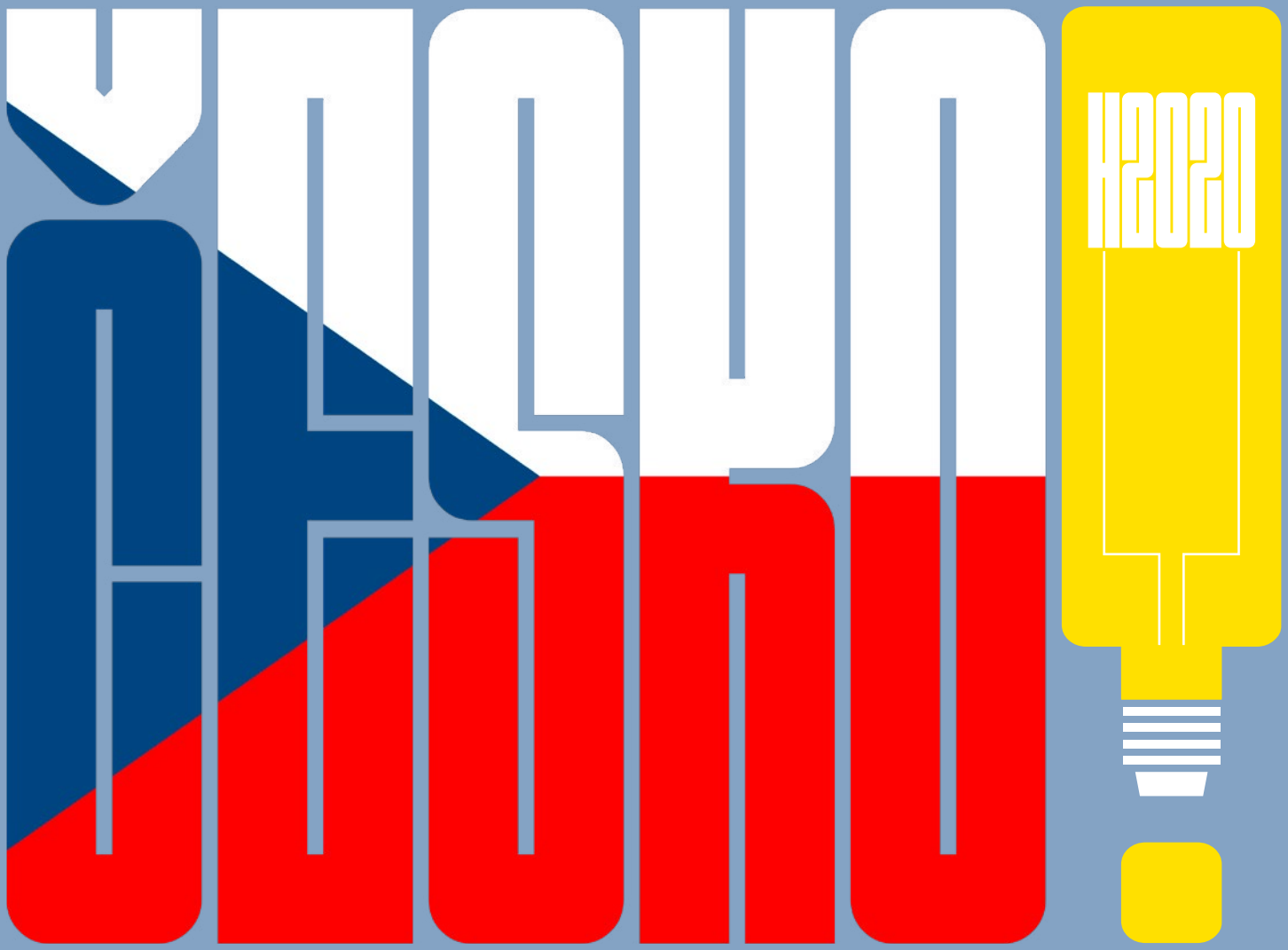
European Commission

The Czech Republic and Horizon 2020

A spotlight by CORDIS



Research and Innovation

Contents

Editorial

In July 2022, the Czech Republic takes over the Presidency of the Council of the European Union. To mark this occasion, CORDIS is providing an insight into the country's vital scientific achievements generated within Horizon 2020.

The Czech Republic, hereinafter referred to as Czechia, has a long history of scientific pursuit supported by government and industry, reflected in its ranking as #24 in the Global Innovation Index. It has produced historical scientists such as astronomers Tycho Brahe, Nicolaus Copernicus and Johannes Kepler, mathematician Kurt Gödel, as well as psychoanalyst Sigmund Freud and pioneering geneticist Gregor Mendel. Czechia also gave the world the term 'robot' – a tireless machine automaton – in a play by Karel Čapek.

In the present day, Czechia continues to build a significant scientific legacy. Since 1993, Czech science and industry have attracted over a billion euro in investment through EU science funding programmes such as FP7 and Horizon 2020, a trend that is set to continue under Horizon Europe.

Czechia's scientific history covers a vast range of subject areas, including material engineering, nuclear research, sustainable agriculture, artificial intelligence, energy efficiency, genetic research, air pollution, climatology, waste recycling, virology, and of course, robotics.

This Spotlight Pack from CORDIS takes a closer look at the innovative results of 16 research projects funded by the European Union under the Horizon 2020 programme, celebrating their achievements and endeavours. They include work carried out to enable the development of more efficient aircraft engines, better speech recognition by computer systems, and hormone-based pest control that can reduce the use of toxic insecticides. This is, of course, just a glimpse of the strength and dynamism of Czech science, and the impact it has.

In this publication you'll also find several informative infographics giving an overview of Czechia's active participation in Horizon 2020, showcasing the size and spread of grants obtained by Czech institutions. With this support, Czech science has produced collaborations across the world and provided decisive growth to SMEs, and advances in science, both at home and abroad – see the map on pages 20-21.

The research industry in Czechia continues to produce solid scientific, political and economic value for citizens, and maintains the country's position as a leading power in research and innovation. The impact of these diverse and influential projects continues to be felt long after the programme ended: for example, the training offered by CraftEdu migrated online during the COVID pandemic, and continues to provide e-learning to the construction industry, while the work carried out under GENDERACTION is being furthered through the Horizon Europe Programme by the GENDERACTIONPLUS project.

As the European Union's primary source of information on the success achieved by EU projects, CORDIS is proud to play a role in disseminating the results of this cutting-edge research, bringing Czech achievements in science to a global audience of researchers, policymakers and citizens.

Czechia's involvement in H2020

Total net EU contribution to H2020 projects involving Czechia

€511.6 million

HORIZON 2020

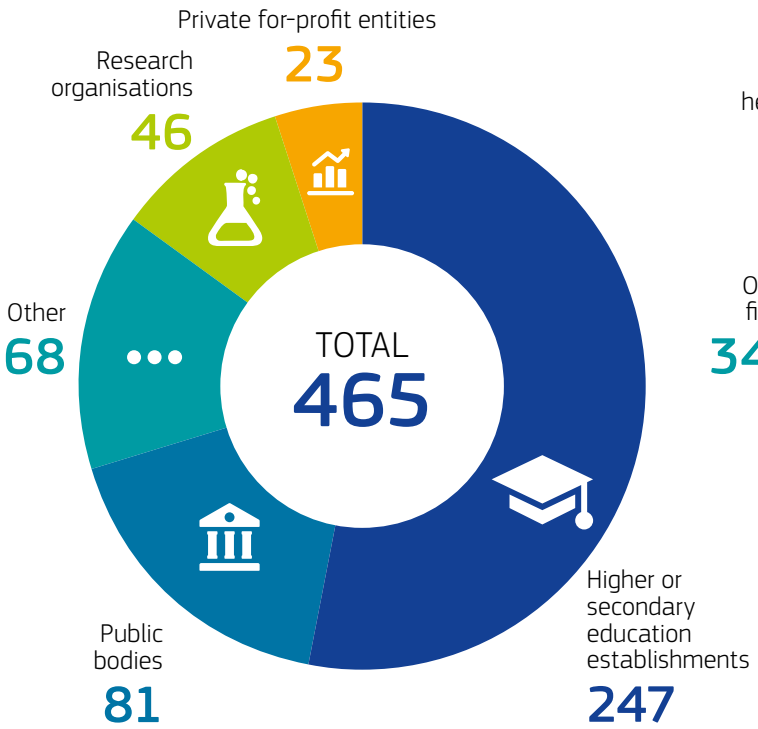
1394
Grants signed

465
Unique participants*

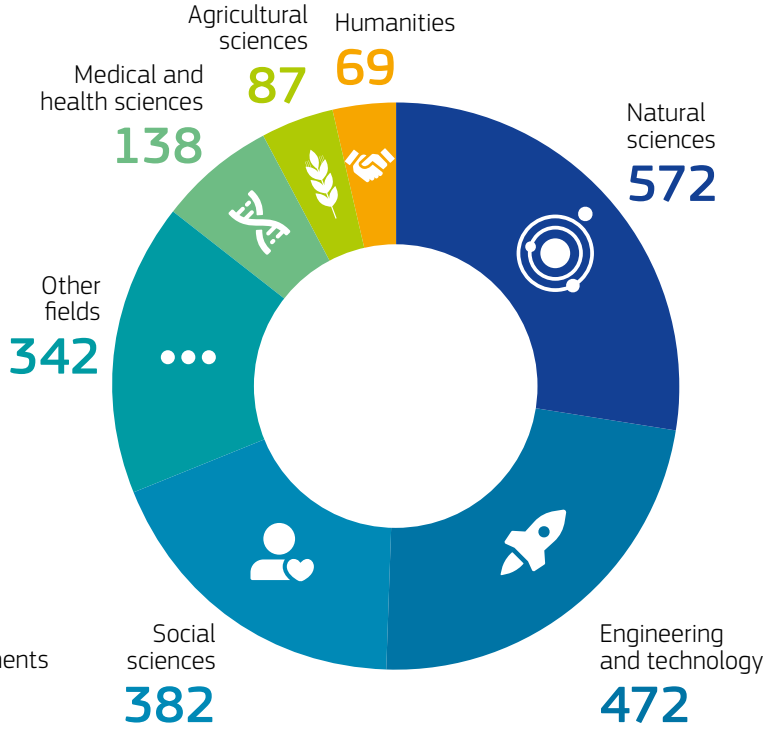
170
SMEs

* Unique participants are the number of distinct organisations involved in the selected projects. One organisation participating in n projects is only counted once.

