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JOANNEUM  
RESEARCH



# JOANNOVUM

GREEN AND DIGITAL TRANSFORMATION

01/2024

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### ARTIFICIAL INTELLIGENCE & CYBERSECURITY

Interview with Branka Stojanovic  
and Andreas Windisch [6](#)

#### IN FOCUS

Carinthian mobility model [12](#)

Green steel [14](#)

Meat from peas [26](#)

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# LANGE NACHT DER FORSCHUNG



Bundesministerium  
Bildung, Wissenschaft  
und Forschung

Bundesministerium  
Klimaschutz, Umwelt,  
Energie, Mobilität,  
Innovation und Technologie

Bundesministerium  
Arbeit und Wirtschaft

## 24.05.2024

Mitmachen. Staunen. Entdecken.



17:00-23:00 Uhr  
Eintritt frei  
[langenachtderforschung.at](https://langenachtderforschung.at)

## Editorial



Dr Heinz Mayer  
Managing Director, JOANNEUM RESEARCH



Particularly when it comes to deploying new methods, it's especially important to make sure they are embedded in a highly competent, agile network



### Green and digital transformation

The twin transition is the thread running through this issue of our magazine JOANNOVUM. Sustainability and digitalisation are inextricably linked. Digitalisation in – and as a product of – science and research is contributing to a shift in the research landscape and in society. JOANNEUM RESEARCH has extensive experience and, above all, broad-based expertise when it comes to the use of AI methods. Drawing on our know-how, we offer a made-to-measure combination of methods for the development of optimised automation solutions, as well as approaches geared towards accelerating processes and boosting efficiency in business and industry.

Particularly when it comes to deploying new methods, it's especially important to make sure they are embedded in a highly competent, agile network. Our role as a research company makes us an important hub in the network that extends across southern Austria – from the Alps to the Adriatic – but also further afield.

Commercial partnerships lie at the heart of everything we do, so I am delighted to report that two highly respected events – the Styrian business development agency SFG's Zukunftstag and the JOANNEUM RESEARCH Zukunftskonferenz – will be merged to create a new event focused on innovation and business in southern Austria: Zukunftstag – Innovations- und Wirtschaftsregion Süd. This will enable us to forge even closer ties between the driving forces behind the economy and research, and to raise the profile of the joint achievements of business and science. You, too, can play a part in this cooperation – and help to shape our future, together. I look forward to seeing you at the event on 9 October 2024 at Messe Congress Graz.

Heinz Mayer



# Contents



[zukunftskonferenz.jonneum.at](https://www.zukunftskonferenz.jonneum.at)



**06** Interview  
Branka Stojanovic and Andreas Windisch on AI and cybersecurity

**12** Carinthian mobility model  
Analysing the mobility habits of the Carinthian population

**14** Green steel  
Ways to make the steel industry sustainable

**18** News and events

**20** Artificial intelligence  
Selected projects

**22** Biodiversity  
Remote sensing for agriculture

**24** Excellent  
Publications and awards

**26** Meat made from peas and milk from oats?  
How our eating habits impact the climate

**28** Organ-on-a-chip  
How simulating organs can reduce animal suffering

**30** Wood Vision Wood Works  
Bernadette Karner (Wood Vision Lab) and Martin Karner (Weitzer Woodsolutions) talk timber

**32** Acute geriatrics success stories  
A report on the effectiveness of geriatric treatments

**33** Transformation, the environment and the circular economy  
Commentary from Christian Holzer

**34** Zukunftskonferenz 2023  
Review

**39** The AI Act – an overview  
Commentary from AI lawyer Jeannette Gorzala

**40** GreenSki  
Innovative snow depth measurement for ski resorts

**42** Smart bicycle tyres...  
...and how a polymer transforms energy

**44** Energy communities  
Freedom and independence in energy resources

**46** Contact



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ARTIFICIAL INTELLIGENCE  
AND CYBERSECURITY

Interview: Elke Zenz

Photo: Pawel Czerwinski-unsplash

## INTERVIEW

Early detection of Alzheimer's, new dimensions in robot autonomy and real-time language translation – artificial intelligence (AI) has potential in numerous spheres. It is already influencing research in countless different ways while opening up completely new possibilities that can be turned into reality at breathtaking speed. AI experts Branka Stojanovic and Andreas Windisch from DIGITAL share their insights.

### How does AI improve efficiency in research and development?

**Andreas Windisch:** AI is already being used to increase efficiency in research and development processes. Taking software development as an example, tools can be used that significantly speed up coding. Smaller sub-problems, such as the ones we encounter in research and development work, can be processed more quickly and efficiently with the help of AI systems. Another example is the opportunity to use AI systems to interact with scientific studies directly. Once scientific studies have been "shown" to an AI system, the contents can be queried. In this particular area of application, there are already fully-trained AI systems in place which have been coached using over 200 million published studies so that they are now in a position to provide detailed information.

### How does AI influence the speed of innovation and what are the challenges for a research organisation like JOANNEUM RESEARCH?

**Windisch:** As one of the leading high-tech companies in Austria, we're very much involved with the latest technological developments – not just on the research side, but also directly, in terms of applications for state-of-the-art tools. These are also based on generative AI. Here, the challenges include the rapid pace of technological advancement, the complexity of the subject matter and the computing resources required. And that's before we even get to data protection, and regulatory and ethical aspects. But thanks to our bro-

ad expertise in all of these areas, we are well placed to meet them.

We see ourselves as one of the central hubs of the Austrian AI community thanks to AI projects with customers and industry partners, international and national research projects, participation in standardisation committees in the field of AI, through training courses and lectures, as well as teaching at universities and FH universities of applied sciences. This topic is affecting society as a whole. It's very close to my heart and I would urge everyone who is interested in it to join us in the dialogue.

**Branka Stojanovic:** AI is catalysing innovation in interdisciplinary research in digital technologies by automating tasks, speeding up decision-making and facilitating predictive analysis. While this increases efficiency, it also poses challenges, such as ensuring data privacy, addressing ethical considerations, overcoming skills gaps, managing integration complexities, and navigating regulatory compliance. Research organisations such as JOANNEUM RESEARCH have a challenging and important role to play in bridging some of these gaps, bringing basic research closer to end users while building and maintaining trust in the technology.

### What role does AI play in ensuring competitiveness?

**Stojanovic:** AI is driving competitiveness in digital technology research and markets by accelerating innovation cycles, automating data analysis, and improving





**Andreas Windisch** heads the Intelligent Vision Applications research group, teaches at FH JOANNEUM and is committed to establishing AI technologies in Austria.

end-user satisfaction. Its ability to uncover patterns, predict trends and improve decision-making enables researchers to stay ahead in rapidly evolving fields, ensuring continued relevance, efficiency and breakthroughs in the dynamic digital landscape.

#### Who should engage with AI and why?

**Windisch:** This is an easy one to answer: everyone should engage with it. AI cuts across every section of society, and it is already having a major impact on our everyday lives in lots of different areas. Because of this, it's essential that people familiarise themselves with the technology so that they are better placed to assess its potential implications, while at the same time ensuring that they know how to use it to their own advantage.

#### Will R&D still be possible without AI?

**Stojanovic:** The fact is that R&D is possible without AI, and historically significant advances have been made without AI technologies. However, integrating AI into R&D processes can increase efficiency, speed up data analysis and provide new insights. AI is a powerful tool, but its absence doesn't make R&D impossible; it simply means relying on other methods and technologies to achieve research goals. The choice depends on the specific requirements, objectives and available resources of the R&D project. However, given the convenience of AI, the real question is: will anyone opt for

research without AI in the future?

#### Blessing or curse: is AI a double-edged sword in cyber security?

**Stojanovic:** AI in cybersecurity is definitely a double-edged sword. On the one hand, AI enables advanced threat detection, automates responses and improves overall security. But on the other, malicious actors can potentially exploit AI for sophisticated cyberattacks. The challenge is to stay ahead of the curve with responsible use of AI, robust defence strategies, and ethical considerations to ensure AI remains a blessing rather than a curse in the realm of cybersecurity.

This emphasises again the importance of applied research and ensuring competitiveness through innovation and resilience to evolving challenges.

#### DIGITAL is part of the EUs ResilMesh project, which will use AI to counter cyberthreats. What expertise is DIGITAL contributing to the project?

**Stojanovic:** ResilMesh, a three-year long Innovation Action project funded by the European Union, focuses on creating an advanced security toolset based on cyber situational awareness and to address the challenges of today's dispersed and diverse cybersecurity landscape.

As a key partner in the ResilMesh initiative, DIGITAL is focused on using cutting-edge AI to detect advanced



**Branka Stojanovic** is a cybersecurity and AI expert. She is in charge of various projects at DIGITAL, including ResilMesh.

cyber threats in both IT and OT environments within industrial control systems. In addition, DIGITAL is actively developing a tool that uses state-of-the-art reinforcement learning techniques to automate security testing in these dynamic environments. DIGITAL is proud to be part of an initiative that is pushing the boundaries of cybersecurity innovation and research.

#### Can cyber attacks be predicted using state-of-the-art technology or does this require quantum computers?

**Windisch:** Quantum computers are a very exciting technology that we are looking at from various angles here at JOANNEUM RESEARCH. Right now, they are at a relatively early stage of development. But there is one possible future scenario under which quantum computers could end up making cryptographic protocols – i.e. encryption methods – vulnerable. A concerted effort is already under way to design new processes that will not be put at risk by advances in quantum computing. On the other side of the coin, some scenarios are already playing out in which quantum computing is able to underpin cybersecurity. Examples of this include the creation of tap-proof communication channels that permit the secure exchange of cryptographic keys between two parties.

