1 Interview with Jan Kříž

2 Breakthrough technology integrates water purification with energy storage

3 Researchers are developing smart storage tanks for towns and cities

> Investing in people is the key to our success

Dear REFRESH friends,

We are pleased to share the latest edition of our newsletter reflecting on the progress and achievements of our project. Six months have passed since our last update, and during this time, we have gathered further evidence that the path we have chosen—supported by the Operational Programme Just Transition —is both right and fruitful. Our efforts are fostering trust among partners across academia, the public sector, and industry, helping us create an innovative ecosystem. Most importantly, we are attracting renowned researchers from around the world to the Moravian-Silesian Region.

These distinguished experts have joined research teams across all four REFRESH living labs and contribute significantly to the scientific excellence of our universities. Their impact extends beyond their impressive publications and experience; they bring fresh ideas, new methodologies, and innovative approaches that invigorate our research environment. It is becoming clear that investing in people – and their excellence – is the most valuable investment we can make in the context of the region's just transition.

Thanks to REFRESH, VŠB-TUO is experiencing unprecedented momentum within the Czech Republic. The University of Ostrava has also gained significant scientific reinforcements. In the pages ahead, you will see how we support applied research, forge stronger connections between science and practical applications, and develop new infrastructure and technologies tailored to regional needs. Our work demonstrates that transformation is not only an economic challenge but also a profound opportunity to rethink our approaches to energy engineering, environmental protection, industry, and daily life.

Jan Kříž, Senior Director of the Environmental Economics Section at the Ministry of the Environment, shares an external perspective in an insightful interview. He emphasizes the complexity of REFRESH and recognizes its potential to serve as a model for other regions.

I want to express my gratitude to everyone involved in the project—your dedication, energy, and collaboration are the foundations of our success.

REFRESH remains an open platform, and I am confident that we will continue to demonstrate how the transformation of the Moravian-Silesian Region can rely on strong and well-functioning teams working towards a common goal.

Kind regards,

Igor Ivan
Director of REFRESH

REFRESH – indicators
goals X current standing

goals		current standing
CZK 450 mil.	in total revenue from commercialization activities with companies during the project	CZK 309 mil.
50	projects co-developed with the public administration	96
15	project applications submitted under European grant schemes	18
10	excellent researchers (ERC laureates, H2020 project investigators, Highly Cited Res.)	48
450	publications in IF journals	811
106 FTE	new jobs in R&D	88 FTE
15	filed patent applications	8

We celebrated the first anniversary

One year after receiving funding from the Operational Programme Just Transition, REFRESH celebrated this significant occasion on the magical date of February 25, 2025, at VŠB - Technical University of Ostrava. As with any proper celebration, the social gathering included cake, balloons, and a small gift.

The event was attended by representatives from all living laboratories and partner organizations. REFRESH Director Igor Ivan presented an overview of the project's accomplishments to date, highlighting the progress made in achieving established project indicators.

"Sharing our achievements and addressing the challenges ahead are essential components of our collective progress. Nonetheless, the primary purpose of this gathering extends beyond mere reporting. I am convinced that such informal gatherings are incredibly valuable for a project like this. While the project will conclude, the partnerships we build will last," remarked Ivan.

The REFRESH project serves as a key tool for implementing the SMAR-AGD strategy, which aims to transform the Moravian-Silesian Region into a smart and green region (SMARt And Green District). The aim of the project is to respond to the region's problems and contribute to its successful economic, energy, and environmental transformation. In four interconnected living laboratories, university researchers work closely with companies with great potential for development and innovation, public administration, and regional leadership. Their mutual synergy will lead to a change in the innovation ecosystem, accelerate the emergence of new technologies, and speed up their implementation in real-world applications.

Suyash Jolly

Suyash Jolly is a senior researcher at the Department of Human Geography and Regional Development at the University of Ostrava. Within REFRESH, he focuses on regional development, economic geography, sustainability transitions, innovation studies, innovation policy, science and technology studies, and development studies.

Before joining the University of Ostrava, he held senior research positions at the Nordland Research Institute in Bodø, Norway; Lund University; and the KTH Royal Institute of Technology in Stockholm. Additionally, he has served as a visiting researcher at various academic institutions across Austria, Norway, and Sweden. He completed his PhD and a master's degree in innovation sciences at Eindhoven University of Technology in the Netherlands.

Throughout his career, Dr. Jolly has gained extensive experience conducting empirical studies on the development of emerging green industries, including onshore and offshore wind energy, solar photovoltaics, bioeconomy, smart grids, etc. He has explored these themes in various regions across Europe and India, with a particular focus on comparative case studies across countries. Currently, his work concentrates on the systemic ecological, inclusive, and just transformation of aging industrial regions in Central and Eastern Europe, addressing structural challenges such as demographic decline, economic stagnation, climate change vulnerabilities, and industrial decline. His research also involves building international research networks and linking academic work with real-world applications.

Indrajit Ghosh

Chemist Indrajit Ghosh, one of the pioneers of photoredox catalysis, has joined VŠB – Technical University of Ostrava (VŠB-TUO), coming from the University of Regensburg. His move to the Materials-Envi Lab was driven by his enthusiasm for working with excellent researchers, the opportunity to utilize the cutting-edge research infrastructure, and the team's emphasis on innovative, high-impact research.

Dr. Ghosh is renowned for developing novel methodologies within visible-light photoredox catalysis, which facilitate the activation and transformation of traditionally less reactive chemical bonds in organic synthesis. His groundbreaking research, published in Science in 2014 and 2019, has significantly expanded the horizons of the use of visible light for organic chemistry. His work on adaptive dynamic homogeneous catalysis (AD-HoC), published in Nature in 2023, introduced a simple and general protocol for cross-coupling reactions–one of the most predictable and reliable to date–which has already attracted significant interest from industry. At the Materials-Envi Lab, within the Center for Energy and Environmental Technologies, he intends to continue this line of research, utilizing the expertise of the local team in materials chemistry to design novel heterogeneous catalysts that aim to enhance the efficiency of photocatalysis and promote application in industrial contexts.