Participants' profiles



Projects per research area



Source: R&I Projects dashboard: https://bit.ly/RI-H2020-projects-dashboard-Czechia

Projects involving Czechia by H2020 section

Industrial Leadership

TOTAL
284

TOP THREE THEMES

LEIT-ICT
Information and Communication Technologies
137

INNOSUPSME
Innovation in SMEs
37

LEIT-ADVMANU
Advanced manufacturing and processing
34

Excellent Science

TOTAL
391

TOP THREE THEMES

MSCA
Marie-Skłodowska-Curie Actions
190

INFRA
Research Infrastructures
121

ERC
European Research Council
45

Societal Challenges

TOTAL
564

TOP THREE THEMES

TPT
Smart, green and integrated transport
161

ENERGY
Secure, clean and efficient energy
118

HEALTH
Health, demographic change and well-being
84

\+ **Euratom Research and Training Programme**
60

\+ **Spreading excellence and widening participation**
51

\+ **Science with and for Society**
39

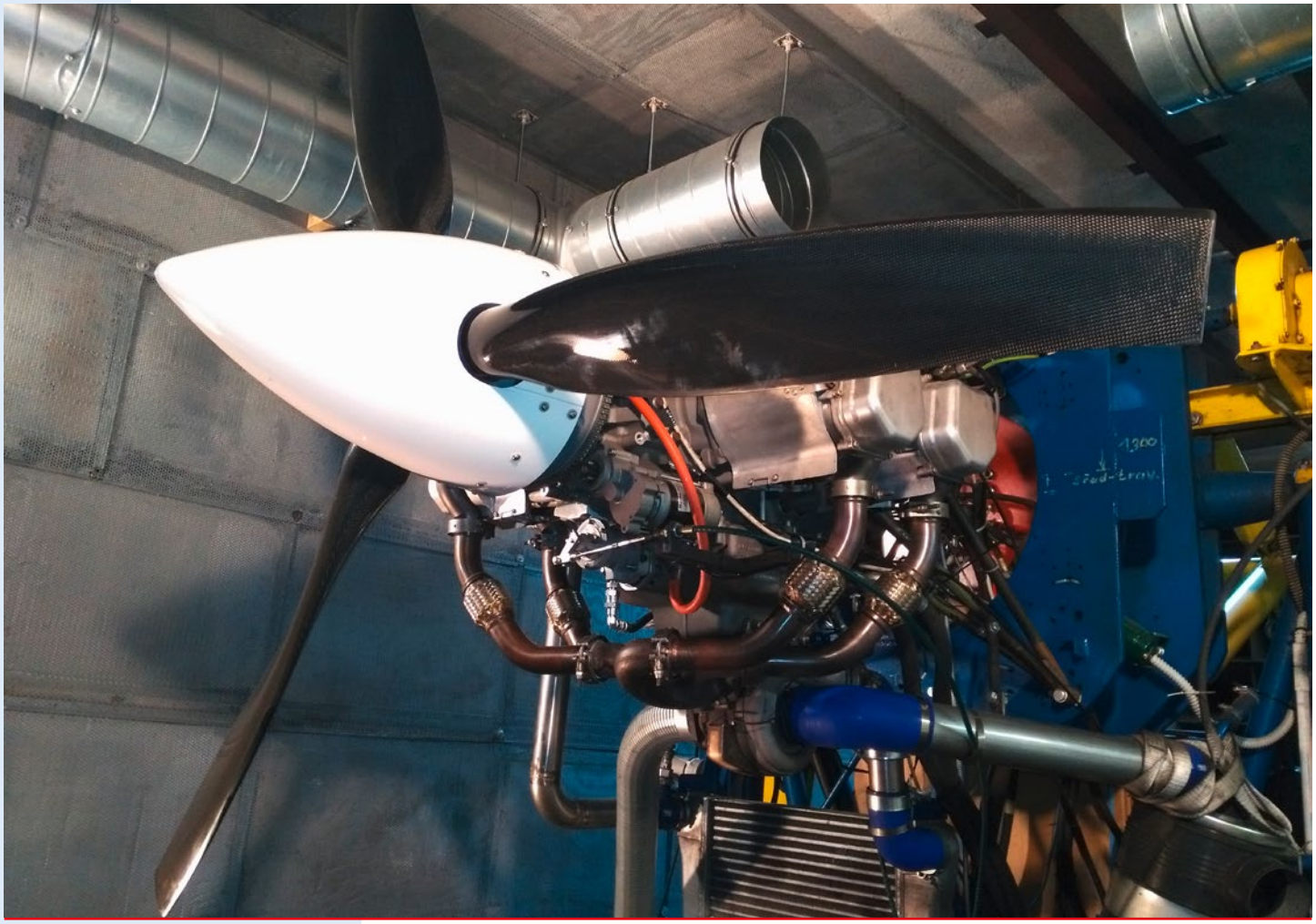
\+ **Cross-theme**
5

Source: R&I Projects dashboard: https://bit.ly/RI-H2020-projects-dashboard-Czechia-2

Innovative propeller design enables diesel aircraft engines

Piston engines are the most efficient option for small aircraft and diesels are even better, but using them first requires optimised propeller design.

Transport and Mobility



© ARGOS

Most small aircraft have traditionally used petrol/piston engines similar to those in cars. Yet, these can be suboptimal for aviation use.

A better alternative is the compression-ignition design, also known as diesel. These engines achieve ignition via compression of the fuel/air mixture. Diesel's higher compression ratio allows more efficient use of energy contained in fuel, which means better burning efficiency and lower fuel consumption. Piston engines' simplicity and low fuel consumption translate to lighter weight and better efficiency for the aircraft. This yields improved environmental credentials and operating costs. An aircraft diesel engine uses jet fuel with low volatility, which contributes to operational safety.

The use of diesel engines in aircraft would be highly desirable. However, before this is possible, a new propeller must be designed to address the problems with this type of engine. Developing a suitable propeller was the task of the EU-funded ARGOS project.

Problems addressed

The first problem with jet-fuel diesel engines is that they run very roughly compared to conventional designs. The uneven torque distribution causes vibrations that eventually fatigue the propeller. This reduces its lifespan and increases risk of failure. The second problem is that propeller design must be carefully matched to the type of engine. Using a propeller designed for a petrol engine in a diesel engine compounds the fatigue problem, besides being inefficient.

Project partners first experimented with neutralising the vibrations via a dampening device. In a car, the gearbox fulfils this function. However, the team rejected that option, partly since the target engine is a so-called direct-drive design lacking a gearbox equivalent. The team instead focused on propeller redesign because that would mean lower drivetrain mass and complexity.

Researchers tested many combinations of propeller shapes, materials and engines. "The most important outcome of the project was the data obtained from this experimentation," explains project coordinator Vilém Pompe. "It's easy to say that a diesel engine runs roughly, but by how much, and why?" The ARGOS project quantified propeller response on both petrol and diesel engines.

New prototype design

Testing results contributed to the design of a completely new prototype propeller optimised for diesel engines. "Our solution involved installation of retention bearings in propeller blades," adds Pompe, "which absorb vibrational energy. We also found suitable materials for the propeller blades and hub, which further absorb the energy."

The new propeller is heavier and more robust than propellers designed for petrol engines of the same power. Despite the extra weight, the new propeller includes minimal notches and stress concentrators. The resulting design is simpler than alternatives meant for petrol engines, while production costs are comparable.

After initial design testing, followed by manufacture and validation of the prototype, testing continues in the post-project period. The team aims to fully certify a design based on the prototype and take the results to market. Based on the ongoing testing, researchers developed a slightly modified prototype now in production. This will be used for the certification process. The team plans to flight-test the propeller soon.

The redesigned ARGOS propeller will enable the use of efficient diesel engines in aviation. This will make small aircraft more economical and environmentally friendly.

Note: this article was first published in April 2020

PROJECT

ARGOS – Aerospace propeller useful for diesel engines with extreme excitation of vibrations

COORDINATED BY

Woodcomp Propellers in

PARTNER ORGANISATION COUNTRY

FUNDED UNDER

Horizon 2020-TRANSPORT

TOTAL BUDGET

€524 153.75

EU CONTRIBUTION

€420 495

CORDIS FACTSHEET

cordis.europa.eu/project/id/714030

PROJECT WEBSITE

projects.woodcomp.cz/ARGOS

New tools to digitalise wasteful fashion industry

An EU-funded project is looking to integrate a body-scanning smartphone app that could help reduce waste and environmental damage.

Digital Economy

© AVATAR_OFFORM3D

Technology can disrupt the use-and-throw-away fashion industry by digitalising key stages of apparel design and production, moving towards a future vision of producing garments only as they are required.

The EU-funded AVATAR project initially aimed to develop 3D digital avatars of buyers to personalise fitting and customise fashion choices. But the team changed its focus, as the market feasibility study undertaken as part of the project identified major gaps in the fashion industry.

"We moved from the first idea of developing avatars – avatar technologies already exist, even if they have limited functionality – to a new model of the fashion industry," says project coordinator Kateřina Čihařová, CEO of Innovation Leadership Agency (ILA) in Prague.

"There is a cacophony of many technologies that are partial solutions for partial problems in the industry," says Ivan Dvořák, ILA founder and managing director. "We mapped both the innovation and technology landscape and market supply and demand in the digital fashion area. This threw up gaps in the market. We regard it as a business opportunity to integrate the whole process of designing and producing digital or virtual garments."

Inefficient and wasteful process

"Textile and apparel production is very inefficient and devastating for the environment," Dvořák explains. "Some 75–85 % of the dresses produced are never worn," he adds.

"Big fashion outlets introduce a collection, have it for a couple of weeks then throw it out. The waste is enormous, the process consumes vast amounts of water and the dyeing process causes extensive environmental pollution. Microfibres from the garments pollute the oceans. And the industry grows and grows."

The AVATAR project is aiming for a future in which garments will only be produced when everything is confirmed by the client. But, the team believes, before this can happen, every aspect of design and production must be digitalised and integrated.

Digitalised fitting and patterns

The project's vision of a totally different type of industry starts with the avatar on mobile phones that measures the body in real time, creating a digital representation. The customer would then go to a tailor, specialised agency or e-shop and choose digital clothes to dress their avatar.

"You adapt it digitally and see how it looks. We are working on making these avatars move so that they can also be used as models for a fashion show or catwalk, as part of the vision of producing dresses with no waste," Čihařová says.

A library of avatars of existing models is being developed in cooperation with fashion fairs and collections agencies, reducing the need for models to travel for try-outs. The project has also created a library of 3D garments that includes tailoring patterns which can be digitally adapted, saving paper. The library currently has 260 garments in 3D, with the goal of digitalising around 800.

"We can offer fashion designers and apparel producers a set of tools, including the library, plus consultancy support to help them master the new integrated technology," Dvořák notes. "Big players do everything in-house but medium players will outsource this part of their work."

The company is currently testing interest, offering avatars and digital patterns to fashion designers to download for free, with a feedback questionnaire. The response so far has been mixed. "Older, well-known designers are resistant and see it as a betrayal of their art. On the other hand, many younger people are very enthusiastic," Dvořák adds.

Note: this article was first published in June 2020

PROJECT

AVATAR – SW application for smartphones enabling accurate and easy-to-use 3D body scanning for digitalized design and production process in fashion and textile industry

COORDINATED BY

ILA in

FUNDED UNDER

Horizon 2020-SME, Horizon 2020-Societal Challenges and Horizon 2020-LEIT

TOTAL BUDGET

€71 429

EU CONTRIBUTION

€50 000

CORDIS FACTSHEET

cordis.europa.eu/project/id/876317

Battery analysis set to revolutionise electronics market

Analytic software that delivers detailed analyses of battery life, as well as reuse and recycling options, could help bring electronics manufacturers into the circular economy.

Digital Economy

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Europe's transition from fossil fuels to renewables has been accelerated in part by the availability of rechargeable batteries. This is because they give both energy providers and users convenient and efficient storage capacity, helping to offset any perceived inefficiencies that renewables have compared with conventional energy sources.

"Batteries are now the primary energy source for practically all electronic devices," notes project coordinator Michal Šaštinský, CEO of BatteryCheck, Czechia.

"From mobile phones and electric vehicles through to industrial solutions and Internet of Things sensors, billions of rechargeable and single-use batteries are currently in use. And their number is growing exponentially."

However, even though we might use a dozen battery-powered devices in a typical day, this does not necessarily mean that consumers – or indeed manufacturers – use this technology as efficiently as they could.

"The way we use, don't use or misuse batteries changes their performance," says Šaštinský. "We have all been in a situation where a battery has died when it shouldn't. How can we make them last longer? And when a battery is at its 'end of life', is it really dead, or can it be reused and repurposed, to make use of its components?"