**Stojanovic:** Although cutting-edge AI technology has

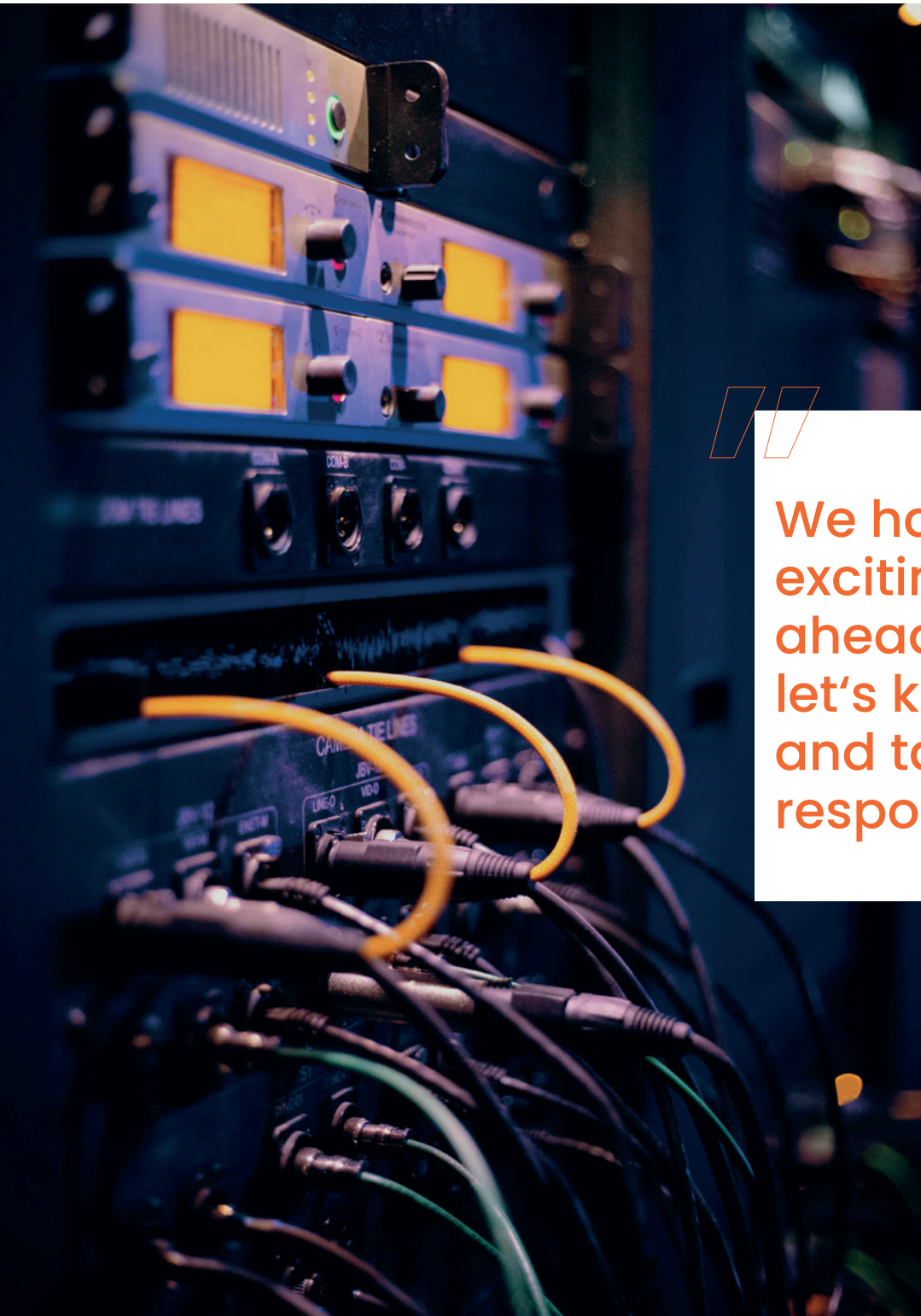
made significant progress in predicting and mitigating cyber-attacks, it is important to note that the promising quantum computers are not essential for predicting cyber-attacks. Currently, cybersecurity prediction and prevention efforts rely on the foundations of conventional computing and advanced AI technologies, rather than quantum computing.

#### Should AI decision-making bodies be multidisciplinary?

**Windisch:** Since AI affects all areas of society, there are many other aspects besides the purely technical side of things that need to be taken into account when it comes to AI-related decision-making processes. These extend to all areas of our lives and all specialist disciplines: from legal and ethical considerations to social science viewpoints and economic and ecological matters. And it is for precisely for this reason that responsible citizens must engage with the topic and play a part in the discussion by sharing their own personal insights. Ultimately, we need to work together if we are to utilise the technology for the benefit of all.

**Stojanovic:** AI technology has moved on from being only a technical tool to having a huge impact on the everyday lives of a large number of people. This includes really diverse aspects, from technical support to medical advice and much more. Multidisciplinary AI decision-making bodies are essential for a holistic





We have an exciting journey ahead of us, let's keep calm and take responsibility.

Photo: Josh Sorenson-Petells

approach to addressing the diverse challenges of artificial intelligence. By bringing together expertise from different fields such as ethics, law, psychology and technology, these teams can ensure a more comprehensive understanding of the technical, ethical and societal implications of AI.

**In 2023, AI research raised important ethical and societal questions, especially with regard to data protection, autonomy and social justice. Do you see any ethical dangers in the use of AI?**

**Windisch:** AI definitely brings numerous dangers and carries potential for misuse. But especially in Europe, where we have made a public commitment to upholding human rights, our concerns centre on using the technology for the benefit of citizens. So this means that we also need to come up with solutions for European AI systems as far as dealing with ethical challenges or – more generally speaking – with potentially detrimental impacts on humans is concerned. This is also where the field of “digital humanism” enters the picture. It approaches technological developments and their impact on people from the joint perspectives of human rights, democratic values and diversity in society.

**Is there anything that AI will never be able to do?**

**Windisch:** Well, there are a lot of limitations that I could cite here, but I’m going to confine myself to the following: as they are right now – and as they are likely to develop in the foreseeable future – AI systems aren’t in a position to seek answers out of a thirst for knowledge. And it is this curiosity, which we can observe in every child and which we unfortunately lose far too quickly in adulthood, that makes us so human. It’s the guiding light behind many of mankind’s greatest and most creative cultural and scientific achievements. Still, and I need to choose my words carefully here, because the really hard and fast limits are the ones imposed by the laws of nature. So we need to be cautious when we make categorical statements within these limits, particularly in the light of recent developments.

**Stojanovic:** Last year I would have said that AI would never be able to cook a home-made meal. Today, there are experiments with robotic arms cooking in AI-controlled kitchens. Today I have to say – we have an exciting journey ahead of us, let’s keep calm and take responsibility, because AI cannot be held accountable. ■





# Carinthian mobility model

## KORALM RAILWAY

Practical public mobility services and needs-based transportation planning are helping to improve quality of life across the Austrian province of Carinthia while at the same time delivering a viable alternative to car ownership.

Text: Nicholas Katz

Photo: iStock

With the Koralm Railway tunnel at its heart, the Koralm-bahn railway project is nearing completion – and promises to change Austria’s mobility landscape forever. Scheduled to become fully operational by the end of 2025, this groundbreaking development will bring the federal states of Carinthia and Styria even closer together by linking the cities of Klagenfurt, Villach and Graz to each other via a direct rail service. In addition to significantly improving accessibility between these urban centres, the connection will be create a “new” urban agglomeration in the south of Austria by bringing the cities within daily commuting distance of one another. However, there is still room for improvement when it comes to connecting outlying regions.

Mobility represents a decisive factor for social inclusion as it provides a link between living, working and leisure spaces. It is a key element in the provision of essential services, which do so much to shape quality of life and personal fulfilment, as well as influencing the inherent quality of a location and future opportunities of a region. POLICIES – the Institute for Economic, Social and Innovation Research – was commissioned to explore the mobility habits of the population of Carinthia: a comprehensive survey of more than 2,300 people living in the province revealed the need for a broad portfolio of measures if it is to meet the mobility needs of the local population. The study demonstrated that while car ownership was a necessity for many, there is still a strong underlying willingness to switch to public transport – provided that it represents a viable alternative.

**Nicholas Katz**  
is a data scientist in POLICIES’  
Regional Economics and  
Structural Policy research group.



## IN FOCUS

The study underlined the importance of an effective mobility transition that takes into account both the need to provide basic services as well as the population’s day-to-day realities, including practicality and safety aspects. For transport planning purposes, a proposal was made to divide Carinthia into functional areas that extend beyond established municipal and district boundaries with a view to creating better infrastructure and increasing people’s willingness to use public transport. Open communication and taking rural areas into account are key factors.

Individual mobility, and mobility for women in particular, form the focus, given that the study confirmed the potential of improved infrastructure to enhance participation for women – who often have a greater burden in terms of everyday errands and provision of childcare. Using public transport can be made more attractive through various measures such as expanding services, providing safe cycle paths and pedestrians routes, as well as park-and-ride facilities.

In conclusion, the Koralm Railway development marks a decisive step towards promoting individual mobility and equal opportunities in Austria. Creation of practicable public transport alternatives and initiating needs-orientated transport planning can help to improve quality of life while promoting social participation for all population groups. ■

## Recommendations for promoting mobility

### 1. Public transport:

Improving the accessibility of educational, health and leisure facilities, administration and services through an expanded public transport network

### 2. Feeder systems:

Establishment of feeder systems between the regions and the Koralm railway for better connections

### 3. Park and ride and bicycle parking spaces:

Expansion of park-and-ride facilities and cycle parking spaces to enhance last-mile efficiency

### 4. Footpaths and cycle paths:

Promoting the expansion of safe footpath and cycle path networks to support sustainable forms of mobility

### 5. Free public transport tickets:

Introduction of a free public transport ticket for children and teenagers up to 18 years of age



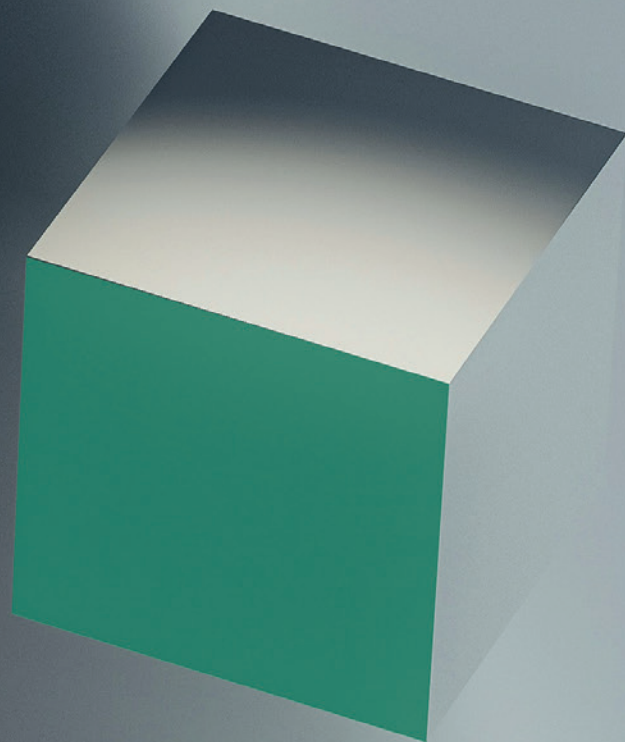


Photo: Milad Fakurian-unsplash

# GREEN STEEL

The steel industry accounts for more than 7% of global CO<sub>2</sub> emissions. A range of different factors are currently being addressed with a view to making the industry greener – from the raw materials and furnaces used in the steelmaking process to the recycling of waste products. But social aspects also need to be taken into account. JOANNEUM RESEARCH is using its expertise to help the transition, too.