Dr. Ghosh completed his PhD at Jacobs University in Bremen, Germany, followed by postdoctoral research at the University of Regensburg and the Max Planck Institute of Colloids and Interfaces. He has authored over 50 peer-reviewed publications that have received approximately 6,000 citations.

Giorgio Zoppellaro

Dr. Zoppellaro's research primarily focuses on the application of the Electron Paramagnetic Resonance (EPR) at the interface of materials science, molecular magnetism, biophysics, nanomedicine, and photophysical spin-correlated phenomena.

Dr. Zoppellaro brings extensive international academic and research experience. He obtained his first master's degree in industrial chemistry at the University of Milan, followed by a second in pharmacology at Kanazawa University at the Institute of Molecular Science in Okazaki. He completed his PhD at Johannes Gutenberg University Mainz, where he investigated high-spin molecules and organic molecular magnets at the Max Planck Institute for Polymer Research. As a postdoctoral researcher in the group of Mario Ruben at the Karlsruhe Institute of Nanotechnology, he explored single-ion molecular magnets, spin crossover systems, and the self-organized molecular nanostructures on constrained surfaces. Subsequently, at the University of Oslo, he examined the electronic 'fingerprints' of a new class of DNA repair proteins.

He has authored more than 130 peer-reviewed publications in leading journals such as Nature Nanotechnology, Journal of the American Chemical Society, Advanced Materials, and Small. His work has garnered over 6,500 citations, and he holds an h-index of 42 (Google Scholar). In the latest edition of the Research.com ranking, he is placed 89th nationally in the field of chemistry.

Vera Kristýna Jandačková

Vera Kristýna Jandačková studied psychology at Palacký University in Olomouc and subsequently obtained her PhD from the University of Ostrava. During her doctoral research, she undertook a research internship with the Psychobiology Research Group at University College London, within the Department of Epidemiology and Public Health, where she has been appointed as an Honorary Research Associate. Currently, she is engaged in academic activities at the Faculty of Medicine and the Faculty of Education at the University of Ostrava.

Her scholarly work primarily investigates the interrelations and interactions between mental and cognitive health and physiological functioning, with particular emphasis on the autonomic nervous system and lifestyle factors. She has an extensive publication record in prominent international journals spanning disciplines such as psychology, clinical psychology, neuroscience, and cardiovascular sciences. Moreover, she maintains longstanding collaborative relationships with leading experts from the United States, the United Kingdom, Germany, Poland, and Austria.

In the context of REFRESH, she serves as the principal investigator, leading a research team at the Department of Human Movement Studies at the Faculty of Education. Her research concentrates on the psychomotor development in children, examining influences such as physical activity, familial and social determinants, environmental conditions, and pedagogical approaches employed in educational settings. Additionally, she oversees several research projects, including the Lerco Neurocognitive Team, which explores the interplay between physical activity and air pollution in relation to brain structure and function, cognition, and mental health.

Leonor Calvo Galván

Leonor Calvo Galván, a professor of applied ecology at the University of León, is an internationally recognized expert in landscape fire dynamics. For over twenty years, her research has focused on how fire regimes influence forest ecosystems in the context of climate change. Her work has led to the development of innovative tools for assessing fire severity, identifying critical drivers of post-fire ecological recovery, and formulating controlled burning strategies to enhance biodiversity.

As a member of the Energy Lab REFRESH team, she integrates ecological science with engineering methodologies to evaluate fire-related hazards and explore alternative energy technologies. Her research focuses on the interplay between fire regimes and the safety of energy systems. She contributes to the testing and validation of novel spectroscopic techniques for monitoring combustion processes under both field and laboratory conditions, employing drones and mobile sensor platforms. Her findings are applied to optimise controlled fire as a tool for environmental management and to inform the design of safety protocols for renewable fuels, particularly hydrogen. In collaboration with modelling experts, she is also engaged in the development of predictive tools that bridge natural system dynamics with the technical parameters of fire loads.

She earned her PhD at the University of León and subsequently held a position at the University of Valladolid. Her academic trajectory includes research stays in France, Italy, Portugal, Germany, and Scotland. Since 2015, she has led the Consolidated Research Unit 210 for Applied Ecology and Remote Sensing. She has authored over 140 publications and participated in numerous international research projects. Beyond her academic work, she maintains active collaborations with public administration, industry, and media outlets and is a prominent science communicator.

Bart Van der Bruggen

Prominent Belgian researcher Bart Van der Bruggen, affiliated with the Catholic University of Leuven, is another significant addition to the REFRESH Energy Lab. He is based at the Nanotechnology Centre at VŠB-TUO, where he not only conducts research but also collaborates with students. His research primarily centers on the development of advanced membrane processes aimed at efficient water purification, heavy metal removal, and resource recycling.

His research is related to membrane science and technology to find sustainable solutions for separations, mostly in liquid media, related to (waste)water treatment, and resource recycling. Water treatment requires selective separation of specific compounds, which can be inorganic (phosphates, nitrates, salts in general, etc.) or organic (micropollutants or dyes). He uses pressure-driven membrane technologies, electrodriven membrane technology, or membrane contactors for this purpose. The topic further expands to resource recycling, considering, for example, lithium, magnesium, and other elements in brines (from desalination or natural brines), which require exceptional selectivities for recovery.

Professor Van der Bruggen has authored more than 800 publications, which have received more than 50,000 citations, and boasts an H-index of 108.