Cloud-based solutions

To address this challenge, BatteryCheck has developed cloud-based analytical software that monitors battery performance in electronic devices. The idea is that manufacturers can make use of the software, without much additional work on their part. "Give us the data, we will provide you with the results of our analytics," explains Šaštinský.

BatteryCheck envisages this feedback to be in the form of usage recommendations, predictions about likely end of life, as well as recommendations for optimal recycling and repurposing. With this knowledge, device manufacturers can prolong battery life and make more effective use of the raw materials contained in batteries.

"This is about taking the mystery out of battery life and solving tomorrow's battery problems today," adds Šaštinský. "I think industry should act now and start monitoring batteries in as many new battery-powered devices as possible."

Rethinking battery life

During the EU-funded project, Šaštinský and his team approached battery-powered device manufacturers. The objective was to educate them about BatteryCheck's unique technology offer, and to start collecting battery data. "We found that even though manufacturers were mostly focused on device functionality and design, they were also concerned about battery performance," explains Šaštinský.

"They also did not have expertise in sourcing batteries or efficiently integrating them into their devices. Many companies had problems with predictive maintenance, replacement and battery warranties. They were therefore very interested in working with us."

Šaštinský and his team got to work, helping a selection of electronics companies to make next-generation products 'BatteryCheck enabled' by design. The idea is that these products will have the optimal type of battery installed, and be able to measure, monitor and send back battery data.

"We will then be able to analyse this data, and provide manufacturers with the results," says Šaštinský. "This means that devices and their batteries can be used predictably and for as long as possible."

Although the technology is still in pre-revenue stage, Šaštinský is confident that market acceptance is just a matter of time. "Once this technology is integrated in significant volumes into marketable devices, the revenue will come," he adds.

"I believe that our vision and focus on promoting battery life through analytics will become a market standard for all the battery-powered devices in the future."

Note: this article was first published in June 2020

PROJECT

BatteryCheck – Take the mystery out of battery life

COORDINATED BY

BatteryCheck in

FUNDED UNDER

Horizon 2020-Societal Challenges, Horizon 2020-SME and Horizon 2020-LEIT

TOTAL BUDGET

€71 429

EU CONTRIBUTION

€50 000

CORDIS FACTSHEET

cordis.europa.eu/project/id/878137

PROJECT WEBSITE

batterycheck.com

E-learning platform ensures green construction skills in Czechia and Slovakia

To meet growing demand for energy-efficient buildings, the CraftEdu project developed an e-learning platform that helps to ensure the availability of the right skills amongst on-site workers and vocational schools in Czechia.

Digital Economy

Climate Change and Environment

Society

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Achieving greener building standards, such as nearly zero-energy buildings or deep renovations, relies on specialist skills amongst construction professionals. The EU-supported project CraftEdu has developed training and qualifications for energy efficiency and renewable energy sources, initially for Czechia.

"COVID-19 restrictions spurred us on to increase the online component of our training. Our interactive e-learning platform will include over 30 training videos and around 20 e-learning modules, with regular online consultations between trainers and students," explains project coordinator Jiří Karásek, from the SEVEn Energy Efficiency Center. "We are already seeing good levels of engagement, with one training video for electricians already receiving over 550 views."

CraftEdu built on the achievements of the previous StavEdu project in Slovakia, which had stimulated a dialogue between policymakers, vocational trainers and employers about how to deliver the construction skills needed to meet the EU's 2020 energy targets.

StavEdu led to a voluntary initiative called Building Future, established in Slovakia, for the training of professionals working on energy efficiency solutions and the use of renewables. CraftEdu extended this initiative to Czechia.

Reaching educational and professional stakeholders

CraftEdu set out to provide a full qualification package for seven established professions key to energy-efficient buildings, in either construction or renovation. These were heating, ventilation and air conditioning installers, carpenters, low-voltage electricians, high-voltage electricians, hydro-insulators, stove and chimney builders and inspecting technicians, to which the project added the more recently established window installers.

Development of the training modules involved trainers and vocational schools already developing training courses, alongside Czech and Slovak ministries and construction associations, guilds and chambers of commerce, including the Czech Technical University in Prague and the Association of Construction Entrepreneurs in both countries.

"While the project initially aimed for just one e-learning programme, given our pivot to e-learning, we will likely develop around 18, increasing the project's impact," says Karásek. "We already have over 350 registered participants, and interest is strong across the portfolio."

Once fully implemented, those who successfully complete a course will receive the CraftEdu certificate. The courses are currently being piloted in Czechia and Slovakia with 280 craftspeople, and should be completed by autumn 2021.

To roll out the programme to nearby countries, such as Austria and Bulgaria, the training is designed to be as visual as possible, using icons instead of words to reduce translation requirements.

The CraftEdu courses and support can be accessed after registration on the CraftEdu database which is available in four languages (Czech, Slovak, German and Bulgarian), with most of the training available in Czech and Slovak.

Enticing young people into Green Growth careers

CraftEdu's programme contributes directly to EU efforts to create Green Growth jobs, by offering training and qualifications in an industry tasked with delivering energy efficiency as part of the European Green Deal.

"Crucially, by designing training which is engaging and modern, CraftEdu helps to attract young people who are starting out in their careers," adds Karásek.

The team will continue to collaborate with ministries, construction companies and schools to further develop the training schemes. It is also working to integrate the platform within the curricula of vocational schools in Czechia and Slovakia.

Additionally, working with construction associations, the team has influenced policy, such as proposing an upgrade to qualification standards in Czechia, while the new Slovakia building code will be introduced with support from project partner ZSPS (website in Slovak).

Note: this article was first published in August 2021

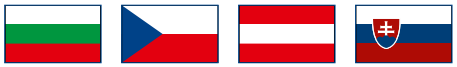
PROJECT

CraftEdu – Setting up national qualification and training scheme for craftsmen in the Czech Republic and developing the further offer of training courses in Slovakia, Austria and Bulgaria

COORDINATED BY

SEVEn Energy Efficiency Center in

PARTNER ORGANISATIONS COUNTRIES



FUNDED UNDER

Horizon 2020-ENERGY

TOTAL BUDGET

€1 001 526.09

EU CONTRIBUTION

€1 001 525.75

CORDIS FACTSHEET

cordis.europa.eu/project/id/785036

PROJECT WEBSITE

craftedu.eu

Electric control units for more efficient diesel jet engines

The United States has been dominating the diesel jet market ever since the aftermath of World War II. But a project led by UNIS could turn the tables thanks to a new generation of electronic control unit.

Transport and Mobility

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Diesel engines have several advantages over their gasoline-based counterparts. They are relatively simple to build, cost-efficient and don't require much maintenance. In the United States, diesel-powered planes transporting up to six passengers have been in high demand for decades – providing American manufacturers with a long-standing competitive edge over their European competitors.

"The Second World War has allowed American aircraft engine producers to thrive. Engineers producing big engines moved on to other segments after the war, and that of small, robust diesel engines was very successful in local markets. The main reason for such high demand was the rather large distances between isolated populations, along with an increase in US customers' purchasing power," explains Jiří Liba, project manager at UNIS. "This competitive advantage has been maintained ever since, despite economic acceleration in Europe."

UNIS has been focusing on the development of a modern electronic control unit for lightweight and efficient jet-fuel reciprocating engines, with EU support under the EDEC project. In light of its specifications, efficient could even sound like an understatement. UNIS promises a 50–65 % reduction in fuel burn compared to small turbine engines, and 30 % compared to aviation gasoline (avgas) engines. This comes with substantial reductions in operating costs, environmental impact and noise thanks to a lower speed of rotation.

The development of the unit is ongoing and should be completed in September 2019. "We are taking a systematic approach to be compliant with ARP4954A and ARP4761 recommendations. Meanwhile, software development will be carried out in compliance with the DO-178C certification for airborne systems and equipment," says István Szabó, director of UNIS' division of aerospace and advanced control.

The project team has successfully developed its prototypes for both three and six-cylinder diesel engines. Preliminary and critical design reviews (PDR and CDR) have already been passed successfully. Prototypes are in the phase of preparation for functional tests (HIL testing) and for selected tests according to the standard DO-160G. Testing cases and procedures are being finalised and the required hardware and software are under construction.

Detailed project results have yet to be unveiled, along with feedback from potential customers. As for the commercial phase, future plans still highly depend on motor producer Safran and the outcomes of its marketing research. As Szabó remarks: "We are talking about a significant investment in the process of re-certification."

"The EDEC project opens a way for us to become a reliable partner and supplier of major players in the aviation market," Szabó adds. "Of course, the most important expected outcome is the product itself: thanks to its modularity, it can control four and six-cylinder engines. We have also obtained a lot of experience in the field of diesel engine control."

Note: this article was first published in August 2019

PROJECT

EDEC – Enhanced Diesel Engine Control

COORDINATED BY

UNIS in

PARTNER ORGANISATION COUNTRY

FUNDED UNDER

Horizon 2020-TRANSPORT

TOTAL BUDGET

€638 823.75

EU CONTRIBUTION

€506 755.88

CORDIS FACTSHEET

cordis.europa.eu/project/id/754869

PROJECT WEBSITE

unis.cz/edec

Climate change impacts on microbe-dominated ice sheet ecosystems

Glaciers and ice sheets contain their own unique ecosystems that are highly vulnerable to climate change. However, it is almost impossible to predict future changes to these ecosystems without mathematical models.

Climate Change and Environment

Fundamental Research

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The EMoGrIS project, undertaken with the support of the Marie Skłodowska-Curie Actions programme, has provided a theoretical framework of the microbe-dominated supraglacial (glacier surface) ecosystem of the Greenland ice sheet (GrIS) and developed a tool for predicting future changes to the ecosystem. It also established the GrIS as a model ecosystem for the study of microbial biogeography and biodiversity patterns.

Climate warming changes ice sheet

The supraglacial ecosystem of the GrIS comprises the top layer of the ice, which is in contact with the atmosphere and receives solar radiation and atmospheric deposition of dust, aerosols and microbial inocula. The GrIS contains distinct ecosystems such as melting snow, bare ice, and surface debris (cryoconite), which are home to diverse microbial communities and are places of significant biological activity.

In addition, supraglacial microorganisms cycle carbon and nutrients, and may also affect the physical behaviour of the ice sheet by increasing melt via lowering the surface reflectivity of ice. "The GrIS supraglacial ecosystem may significantly impact neighbouring terrestrial and marine ecosystems via meltwater export of live cells, organic carbon and other nutrients, and is changing rapidly due to climate warming," remarks project researcher Marek Stibal.

To better understand these processes, a conceptual model of the GrIS surface ecosystem was created, involving mathematical formulation, verification and validation, and subsequent simulations of future climatic scenarios. A sampling strategy was also devised for testing relevant ecological hypotheses such as the relationship between diversity and productivity.

Model reveals what we don't know

The model is a process-based (meaning it resolves processes, such as carbon flux rates, through time) ecosystem model based on organic carbon. The aim was to simulate carbon cycling processes at the surface of the GrIS, by applying dissolved and particulate organic carbon and auto- and hetero-trophic biomass, and variables such as atmospheric deposition, meltwater flushing, primary production, and respiration.

The model was also tested by applying meteorological data (surface temperature, surface melt, incident radiation). By altering these factors, scientists can change the model's outputs, enabling simulations of future climates with higher surface temperatures and longer melt seasons, which can be used to predict the future fate of the ecosystem.

Results show how little was previously known about the system. "I have been working on the GrIS for almost 10 years, but the model I have developed identified some processes we haven't quantified, or even understood we should quantify, as integral components of the ecosystem's functioning," observes Stibal. "For example, we have a relatively good idea about what is occurring on the ice sheet in terms of carbon cycling in the summer melt season but are completely ignorant of winter activity."