Text: Petra Mravlak

Last year, the 71 World Steel Association (worldsteel.org) member states alone produced a total of 145.5m tonnes of steel. Production is energy-intensive and generates huge quantities of CO<sub>2</sub>. But is there anything we can do to counteract these problems?

“Using scrap steel instead of the primary raw material iron ore for steel production delivers a reduction in carbon emissions of up to 75%,” says Harald Ganster. “And it makes production more energy efficient,” adds his DIGITAL Institute colleague Malte Jaschik. The pair are currently working on an innovative approach to the material characterisation of scrap metal as part of the InSpecScrap project, using artificial intelligence (AI) and hyperspectral multisensorics to characterise the composition of the metal – which has a decisive influence on the quality of the steel produced. This technique allows for detection of impurities and the automated assessment of quality specifications. “The findings will lay the foundations for the development of new approaches to AI-based classification methods for the future, which adds another key aspect to the steel industry digitalisation chain,” the researchers point out.

The institute is working closely with TU Graz, the K1-MET competence centres and the Know Center. Industrial partners Marienhütte (a steel mill) and Voestalpine Stahl Donawitz are also supporting the project.

## Social responsibility

If the transformation of the steel industry is to be truly sustainable, the social dimension also needs to be kept in mind. In cooperation with the University of Graz, Ingrid Kaltenecker and Michael Brenner-Flieser from the LIFE Institute examined the social compatibility of a transition to more environmentally friendly steel production – using waste wood as opposed to coal – in Belgium, China and the USA. They found that the effects on society depend to a large extent on the location and suppliers. Partially replacing coal with waste wood to fire the blast furnaces undoubtedly translates into lower CO<sub>2</sub> emissions, but does not necessarily have a positive impact on the community. For example, China imports coal from Australia, where production standards are high. A changeover would mean replacing this coal with local products, where social sustaina-





## IN FOCUS

### InSpecScrap



The InSpecScrap project – the name is short for ‘intelligent multispectral characterisation for material analysis in scrapyards’ – is financed through the Province of Styria’s Zukunftsfonds research fund.

bility is far less of a priority. By contrast, Belgium imports coal which is mined under poor social conditions. In this case, using waste wood from surrounding regions would generate benefits for society. As part of the EU’s Torero project, waste wood from demolished roof frames and offcuts from sawmills are being used to heat the furnaces at a pilot plant in the Belgian city of Ghent. The research team also analysed its impact on people and the environment: “The results could be applied here in Austria, too, and using waste wood instead of coal has the potential to improve environmental and social conditions in this country as well.” However, steps would also need to be taken to avert the negative effects on countries that currently export the raw material. For instance, they could switch from fossil fuel extraction to alternative energy generation in order to create new jobs.

#### From coke to green hydrogen

The MATERIALS Institute is involved in the RecHycle project, which is also focused on the use of alternative energy forms. Researchers are investigating the use of green hydrogen and recycled steel mill gases in steel manufacturing as substitutes for coke and coal dust. At the ArcelorMittal steel plant in Ghent, the blast furnaces run on a mixture of hydrogen and cycle gas. The corresponding life cycle assessment (LCA) for evaluating the reduction in CO<sub>2</sub> emissions has been defined and optimised. “We are analysing the hydrogen embrittlement of the materials used in the furnace, which poses a significant risk for the proper functioning of the furnace system,” explains Vojislav Petrovic Filipovic,

who is heading the project at the MATERIALS Institute. And the primary benefit of hydrogen as an energy source for steel production: steam is the only by-product of the combustion process.

#### Slag for road construction

The Marienhütte steel works in Graz produces gravel for use in the construction industry from slag. A by-product of rebar steel manufacturing, slag was once viewed with suspicion due to environmental concerns, but it actually delivers ecological and financial advantages – as the LIFE Institute has discovered: “In terms of greenhouse gas potential, using rebar steel slag for road construction saves 300 tonnes of carbon dioxide emissions compared with dumping and natural gravel mining,” says Head of Institute Franz Prettenhaler. “The circular economy approach also performs better than natural gravel and dumping as regards other metrics that we investigated, including primary energy use, space requirements, fine particulate emissions and utilisation of wastewater.” Prettenhaler also points out an economic benefit: the costs of this approach are some 88% lower than disposal. The LIFE research team has calculated that using rebar slag produced in the course of a year translates into EUR 9.1m in value added – a difference of EUR 3m compared with dumping. The Marienhütte mill manufactures around 410,000 tonnes of rebar rods and rings each year and generates 72,000 tonnes of metallurgical gravel. Produced when steel is recycled in the electric arc furnace, this slag has stone-like properties. ■

## IN FOCUS

### Construction for future generations



#### Markus Ritter

CEO, Stahl- und Walzwerk  
Marienhütte GmbH

*It’s hard to imagine modern-day lifestyles without built environments. But construction always has adverse effects on the natural environment. If we want to leave a liveable world for our grandchildren, we need to make sure that new buildings leave as small an ecological footprint as possible – you might call it construction for future generations. This means that the CO<sub>2</sub> emissions caused by production and transportation of building materials must be kept to an absolute minimum. In other words, the materials should be produced locally to the greatest possible extent. This will also involve using large amounts of recycled materials as opposed to valuable primary raw materials, as well as ensuring that no production residues are left behind that*

*need to be disposed of or incinerated. Ideally, the energy used can be recycled several times, thanks to combined heat and power systems, for instance. And it should be possible to recycle building materials when they reach the end of their useful lives. Only materials that meet these requirements will enable us to build for future generations. In light of the challenges we are currently facing, in future we will have to take a much stricter view of whether construction activities really do have our grandchildren’s futures in mind.*

### RecHycle



This EU-funded project is investigating the use of green hydrogen and recycled steel mill gases in steel manufacturing. Intended as substitutes for coal, they will play a part in making Belgian steel manufacturer ArcelorMittal’s facilities carbon-neutral by 2050.

### Torero



The aim of this EU project is to develop a cost-, resource- and energy-efficient technology concept for the production of bioethanol from waste wood, which can be fully integrated into an industrial-scale, commercial steel plant.



# NEWS AND EVENTS

## 108th Digital Dialogue: Decrypting Cyber Security

JOANNEUM RESEARCH and the SILICON ALPS cluster hosted the most recent event in the Decrypting Cyber Security series on 19 March 2024. An audience of around 80 people took the opportunity to find out about the latest developments regarding the EU's NIS2 cybersecurity directive at JOANNEUM RESEARCH's headquarters in Graz. Photo (from left): Michael Zwantschko (SILICON ALPS Cluster), Daniela Geier-Johnnie (NTT Data), Thomas Schober (PwC), Wolfgang Rosenkranz (CERT) and JR authorised signatory Helmut Wiedenhofer



## Gratitude and appreciation

Styria's Provincial Governor Christopher Drexler presented well-deserved awards to employees of local government enterprises at a special ceremony in the main auditorium at Graz's Alte Universität on 12 March 2024. Medals of recognition were awarded to two members of the JOANNEUM RESEARCH team: Alexander Almer from the DIGITAL Institute and POLICIES Director Wolfgang Polt. Works Council Chair Ferdinand Golja, DIGITAL Director Matthias Rüther, Managing Director Heinz Mayer, and POLICIES research group heads Eric Kirschner, Hermann Katz and Michael Ploder were also in attendance.



## GRANted: equal opportunities in research

Last year, delegates at the second GRANted Stakeholder Conference in Vienna debated gender-specific disparities in research funding and academic careers. The project's initial findings were presented, with discussions focusing on their significance for different research system participants. Five research funding organisations (RFOs) were examined – regional RFOs play a key role in reducing gender-specific bias and contribute to creating a fairer scientific ecosystem.

## motionexpo 2024

This year, JOANNEUM RESEARCH was once again a partner of motionexpo, which took place from 8-10 March 2024 at Stadthalle Graz. The DIGITAL Institute's stand in the Technology Hall focused on digital twins. Photo (from left): JR Managing Director Heinz Mayer and Provincial Governor Christopher Drexler with the Virtual Vehicle exhibition team.



## Styrian delegation visits northern Italy

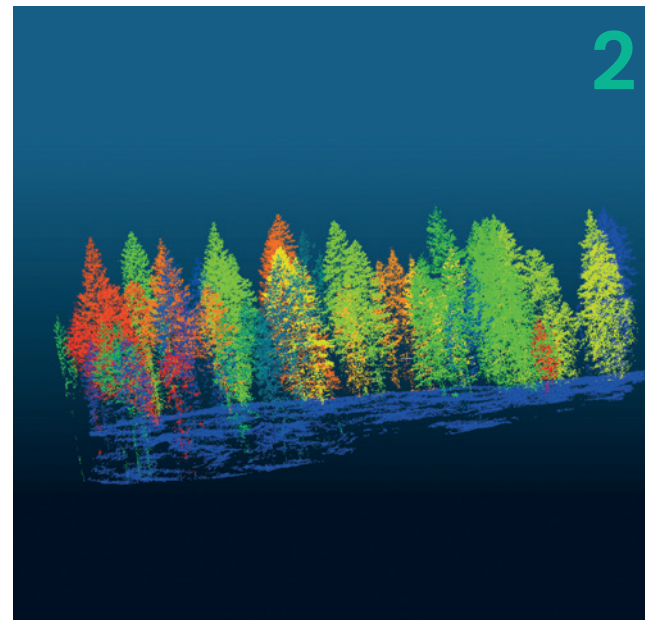
A delegation from Styria headed by Provincial Councillor Barbara Eibinger-Miedl and JR Managing Director Heinz Mayer recently travelled to Udine and Bozen, with a view to consolidating relations with the highly developed economy of northern Italy. Options for cooperation with JOANNEUM RESEARCH were explored during discussions with representatives of the universities of Bozen and Udine, NOI Techpark, South Tyrol research institute EURAC Research as well as various company representatives.



## Carinthia Innovates

JOANNEUM RESEARCH was closely involved in the Carinthia Innovates event held on 28 November 2023. The schedule included five-minute pitches by Carinthian research institutions – ROBOTICS Director Anton Scheibelmasser outlined his institute's competences and research focuses, while Patrick Luley (DIGITAL) introduced the audience to the Digital Twin Lab, which opened at the Lakeside Science & Technology Park in 2023.





# ARTIFICIAL INTELLIGENCE

Text:  
Petra Mravljak



**1. AI in recycling:** Until now, the composition of household waste has only been analysed at the point of unloading. But thanks to the installation of one of our multisensory recording systems in waste disposal vehicles, it is now possible to scan waste household by household and use this information to generate a kind of fingerprint. The data collected during scanning can be subsequently analysed using artificial intelligence to identify recyclables and hazardous substances immediately. It also has the potential to improve households' waste separation by providing them with direct feedback. Responsibility for capturing images in the vehicle and processing them in the cloud falls to a group of experts from DIGITAL who also developed a robust stainless steel housing with a total of four camera systems, an industrial computer and various other electronic components. Once captured, the images are ready to be analysed with AI.