Carlos Marques

Professor Carlos Marques, an excellent researcher at the Industry 4.0 & Automotive Lab within REFRESH, has extensive research experience in optical sensing technologies applied across environmental, industry, aerospace, transportation, and biomedical systems. At VŠB-TUO, he and his colleagues focus on developing cost-effective, high-sensitivity optical fiber sensors for monitoring physical and chemical parameters, directly targeting pressing needs in real-world industrial and infrastructure applications.. His research is closely aligned with sensor deployment in transportation, industry, healthcare, and advanced manufacturing sectors. Last year, the work in the Refresh Project carried out contributions to high-impact journals such as Opto-Electronic Advances, APL Photonics, OPTICA Photonics Research, ACS Applied Nano Materials, IEEE Transactions on Instrumentation and Measurement, and TrAC – Trends in Analytical Chemistry.

Professor Marques is also affiliated with the University of Aveiro. There, he oversees theoretical developments, particularly in modeling interactions among electrical, magnetic, and optical environments, as well as conducting experimental validation of new sensor concepts. With access to cutting-edge facilities at CICECO and VŠB-TUO, the research teams foster international collaboration, technology transfer, and graduate training.

He has authored more than 250 publications with over 13,000 citations and an h-index of 74 (ORCID, Google Scholar). According to the global ranking by Stanford University, he is recognized among the most cited and influential researchers worldwide.

Aki Mikkola

Mechanical engineer and renowned researcher Aki Mikkola is a visionary and pioneer in the field of machine design, advancing modern approaches to real-time modeling and simulation of mechanical systems. Since earning his PhD in 1997, he has dedicated his career to research and educating the next generation of engineers. His research group is well-known for innovative breakthroughs in flexible multibody dynamics, rotating structures, and biomechanics. In 2002, he was appointed Professor at the Department of Mechanical Engineering at Lappeenranta–Lahti University of Technology (LUT University). Within the REFRESH project, he contributes as a member of the Department of Robotics, focusing on multibody dynamics, modeling of flexible elements, and mechatronic systems.

An internationally recognized researcher, Professor Mikkola is the author of a novel approach to analyzing machine behavior. The theory he developed enables the modeling and simulation of machine and equipment performance in virtual environments, revealing functional flaws in the early stages of design. He has collaborated with a number of Finnish and international companies, including Kone, Cargotec, Metso Outotec, Ponsse, Valtra, and Mevea. The methods and theories he has developed are applied not only in machinery research but also in biomechanics, medical rehabilitation, and sports science.

Professor Mikkola holds five patents and has delivered over a hundred conference presentations. He has authored more than 300 publications. His position as a leading expert is further confirmed by his role as Editor-in-Chief of the Journal of Multibody System Dynamics. In 2023, he was awarded the title of Professor of the Year in Finland.

Jan Kříž

REFRESH stands out for its ambitious goal of bringing together science, business, and public administration.

The Operational Programme Just Transition (OP JT), which awarded REFRESH a grant of CZK 2.5 billion, represents a completely new experience for the Ministry of the Environment. Nevertheless, it is often referred to as one of the most successful programmes in terms of drawing funds from the Just Transition Fund (JTF) in the European Union. We spoke with Jan Kříž, Senior Director of the Environmental Economics Section at the Ministry of the Environment, to discuss the reasons behind this success and other related topics.

How do you explain the success of the OP JT?

From the beginning, we designed OP JT with the actual needs of regions undergoing transformation in mind. The key was to provide targeted support while maintaining flexibility and emphasizing collaboration with local actors. We leveraged our experience with structural funds to establish processes that are straightforward, transparent, and effective. The active involvement of regional partners, the readiness of projects, and the ability to respond swiftly to calls and regional proposals have also played significant roles.

What stage is the implementation of OP JT at now? What is going well, and what challenges have you faced?

Currently, over 80 calls for proposals have been announced, totaling CZK 40 billion. We are gradually completing the intensive evaluation of applications and moving on to the implementation phase of approved projects, which already amount to almost CZK 30 billion. We are particularly successful in areas where strategic projects and a strong network of partners were already established, such as education, entrepreneurship, infrastructure, and public services.
We have embarked on a number of unconventional solutions, blending hard and soft activities from a wide range of topics. In some cases, the challenge remains to set conditions that do not impose an excessive administrative burden on applicants. Additionally, there are longstanding issues associated with European and national subsidies, such as sufficient capacity to prepare projects for smaller municipalities or securing resources for co-financing in the non-profit sector. To address these, we are systematically working on simplifying procedures and providing methodological support, and as a result, we have already managed to reimburse over six billion crowns to projects.

How do the Moravian-Silesian Region and the REFRESH project fit into this framework? What is your perception of our project?

The Moravian-Silesian Region has long been a leader in transformation efforts—it has a clear strategy and a well-functioning ecosystem capable of achieving its objectives. I see the REFRESH project as an example of innovative transformation based on research and development in key regional sectors such as energy, materials, and the automotive industries. I particularly value the integration of research capacities, companies, and regional institutions. Projects like REFRESH demonstrate, through specific examples that transformation is not solely about technological change but also about developing human capital and fostering innovations that are competitive at least at the European level.

Are there other projects similar to REFRESH that focus on regional development driven by research and innovation results?

Within OP JT, there are projects that utilize research and innovation—whether in renewable resources, sustainable technologies, or new educational methods. However, REFRESH stands out due to its complexity and its ambitious goal to create synergy between science, business, and public administration. In this regard, it is truly unique and can serve as an inspiration for other regions.

With over 80 calls issued under various OP JT initiatives, how are insights from previous experiences reflected in the current implementation process? What types of projects are most common?

The most frequently submitted projects focus on education. For instance, we are modernizing traditional classrooms as well as those equipped with robotics or virtual reality technologies. Supporting small and medium-sized enterprises is another key area—through smaller projects with straightforward vouchers for start-up businesses or interest-free loans for larger investments, such as acquiring expensive equipment or renovating buildings, with budgets up to CZK 100 million.