EMoGrIS is important for all researchers interested in the fate of the GrIS, whether biologists, ecologists, geochemists or glaciologists, and all those affected by changes to the ice sheets. The work will also form the basis for future research into the fate of supraglacial microbes flushed downstream from the ice sheet surface and on diversity patterns of phylogenetic and functional groups of microbes.

Note: this article was first published in May 2018

PROJECT

EMoGrIS – Ecological Modelling of the Greenland Ice Sheet Surface Ecosystem

COORDINATED BY

Charles University in

FUNDED UNDER

Horizon 2020-MSCA-IF

TOTAL BUDGET

€142 720.80

EU CONTRIBUTION

€142 720.80

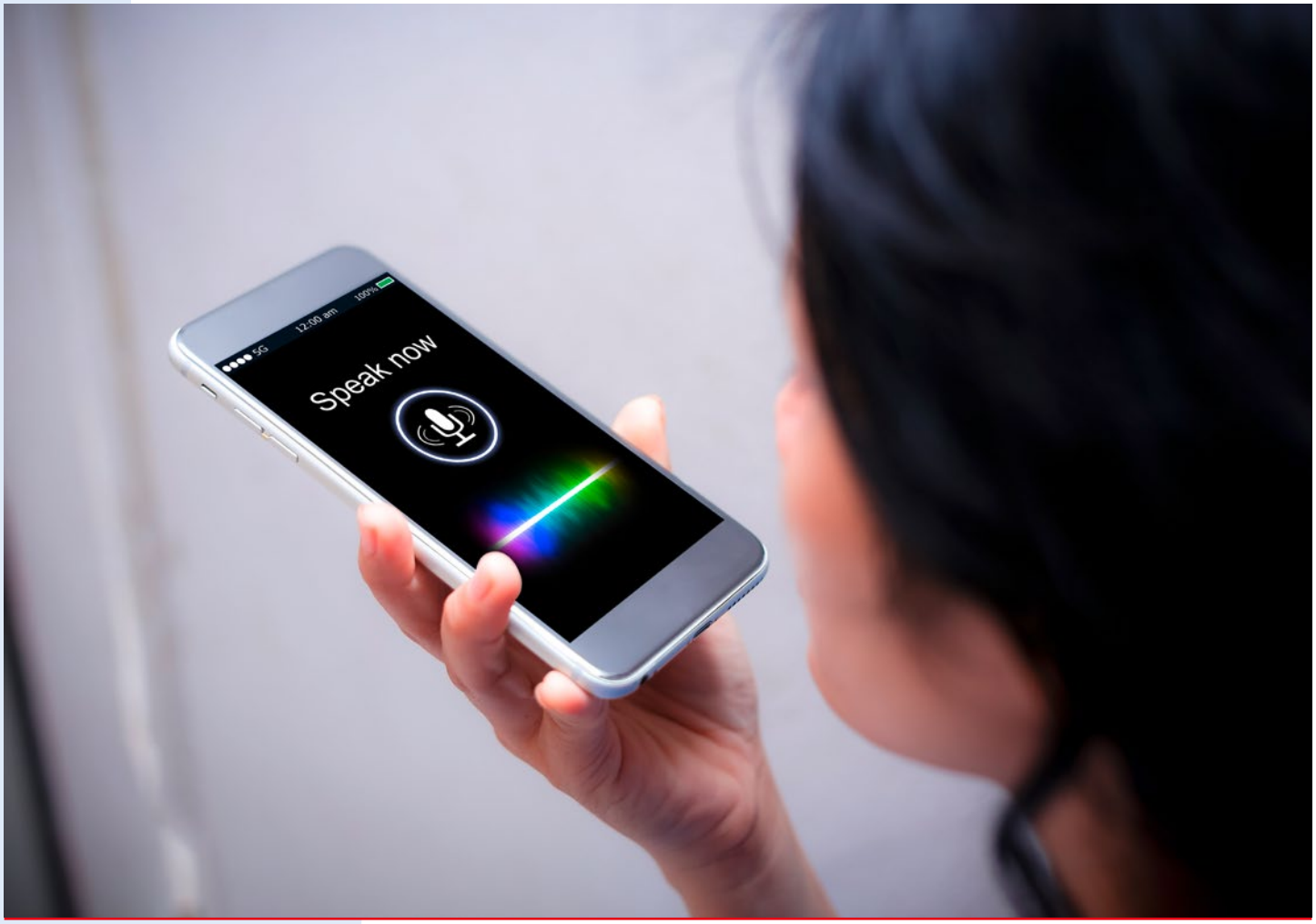
CORDIS FACTSHEET

cordis.europa.eu/project/id/657533

Improving computer abilities to recognise speakers

Automated speech recognition often runs into problems when multiple people are speaking. By applying big data, researchers have shown how machines can be taught to identify individual speakers.

Digital Economy



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Automatic speech recognition (ASR) technology enables the recognition and translation of spoken language into text by computers. As humans increasingly interact with machines using their voices – such as through mobile applications, search queries and personal assistants like Google Home – demand for this technology is set to increase.

Distinguishing individual speakers and saying who speaks when in a given recording (known as speaker diarisation) are specific tasks of ASR. Potential applications include granting access to an authorised person, or customising devices to provide specific functionality, depending on the speaker.

In order for this technology to be consistently effective however, certain challenges need to be fully addressed. High-level background noise or when two or more speakers overlap often degrade machine performance. A lack of available hardware to train automatic systems to learn from large amounts of data has also hampered progress.

Accurate speaker recognition

The ETE SPEAKER project, which was undertaken with the support of the Marie Skłodowska-Curie Actions (MSCA) programme and coordinated by Brno University of Technology in Czechia, set out to examine potential new approaches to speaker recognition.

"Conditions that are common in real speech applications are still a challenge for automatic systems," explains MSCA fellow Alicia Lozano-Diez, now assistant professor at the Autonomous University of Madrid in Spain.

Lozano-Diez and her team sought to develop robust speaker recognition systems that could perform the task in different scenarios. For this, they used deep learning-based algorithms, capable of discriminating between speakers directly from data.

The project began with a thorough review of existing approaches, to see where new methods might be more effective. They then tested these new approaches.

"A key means of making progress is technology evaluations that different experts and institutions organise," says Lozano-Diez. "In these evaluations, experts from around the world develop systems to solve a specific task."

The ETE SPEAKER project team used these opportunities to develop and trial different approaches they developed. They then compared these with other teams, to identify remaining challenges to tackle.

Deep learning approaches

Participation in these evaluations enabled Lozano-Diez to demonstrate how speaker recognition could be improved, and how some of the limitations of traditional approaches could be overcome. The team was able to exploit the potential of deep learning approaches, in part thanks to the data available today.

"One system we developed for a particular challenge achieved the best results among all participants," adds Lozano-Diez. "This evaluation focused on short-duration recordings. These can pose an extra challenge for automatic speaker recognition systems, given that each recording contains only a few seconds of speech."

The project also developed new methods for dealing with overlapped speakers for the task of speaker diarisation. Lozano-Diez plans to continue her research in this field, in pursuit of ever more accurate speaker recognition and diarisation technology.

"New approaches are now able to handle the complex issue of overlapped speech by learning directly from data," she explains.

However, this type of data – accurately labelled and gathered from several different scenarios – is scarce, and Lozano-Diez believes that more research is needed in order to make this technology work properly in challenging conditions. A good example of this might be conversations in restaurants where there is a lot of background noise, or comments in a conference recorded from distant microphones.

Note: this article was first published in June 2021

PROJECT

ETE SPEAKER – Robust End-To-End SPEAKER recognition based on deep learning and attention models