**2. AI in forest inventory:** Each individual tree must be identified, localised and monitored over time to ensure optimal forest maintenance and protection. And its vertical structure also has to be recorded. Something that cannot be done with sufficient accuracy using conventional satellite data. In the DeepDigitalForest project, a team from DIGITAL processed particularly dense 3D point clouds (100–400 points instead of the usual 2–8 points per m<sup>2</sup>) thanks to a technique known as airborne laser scanning. The goal was to detect individual trees in the 3D point clouds using artificial intelligence so that forest inventory parameters could be defined. And because it can be fully automated, the process is also suitable for analysing very large areas. Especially in times of climate change, monitoring forest areas is becoming increasingly important as a measure to counteract the effects of global warming.

**3. AI in industry:** Robot technologies are making deeper and deeper inroads into the industrial sector as their capabilities grow. The new possibilities that have emerged in terms of using robots are attributable to advances in sensorics, communication and AI technologies. But at the same time, these new technologies are changing the landscape for workers. Increasing use of autonomous robots requires an assessment of the changes to be expected, identification of where new stresses may arise, and analysis of the new challenges that will arise for employees in this new world of work. As part of the research into this technology, a team from ROBOTICS has mapped out a technology forecast (with a time horizon of 5–10 years) for autonomous transport systems.

**4. AI in medicine:** A team at HEALTH is conducting research into the development of artificial intelligence that enables health risks to be identified at an early stage. Specifically, the researchers are focusing on the treatment of older people. If genuine improvements are to be made for patients and medical staff alike during the course of treatment, a close eye has to be kept on potential risks to prevent them from developing into real threats. And this is exactly where artificial intelligence comes in: it maintains an overview for us by pinpointing potential risks at an early stage before warning us of the pending danger. This allows healthcare professionals to initiate preventive and therapeutic measures in good time to prevent possible complications.



## BIODIVERSITY VIEWED FROM ABOVE

**Text: Elke Zenz**

In a rapidly changing world, understanding the interactions between human activity and the natural environment is more important than ever. Manuela Hirschmugl and Petra Miletich from DIGITAL's Remote Sensing and Geoinformation research group are taking a decisive step towards achieving precisely this through their work on the development of innovative solutions and products that are designed to monitor our planet. The goal? To find answers to some of the most important questions facing biodiversity monitoring right now – and not just in protected areas, but in agriculture and forestry, too.

The key to it all lies in remote sensing – a technology that can be used to collect information about the Earth's surface from high in the sky. "This primarily involves the use of satellite images, which allow us to take a detailed look at the most diverse habitats on our planet. By analysing these images we can pinpoint and monitor changes in land use, vegetation density and the composition of animal

and plant species," explains remote sensing expert Manuela Hirschmugl. "We are experiencing extreme declines in biodiversity, above all the insect world. Setting aside 10% of the area for biodiversity to flourish is important, but no longer enough on its own. Farmers are now trying to address this problem more closely and create new habitats here too."

One project that is worthy of particular mention in this context is RestorEO, which is funded by the Austrian Research Promotion Agency (FFG). In cooperation with Environment Agency Austria, the University of Graz and the E.C.O. Institute, a monitoring system based on a combination of Earth observation data and field surveys is currently under development. This system is intended to provide a transparent overview of the state of biodiversity as well as the progress being made by efforts to restore ecosystems. Loss of biodiversity is one of the greatest challenges of our time. The EU has set clear targets in its Biodiversity

Illustration: Freepik | Photo: Kristine cinate-unsplash



### Good 2 know

The experts developed a special software toolbox to automate and simplify the classification process. It optimises the processing of Sentinel-2 satellite data by enhancing various processes such as image alignment, terrain adjustment, atmospheric corrections and the removal of aggravating factors such as clouds and shadows. The project incorporates additional information such as terrain heights from the digital terrain model (DTM), and integrates geological and soil maps as well as data on land use and climate to further improve classification accuracy.

This improvement in accuracy confirms the effectiveness of the underlying methods and shows the importance of additional data for precise classification. The MeadowTypes project provides an important basis for the identification and monitoring of different types of meadow, which has a key role to play in environmental monitoring and the conservation of ecosystems.

Strategy for 2030 aimed at protecting biological diversity as part of the European Green Deal and wider efforts to protect life on Earth.

A key aspect of this strategy is the development of an EU-wide nature restoration plan that is rooted in legally binding targets. "What's innovative about RestorEO is the way that it combines traditional fieldwork with state-of-the-art remote sensing data, primarily from the Copernicus programme. The aim is to facilitate comprehensive and quantitative monitoring that records the condition and integrity of key ecosystems with a high degree of accuracy. This kind of monitoring will not only provide reliable information on the state of biodiversity; it will also help public authorities to meet their responsibilities more effectively," notes geographer Petra Miletich, who works primarily at the JR site in Klagenfurt.

Using remote sensing data opens up fresh possibilities when it comes to safeguarding our natural resources and preserving the planet's diverse ecosystems for future generations.

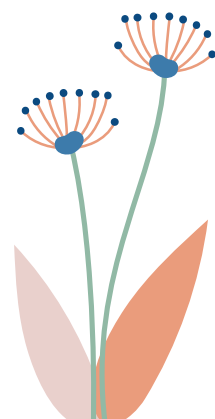
Another example of how remote sensing technologies are being used is provided by the MeadowTypes project, which has set itself the task of precisely classifying different types of meadows. This is a crucial step towards understanding and protecting the diversity of our grasslands. To begin with, the project team developed a customised classification scheme based on soil characteristics and cultivation intensity that would allow them to identify different types of meadow. The field work carried out by colleagues at HBLFA Raumberg-Gumpenstein saw them classify meadows and analyse 216 extensively and 183 intensively farmed areas," explains Petra Miletich. This information was then used as the training data to create the model. "We use the model to analyse time sequences of satellite images so that more precise differentiations can be made. Though we are unable to make out precisely which plants are growing in the meadow from the satellite images, we can see spectral signatures over a vegetation period. And this is what allows us to identify what type of meadow it is." In summary: the actual classification is based on a machine learning model that uses spectral information from satellite data and minimises sources of error through the application of various rules and methods. The outcome is a detailed and reliable classification of meadow types at a scale of 1:50,000. "We achieve a high level of classification accuracy by integrating additional information and analysing plausibility. This increases accuracy to fully 80%," says Miletich. Analysis like this is important for a number of reasons, such as reviewing measures and specifications. It makes it possible to identify whether a greater number of meadows are being mowed at longer intervals, which increases biodiversity. The project is funded by the Austrian Federal Ministry of Agriculture, Forestry, Regions and Water Management. ■



**Petra Miletich** is a project manager in DIGITAL's Remote Sensing and Geoinformation research group.



**Manuela Hirschmugl** is a senior researcher at DIGITAL and teaches at the University of Graz.





# EX CELL ENT



From left to right: Stephan Wölcher (SETEC), Johann Wiedner (Wasserwirtschaft Steiermark), Matthias Rüter (JR), Franz Zellinger (DATAVIEW), Stefan Grebien, Franz Graf and Heinz Mayer (JR), Hans Kupfersberger (JR-AquaConSol) and Styrian Provincial Councillor Simone Schmiedtbauer

Photo: Lebensressort/Fischer

## AWARD-WINNING:

### WASSERLAND PRIZE FOR KI-WAZU PROJECT

*AI-supported water supply is the topic of the KI-WAZU project.*

JOANNEUM RESEARCH received the Province of Styria's Wasserland Prize for its KI-WAZU project. Focused on AI-supported water supply for the future, KI-WAZU is addressing supply challenges that are being exacerbated by climate change. The goal is to implement data- and model-based control systems that will ensure efficient resource use and drinking water distribution. A core aspect of the project is AI-assisted observation of water supply facilities, which will enable 24/7 monitoring as well as early identification of faults and initiation of countermeasures. In future, facilities will be operated proactively on the basis of forecast parameters.

## FOUR MODEL REGIONS

The project is being put into practice in four regions in Styria, Carinthia and Burgenland, in cooperation with local water supply companies. These partnerships are essential in order to put the developed systems through their paces under real-life conditions. KI-WAZU is sponsored by the Austrian Federal Ministry of Agriculture, Forestry, Regions and Water Management and the provinces of Styria, Carinthia and Burgenland. The corporate project partners are JR-AquaConSol, DATAVIEW and SETEC.

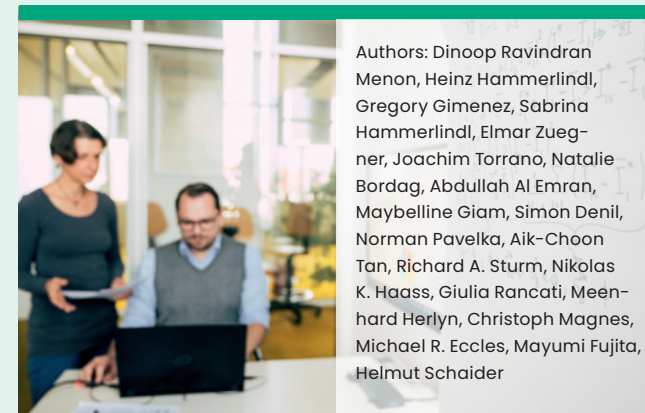


## MATERIALS & HEALTH HOUSKA PRIZE NOMINATION

### PRIZE-WINNING PROJECTS

The MATERIALS and HEALTH institutes were both nominated for the 2024 Houska Prize in the Non-University Research category, with one project each. As nominees, both are guaranteed

at least EUR 10,000 in prize money. Entitled NextGen-Microfluidics, research for the MATERIALS project is centred on miniature laboratories known as lab-on-a-foil solutions. Headed by Martin Smolka at the Weiz site, the project is aimed at achieving cost-effective and scalable manufacturing of microchips developed for a variety of different customer applications. In parallel, the MATERIALS team has set up a Microfluidics Innovation Hub – a European network that gives small and medium-sized businesses access to microfluidics experts and various implementation options ranging from development through to production. The HEALTH Institute's Dermal OFM project aims to find proof of the efficacy of drugs for the treatment of skin conditions with the help of dermal open flow microperfusion (OFM). This involves continuously taking samples of interstitial fluid from the skin using a minimally invasive probe. The fluid enables researchers to discover whether a drug has penetrated the skin barrier, as well as the concentration levels when the drug reaches the skin and the effect it triggers there.