An essential part of the transformation involves rehabilitating landscapes affected by coal mining. Restoring these areas is crucial for removing the scars of mining activity. The goal is to return these landscapes to nature by supporting biodiversity enhancement measures, or to communities through improving public services, boosting tourism, and fostering cultural and sports activities. Our focus is on solutions that generate tangible impacts—initiatives that deliver enduring benefits to local communities, employment opportunities, and the environment.

As the Senior Director of the Environmental Economics Section, which projects resonate most strongly with you?

I am particularly engaged with initiatives that integrate environmental conservation with economic viability—such as renewable resource utilization, circular economy principles, energy efficiency, and adaptive strategies to address climate change. Equally, I value projects that involve young people, educational institutions, and local entrepreneurs, as these are vital for cultivating sustainable, long-lasting change.

A pivotal issue concerns the financing of the transition beyond 2027. What are the prospects?

The European discourse on the future of cohesion policy, including the continuation of the Just Transition Fund post-2027, remains ongoing. We are actively participating in this debate, highlighting the Czech Republic's experience and successes with the OP JT. Ensuring the availability of targeted tools for regional transformation amidst structural shifts will be essential, as well as leveraging private capital and developing innovative financial instruments. Our goal is to ensure that the transformation is not merely a series of isolated projects but a systemic, sustainable process with long-term stability.

Ing. Jan Kříž

Jan Kříž currently works as the Senior Director of the Environmental Economics Section at the Ministry of the Environment of the Czech Republic.

Born in 1976, he graduated from the Faculty of Civil Engineering at the Czech Technical University in Prague. Throughout his career, he has gained substantial experience in EU funding and financial management.

From 2007 to 2010, he worked at the Ministry of the Environment as Director of the Department of the Operational Programme Environment and then as Deputy Director and Head of the EU Structural Funds at the State Environmental Fund of the Czech Republic. Between 2010 and 2013, he was involved in financing initiatives under the Operational Programme of Research and Development for Innovation, first as a department director and later as a senior director of the section at the Ministry of Education, Youth and Sports. He has also worked at the BIOCEV research centre.

Trends

PUBLICATIONS 811 — 204% increase compared to 2023

INTERNATIONAL PROJECTS 15 — 150% increase compared to 2023

FINANCIAL SUPPORT from international grants — EUR 8 667 296 — 269% increase compared to 2023

CONTRACT RESEARCH FUNDING — CZK 309 164 253 — 96.8% increase compared to 2023

PATENT APPLICATIONS 8

NEW PROJECT

Advanced technologies for safe and efficient hydrogen storage

The international Core-H2 storage project aims to develop energy-efficient and reliable hydrogen storage solutions to facilitate its role as a flexible and scalable energy resource. This project is conducted by experts from the Centre for Energy and Environmental Technologies at VŠB-TUO in collaboration with colleagues from the Fraunhofer Institute UMSICHT. With a budget approaching five million Czech crowns, the project has received funding from the Technology Agency of the Czech Republic and is scheduled to conclude in October 2027.

The primary objective of this initiative is to address the challenges posed by the intermittent nature of hydrogen production and to enable its integration across various sectors, including transportation, industry, and energy production. Specifically, the project seeks to develop cost-effective and energy-efficient hydrogen storage systems operable at ambient temperature and pressures up to 3.5 MPa.

"The project is centered around five key objectives: optimizing storage efficiency, maximizing storage capacity relative to usable sorption capacity under new conditions, ensuring safety, and scalability. Thematically, the project is very closely linked to the REFRESH project, and we expect it to bring economic savings as well as environmental and safety benefits," said principal investigator Karel Borovec from the CEET Energy Research Centre (ERC).

Researchers in Ostrava utilize advanced analytical equipment from the ERC hydrogen laboratory, acquired through internal funding in recent years. This equipment includes a stand designed to assess hydrogen storage efficiency on the surface of specialised materials such as metal hydrides, along with a set for the accredited determination of hydrogen purity.

Developing research infrastructure

To date, we have purchased equipment valued at over CZK 246 million as part of the project's investments. The total expenditure in this sector amounts to nearly CZK 687 million.

1 High-pressure reactor for catalytic methanation of syngas

A new high-pressure reactor at the ENET Center will enhance the research team's technical capabilities in the field of catalytic hydrogenation of gas mixtures characterized by elevated concentrations of carbon dioxide and carbon monoxide to methane. This reactor, manufactured by Parr Instrument Company and constructed from stainless steel, is equipped with high-pressure valves and has a working volume of 500 milliliters. Its design permits operation at temperatures up to 500 °C and pressures reaching 350 bar, while ensuring effective stirring of the reaction mixture. The apparatus facilitates periodic sampling during the reaction process and allows for precise regulation of operating parameters—namely temperature, pressure, and mixing—via an automated control system. This configuration will enable comprehensive testing of various catalysts across a broad spectrum of reaction conditions, including diverse temperatures, pressures, and feedstock compositions. Researchers anticipate that the experimental outcomes will deepen the understanding of methanation processes and foster their application in industrial settings, thereby contributing positively to environmental sustainability and enhancing possibilities for efficient energy conversion.

2 Helios 5 CX

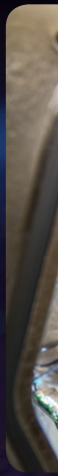
The Helios 5 CX, one of the world's most advanced electron microscopes, integrates scanning electron microscopy (SEM) with a focused ion beam (FIB). This system facilitates not only the detailed imaging of materials at nanometer-scale resolution but also their precise modification and preparation for subsequent analyses. Owing to its capabilities in ion microfabrication, advanced 3D control, and automation, it serves as an indispensable tool for the fabrication of ultrathin lamellae, with thicknesses in the tens of nanometers range – a key step for advanced single-atom analysis.

The instrument is utilized across various faculties at VŠB-TUO, particularly in collaboration with the Faculty of Materials Science and Technology within the framework of the REFRESH project. This project links research on material structure with its practical applications in energy engineering, chemistry, mechanical engineering, and semiconductor technologies.