COORDINATED BY

Brno University of Technology in

FUNDED UNDER

Horizon 2020-MSCA-IF

TOTAL BUDGET

€120 817.20

EU CONTRIBUTION

€120 817.20

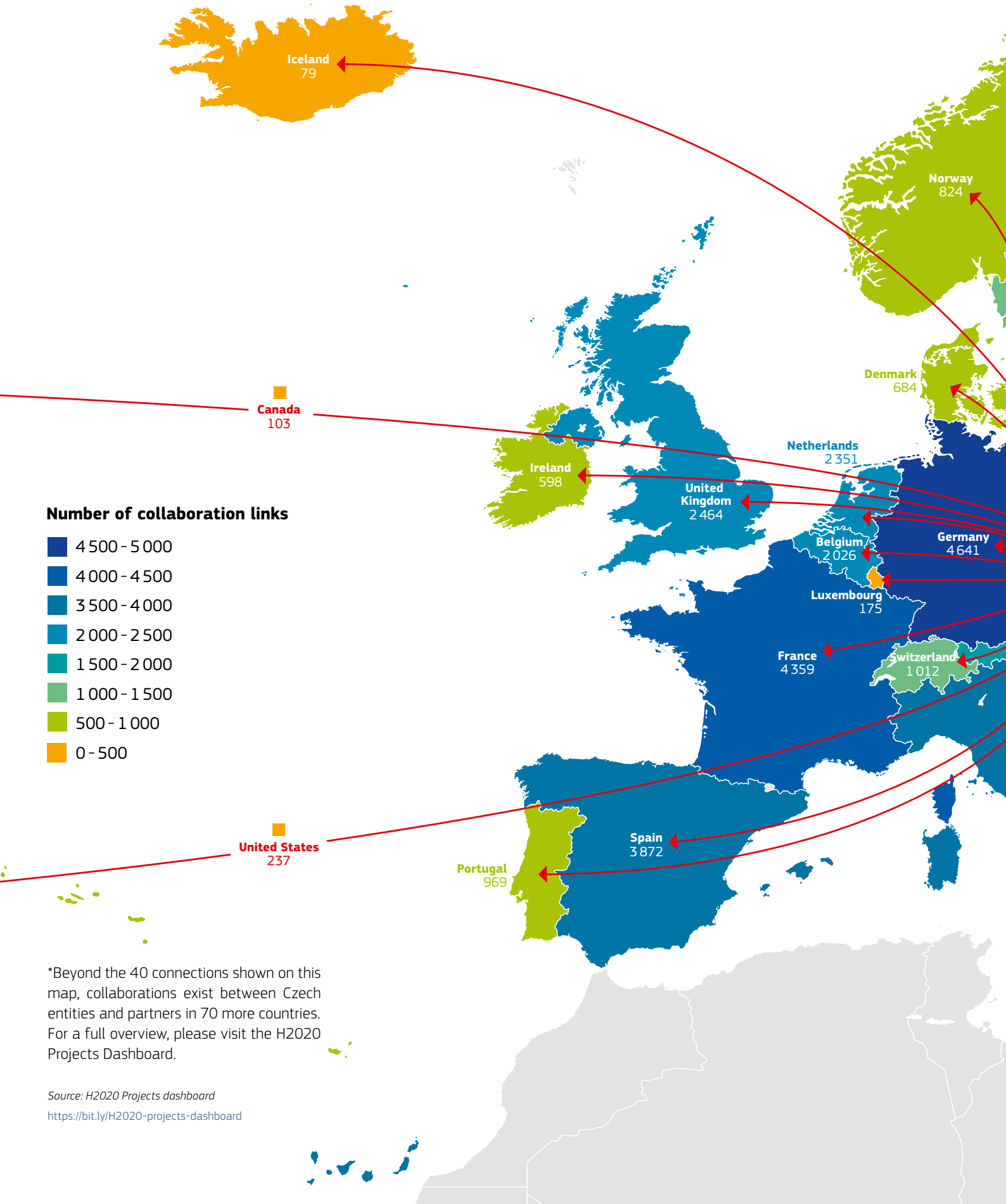
CORDIS FACTSHEET

cordis.europa.eu/project/id/843627

PROJECT WEBSITE

fit.vut.cz/research/project/1301/.en

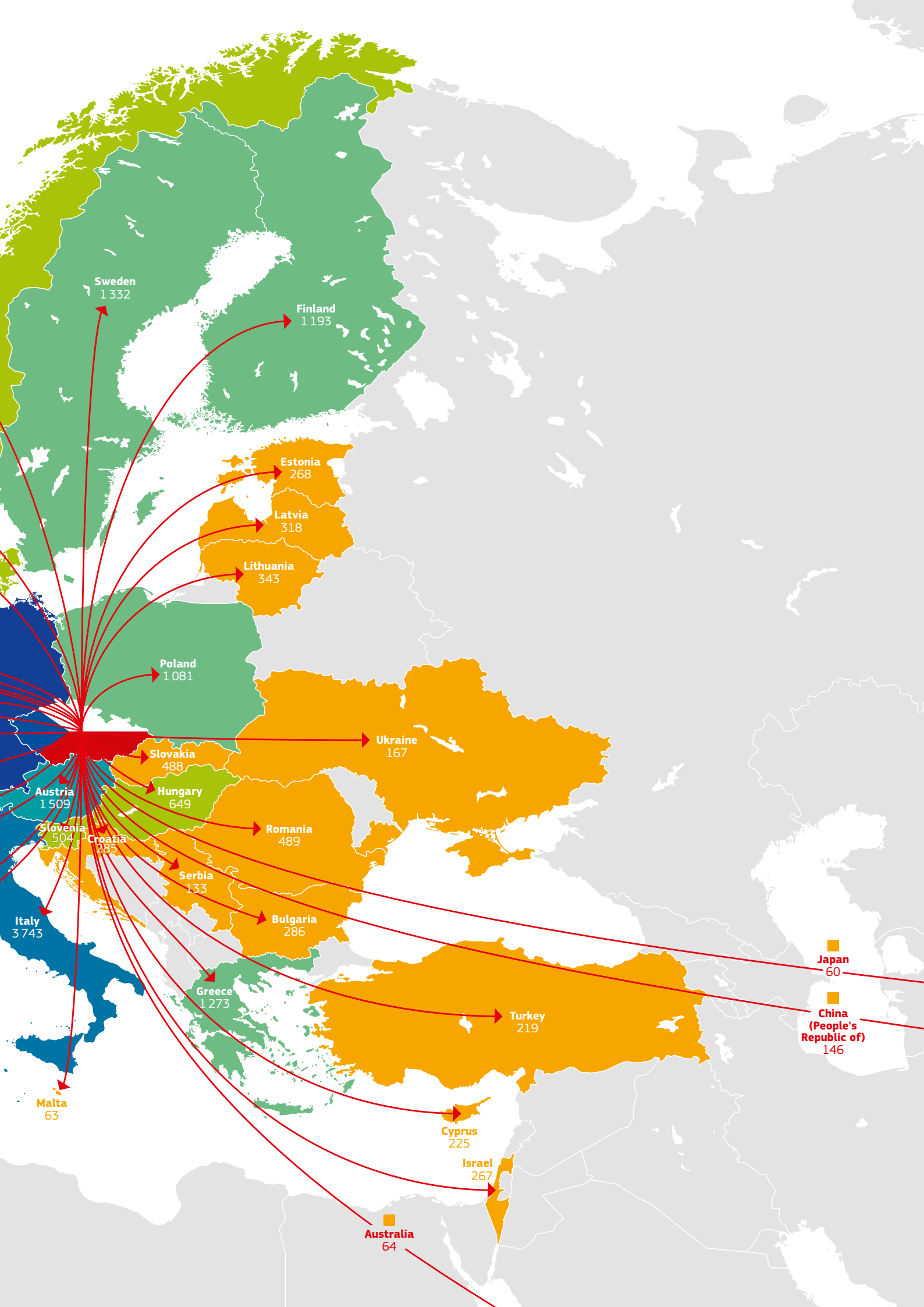
The top 40 Czech cross-border H2020 collaborations*



*Beyond the 40 connections shown on this map, collaborations exist between Czech entities and partners in 70 more countries. For a full overview, please visit the H2020 Projects Dashboard.

Source: H2020 Projects dashboard

https://bit.ly/H2020-projects-dashboard


Sweden
1 332
Finland
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Estonia
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Latvia
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Lithuania
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Slovakia
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Italy
3 743
Greece
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Turkey
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Malta
63
Cyprus
225
Israel
267
Australia
64
Japan
60
China
(People's
Republic of)
146

Improving the use of fibroblast growth factor products for therapeutic applications

The EU-funded FGFSTAB project is producing robust fibroblast growth factors with the high operational stability needed for use in regenerative medicine.

Health

© Enantis

Across much of the developed world, populations are becoming older, more obese, and increasingly prone to such chronic diseases as diabetes. As a result, the global wound-care market is rapidly evolving, with innovative fibroblast growth factor (FGF) products driving the field of regenerative medicine.

FGFs are a family of cell signalling proteins that are essential to embryonic development and maintaining tissue homeostasis. In the clinical setting, they are used to promote angiogenesis and wound healing, and have the potential to slow down ageing. However, despite their clinical value, FGF applications are limited by the fact that natural proteins have poor thermal stability, meaning they are often cleared from the body within hours – if not minutes. As a result, FGF applications must be administered frequently, which in turn raises the risk of adverse effects and lowers the cost-effectiveness of the protein therapy.

By addressing the poor stability of selected FGFs, the FGFSTAB project is working to increase their commercial use within the therapeutic arena. "The main aim of the project is to develop and produce robust FGFs with sufficiently high operational stability for regenerative medicine," says FGFSTAB project coordinator Veronika Štěpánková.

Development of two innovative molecules

Using lead partner Enantis' in-house computer-assisted protein stabilisation platform, project researchers successfully stabilised three selected FGF proteins. This in turn led to the development of two innovative molecules exhibiting higher structural stability at elevated temperatures, higher resistance against proteolytic degradation and a significantly prolonged half-life after pretreatment at elevated temperatures when compared to corresponding native proteins.

One of these stabilised FGF molecules (FGF2-STAB) was then successfully evaluated using the animal model of diabetic wounds. In vivo safety and efficacy testing of FGF2-STAB, which was carried out in a diabetic rat model, clearly demonstrated the molecule's positive impact on the wound healing process compared to the controls. Specifically, FGF2-STAB increased cell proliferation and angiogenesis, while also decreasing inflammation.

"The performed preclinical test revealed a prolonged half-life of FGF2-STAB in the wounds without any sign of compromised biological activity or of induced wound infection," explains Štěpánková. "These results represent an important milestone in the process of performing the complex preclinical safety tests needed to get FGF2-STAB approved for clinical trials on humans."

Set to enter the global market

As a direct result of the FGFSTAB project, Enantis has significantly expanded and strengthened its capability, efficiency and competitiveness. In September 2018, the company signed an important distribution agreement with a leading life sciences company.

"The company is not only a key global player in the field of stem cell research, it is also one of the world's main suppliers of reagents for stem cell culturing and research," says Štěpánková. "This distribution agreement enables Enantis to enter the global market of stem cell research with its first stabilised molecule FGF2-STAB."

With the molecules developed during the project set to begin clinical trials, and with an eye towards commercialisation, Enantis has bolstered its team with the addition of nine new positions. Its R&D team has also been trained in a wide range of new laboratory techniques, and the company has initiated strategically important cooperation with three academic institutions and with four companies.

Note: this article was first published in July 2019

PROJECT

FGFSTAB – Industrial Production of Stable Fibroblast Growth Factors for Regenerative Medicine and Related Research Areas

COORDINATED BY

Enantis in

FUNDED UNDER

Horizon 2020-HEALTH

TOTAL BUDGET

€1 030 000

EU CONTRIBUTION

€1 030 000

CORDIS FACTSHEET

cordis.europa.eu/project/id/756471

Supporting EU policies to deliver on gender equality in research and innovation

A series of policy support activities and policy recommendations to address gender inequality issues in research and innovation at national and EU level has been developed by the EU-funded GENDERACTION project.

Society

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While nearly half of doctoral graduates in the EU are women, disparities persist across certain disciplines. Critically, too few female graduates go on to follow careers in research and innovation.

"The percentage of women among researchers in the EU is just under 33 %," notes GENDERACTION project coordinator Marcela Linková, head of the Centre for Gender and Science at the Institute of Sociology of the Czech Academy of Sciences.

"Men are also twice as likely to hold full professorships than women. In terms of leadership positions, women make up less than 24 % of heads of higher education institutions. We see positive developments, but change is slow."

Academia tends to be hierarchical, and many biases are deeply entrenched, which can compromise meritocracy. Also, when the gender dimension in research and innovation content is not properly taken into account, it can produce skewed and less than robust research that does not answer the needs of all.

Importance of policy

The GENDERACTION project was launched in recognition of the importance of policymaking in achieving gender equality progress. "Policy sets the framework," says Linková. "Our objective was to create a European network of policymakers in order to coordinate policy, advocate gender equality and exchange good practices. One of the benefits was that in doing this we have also built a community of colleagues with whom to share challenges, because working to advance gender equality can be challenging."

The project team worked to support structural change in Member States through Gender Equality Plans. The team studied national action plans and strategies defined by Member States in the context of the European Research Area priorities, and reviewed the types of indicators used to measure progress towards gender equality.

This enabled the team to demonstrate that careful attention needs to be paid to indicator selection. Using a specific indicator, such as the proportion of women among professors, is not sufficient on its own to capture the reality of gender equality in research.

Another major task for the project team was to develop policy advice. Much of this advice focused primarily on Horizon Europe, the EU's key funding programme for research and innovation (R&I). Recommendations include fostering intersectional approaches to gender equality and addressing sex and gender analysis in research.

"We published a series of policy briefs, and this was recognised by the European Commission as a key contribution to gender equality in the European Research Area," says Linková. "This makes us very proud. We also opened up new areas, such as gender equality in international cooperation in science, technology and innovation. All this advice is now available on our website."

Prioritising gender equality

The GENDERACTION project has already helped to reshape how gender inequality in research is addressed. The project team's work contributed to the early drafting of the Ljubljana Declaration, an acknowledgement of gender mainstreaming and gender equality that has been endorsed by 36 countries, including 25 Member States, as well as by the European Commission.

"The Declaration is a great achievement of the Slovenian Presidency of the Council of the EU, and sets the priorities for gender equality in R&I for the coming years," remarks Linková. "Our policy advice has also been used in the negotiation of Horizon Europe, as well as the new European Research Area policy agenda that has just been adopted."

In the meantime, the policy network established by the project will continue to discuss and make use of the project's recommendations at national level. "We made it clear that having a policy network in Europe to advance gender equality in R&I can be a very efficient way to achieve progress," adds Linková. "The only thing now is to make sure that we continue moving forward."