## KH3K4ME3 REMODELING INDUCED ACQUIRED RESISTANCE THROUGH O-GLCNAC TRANSFERASE ScienceDirect, Drug Resistance Updates

## PUBLICATION: DRUG RESISTANCE IN CANCER PATIENTS

Permanent drug resistance is the leading cause of death among cancer patients. One of the mechanisms that precedes resistance to cancer medications is a process of adjustment based on a chronic stress reaction. Now, the metabolics team at JOANNEUM RESEARCH's HEALTH Institute, working in collaboration with the Frazer Institute at the University of Queensland in Australia as well as international researchers, has identified a new target for cancer drugs. The target combines metabolism and epigenetics (the influence of environmental factors) – two of the main drivers of the adaptation process – and plays a decisive part in enabling cancer cells to regain the ability to multiply, grow and divide during treatment.



## JOSEF KRAINER PRIZE FOR COREMED RESEARCHER

Ines Fössl won the Josef Krainer Prize for her outstanding scientific research at the Division of Endocrinology and Diabetology at University Hospital Graz and at JOANNEUM RESEARCH's COREMED Centre. Her research focuses include bone metabolism, age-related changes in metabolism, imaging and biomarkers. Her work concentrates primarily on the biological mechanisms behind diseases. She is currently investigating skin regeneration processes. Ines Fössl is an active member of various national and international societies, and a founder member of MuSkITYR, an association of young scientists focusing on interdisciplinary, translational research into the musculoskeletal system.



# Meat made from peas and milk from oats?

Our eating habits have a massive effect on the environment and the climate. This isn't just a topic that the LIFE Institute is focusing on – it's also a matter for food retailers and meat producers. At our most recent Zukunftskonferenz, Christoph Weigl from meat company Marcher Fleischwerke and Tanja Dietrich-Hübner from supermarket chain Billa spoke about meat alternatives and climate protection.

Text: Petra Mravljak

Depending on how you calculate it, the food we eat accounts for between a quarter and a third of global greenhouse gas (GHG) emissions. "Animal-based products have a particularly large carbon footprint," explains Benjamin De Groeve of the LIFE Institute. Conventionally reared beef has one of the biggest, averaging 36.4kg of CO<sub>2</sub>-equivalent (CO<sub>2</sub>e) per 1,000 kilocalories (kcal)\*. On this metric, pork (5.2kg CO<sub>2</sub>e) and poultry (5.3kg CO<sub>2</sub>e) perform well, comparatively speaking. "But take a look at plant-based products and you see the true potential that could be unlocked by changing our eating habits," De Groeve adds. By way of comparison: tofu generates 1.2kg of CO<sub>2</sub>e, wheat-based alternatives 0.6kg and pea-based substitutes 0.3kg. And when it comes to milk and its plant-based replacements, the difference is glaring. With one exception: coconut milk.

## Meat production

Marcher's carbon balance paints a clear picture of the factors that cause high emissions in meat production. Based in Villach, the meat processing company began analysing the carbon footprint of its operations and

products in 2021: "We compiled a greenhouse gas balance for our entire production chain – from rearing and feeding the animals, to transportation to the abattoir and between different facilities, as well as emissions at the various sites including waste and wastewater management, all the way through to how the employees commute to work," Christoph Weigl, Marcher's Sustainability Manager, reports. The results: "95% of the emissions attributed to Marcher Fleischwerke come from raising cows and pigs – something we have no influence over at all. A large proportion of emissions are also accounted for by packaging and labelling, but the actual production plays a minor role in comparison." What's more, Marcher's meat substitutes underline the huge differences between meat and plant-based meat analogues – the GHG emissions from production of a beef burger patty are about six times higher than for an alternative pea-based product. And a Marcher-developed upcycling recipe that uses brewery by-products performs even better.

Photo: Victoria Shee-unsplash



## Meat

CO<sub>2</sub>e per 1,000 kcal:\*

- Beef from meat production: 36.4kg
- Prawns: 26.1kg
- Lamb: 12.5kg
- Meat from dairy cattle: 12.2kg
- Poultry: 5.3kg
- Pork: 5.2kg

## Plant-based alternatives

CO<sub>2</sub>e per 1,000 kcal:\*

- Tofu: 1.2kg
- Pea-based: 0.3kg
- Wheat-based substitute: 0.6kg

Source: Ourworldindata

## Plant-based products

"We're focused on expanding our plant-based range and on higher-quality animal products," explains Tanja Dietrich-Hübner, who has been Head of Sustainability at Billa for the past 13 years. "Eating is very closely tied in with enjoyment, and that's just as true for plant-based foods," she adds. "Our job is to give the customers some guidance and design the product range so that it's good for the climate and fit for the future in the long run." A study carried out on behalf of organic label Ja natürlich and Greenpeace provided some data on this topic. Compared with the emissions caused by the current average diet, switching to a balanced, low-meat diet cuts GHG emissions by 28%, while going vegetarian can cut emissions by up to 47%, and the potential emissions savings from a vegan diet are 70%. "This means people can help to reduce emissions significantly simply by choosing a more balanced diet. If you can cut your meat consumption and choose organic options for part of your food intake, then that really does have an effect."

## Conclusions

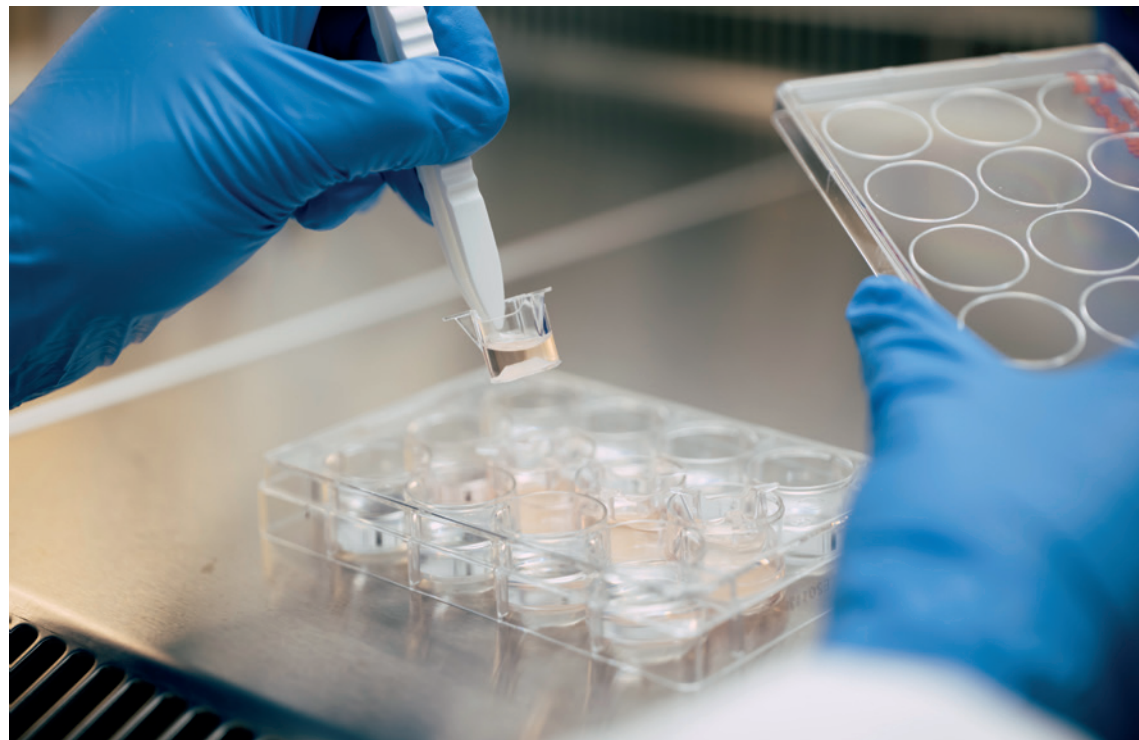
The carbon footprints of most animal-based products are substantially larger than they are for plant-based alternatives, so even small changes in behaviour can make a difference. Which would make this an effective weapon in the fight against climate change.

\*CO<sub>2</sub>e per 1,000 kcal includes carbon dioxide as well as other greenhouse gases. It shows how many kilograms of GHGs are emitted in order to achieve a nutritional value of 1,000 kilocalories for a given product. The figures stated in this article are averages, and they can vary significantly depending on the type of production, as well as the ingredients used in meat analogues.

In their research, **Benjamin De Groeve** and **Michael Brenner-Flieser** of the LIFE Institute focus on how diet influences the environment. ■



# ORGAN ON A CHIP



**An organ-on-a-chip device consists of cells and cell clusters that simulate an organ or organ system. They are built on microfluidic channels that replicate the function of vessels in the body, which transport nutrients and information. This type of laboratory setup simulates physiological functions in a manner that allows for the replacement of animal experiments.**

**Text: Elke Zenz**



**Petra Kotzbeck** is Deputy Director of the COREMED institute and an assistant professor at the Medical University of Graz.



**Thomas Birngruber** is Deputy Director of the HEALTH institute.

Science never stands still, especially when it comes to medical research. Three institutes at JOANNEUM RESEARCH are currently working on revolutionary organ-on-a-chip methods. This technology makes it easier to understand human physiology while also unveiling new possibilities for the development of treatments without having to rely on animal experiments. As a result, it holds the prospect of faster, more accurate and ethically acceptable results for medical research. JOANNEUM RESEARCH's activities in this area focus on the skin as it works to address various relating to wound healing and the effects of different medication.

The development of organ-on-a-chip technology represents a significant breakthrough in biomedical research. By simulating the complex environment of human organs on a chip, these microfluidic devices facilitate the precise monitoring of diseases and their treatments. With the help of the technology, researchers are now able to observe the reactions of human tissue to active substances in real time, which opens the door to more efficient and targeted drug development.

The name references the size of the device and its resemblance to a computer chip. Usually, cell culture inserts are embedded in a plastic frame. These slides can also be combined with electronics. Microfluidic channels running beneath the surface of the chip mimic the function of blood vessels in the body. This means that they transport nutrients to the "organ", and carry waste and information from it. To create the chips, researchers

isolate skin cells from the samples donated to clinics.

The isolated cells can be used to cultivate an artificial, three-dimensional skin model in the laboratory, which the researchers can then transfer in miniature form to chips, creating a test environment for biomedical research.

Advances in this technology will reduce the need for animal testing in medical research. This development is in line with the growing demand for ethically justifiable research methods and increased efforts to minimise the suffering of animals. The ability to directly study human disease models represents a paradigm shift in the way that we understand – and treat – biological processes.

Covering a broad scope of applications, organ-on-a-chip technology is suitable for use in numerous areas, including personalised medicine, and has the capacity to open up new horizons in the treatment of diseases. It also has the potential to enhance the effectiveness of existing treatments while cutting costs and development times in pharmaceutical research.