3 Bruker ELEXSYS-II E500 EPR Spectrometer

The EPR spectrometer is employed for detecting paramagnetic centers with extreme sensitivity, reaching nanomolar concentration levels. The Electron Paramagnetic Resonance (EPR) technique enables analyzing free radicals, metal ions, and defects within materials that are exceedingly difficult to detect using conventional techniques.

This non-invasive method has wide-ranging applications in chemistry, physics, biology, and materials research. Researchers within the REFRESH project primarily utilize the spectrometer for the development of materials for energy conversion and storage, sustainable chemistry, and environmental applications.



4 OptiTrack 3D Tracking System

The recently installed OptiTrack optical three-dimensional (3D) tracking system at the IT4Innovations National Supercomputing Center, affiliated with VŠB-Technical University of Ostrava, will enable researchers to visualise complex scientific data and boost research within REFRESH. The procurement of this technology signifies a substantial advancement in the capability to visualise the results of large-scale calculations in real time. The system utilizes Primex 13W cameras characterized by a high frame rate of 240 Hz, a minimal latency of 4.2 milliseconds, and positional accuracy within tenths of a millimeter. The system will be used primarily in applications combining visualisation, scientific simulation, and artificial intelligence.

Digitization and visualization constitute fundamental tools across the diverse domains targeted by the REFRESH initiative, including sustainable energy production, industrial digitization, transportation automation, and environmental and smart material technologies. Utilizing this advanced 3D tracking system, in conjunction with large-screen projection technology and the capabilities of IT4Innovations supercomputer, will markedly facilitate the practical implementation of cutting-edge technologies in real-world applications, including community-based energy systems, hydrogen economy, and electromobility.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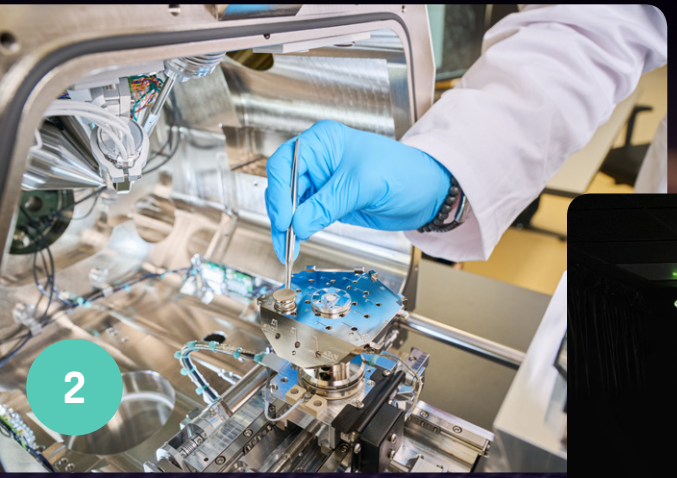
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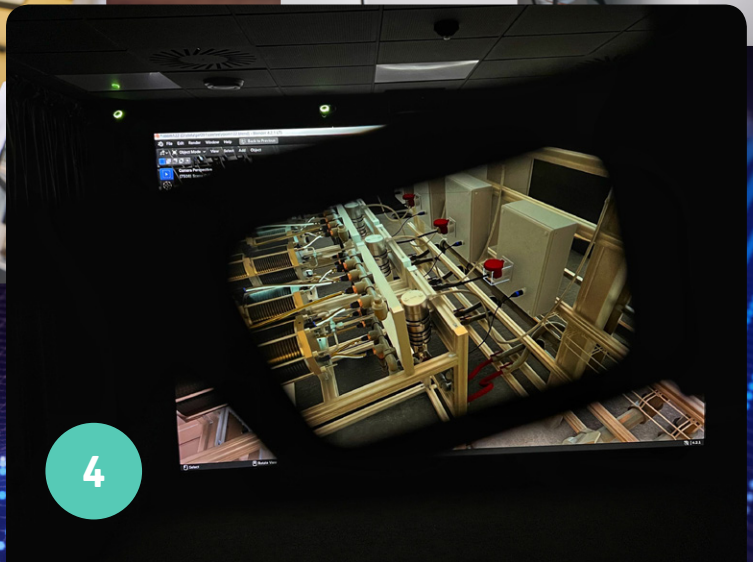
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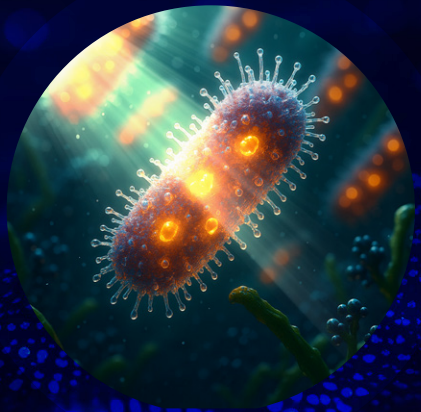

Innovative material to fight bacteria and viruses while exposed to infrared radiation

Killing bacteria with light. Disinfecting surfaces could be that simple in the future. A pioneering coating, developed collaboratively by researchers from EMPA, VŠB-TUO, and Palacký University, presents a significant step toward this goal. This novel antimicrobial material, characterized by its environmental and dermatological safety, becomes active upon exposure to infrared radiation.

The new metal-free material is designed to destroy microorganisms quickly and locally. It is based on polyvinyl alcohol, a biocompatible polymer commonly used in the food industry. "Embedded within this matrix is a synthesized nitrogen-doped graphene acid, which enhances antimicrobial efficacy through its chemical properties. Upon irradiation with near-infrared light, the material employs a dual antimicrobial mechanism: firstly, converting light energy into localized heat to eradicate bacteria; secondly, generating reactive oxygen species that compromise microbial cell membranes," explained Radek Zbořil, Scientific Director of the Materials & Envi Lab within the REFRESH project.