Note: this article was first published in February 2022

PROJECT

GENDERACTION – GENDer equality in the ERA Community To Innovate policy implementatiON

COORDINATED BY

Institute of Sociology of the Czech Academy of Sciences in

PARTNER ORGANISATIONS COUNTRIES

FUNDED UNDER

Horizon 2020-Science with and for Society

TOTAL BUDGET

€1 948 400

EU CONTRIBUTION

€1 948 400

CORDIS FACTSHEET

cordis.europa.eu/project/id/741466

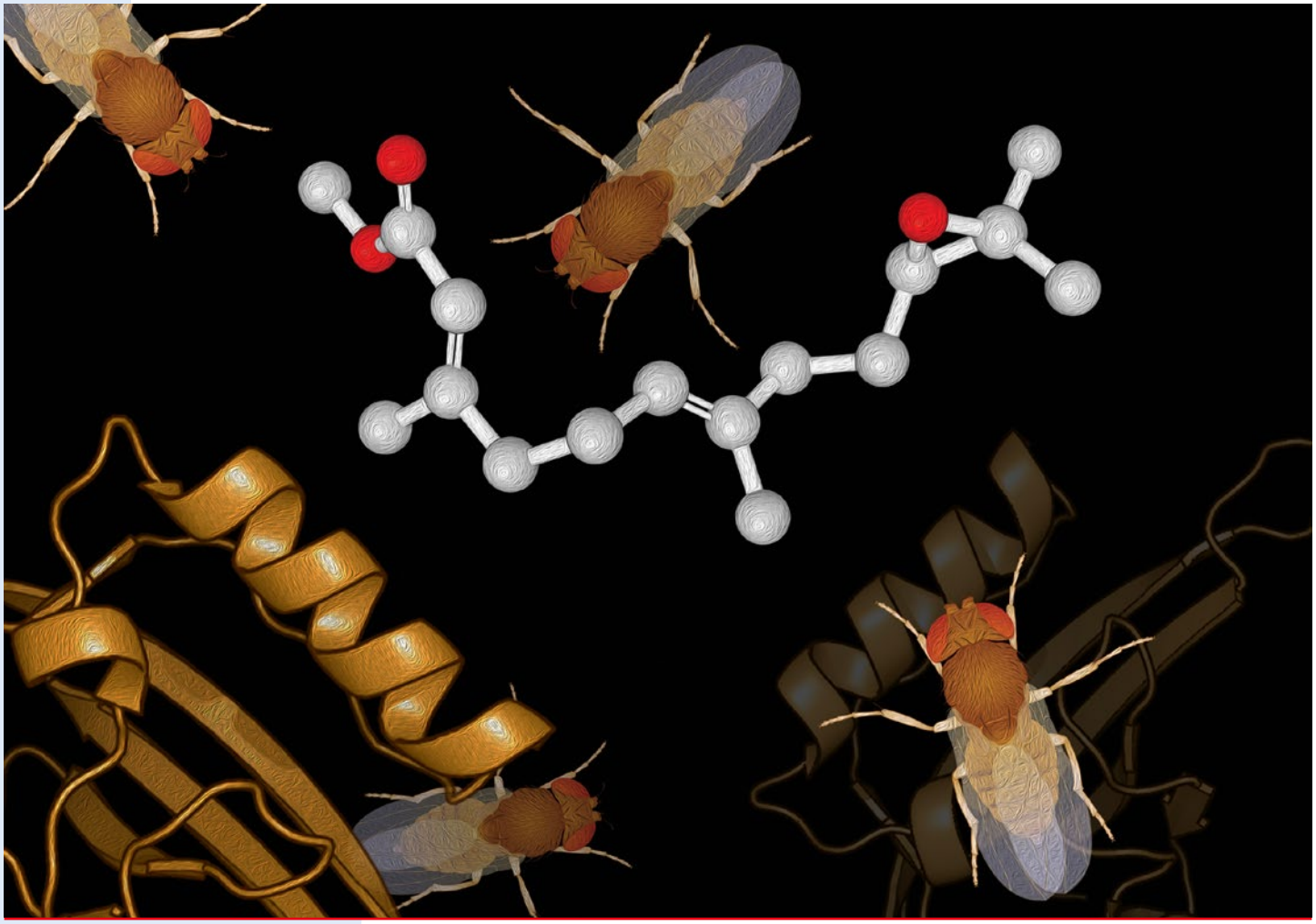
PROJECT WEBSITE

genderaction.eu

From pests to pollinators: Safe sustainable population management using insect hormones

Public opinion decries the population decline of bees while mosquito resistance to commonly used insecticides causes rising panic. EU research has investigated the action of insect hormones to improve insect control.

Fundamental Research



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While insects have started making magazine headlines, entomologists are alarmed. According to a current analysis by the Biological Conservation journal, the inconspicuous insect world is making giant strides towards extinction, threatening a "catastrophic collapse of nature's ecosystems".

Targeted juvenile hormone (JH) insecticides kill only the bad guys

"The core goal of our proposal was to shed more light on the action of JH, one of the major regulators of development and reproduction in insects and related arthropods," explains Lenka Bittová, principal fellow with the Marie Skłodowska-Curie Actions (MSCA) funded JHSIGNAL project.

Species relying on regulation by JH range from beneficial pollinators to agricultural pests and disease vectors. "Better understanding of JH signalling is therefore a prerequisite for improving currently available JH-based insecticides that fail to target pests without killing beneficial species," Bittová adds.

JH signalling at molecular level

"We certainly don't come empty-handed after 2 years of dedicated work on the project and have successfully completed a study aimed at better mechanistic understanding of JH signalling," Bittová says. A collaborative paper with the Institute of Organic Chemistry and Biochemistry in Prague pinpoints the key molecular features of an effective JH receptor ligand.

In collaboration with the Australian Commonwealth Scientific and Industrial Research Organisation (CSIRO), where Marek Jindra – the project coordinator – worked during his previously completed outgoing MSCA fellowship, JHSIGNAL work has confirmed the importance of the JH receptor phosphorylation for its function, both biochemically and in live insects. "Harnessing the sensitivity of mass spectrometry data, we have found JH receptor mutations which cause a deficiency in proper nuclear localisation. Moreover, flies with a mutated phosphorylation site within the JH receptor display strong developmental defects, such as rotated genitalia in males or reduced fertility," Bittová adds.

Alternative study plan for insects that damage food

The red flour beetle, Tribolium castaneum, is the scourge of all who store grain and its products – from cake and pastry makers to cereal silo owners. The original JHSIGNAL research plan was to investigate red flour beetle cell lines where Jindra had successfully identified a JH receptor. However, due to technical challenges, the team changed the research target to the fruit fly Drosophila melanogaster, the model insect that offers supreme genetic tools and whose cousins are serious fruit pests.

Towards species-selective, safer insecticides

Results have spurred additional experiments aiming to further characterise the promising JH receptor mutants. "We hope to publish the complete story in one of the high-ranking journals," remarks Jindra.

In collaboration with a leading Czech scientific institution and an EU-funded National Infrastructure CZ-OPENSCREEN in Prague, the team submitted a proposal to advance this research. Their aim is to uncover missing genetic components and new chemical regulators of JH signalling via high throughput screening of available small molecule libraries.

Together, these promising results have already started to reveal novel and significant aspects of the JH receptor signalling mechanism. They will certainly improve understanding of the regulatory role of post-translational modifications in insect development.

Note: this article was first published in June 2019

PROJECT

JHSIGNAL – Modulation of juvenile hormone signaling by receptor phosphorylation

COORDINATED BY

Biology Centre of the Czech Academy of Sciences in

FUNDED UNDER

Horizon 2020-MSCA-IF

TOTAL BUDGET

€154 720.80

EU CONTRIBUTION

€154 720.80

CORDIS FACTSHEET

cordis.europa.eu/project/id/708832

PROJECT WEBSITE

marek-jindra-lab.webnode.cz/jhsignal-project

A game-changing battery-supercapacitor pair for hybrid vehicles

An EU-funded project unveiled a new device for hybrid vehicles that combines the high energy density of lithium-ion batteries with the rapid charge and discharge rate of supercapacitors.

Industrial Technologies

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Hybrid cars have long been touted as a sustainable alternative to conventional cars as they use substantially less fossil fuel and produce far fewer greenhouse gases. Despite their promising potential, the battery type they require is limiting their market acceptance.

Lead-acid batteries, which have been used for decades in cars, are affordable and safe with proven performance. However, newer battery technologies and tougher anti-pollution regulations about carbon dioxide emissions and the ban on the use of hazardous materials are leading to a major reduction in their use.

The aim of the EU-funded project LEFAPO was to offer alternative technology to lead-acid batteries, which have been around for over 150 years. "Due to their low cost and high surge currents, lead-acid batteries remain in high demand as starter batteries in cars, including electric vehicles. However, they are heavy for the energy they store – a bad trait for mobile applications," says Josef Tichánek, business development manager of Olife Corporation.

Supercapacitor advantages

Supercapacitors can store more electrical charge than standard capacitors. The large surface area of the activated-carbon electrodes, coupled with the extremely thin double-layer distance, gives the device one of the highest capacitance outputs.

Supercapacitors are finding increasing application in transport. Their charge and discharge rates are spectacular compared to batteries. This is due to storing electrical energy purely electrostatically and not in the form of bound chemical energy as conventional batteries do. Since no chemical reaction takes place, they have exceptionally long lifetimes.

Drawbacks and the hybrid solution

While supercapacitors offer high capacitance and can charge hybrid cars in a matter of seconds, they have a few inherent properties that are not desirable. Supercapacitors exhibit a characteristic called self-discharge, which means that they are not very good at holding much energy for very long. In addition, their poor energy density – the amount of energy they can hold per kilogramme – puts them at a significant disadvantage to lead-acid or lithium-ion batteries.

The LEFAPO project realised the full potential of supercapacitors, at least in the electric vehicle domain, by pairing them with a lithium-ion battery. The result is a device with better energy density than a supercapacitor, but without the self-discharge characteristic, and more charge-discharge cycles than a lithium-ion battery.

"Combining lithium cells and supercapacitors is the latest technology for hybrid cars. Supercapacitors can quickly absorb the generated electrical energy during a braking event and store it in the battery for later use. The speed this needs to happen at is difficult for lead-acid and even lithium technology alone to achieve," notes Tichánek. This ability to quickly store energy makes the hybrid system ideal for start-stop systems.

"Olife's new technology is designed to provide 10 years of service which is double the lead-acid battery lifetime," remarks Tichánek. What's more, it is 50 % lighter and lends itself to faster charging – about three times faster than its counterpart.

"Our goal was to develop a state-of the-art starting battery for cars that is safe and meets both new ecological and new technical requirements of modern cars. The battery can be used as it is or further tailored to the needs of the target markets," concludes Tichánek. Importantly, the battery is 100 % lead-free and contains no other toxic materials.

