate high energy storage capacity, rapid charge capabilities, and stability, all without the use of harmful organic solvents. This advancement was reported in the esteemed journal Energy & Environmental Science by researchers from VŠB-TUO, Palacky University, and Germany. Their work offers a more environmentally friendly and energy-efficient solution for electricity storage in batteries and supercapacitors.

"Organic molecules present a promising alternative due to their accessibility, ecological benefits, and adaptability. The self-assembled organic nanowires significantly enhance lithium ion transport, resulting in batteries with high capacity that maintain their performance even after multiple charge cycles. Our preparation method eliminates the use of harmful organic solvents, addressing a major safety and environmental concern in the current battery industry," explained Aristeidid Bakandritsos, one of the study's authors. The organic nanowire anode also shows reduced exothermic activity during charging, which enhances safety. Furthermore, the material performs exceptionally well in hybrid supercapacitors that combine lithium metal ions with commercially available porous carbon. This new approach from the international team comes at a crucial time when researchers worldwide are seeking alternatives to lithium batteries. As the demand for lithium batteries continues to rise with the growth of electric mobility, it is essential to address the environmental and safety challenges associated with their use.

A new method may enhance the evaluation of diffusion coatings for steel treatment

Researchers from the IT4Innovations National Supercomputing Centre at VŠB-TUO and the Fraunhofer Institute for Chemical Technology ICT have introduced a novel methodology for segmenting and assessing diffusion coatings used in steel surface treatment. Their findings were published in the journal High Temperature Corrosion of Materials. This innovative approach aims to streamline the preparation of coatings tailored for various specific environments.



"The study focuses on the design of an automatic evaluation of the parameters for aluminium-based diffusion coatings that are applied to steel to protect the material's surface. The aim is to prevent adverse environmental influences on the material by appropriate choice of coating layer. The parameters of the coating layers are evaluated using data from electron microscope images. Our method leverages machine learning, integrating real and synthetically generated data to accurately determine material parameters," explained Petr Strakoš, one of the paper's authors. According to Strakoš, this new method will facilitate the effective optimization of coatings for high-temperature and corrosion resistance, thereby advancing the development of specialized materials suited for demanding environments. It will be particularly beneficial in the energy sector, such as in the design of a new generation of steam turbines that can operate at higher temperatures than currently possible.

University has honored chemist Aristeidis Bakandritsos

Aristeidis Bakandritsos from the CEET Centre for Nanotechnology received an award for his exceptional research results and a symbolic cheque for one million crowns. The esteemed researcher, who is also affiliated with the Materials & Environment Lab of the REFRESH project, was awarded for his success in the international MERGE project aimed at converting biomass into green fuels. This initiative brings together partners from prestigious institutions in the Netherlands, Italy, and Greece, alongside VŠB-TUO. The European Union has provided €1.5 million in funding.

"I am incredibly honored and delighted to receive this award. This recognition is profoundly meaningful, as it acknowledges the hard work and dedication invested in research and securing funds for our university. This award belongs to many colleagues with whom we are consistently working together towards common goals and results, like in the case of this project. It is also a great encouragement to keep up the hard work, not only for me but for all researchers at VŠB-TUO. It can motivate them to keep striving for excellence. I am grateful to the management of VŠB-TUO for their unwavering support and to my colleagues and partners who share this journey with me," commented Bakandritsos on receiving the award. Bakandritsos joined VŠB-TUO through REFRESH and currently supervises the international MERGE project.

Radek Zbořil has received a prestigious award

The prestigious Prince Sultan Bin Abdulaziz International Prize for Water (PSIPW) has arrived in the Czech Republic for the first time. In November, physical chemist Radek Zbořil from the Nanotechnology Centre at the VŠB-TUO and Scientific Director of the Materials & Environment Lab of the REFRESH project received the prize in Vienna.