In conclusion, organ-on-a-chip devices are more than just a scientific innovation; they hold the promise of a future in which medical research can be carried out faster and with greater precision. By bridging the gap between traditional animal testing and human clinical trials, they introduce precious value added for society as well as a fresh glimmer of hope for people awaiting breakthroughs in the treatment of diseases. ■



# Wood Vision Wood Works

**Martin Karner**, Managing Director of Weitzer Woodsolutions and **Bernadette Karner**, Managing Director of Wood Vision Lab

For many, the Green Deal has taken on some particularly negative connotations. Though an intrinsically great vision, rather than leading the way towards its actual goal, its current implementation is bringing about Europe's deindustrialisation. But for us, this is not the time to bury our heads in the sand, but to look ahead and roll up our sleeves instead. It forces us to look for solutions that, while contributing to the Green Deal, also have the ability to unlock value creation in a high-wage country. Realising this vision calls for thinking outside the box and the willingness to go that extra mile. And that is precisely what we have been doing with our partners over the past 10 years.

Working alongside renowned research institutions, regional and international industry and network partners, we have proven in various research and development projects that it is indeed possible to pull off this delicate balancing act between sustainability and regional value creation. And Styria turned out to be the ideal incubator: the most timber-rich of all the Austrian provinces, it is also one of the most active research regions anywhere in Europe and presides over the necessary research and education landscape. Known as the green heart of Austria, it also has the manufacturing and application industry to go with it,

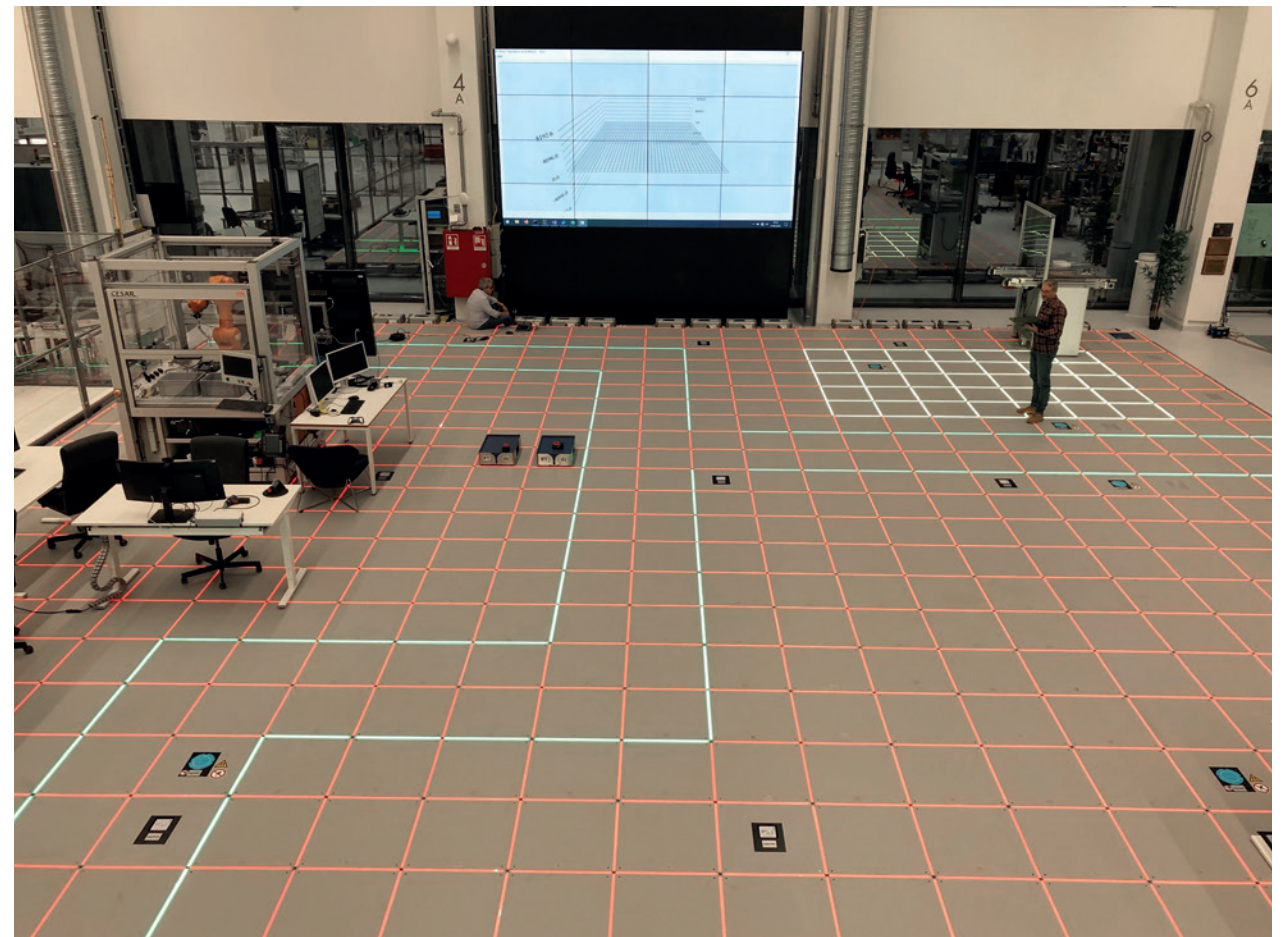
all underpinned by the political support needed for innovation and location development. A naturally regenerating raw material, wood is available in sufficient quantities in the region thanks to an established sustainable forestry sector – meaning that supply is not only predictable, but also now officially certified and approved for many areas of application in the automotive, rail and mechanical engineering sectors. With the support of well-known rail and automotive companies, it has been proven that it will not be long before volume production starts to ramp up. The task now is to secure the international knowledge leadership – primarily built up in Styria – at Weiz-based Wood Vision Lab's disposal and position the company even more strongly for the future ahead. The Wood Vision Lab will serve as a one-stop shop for natural lightweight hybrid components, covering every step in the value chain from basic research all the way to the transition to volume production.

Under this approach, our pioneering facility is not only realising this "wood vision" but demonstrating timber competitiveness without a shadow of a doubt and proving its suitability as a regional, ecofriendly, high-tech lightweight construction material for volume production. Put simply: wood works.

## PyzoFlex®

*Sense your future!*

*The industrial floor of the future based on PyzoFlex technology*



Developing innovative and multifunctional industrial floors is a key element of the factory of the future. MATERIALS is working with its project partner Bosch Rexroth AG on the industrial floor of the future, which consists of individual modules (60cm x 60cm) containing inductive charging stations and colour-adjustable LEDs, as well as a host of sensory components. The aim is to optimise production cycles and processes, while also enhancing occupational health and safety.

Produced in response to this brief, our bespoke PyzoFlex® systems consist of foil sensors and the hardware needed to record and relay the signals they generate.

The complete modules recognise movement sequences and seat occupancy for applications such as shuttles. 80 of these modules have been installed by Bosch Rexroth as a demo floor at Forschungscampus Arena 2036 in Stuttgart where they serve as a showcase for prospective clients.

**PyzoFlex® is an award winning sensor technology** that enhances your product with novel sensory function to detect pressure and temperature changes as well as structure borne sound. It can be adapted to a wide range of applications.

Over the past ten years we have continuously developed PyzoFlex® solutions for our customers in the fields of Industry 4.0, Smart City and Smart Mobility, Smart Living, and Consumer Electronics.

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## NEW STUDY

## Acute geriatrics success stories



Text: Elke Zenz

Acute geriatrics is usually located within a care institution as an interdisciplinary facility. Facilities like these are becoming increasingly important due to the enormous benefits that they offer for older people who find themselves at a crossroads between living independently and needing care. And when such individuals suffer an acute illness or injury, such as a broken bone after a fall, acute geriatrics steps in to help them regain functionality and restore mobility in readiness for a return to their familiar surroundings. Something achieved by fully 90% of people who had previously been living independently in their own home according to a report by HEALTH – the Institute for Biomedical Research and Technologies at JOANNEUM RESEARCH.

“The number of over-80-year-olds in Austria is set to double over the next 20 years. The social and medical treatment – both in hospital and extramural – of this

growing demographic will depend to a significant extent on the solidarity of the younger working population, as well as the social conscience of future generations,” predicts Peter Mrak, Chairman of the Association for Quality in Geriatrics and Gerontology (QiGG).

The 2022 Acute Geriatrics Report aims to highlight the effectiveness of this form of treatment. Julian Gutheil, HEALTH project manager, explains: “The report reveals how successful this approach has been. The fact that 90% of all those treated are able to carry on living in their own homes represents an enormous win for patients and society alike.” The analysis is based on inpatient cases at the 14 participating Austrian acute geriatric clinics that were uploaded to the JOANNEUM RESEARCH benchmarking system. Operational since 2008, it was developed in co-operation with QiGG. Close to 6,000 cases were logged in 2022. ■

# Transformation, the environment and the circular economy



**Christian Holzer** is Head of the Environment and Circular Economy Department at the Austrian Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology

Achieving national and international climate goals, and hitting sustainability targets in line with the United Nations' Sustainable Development Goals will require a comprehensive energy transition, with renewable energy sources replacing fossil fuels (in tandem with a massive increase in energy efficiency). But achieving this also hinges on our ability to transform our management of material resources. Developed by the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology and passed by the Austrian Council of Ministers in December 2022, the national circular economy strategy includes specific guidelines for the measures to be introduced in priority areas. The federal government and all government ministries have made a commitment to implement these measures. As a result, Austria is one of the first EU members to have taken the necessary steps at the national level for implementation of the Circular Economy Action Plan for a clean and competitive Europe. Adopted by the European Commission in March 2020, this is one of the most important elements of the Green Deal.

The circular economy strategy envisages the remodelling of Austria's economy and society with a view to building a climate-neutral, sustainable circular economy by 2050. The strategy is centred on four measurable objectives:

- **Cutting domestic material consumption (DMC) by 14 tonnes per capita/year (2030) and reducing the material footprint (MF) to seven tonnes per capita/year (2050)**
- **Increasing resource productivity by 50% (2030)**
- **Increasing the circularity rate to 18% (2030)**
- **Reducing private households' material consumption by 10% (2030)**

When the circular economy strategy was drawn up, around 600 measures were devised in connection with the transformation focal points: electrical and electronic devices, information and communications technologies; the construction industry and infrastructure; waste and secondary resources; mobility; plastics and packaging; biomass; and the textile industry. Specific plans have been set out along the entire value chain for each of these focal points – from product design through to use and ultimately waste management. Implementation of these measures is intended to ensure that materials are deployed in a more targeted fashion, used for longer, and reused or recycled as materials while at the same time preserving their properties. Other essential developments include extending the useful lives of products, making them more repairable, and devising business models based on services as opposed to products.



The vision is to remodel Austria's economy and society with a view to building a climate-neutral, sustainable circular economy by 2050.