Note: this article was first published in February 2019

PROJECT

LEFAPO – Lead free automotive SLI power

COORDINATED BY

Olife Corporation in

FUNDED UNDER

Horizon 2020-ENVIRONMENT and Horizon 2020-SME

TOTAL BUDGET

€3 608 500

EU CONTRIBUTION

€2 525 950

CORDIS FACTSHEET

cordis.europa.eu/project/id/697234

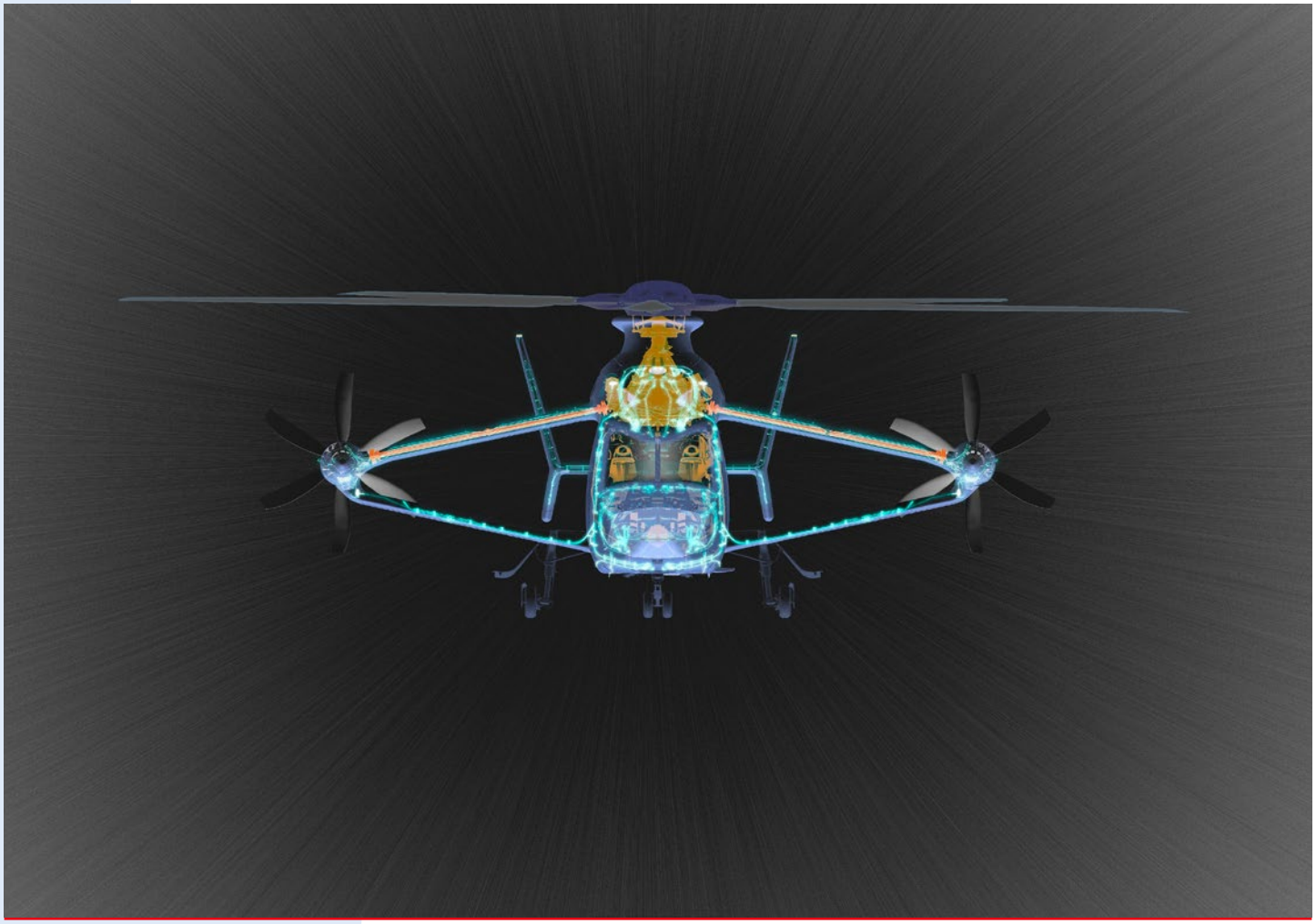
PROJECT WEBSITE

olifebattery.com/batteries

Gearbox test rig for next-generation compound helicopter

For the past 60 years, helicopters have been built according to the same basic principle. Now, European partners are developing and testing a revolutionary new design for rotorcraft.

Transport and Mobility



The MUTR project focused on the design of the gearbox test system for the newly created Rapid and Cost-Effective Rotorcraft (RACER) helicopter demonstrator. RACER is an experimental compound helicopter developed by Airbus that combines high speed and vertical take-off and landing and features wings and propellers for propulsion support instead of a conventional tail rotor. The rotorcraft is driven by two engines, one of which can shut down and restart once in flight to save fuel and increase range.

The MUTR project was funded within the framework of the Clean Sky 2 Joint Undertaking, a public-private partnership between the EU and industry set up to strengthen European aero-industry collaboration, global leadership and competitiveness.

Researchers from the Czech Aerospace Research Centre (VZLU) carried out the design and implementation of an auxiliary (adaptive) gearbox that is part of a multipurpose testing device for validating special newly designed helicopter gear reducers for RACER. This is a key component for the helicopter's drive device, transmitting power from two turbo shaft motors to the main rotor and side rotors.

Validated under emergency conditions

The team first designed the test rig and then designed, manufactured and tested the hydraulic torque loader (torquer) and the torquer test rig for the validation of RACER. "The test rig is a powerful device that allows us to trial not only the normal travel modes, but also all emergency and overload conditions to which the main rotorcraft reducer may be exposed during operation," says project coordinator Petr Pick.

The proposed test mode comprised four parts: the main gearbox plate, side load groups, adaptive gearbox, and support mechanisms. Validating the main reducer on the test rig is the same as for the actual rotorcraft, thus enabling the measured values to be applied to the verification and certification process.

The energy-efficient hydraulic torquer simulated the load from the side rotors. The power transmitted by the shafts representing the drive units was conducted from the adaptive gearbox to the main gearbox, which branches into two side rotor branches and one main rotor branch. The layout results in three power loops in which the power flow can be independently changed, while simultaneously allowing the simulation of running in single-engine inoperative mode and in different flight modes of the machine.

A reliable, efficient torque loader

In addition to two pairs of gears, a unique torquer and torque meter, located in the gearbox, make it possible to perform load tests and calibrate the torquer. The hydraulic system used by the torquer not only loads the torsion, it also solves the problem of cooling gearing and gearbox bearings.

According to Pick: "VZLU is developing the interconnection of the lateral rotor gearboxes via vertical transmission shafting, supported on two or three auxiliary bearing housings, to lock the two gearboxes together. The transmission shafting is connected to the lateral gearboxes by means of bevel gearings."

Gearbox testing requires an efficient, reliable and durable torque loader. MUTR exactly meets all these criteria and has been successfully validated for a load capability up to 5 900 Nm at 3 330 rpm. The device can also be applied to sophisticated load simulation systems like the RACER test rig.

Note: this article was first published in November 2020

PROJECT

MUTR – Multipurpose test rig for transmissions gearboxes

COORDINATED BY

Czech Aerospace Research Centre (VZLU) in

FUNDED UNDER

Horizon 2020-TRANSPORT

TOTAL BUDGET

€606 400

EU CONTRIBUTION

€606 400

CORDIS FACTSHEET

cordis.europa.eu/project/id/717199

Plastic-related chemicals disrupt metabolism and immunity

The global production of synthetic polymers such as plastic materials is increasing at a rapid rate. To improve the durability and flexibility of plastics, producers enrich them with different chemicals but their impact on human health is unknown.

Climate Change and Environment

Health

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Phthalates, a ubiquitous class of plastic softeners, is a common environmental contaminant that is also believed to affect human metabolism. They are frequently found in indoor and outdoor environments, and ingested passively through environmental contact or household products. Recent epidemiological evidence associates phthalates with body mass index, obesity and weight in children and adults, but the underlying mechanism is yet to be revealed.

Studying the impact of phthalates on zebrafish metabolism

Undertaken with the support of the Marie Skłodowska-Curie Actions (MSCA) programme, the OBESOGENS project aimed to shed light on the key mechanisms by which phthalates initiate adverse health outcomes. The scientists employed zebrafish as a model and investigated the impact of phthalates on the microbiome-gut axis as a key regulator of health. Zebrafish constitutes a powerful tool for conducting metabolic research in a high-throughput manner to identify metabolic disruptors. "We used an integrated approach that included transcriptomics, metagenomics and the latest bioinformatics approaches to study the effect of phthalates on the microbiome-gut axis," explains MSCA fellow Ondřej Adamovský.

Project results indicated an overall deregulation of biological processes in both the host microbiome and the gastrointestinal tract in animals exposed to phthalates. These chemicals affected a wide array of physiological functions, including metabolism, gut integrity and homeostasis, as well as the immune function. Investigation into their mechanism of action unveiled a deregulation of receptors implicated in lipid metabolism and energy homeostasis.

OBESOGENS describes for the first time the involvement of adaptive immunity and in particular of helper T-cells in phthalate-induced deregulation of cell-cell communication. Although phthalates are known contributors to allergic responses, there was no prior insight on the mechanism by which they activate helper T-cells. In this context, scientists used several computational approaches and predictive functional models to study potential interactions with the host gastrointestinal tissue and the microbiome.

Results demonstrated that phthalates affect host microbial composition and diversity and lead to the production of metabolites. In turn, these stimulate intestinal adaptive immunity, which may initiate inflammation or contribute to inflammatory diseases.

Long-term impact of project results

The OBESOGENS project identified a multifaceted metabolic disruption caused by phthalates with the intestinal adaptive system and the microbiome-gut axis playing a central role. "By uncovering the specific mechanisms implicated in phthalate-induced metabolic deregulation, we hope to unveil novel molecular targets that can be exploited for therapeutic intervention," remarks Adamovský.

Overall, there is very little information on how the gut microbiome is altered by environmental contaminants leading to metabolic disruption. Further studies are required to fully characterise the role of microbial metabolites in phthalate-related adverse effects.

Collectively, the work emphasises the importance of risk assessment on phthalates and other chemicals with potential side effects on human health. Given the widespread use of plastic, efforts should be redirected to materials that are both ecologically friendly and safe. Considering that obesity has reached epidemic proportions and incurs high long-term healthcare costs, the identification of contributing factors may help redesign lifestyle interventions to mitigate life-threatening co-morbidities.