Unlike traditional antibiotics, this light-activated material provides broad-spectrum antimicrobial protection without fostering resistance. Its first practical use is being developed in dental medicine.

Breakthrough technology integrates water purification with energy storage

Using functionalized graphene, experts effectively removed pharmaceutical contaminants from water and then directly - without any further processing - converted the used sorbents into electrodes for so-called supercapacitors. These electrodes outperformed the original materials by up to 100 percent and show great promise for usage in modern energy storage technologies. This achievement was accomplished by researchers from the Center for Energy and Environmental Technologies (CEET) and IT4Innovations at VŠB-TUO in collaboration with colleagues from Palacký University. The breakthrough technology, which supports circular economy principles, was featured in the prestigious Journal of Colloid and Interface Science.

"It is essential to seek simple and low-cost solutions for water purification. We can prepare and chemically modify graphene materials on an industrial scale and use them as effective sorbents for removing a variety of pharmaceutical pollutants from contaminated water. We demonstrated exceptional efficiency in removing conventional drugs such as ibuprofen, diclofenac, and paracetamol. Moreover, the used 2D sorbents proved highly effective in the development of a new generation of so-called supercapacitors. These offer significant advantages over Li-ion batteries, including very fast charging and discharging, long lifespan, and resistance to extreme temperatures. Thanks to these properties, they are particularly suitable for applications requiring rapid energy delivery or absorption," said Aristeidis Bakandritsos from the Materials & Envi Lab of REFRESH.

Researchers report progress in ammonia synthesis using new materials

The latest advances in the usage of low-dimensional materials in the production of "green" ammonia are summarized in a review article authored by an international team led by Martin Pumera from the Faculty of Electrical Engineering and Computer Science at VŠB-TUO, published in the prestigious journal Chemical Society Reviews. The study focuses on photo- and electrocatalysis techniques as well as novel approaches to harness waste nitrogen compounds. The review article compares various methods for ammonia synthesis and highlights potential pathways toward more sustainable production, including applications in wastewater treatment and carbon-free energy systems.

"Our goal was to provide a comprehensive overview of the catalytic properties of low-dimensional materials that could enhance the efficiency of ammonia production and promote the synthesis of value-added products. The publication confirms our research team's position among the leaders in the field of green chemistry and nanomaterials," said team leader Martin Pumera from the Advanced Nanorobots and Multiscale Robotics Lab, who also works in one of the REFRESH project's living labs.

Ammonia is a vital chemical, extensively used in agriculture and industry. Recently, it has also gained importance for storage, transportation, and energy recovery purposes. Ammonia acts as a carbon-free carrier of hydrogen and energy (unlike its carbon counterpart, methane) and, unlike hydrogen, is significantly cheaper to transport. However, traditional ammonia production is energy-intensive and contributes to increased global CO2 emissions. Consequently, researchers are exploring new, more cost-effective, and efficient methods for ammonia synthesis, aiming to leverage its carbon-free properties for energy storage and transport.

White rot fungi may contribute to higher methane production from digestate

Researchers from the Institute of Environmental Technology at CEET, VŠB-TUO, in partnership with the Faculty of Science at the University of Ostrava, have achieved a breakthrough in the eco-friendly treatment of a biogas plant by-product—digestate. Their findings, published in the esteemed Chemical Engineering Journal, reveal that white rot fungi can greatly enhance the utilization of digestate which results from the anaerobic breakdown of organic material during biogas production. While digestate is typically used as fertilizer, its full potential remains largely underexploited.

By employing specific fungi species—Dichomitus squalens, Pleurotus ostreatus, and Irpex lacteus—researchers successfully pretreated the digestate biologically, transforming it into a more suitable substrate with considerable promise for increased methane generation. "Using these fungi could be an easy way to produce more methane and generate additional energy from digestate without requiring new technology developments," explained Kateřina Chamrádová, a researcher from the Biochemical Processes group at the Institute of Environmental Technology.

These fungi produce enzymes that break down organic material, boosting methane production by up to 2.15 times.

REFRESH accelerates applied sciences at the University of Ostrava

The REFRESH project has facilitated the establishment of a new research group called URSA (Urban and Regional Studies & Applications), consisting of staff members and doctoral students from the Department of Human Geography and Regional Development at the University of Ostrava. This young team is gaining practical experience in transferring scientific insights into real-world urban and regional development solutions.

"The idea of forming this research group developed over the past two to three years as we began collaborating intensively with local governments and businesses interested in our expertise. The REFRESH project has helped us systematize this work and focus on improving how we transfer our knowledge about the region and its cities into practical applications," said Ondřej Slach, head of URSA and scientific director of the REFRESH Social Lab.

URSA adopts an interdisciplinary, participatory approach, engaging local communities in development strategies. Within REFRESH, the team focuses on applying research outputs to improve residents' quality of life and sustainability. They develop strategic documents for regional growth and address social issues like industrial decline, exclusion, and new economic opportunities. Key initiatives include the Walkability and Family Policy 2030 Concepts for Ostrava.

Smart networks prove critical to enhancing water management efficiency

A comprehensive review study, authored by researchers from VŠB-TUO and Mendel University in Brno and published in the prestigious journal ACM Computing Surveys, delineates current advancements in integrating Internet of Things (IoT) and artificial intelligence (AI) for efficient and sustainable water management. The publication offers an in-depth analysis of the state-of-the-art and defines primary future research challenges.

Water treatment, monitoring, and distribution are vital to national infrastructure, facing growing pressures on water distribution networks. Climate change and droughts increase resource extraction, while transmission losses remain a challenge. IoT and smart distribution systems offer promising solutions to improve efficiency, safety, and leak detection.