Text: Elke Zenz

# ZUKUNFTS KONFERENZ

# 2023

Making it all come together: persistence, enthusiasm, flexibility, team spirit and dedication

What will it take to achieve the twin transition? A shared vision, conviction and openness

JR Managing Director Heinz Mayer sums up the topic and the event: "Digitalisation has a key role to play in our health and care, mobility, politics and society, production and manufacturing, security and defence, environment and sustainability, and space business areas. It is the driving force behind lasting ecological effects in many areas. At the end of the day, the green transformation cannot take place without support from digital technologies."



# GREEN AND DIGITAL

Expertise and innovation – the keys to success

Digital technologies enable us to reimagine long-established methods and processes, enhance our innovative capabilities and develop environmentally friendlier alternatives. Taking this as their point of departure, around 700 researchers converged on Messe Congress Graz for JOANNEUM RESEARCH's Future Conference and Exhibition on 15 November 2023.



# TRANSFORMATION

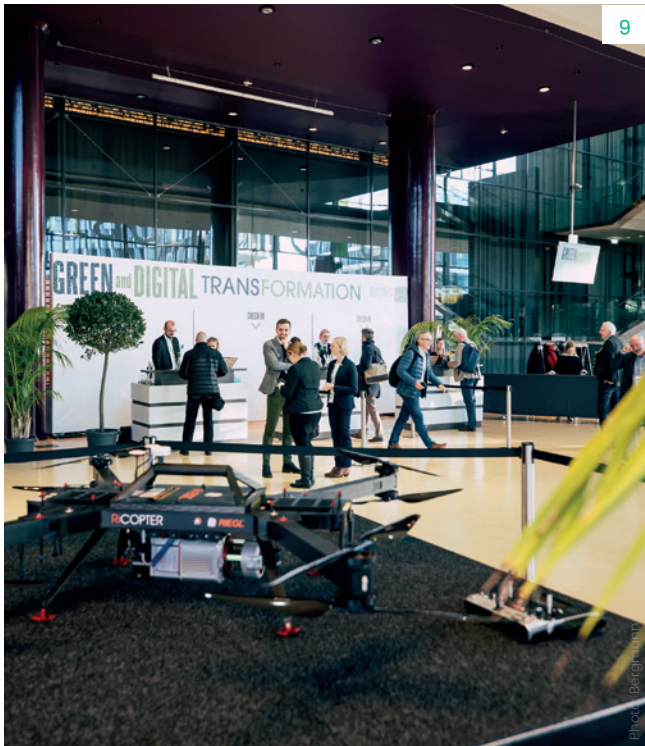






## Network Inspiration Know-how

- 1 In-person exchange at the exhibition staged by the JR research units
- 2 Left to right: Michael Gerbavits (Managing Director of the Burgenland Business Agency), City Councillor Günter Riegler, Provincial Councillor Barbara Eibinger-Miedl, Provincial Assembly Member Veronika Nitsch, Innovation and Energy Spokesperson Lara Köck (both Green Party) and JR Managing Director Heinz Mayer
- 3 Jacqueline Erhart (ASFINAG) gave a compelling keynote on digitalisation in our road network.
- 4 In his keynote speech, Karl Rose painted a realistic picture of the need for a successful energy transition.
- 5 Visitors to the SINNVOLL stand had the chance to find out about employment opportunities at JOANNEUM RESEARCH.



## Top performance Sustainability Transformation

- 6 The JR research units showcased projects featuring a range of digital and green approaches.
- 7 The best projects and project leads were selected in a two-stage voting process. The award ceremony played out during the conference.
- 8 Around 700 people came to find out more about JOANNEUM RESEARCH's innovative capabilities for themselves.
- 9 The company's cooperation partners and experts from the Digital Twin Lab showcased their activities in the foyer.
- 10 The awards were designed by Weitzer Woodsolutions GmbH.





## Targeted data analysis helps deliver **cost savings** for **e-charging station users**



www.dih-sued.at

**A familiar picture: your e-vehicle only has enough battery capacity to get you half way to your holiday destination. Impatient to get to the seaside, you don't want to waste too much time top-ping up. Rapid charging points are the answer! The collaboration between e-charging station operator Kreisler GmbH and JOANNEUM RESEARCH as part of a DIH-Süd project has opened up new insights and set the signal for the development of new methods.**

**Text: DIH Süd**

Kreisler GmbH embarked upon its journey in 2016 when it established itself as a regional food distribution automation pioneer. The turning point came in 2023, when the company decided to call a halt to its regional food project and shift its focus to the energy sector instead. A strategic decision that would open new doors, particularly once their attention was drawn to the activities of Digital Innovation Hub Süd. At JOANNEUM RESEARCH's recommendation, the company participated in a workshop on data analysis, which laid the foundation for its next venture.

Liaising with JOANNEUM RESEARCH and taking part in DIH-Süd's programme gave Kreisler GmbH valuable impetus for its projects going forward. Subsequently, the focus shifted to ways of optimising charging parks in the electromobility sector, an area in which the expertise of JOANNEUM RESEARCH, in particular Hermann Katz, played a decisive role.

The company is implementing predictive analytics, a method which draws on historical data to predict

future events. This approach enabled the company to create room for manoeuvre within clearly defined parameters. Besides helping to optimise ongoing operational processes, the method also allows it to respond proactively to future challenges. Analysing this data in detail will put Kreisler in a position to develop effective procedures for obtaining electricity from different sources efficiently ahead of ensuring its optimal distribution. Strategic diversification of electricity procurement approaches delivers considerable cost savings and enables the company to utilise the energy it has extremely cost-efficiently.

The decision to partner with JOANNEUM RESEARCH for its e-vehicle charging park optimisation project turned out to be a smart move strategically. Hermann Katz provided cutting-edge specialist insights and specific expertise which allowed the very latest findings and methods to be integrated into the project. Cooperating with DIH Süd also put Kreisler in touch with other companies and experts, which, in turn, opened the door to



**Aboard the train of success, the right partners set the signals and flexibility drives everything forward.**



**Andreas Höcher**  
Managing Director, Kreisler GmbH

new networks and fresh sources of inspiration.

Overall, this particular success story clearly demonstrates how flexibility, strategic decision-making and the right partnerships can help to successfully position a company in a constantly changing market. ■

## The AI Act at a glance – an imperative for AI competence



**Jeannette Gorzala** is a lawyer in Vienna specialising in AI, founder of an AI and data literacy platform, public speaker and author of numerous specialist publications.

Three years have passed since the initial draft of a new EU law on artificial intelligence – widely known as the Artificial Intelligence (AI) Act – was published in 2021. Following adoption of a resolution by the European Parliament on 13 March 2024, the AI Act is now expected to be passed by the European Council in May this year before coming into effect this summer. The new regulations will be gradually introduced before becoming fully applicable by 2027. While the underlying legislative process will be concluded in the foreseeable future, AI has already established itself as a key technology, mainly thanks to breathtaking advances in generative AI.

In summary, the AI Act will (i) prohibit certain AI practices (including social scoring and emotion recognition in the workplace), (ii) introduce wide-ranging compliance requirements for AI systems in high-risk areas (e.g. critical infrastructure, HR management, insurance, credit score evaluation, training and development, and medical products), and (iii) require marking of AI-generated output in certain cases. The Act deals with general-purpose AI models (GPAIMs), which are also known as large language models (LLMs), generative AI and foundation or frontier models. Here, the requirements mainly concern documentation. The legislation also sets out additional risk mitigation, reporting and cybersecurity obliga-

tions for particularly powerful GPAIMs that pose systemic risks (models that require training of more than 1025 FLOPS). Regulations regarding prohibited systems will become applicable six months after the Act comes into force, and the GPAIM obligations after 12 months. Introduction of the requirements for high-risk AI systems will be staggered and take effect 24 months (Annex III) and 36 months (Annex II) after the Act enters into force. However, the AI Act is more than just a set of regulations – it also outlines



**The requirements of the AI Act aren't a one-way street – they apply to both AI system developers as well as companies that use the systems for professional purposes.**



innovative measures including AI real labs, where providers can carry out supervised testing of their AI systems under real-world conditions before they are deployed. AI systems that are used solely for research and development are exempt from the Act. If a provider is planning to commercialise their system further down the line, it is definitely recommendable to take the AI Act into account from the outset, in order to avoid regulatory

stumbling blocks later on.

The requirements of the AI Act aren't a one-way street – they apply to both AI system developers as well as companies that use the systems for professional purposes. The AI Act will have a far-reaching impact on system design, implementation, IT architecture and governance, so examining the legislation should be the number one priority on the timeline. Aimed at building up an overview of the current situation, an AI Act impact assessment is a potential starting point.

Right now, and in parallel with the entry into force of the AI Act, it is important that everyone who works with or uses AI at companies or for research purposes takes part in the AI transformation process, in order to implement successful change management through training and workshops and build up the relevant know-how. AI competence is one of the most important steps in successful transformation processes – it is also a core requirement of the AI Act for all developers and professional users of AI systems, and one which is overlooked from time to time. In many cases, transformation processes are launched but never completed. Let's move past the initiation stage and start implementing effective AI governance together – so that we can use AI for everyone's benefit.



# GreenSki: Innovative snow depth measurement for ski resorts



Photo: Kreischberg



Left to right: project team members Roman Lesjak, Julia I. M. Hauser, Manuela Hirschmugl

**As part of the joint GreenSki research project conducted by JOANNEUM RESEARCH in partnership with SkiBro and derstatistiker, numerous skiers collected statistical data to help improve and enhance the energy efficiency of artificial snow production on the slopes of the Kreischberg hill.**

The goal of the GreenSki project is to develop an efficient and cost-effective method for measuring the depth of snow in ski resorts. Intended to provide high coverage in terms of area as well as daily updates, the method will ensure artificial snow production is aligned with reliable forecasts. The aims are threefold: to minimise costs, cut consumption of resources and reduce CO<sub>2</sub> emissions in ski resorts. Adopting the method represents an opportunity for the approximately 70% of ski resorts that use snowmaking to play a meaningful role in the green transformation.

Project manager Roman Lesjak, Julia I. M. Hauser and other DIGITAL researchers are currently working on algorithms that will process crowdsourced location data from skiers' smartphones and satellite radar data (Sentinel-1A and ICEYE) to determine snow depth. The first phase of data collection centred on the Kreischberg ski region. "The aim is to establish a snow management platform that provides 3D snow depth models with a height resolution of ten centimetres and a time resolution of four to eight hours," explains Roman

Lesjak. Data collected via the app is supplemented by drone images and mobile laser scan data harvested using a rucksack system. Manuela Hirschmugl, remote sensing expert at DIGITAL, adds: "The satellites orbiting the earth at an altitude of 500 to 700 kilometres beam signals to the Earth and measure the resulting backscatter. In tandem with information on the exact position of the satellite, this signal can be used to determine the height of the observed object – or, in this instance, snow cover thickness. And we hope that combining the app data with the satellite data will improve accuracy."