"I am truly grateful for this award. The competition was fierce, and it is a privilege to be recognized alongside distinguished researchers from institutions in Texas, Berkeley, and Milan. However, the significance of our research is what truly matters. Many of our findings stem from the Center of Competence project where I served as principal investigator for several years, and where we developed practical water treatment technologies. I would also like to extend my gratitude to my colleagues who contributed to the research. Ensuring access to clean drinking water is a critical global challenge, and every small advancement takes us closer to achieving this goal," Zbořil remarked upon receiving the award. The leader of the four-person team recognized in the Alternative Water Resources Award category, Virender K. Sharma from Texas A&M University, has collaborated closely with Zbořil for a long time. Together, they have published over 50 papers, which have garnered more than 6,000 citations in total. Notably, last year, their co-authored invited article on single-atom catalysts in water treatment was featured on the cover of Chemical Society Reviews, the premier journal of the Royal Society of Chemistry.

Social research will focus on former miners and metallurgists

Sociologists Nicole Horáková and Dawn Norris from the University of Ostrava are conducting a comprehensive study to explore how former miners and metallurgists navigate the labor market. Their research emphasizes the subjective perceptions of former workers in heavy industry, which is closely linked to the Moravian-Silesian region.

"My colleague from the USA, Dawn Norris, and I are reaching out to miners, metallurgists, and others involved in related production, both men and women, to share their experience with us. We aim to enhance the understanding of how these people perceive their situations," stated Nicole Horáková, who has long been involved in the sociology of work.
The decline of coal and steel industries is a key change in the Moravian-Silesian region. Over the past thirty years, tens of thousands of workers have left these in-

dustries. Horáková's research will focus on their coping strategies and adaptations to job loss.

The workshop brought together researchers from VŠB-TUO and Fraunhofer Institute

At the end of October, specialists from VŠB-TUO and Fraunhofer ICT, a part of the Fraunhofer Innovation Platform (FIP-AI@VŠB-TUO),came together for a workshop entitled Thermal Energy Storage and Energetic Materials. The purpose of the workshop was to present existing research in the field and explore opportunities for collaboration on related topics, potentially leading to joint publications and projects. This meeting was part of the new Advanced Materials for Energy and Environmental Technologies project, which falls under the Intersectoral Cooperation for ITI of the Operational Programme Jan Amos Komenský, highlighting the practical application of research outcomes and fostering collaboration between researchers and industry.

"The goal of the workshop was to pinpoint research topics for collaboration in thermal energy management and storage and to foster closer ties between researchers from both institutions," stated Vladislav Kolarik from Fraunhofer ICT.

Researchers collaborate with automotive manufacturers

At the October meeting of automotive suppliers, Petr Šimoník, Scientific Director of the Industry 4.0 & Automotive Lab (IAL), presented REFRESH, outlining collaboration opportunities between VŠB-TUO researchers and the automotive sector. This meeting, organized by the Czech Automotive Industry Association (AutoSAP), was hosted by ON Semiconductor Czech Republic, which specializes in silicon and silicon carbide semi-finished products and chip manufacturing.

"My aim was to present the potential for utilizing R&D personnel and infrastructure, highlighting examples of successfully addressed applied research, development, and innovation tasks within the automotive industry that VŠB - Technical University Ostrava undertakes as part of the REFRESH project. I acquainted the participants with our focus on smart manufacturing, approaches to AI applications, modeling and simulation in manufacturing, our 5G industrial test network, and the technologies we are developing for automated control systems. I am grateful for the opportunity to present our work to top executives who care deeply about the future of the Czech automotive industry," stated Šimoník, who together with his team, in collaboration with domestic companies and European automobile manufacturers and their suppliers, are developing cutting-edge systems for vehicles.


REFRESH


REFRESH

Presenting
REFRESH to the public

VŠB - Technical University of Ostrava
17. listopadu 2172/15
708 00 Ostrava-Poruba

smaragd@vsb.cz
web: www.smaragdova.cz
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