"This type of smart network, referred to as Smart Water-IoT (SW-IoT), is a new, comprehensive concept for water management. In our review study, we looked at the application of IoT and artificial intelligence components in five key areas: agriculture, water treatment, safety, water supply networks, and wastewater treatment. The study also provides an overview of relevant legislation in the EU, US, Canada, Australia, China, Japan, and India. In this context, it also outlines the mandatory implementation of smart solutions for remote data reading in the critical infrastructure of EU member states, which highlights the importance of responsible water management," said one of the authors of the article, Radek Martinek from the Faculty of Electrical Engineering and Computer Science at VŠB-TUO and the Industry 4.0 & Automotive Lab of the REFRESH project.

Researchers are developing smart thermal storage tanks for towns and cities

Researchers from the Faculty of Mechanical Engineering at VŠB-TUO aim to provide a reliable central supply of affordable heat for towns and villages year-round, particularly during winter, using thermal storage tanks. A team of experts has been addressing this challenge for over three years through the Accumulation Hydroelectric Power Plant of a New Type (AVE) project, and now as part of the Energy Lab of REFRESH. As a result, four invention applications and four utility model applications have been filed, and an international patent application is being developed.

Thermal storage systems are employed for both short- and long-term thermal energy storage. They are especially beneficial in situations where heat cannot be supplied from a production source when it is needed. Historically, such devices were not essential, as inexpensive and easily adjustable fossil fuels like coal and natural gas were readily available. However, as we move towards renewable energy sources, the landscape is shifting, leading to an increasing demand for adaptable heat storage options.

Stanislav Honus from the Faculty of Mechanical Engineering and head of the research programme on the Use of Secondary Raw Materials and Alternative Energy Sources at the Energy Lab shared some preliminary findings: "We have created a comprehensive optimization calculation for sizing the thermal storage tank system, as well as assessing its performance and cost factors. Users can choose various input data, including the dimensions and quantities of storage tanks, internal and external temperatures, types, quality, and arrangement of thermal insulation, material costs for tanks and insulation, and energy inputs."

Experimental results to develop guidelines for safe hydrogen handling

The results of experiments conducted at the end of April by experts from the Faculty of Safety Engineering (FSE) at VŠB – Technical University of Ostrava (VŠB-TUO), in partnership with commercial companies, in the military training area in the Doupov Mountains, will form the foundation for developing safety regulations and standards for hydrogen handling. Researchers involved in REFRESH plan to revisit the site in June and autumn, with additional experiments also scheduled to take place in Ostrava.

"The tests involved a 245-liter hydrogen cylinder rated for 200 bar. During testing, we monitored pressure and temperature changes under external fire. We simulated cylinder failure to evaluate fragmentation risks and environmental hazards, and also tested controlled puncturing for hydrogen release as an alternative safety measure," remarked Vojtěch Jankůj from the FSE. The team collaborated with the University of Defence, Vítkovice Cylinders, and Linde.

REFRESH was presented to President Petr Pavel

During his visit to the Moravian-Silesian Region in May, President Petr Pavel participated in a meeting held in Třinec, where he was introduced to strategic initiatives within the framework of the Operational Programme Just Transition. The objectives, primary tasks, and current outcomes of REFRESH were presented by the project director and vice-rector of VŠB-TUO, Igor Ivan.

"It was a very pleasant meeting, and I am glad I had the opportunity to present the specific results and benefits of our project for the Moravian-Silesian Region to the President," said Ivan.

Additionally, President Pavel visited VŠB-TUO, where he toured the IT4Innovation national supercomputing centre and observed the country's first VLQ quantum computer. The visit focused on advanced research infrastructure in high-performance computing, artificial intelligence, and quantum technologies, emphasizing their significance for enhancing the Czech Republic's competitiveness.

VŠB-TUO to build a Center for the Vehicle of the Future with a Korean partner

A collaborative Advanced Industrial Centre for the Vehicle of the Future will be launched at VŠB-Technical University Ostrava through a partnership with the Korea Automotive Technology Institute (KATECH). Both institutions officially established collaboration on Wednesday, 7 May, by signing a memorandum in the presence of Industry and Trade Minister Lukáš Vlček, government officials, and guests.

"The centre aims to bring together Czech and Korean researchers and companies within the automotive industry. It will involve expert teams from multiple faculties, some already collaborating with Hyundai Motor Manufacturing Czech and its suppliers. We anticipate an even greater deepening of ties with Korean firms and academic institutions," stated Václav Snášel, Rector of VŠB-TUO.

"We will focus on applications for intelligent transport systems and innovations in cooperative, connected, and automated mobility. A key topic is software-defined vehicles—future cars primarily managed through services and applications, akin to modern smartphones," explained Petr Šimoník from the Faculty of Electrical Engineering and Computer Science at VŠB-TUO, expert guarantor of the planned centre for VŠB-TUO, and scientific director of the Industry 4.0 & Automotive Lab of REFRESH.

MAGNUM connects the university with the Max Planck Institute for Plasma Physics

VŠB-TUO and the Max Planck Institute for Plasma Physics (IPP) have reached an agreement to collaborate on developing innovative technologies aimed at tackling global energy and environmental challenges. In a joint memorandum, representatives of both institutions officially established a partnership called MAGNUM (Machine Learning, Advanced Material Engineering, General Characterisation and Understanding of New Materials)

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The partners will focus on scientific and technological cooperation in the fields of machine learning, advanced materials engineering, general characterisation of materials and surfaces using a wide range of state-of-the-art spectroscopic and microscopic methods, and understanding new materials through the evaluation

of the results obtained. To this end, they will combine leading scientific disciplines, including nuclear fusion, photonics, catalysis, decarbonisation, and nanotechnology.

MEL enhances collaboration with the Leibniz Institute for Catalysis

Radek Zbořil, director of the Materials-Envi Lab, visited the Leibniz Institute for Catalysis (LIKAT) in Rostock, Germany, upon an invitation from Professor Matthias Beller, Vice-President of the German Leibniz Society and a distinguished expert in chemical catalysis.