Note: this article was first published in October 2019

PROJECT

OBESOGENS – Environmental chemicals as obesogens

COORDINATED BY

Masaryk University in

PARTNER ORGANISATION COUNTRY

FUNDED UNDER

Horizon 2020-MSCA-IF

TOTAL BUDGET

€249 490.80

EU CONTRIBUTION

€249 490.80

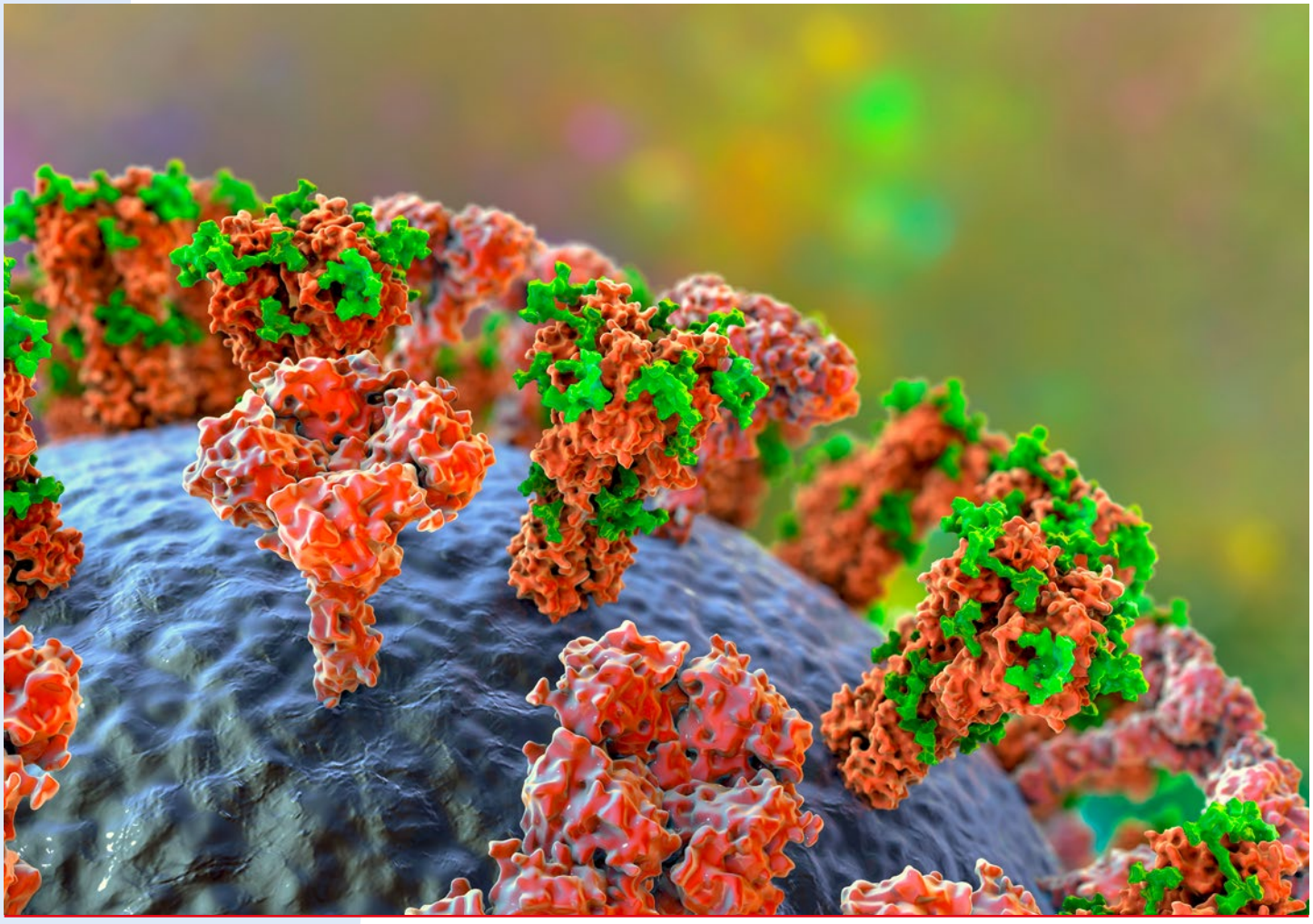
CORDIS FACTSHEET

cordis.europa.eu/project/id/707241

Glycans could be the key to immunity-boosting therapies

Therapies which modify immune cells are touted as a possible cure for infectious diseases, and even cancer. SWEETOOLS has created glycopeptide libraries which could lead to new drugs able to act on key proteins and enzymes.

Health



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Glycans are carbohydrate-based polymers ubiquitous within living cells. Key to many biological processes, they enable cells to recognise molecules and orchestrate cell-to-cell interaction. Within cells, they are involved in protein folding, positioning, transport and quality control.

Viruses and bacteria not only attach themselves to glycans, but the spike protein of viruses, including SARS-CoV-2, is sometimes coated with glycans, camouflaging the virus from the immune system. Glycan changes often correlate with pathological states, such as inflammation and cancer.

The structure of glycans is not genetically encoded, but rather results from the actions of various glycan-processing enzymes, making their position and composition hard to determine. Additionally, their complexity makes manipulation difficult using current methods.

The SWEETOOLS project, funded by the European Research Council, developed a methodology to construct libraries of glycans linked to a peptide. These 'glycopeptides conjugates' can be used to screen various glycan-processing enzymes.

"Knowing how specific enzymes bind with and process glycans, means our library's glycopeptides can be tweaked to control the functioning of specific glycan-processing enzymes, paving the way for new drug therapies," explains project coordinator Milan Vrábel.

The glycopeptide library

Synthetic peptide libraries are short chains of amino acids – 4 to 15 in SWEETOOLS – prepared using a chemical technique known as the one-bead-one-compound methodology.

A set of polymer resin beads containing an amino acid are divided into equal portions to which the next amino acid is added. These portions are pooled and chemically coupled to the next amino acid. The beads are divided again and the steps repeated, producing a synthetic library where each bead contains a unique sequence of amino acids – a peptide.

SWEETOOLS added a small molecular inhibitor that binds to selective enzymes, resulting in peptide libraries of different amino acids but the same inhibitor.

"While the peptides recognise, select and bind to the enzyme, the inhibitor stops that enzyme functioning. We can then monitor any resulting changes, such as whether inhibition of this enzyme boosts the immune system," adds Vrábel.

The peptide library was built using click reactions – a set of fast, efficient and selective chemical reactions. Glycan residue was then added to the peptides. The resulting glycopeptide library can be used to find proteins, such as lectins, that recognise specific glycans. As this is the mechanism by which bacteria and viruses bind to their targets, understanding it offers the prospect of subverting it.

For cellular experiments, probes were developed and produced light as a result of key chemical reactions. This enabled the team to track and visualise the biomolecules in detail.

"Preliminary data shows that one of our glycopeptides protects T-cells from Galectin 1-triggered cell death, a mechanism certain cancer cells use to evade our immune system. With the benefit of this glycoconjugate, we could fight these cancers more effectively," says Vrábel.

Towards a future of 'living drugs'

The team also discovered that synthetic versions of naturally occurring glycans can be metabolically processed by live cells, forming natural glycoconjugates. The team engineered these to be 'chemically' modifiable inside cells or at the surface, offering cheaper immunomodulators.

"Reagents could install artificial molecules onto living cells to protect them, with cellular interactions prevented or new interactions promoted. We could install antibodies onto immune cells which then find and destroy cancers or protect against side effects after organ transplantation," concludes Vrábel.

The first patent application on the chemical re-engineering of cells has already been filed, with in vitro experiments using different cancer cell lines underway.

Note: this article was first published in January 2022

PROJECT

SWEETOOLS – Smart Biologics: Developing New Tools in Glycobiology

HOSTED BY

Institute of Organic Chemistry and Biochemistry of the Czech Academy of Sciences in

FUNDED UNDER

Horizon 2020-ERC

TOTAL BUDGET

€1 405 625

EU CONTRIBUTION

€1 405 625

CORDIS FACTSHEET

cordis.europa.eu/project/id/677465

New graphene derivative advances the supercapacitor's energy storage advantage

With a new scalable graphene derivative, researchers hope to create supercapacitors that can store comparable energy to batteries while also offering superior rapid charging capabilities.

Energy

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The world is in the midst of an energy transition. But as we move away from fossil fuels and towards renewable sources, we must address the challenge of energy storage.

One possible solution is the supercapacitor.

According to ScienceDirect, supercapacitors are "electrochemical energy storage devices that store and release energy by reversible adsorption and desorption of ions at the interfaces between electrode materials and electrolytes."

One advantage supercapacitors have over other energy storage solutions, such as batteries, is a significantly longer lifespan. Whereas batteries can typically handle between 2 000 and 3 000 charge/discharge cycles, supercapacitors can handle more than 1 million rapid charges – resulting in a major reduction in materials and costs.

Despite their charge/discharge advantage, supercapacitors cannot compete with the battery's far superior energy storage capabilities. But this could soon change, thanks to a new graphene derivative being developed by the EU-funded UP2DCHEM project.

"By replacing activated carbon with a novel graphene derivative, we can create supercapacitors capable of storing comparable energy to a typical battery, while maintaining superior, rapid charging capabilities," explains Michal Otyepka, head of the nanomaterial division of the Czech Advanced Technology and Research Institute, part of Palacký University Olomouc, which hosted the UP2DCHEM project.

Scaling up

Graphene is a thin layer of pure carbon, tightly packed and bonded in a hexagonal honeycomb lattice. "It is widely regarded as a 'wonder material' because it is endowed with an abundance of astonishing traits – from being the thinnest known compound to the best known conductor," reports Graphene-info. "It also has amazing strength and light absorption traits and is even considered ecologically friendly and sustainable."

It was these traits that attracted Otyepka to the material in the first place.

In a previous project, Otyepka designed new functional materials derived from graphene, one of which showed very promising results in labs. In the UP2DCHEM project, which was supported by the European Research Council, he aimed to upscale the material's synthesis from milligrams to kilograms and to verify its utilisation in energy storage devices.

"In the laboratory, we normally prepare and test rather small samples, often quantities of less than a gram," remarks Otyepka. "However, commercial partners need orders of magnitude larger quantities, more than half a kilogram, to assemble device prototypes."

Yet scaling up from small to large quantities proved more challenging than expected, especially as the synthesis requires one chemical to be used as an airbag propeller. "Initially, it was quite hard to find a company willing to collaborate on such a potentially 'explosive' project," adds Otyepka.

Ultimately, the project found a company that managed the synthesis, allowing Otyepka to confirm that it is possible to synthetise such quantities and that the material still exhibits the required properties under these conditions and volumes.

Not only does this finding allow Otyepka to further optimise the synthesis, it has also opened the door to supercapacitor devices and further evolution of the project. "We are now working to transform these new materials into devices that contribute to solving the ever increasing demand for stable, cheap and sustainable energy," concludes Otyepka.

Researchers are currently collaborating with several companies and universities to create graphene-based supercapacitor prototypes.

Note: this article was first published in March 2022

PROJECT

UP2DCHEM – Upscaling of fluorographene chemistry for supercapacitor electrode material

HOSTED BY

Palacký University Olomouc in

FUNDED UNDER

Horizon 2020-ERC

TOTAL BUDGET

No data

EU CONTRIBUTION

€150 000

CORDIS FACTSHEET

cordis.europa.eu/project/id/899245

A new vision for ensuring the safety of road and rail tunnels

An innovative system using ground-penetrating radar to test for failures in a tunnel's infrastructure paves the way towards significantly faster and improved inspections.

Transport and Mobility

Today, engineers test the structural integrity of a road or rail tunnel by hitting the tunnel wall with a hammer and recording the reflected sound. Although this process has the advantage of being remarkably simple, the downside is that it is time-consuming. Furthermore, interpretation of the acoustic data is prone to errors, a factor that could have serious – if not catastrophic – consequences for the safety of a tunnel.

To prevent such disasters, Euromobilita, a Czech technology company, has created a new concept in ground-penetrating radar (GPR) for use in tunnel construction and maintenance. Called Tunnel Vision, the system uses rotating antennae to form 3D high-resolution images of the surface that can be easily interpreted by the end user. The soundness, economic viability and market potential of this concept was tested during the EU-funded TUNNEL VISION project.

"We believe the creation of clear 3D augmented reality images will allow civil engineers to accurately determine failures in the tunnel's infrastructure," explains Ales Loncaric, Euromobilita technical director and TUNNEL VISION project manager. "By providing this, Tunnel Vision will improve a tunnel's performance and resilience while reducing the risks, effects and costs of structural failures."

Adjusting to meet end-user needs

Working with industry professionals and potential end users, project researchers proved the GPR technology's ability to achieve the intended results while operating in a tunnel environment. The project also determined the costs of acquiring the required subsurface tunnel infrastructure inspection radar, including the unit price of the hardware, integration of the hardware with customer-owned rail vehicles, establishment of a capable data communication infrastructure, manufacturing partner software licensing fees, and initial staff training.

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To ensure the system would be accepted on the market, project researchers also studied the needs of infrastructure managers. Here, researchers discovered that the proposed system was not appropriate, as infrastructure managers need to be able to place the antennae in the centre of the tunnel.

"The original concept used a rotating antenna that could only be positioned using a robotic arm, which was not practical for our targeted end users," explains Loncaric. "As a result, we went back to the drawing board to redesign the Tunnel Vision concept."

The disruptive technology of the future

Once complete, the Tunnel Vision system will achieve surface measurements of up to 3 metres deep (compared to the 10 cm capability of traditional acoustic systems). Tunnel Vision will also significantly increase the speed at which inspections take place – from a maximum of 7.5 metres per hour to over 5 km per hour.

"By being able to scan deeper and faster, Tunnel Vision is positioned to be the disruptive technology of the future," adds Loncaric.

Note: this article was first published in November 2019

PROJECT

TUNNEL VISION – Novel Subsurface Inspection Radar to Inspect Tunnels and Tunnels Linings for improved maintenance

COORDINATED BY

Euromobilita in

FUNDED UNDER

Horizon 2020-Societal Challenges, Horizon 2020-LEIT and Horizon 2020-SME

TOTAL BUDGET

€71 429

EU CONTRIBUTION

€50 000

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