Next, the results are validated by highly accurate measurements using drone data. In practice, this approach would be too expensive for daily use and the drones could not be flown above the piste when people are on it. In conclusion, the evaluations will reveal whether it is possible to achieve the degree of accuracy needed and whether we will all be in a position to contribute to a more eco-friendly skiing experience going forward, simply by using our mobile phones. ■





# How a polymer converts energy and makes bicycle tyres smart

What if you could simply glance at your mobile phone or bike computer and get up-to-date information on your bike's tyre pressure right away? Sounds like a dream. But it isn't – thanks to the EU's SYMPHONY project, which JOANNEUM RESEARCH is coordinating. And it's important for a number of reasons, including e-bike energy efficiency as well as safety for people out mountain biking.

Photo: iStock

Already a standard feature in cars for some time now, automated tyre pressure monitoring would also deliver all kinds of benefits for cyclists. This is because tyre pressure has a direct effect on rolling resistance, ride comfort, grip, puncture protection and, as a result, safety. Take e-bikes (3–8 bar), for example, where rolling resistance has an influence on battery runtime. Rolling resistance is a decisive factor in triathlons (8 bar) and in mountain biking (1.5–2 bar), while tyre pressure also has a significant influence on grip. Whatever the activity, regular pressure checks are advisable. But how can we generate the power required to transmit the data from inside the inner tube? This is the focus of the EU's SYMPHONY project, which aims to generate cost-effective, eco-friendly energy without a cable connection or battery.

## Energy harvesting: converting kinetic energy into electricity

"The deformation of the tube while cycling is converted into energy, which is used to transmit sensor data. In other words, kinetic energy is converted into electrical

energy," says project coordinator Jonas Groten from the MATERIALS Institute. "This calls for a material with electromechanical properties to act as a converter." In the past, lead compounds – which are toxic – were often used for this purpose. And this is where the MATERIALS Institute comes in: researchers there have been working with the piezoelectric polymer PVDF for more than 10 years. It has several advantages – it is non-toxic, cost-effective, and large-scale surface printing is also possible. Under certain conditions, the polymer forms a structure in which the smallest molecular dipoles add up over a large area. This is known as remanent polarisation. If the polymer is deformed, the polarisation changes, as does the number of electrical charges in the electrodes applied to the polymer. If these electrodes are connected, any mechanical deformation generates electricity. In collaboration with Viennese inner tube manufacturer Tubolito and semiconductor producer Infineon, the system was put through its paces in a mechanical stress test equivalent to a 5,000km ride.

## Wide range of possible applications

But the technology doesn't only create smart inner tubes. It can be deployed wherever sensors generate data and in situations where a self-sufficient energy system is useful – if cabling is out of the question, and a battery or photovoltaic system isn't practicable, for example in house walls, vehicle bodywork, in floors and toys, and in agriculture. SYMPHONY is also examining two other potential applications for this energy-transforming polymer: condition monitoring in wind turbines, and energy-efficient room heating and cooling in smart homes.

The EU's SYMPHONY (Smart Hybrid Multimodal Printed Harvesting of Energy) project was launched in 2020 and will be concluded in April 2024. ■

Project partners: JOANNEUM RESEARCH MATERIALS, Würth Elektronik eiSos GmbH & Co. KG, Semperit Technische Produkte GmbH, Fraunhofer Institute for Silicate Research (ISC), Tubolito GmbH, Polymer Competence Center Leoben GmbH, Research Institute of Sweden (RI.SE), Messfeld GmbH, Infineon Technologies Austria GmbH, Linköping University, Eoligix Sensor Technology GmbH, Arkema France SA, InnovationLab GmbH



**Jonas Groten** is a Senior Researcher in the MATERIALS research group Hybrid Electronics and Structuring.





Free and independent?

# Energy communities

Over the last few years, a sense of unease at the thought of being tied to major energy suppliers has crept into the minds of many citizens. Without a doubt, the war in Ukraine and public debate about gas supplies has driven the trend towards choosing an independent path when it comes to energy resources.

Energy communities are a core element behind moves towards low-emission energy generation at all levels. They reduce dependence on fossil fuels and speed up the transition towards a decentralised, renewable-based energy system. But what are energy communities exactly? The idea is that citizens team up and jointly produce, share, consume and trade renewable energy with one another. Rather than making a profit, the aim is to secure independent supplies of renewable energy.

For several years now, experts at JOANNEUM RESEARCH's Institute for Climate, Energy Systems and Society – or LIFE – have been working on ways to support the development of energy communities and improve the frameworks they work under. As part of the International Climate Policy and Economics research group, they primarily focus on legal and economic frameworks, while members of the Climate-Neutral Energy Systems and Lifestyles group analyse the social conditions that are necessary to make energy communities a success.

Adopted in 2019, the European Union's Clean Energy for all Europeans Package laid the foundations for



Camilla Neumann and Michael Brenner-Fliesser, two energy experts from the LIFE Institute, are supporting numerous projects in this particular field.

participation in energy communities in the highly regulated energy market. It distinguishes between renewable energy communities, which are only concerned with renewable electricity and heat, and citizen energy communities that focus solely on electricity. But general EU regulations have been integrated into national legislation in various different forms. Taking Austria as an example, participants in a given renewable energy community must all be based within the supply area of a particular transformer substation – something which does not apply to citizen energy communities. The outcome is that only renewable energy communities benefit from lower system charges.

One element that both forms have in common is that their structures must be as democratic and non-profit-oriented as possible. A jointly used photovoltaic (PV) system is a classic example. The participants form a community, which operates like an Austrian 'Verein' or association, and define the conditions for joint electricity production and consumption.

Michael Brenner-Fliesser is one of JOANNEUM RESEARCH's energy community experts: "There are now more than 300 registered energy communities in Austria, and many are in the process of being set up. As hinted at by the complexities involved in implementing the EU directives, bureaucratic uncertainties represent a particularly hard obstacle to overcome for energy community founders, alongside the financial hurdles. Several of our projects, which we run in cooperation with international research partners, are examining ways to reduce these and other obstacles, as well as

identifying support measures that maximise the benefits for energy communities."

In one of these projects, called ENCLUDE, Brenner-Fliesser and his team are collaborating with over 70 energy communities across Europe. They are mainly using various social sciences survey methods, including member questionnaires and in-depth interviews, to build up a more detailed picture of the communities themselves. "One of the most interesting points is that the bureaucratic and financial hurdles I mentioned play a particularly important role at the start of the process, but later on the focus is more on the community members. In particular, increasing passivity among members is a problem that is frequently observed. To help find out why, we've also analysed the reasons that lead people to join an energy community in the first place. Interestingly, saving money often turns out not to be such an important factor. In many cases, people are just as likely to mention increased independence, the chance to lead a more sustainable life and the enjoyment of implementing a project with others," Brenner-Fliesser explains.

The European Union is currently aiming to broaden the energy community concept. As part of two research projects commissioned directly by the EU, LIFE experts

are investigating the extent to which energy communities can provide support for citizens when it comes to renovating their homes and making them more energy efficient.

"The expertise we are building up through these projects will help us to advise energy communities. Especially during the start-up process, people who want to set up a community need support to make sure that the organisation is resilient from day one and in the long run," Brenner-Fliesser adds. With this in mind, and with an eye to ensuring a practical approach, the EEG Mörtschach\* renewable energy community research project – headed by Camilla Neumann – is looking at the steps that need to be taken to set up such a community in a municipality, as well as the data that are required and how to obtain them. "We used simulations to examine whether this type of energy community makes sense from a financial point of view and what effect additional participants have. We're currently in the process of sharing our findings with other local authorities in Carinthia," Neumann says. ■

\*The project is managed by JOANNEUM RESEARCH in cooperation with DIH Süd and Montanuniversität Leoben, and with the support of the Oberes Mölltal climate and energy model region.

## Schiene Forum II INFRASTRUCTURE

**How can rural areas be linked to urban centres? And how can this be done in the most sustainable and environmentally-friendly way possible? The answer: railways. It's one of the most important means of transport for both people and goods. And public railways are playing an increasingly important role as a low-emission mode of transportation. Public transport is going through a renaissance at the moment – which is good news, but also calls for investment in infrastructure. This was the focus of the second Schiene Forum discussion event organised by JOANNEUM RESEARCH.**

Andreas Solymos is a transport expert, Head of Planning Management and Infrastructure at Holding Graz, and Managing Director at Moderne Urbane Mobilität (MUM). His mission centres on continuously enhancing the attractiveness of public transport in Graz. At the forum, Solymos presented a transportation project designed to reduce the burden on Graz city centre, which covers everything from tree protection and archaeological artefacts to rail construction and pipeline infrastructure, as well as communications and compensation for local residents. Gernot Winter, Head of Infrastructure at bus and



From left to right: JR Managing Director Heinz Mayer, DIGITAL Director Matthias Rüther, Philipp Sandheigl of NEXTSENSE, Eric Kirschner, Gernot Winter (GKB) and Andreas Solymos (Holding Graz)

rail operator Graz-Köflacher Bahn und Busbetrieb GmbH (GKB), talked about the challenges involved in making rail transport more attractive in rural regions, and creating effective links to cities as a result. Eric Kirschner from the POLICIES Institute reported on the regional impact of the Koralmbahn railway, while Philipp Sandheigl of NEXTSENSE GmbH spoke about the latest developments on the wheel set maintenance market. The event was hosted by DIGITAL Director Matthias Rüther.



## THE NEUROBIOLOGY BEHIND “RUNNER’S HIGH”

The runner’s high describes the deeply euphoric and anxiety-reducing state that people experience during and shortly after running. Although the underlying neurobiological mechanisms are not fully understood, the assumption is that endocannabinoids have an important role to play in this mood-enhancing phenomenon. Endocannabinoids are cannabis-like biochemical substances that the body produces itself. During the course of her research commission, HEALTH’s Anita Eberl came across a highly-charged debate about which substances are actually responsible for the runner’s high. “It was widely believed that the release of endogenous opioids such as endorphins was responsible for triggering feelings of euphoria when running. But endorphins are not able to cross the blood-brain barrier. By contrast, highly lipophilic – fat-soluble – endocannabinoid molecules are able to cross the blood-brain barrier and subsequently bind to cannabinoid receptors in the brain. And that has an influence on mood,” she explains.



Photo: iStock

## Any questions?

If you are looking for a reliable partner for your research project or would like to find out more about our technologies, please contact our institutes directly:

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foster innovation, we always live up to the highest social and scientific standards. As a research institute backed by the public sector, JOANNEUM RESEARCH plays a key role in identifying and generating solutions for challenges facing society, including climate change, energy supply, digital transformation, mobility, civil and military security, and social change.

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