During his visit, he delivered a guest lecture titled "Low-dimensional Materials in Advanced Biomedical and Chemical Applications" and explored opportunities for further partnership.

"We have established plans for medium-term exchange internships for our staff. We aim to move into the field of photocatalysis and catalytic hydrogen production from organic sources. Furthermore, we are developing a major joint project within the European Teaming initiative, focusing on single-atom engineering, which we intend to submit in collaboration with colleagues from the University of Cambridge and the Karolinska Institute in Sweden," Zbořil explained. His laboratory is already engaged in several collaborative projects with LIKAT, particularly in single-atom catalysis, organic synthesis, and biomass valorisation.

VŠB-TUO hosted the 12th National Transfer Conference

Technology transfer as part of the innovation ecosystem was the main topic of the 12th National Transfer Conference, hosted by VŠB-TUO on 19 and 20 March. The conference brought together around 100 key players in technology transfer in the Czech Republic from academia, business, public administration and innovation and transfer centres. The prestigious event was organised by Transfera.cz and partnered by the Confederation of Industry of the Czech Republic, the Moravian-Silesian Innovation Centre and the REFRESH project.

"Technology transfer is one of the important pillars of REFRESH, which is why we participated in organising he conference. REFRESH has already made a significant impact not only in research and development, but is also beginning to drive transfer at both universities. This is evidenced by the patents filed and also by two licences sold to industrial partners," said Igor Ivan, Vice-Rector of VŠB-TUO and Director of REFRESH, who also participated in a panel discussion entitled Industry and Technology Transfer: From Innovation to Economic Growth.

Collaboration was the key word at the Czech-German meeting

Over 100 participants, more than 20 presentations, and over 20 exhibitors, primarily from the commercial sector, attended the event. This summarises the 2nd Czech-German Business Meeting held on April 10 at VŠB – Technical University of Ostrava, organised by the local Fraunhofer Innovation Platform (FIP-AI@VSB-TUO). The event aimed to foster international cooperation and innovation within industry and cutting-edge technologies. The primary focus was on transforming industry through smart manufacturing and energy solutions.

Jana Kukutschová, Vice-Rector of VŠB-TUO and Director of FIP-AI@VSB-TUO, stated, “The event serves not only as a platform to exchange new information and stay updated on current trends but also, importantly, to forge new partnerships for future collaboration. We’ve successfully reached a diverse range of companies, from traditional manufacturing to urban agriculture. It’s clear that a well-chosen topic—such as applied artificial intelligence—is highly relevant to them, and they are eager to explore cooperation possibilities.”

Researchers from VŠB-TUO presented their findings to experts from Škoda Auto

Researchers from VŠB-TUO showcased their findings to specialists from Škoda Auto at a collaborative workshop held in Mladá Boleslav. Representatives from the Industry 4.0 & Automotive Lab (IAL) of the REFRESH project outlined specific research areas and expertise related to technical vehicle development, safe transport and logistics, manufacturing processes, AI applications, modeling and simulation, as well as additive manufacturing. Over 120 automotive professionals attended presentations from experts from the Faculty of Electrical Engineering and Computer Science (FEI) and the Faculty of Mechanical Engineering.

“I was very pleased with the great interest of the automotive company in our expertise and the positive response to the event. We presented the best we can offer our industrial partners, gathered concrete ideas for further collaboration, and negotiated several new assignments for specific partnerships focused on the experimental development of new outputs,” said IAL Scientific Director Petr Šimoník from FEI.

Academics addressed topics such as advancements in the development of sophisticated automotive systems and technical tools for the development and testing of ADAS and automated driving, software-defined vehicles, image processing, and the application of artificial intelligence and machine learning in manufacturing and logistics. They also discussed advanced signal processing using AI and ML, digital twins for manufacturing processes and automation, and various aspects of additive manufacturing including application management and processing stages.

Licence

ABB, a global leader in industrial automation, acquired the robotic welding control license from VŠB-TUO. Originally developed at the Faculty of Mechanical Engineering, this technology is now transitioning into practical use. Moreover, the commercialization process of these scientific advancements was completed in record time.

The system employs intelligent sensors to continuously oversee the welding process. By analyzing welding current and voltage with advanced techniques, it can detect weld defects in real time. ABB intends to incorporate this technology into its robotic welding cells to help clients enhance the efficiency and quality of their industrial welding operations.

Robotic welding is widely applied across various industries that demand high precision, efficiency, and consistency. Its primary sectors include mechanical engineering, automotive, aerospace, and shipbuilding industries, and energy engineering.

MSIC LabZero supports researchers and students in bringing innovations to market

The innovative MSIC LabZero initiative aims to assist researchers and students in transforming their ideas from the laboratory into market-ready solutions. Organized by the Moravian-Silesian Innovation Centre Ostrava (MSIC), this program is open to those interested in fostering innovation. The comprehensive series of events includes workshops, idea exchanges, a Bootcamp, and Demo Day. Following the successful pilot held in spring, MSIC is now working on another edition scheduled for this autumn.

“Our objective is to foster collaboration among researchers, businesses, and students. We seek to connect research teams and companies with students eager to work on impactful projects and contribute to regional innovation. Participation is free for students from all universities and colleges in the Moravian-Silesian Region,” explained Pavlína Baranová, project manager of MSIC LabZero.

The cycle kicks off with workshops designed for researchers who often develop pioneering ideas but need guidance to bring them to market. With expert support, participants gain vital knowledge for commercializing their research outcomes. Another key component is Reverse Pitching—an idea exchange where companies and researchers seek out students interested in tackling specific challenges. This is followed by a three-day Bootcamp, culminating in a public Demo Day where teams showcase their solutions in English to an audience of industry professionals, academics, investors, and the public, and receive feedback from a jury. The programme doesn’t end here; even after the official series concludes, students can continue to access MSIC support to further develop their innovations.


REFRESH


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Presenting REFRESH to the public

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