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activity

SPECIAL FEATURE
NUCLEAR POWER, THE
UNDERDOG OF EUROPE'S
ENERGY MIX

Editorial

Is there still a role for nuclear power, rediscovering a 170-year-old opera and launching graphene from the lab to the market –

welcome to this month's official Research*eu magazine

Way back in the 1950s and 1960s, nuclear power was considered the epiphany of technological progress in a future atomic age. It was the future, it was the apex of human technological development. Then the Cold War between the armed-to-the-teeth nuclear superpowers, the United States and the USSR, got hotter, then cooler, and then hotter again, before finally whimpering out of existence at the beginning of the 1990s. The whole of humanity was taken along for this wild nuclear-themed geopolitical ride for more than 40 years.

Then, on 26 April 1986, the Chernobyl disaster dealt a harsh blow to domestic nuclear power generation's reputation. As of 2016, 26 April is now annually observed as International Chernobyl Remembrance Day. In 2011, a devastating tsunami was then the catalyst of Japan's Fukushima nuclear disaster, with positive public opinion towards nuclear power again seeing a sharp tumble amongst Europeans.

But nuclear power isn't going away anytime soon and it's important to try to distinguish in our minds (even though that can be difficult sometimes due to the history) nuclear power used for war and nuclear power used for peaceful power generation. In this month's special feature, we focus on the latter and whether it has a future within the EU's increasingly diversified energy mix.

By talking to several EU-funded projects that have been hard at work on nuclear energy issues, we can see the argument that yes, if there is a high

emphasis on safety and positive international cooperation, nuclear does indeed still have a role to play in EU energy policies, especially given the fact that a quarter of the EU's electricity generation comes from nuclear power.

Elsewhere in this month's edition, we're wowed by the amazing story of how one ERC-funded researcher spent three years of his professional life piecing back together a 170-year-old opera by famed Hungarian composer, Franz Liszt, that was previously considered lost – go to our **Project of the Month** feature at the end of the 'Society' section to find out more!

Then, in **Life After**, we catch up with the GRAPHENESENS project that has been working with everyone's favourite new and revolutionary material, graphene. In this case, they pioneered graphene-coated sensors for the automotive industry, and as our catch-up article with them highlights, maybe more as well.

Finally, **EU Agenda** gives you the lowdown on EU-funded project events and relevant conferences and international days, and of course, our nine regular thematic sections will fill you in on all the latest goings-on, from health to fundamental research, climate change to the digital economy... to name but four.

If you have queries, questions, suggestions (but hopefully never a complaint), please feel free to drop us a line at editorial@cordis.europa.eu

Published on behalf of the European Commission by the Community Research and Development Information Service (CORDIS) at the Publications Office of the European Union
2, rue Mercier
2985 Luxembourg
LUXEMBOURG
cordis@publications.europa.eu

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ISSN 2599-7912 (printed version)
ISSN 2599-7920 (PDF)
Catalogue n° ZZ-AG-19-003-EN-C (printed version)
Catalogue n° ZZ-AG-19-003-EN-N (PDF)

Luxembourg: Publications Office of the European Union, 2019

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APRIL 2019



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Saving the sight of pre-term infants

Retinopathy of prematurity (ROP) is a major cause of blindness in young children. Although considered a rare disease, the incidence of ROP is increasing as developing countries provide more and better neonatal care, increasing the survival rate for pre-term children. One EU-funded project has been at the forefront of developing a potentially ground-breaking new treatment that could transform the lives of thousands of children.

Approximately 40% of perinatal blindness can be attributed to ROP, a potentially blinding eye disease that primarily affects premature infants weighing around 1 250 grams or less that are born before 31 weeks of gestation. In effect, the smaller the baby at birth, the more likely it is to develop ROP. The disorder usually affects both eyes and is one of the most common causes of visual loss in childhood, leading to lifelong vision impairment and blindness.

The treatment of ROP, specifically ablation of the avascular retina with laser photocoagulation, has remained fundamentally the same for almost 50 years. In addition, these treatments are also damaging – they destroy the peripheral (non-vascularised) parts of the retina and can lead to a partial loss of peripheral or side vision.

DEVELOPING THE DRUG

This is where the EU-funded PREVENTROP (New approach to treatment of the blinding disease Retinopathy of Prematurity (ROP)) project comes in. The overall aim of this project, consisting of 10 partners from five EU Member States, was to develop a novel preventative pharmaceutical intervention for ROP and other complications of prematurity, thus rendering the standard but destructive treatment of laser photocoagulation unnecessary.

“When pre-term children are deprived of their natural intrauterine environment, they lose important factors, normally found *in utero*, such as proteins, growth factors and cytokines. It has been demonstrated that the insulin-like growth factor I (IGF-I) is one such factor, but it is likely there are others,” explains project coordinator Prof. Ann Hellstrom.

“During foetal life, these elements are introduced through placental absorption or ingestion from amniotic fluid (AF). The deprivation of such factors is likely to cause inhibition or improper stimulation of important pathways, which may cause abnormal vascular growth in several organs, such as the lungs and brain – the hallmark of retinopathy of prematurity (ROP).”

For the PREVENTROP team, it was vital to understand which factors are lost with pre-term birth and then to evaluate their impact on the development of ROP. This would have much greater implications for the growth and development of other organ systems, such as the brain, lungs and gut. The team believed that replacing lost factors would likely improve the overall development in these organs, and this was what their proposed treatment was designed to do.

CAUTION REQUIRED

However, it wasn't easy going for the team, since they were working with an extremely vulnerable patient group. “This project definitely required extreme caution,” says Prof. Hellstrom. “A large multicentre trial in a very delicate intensive setting, like neonatal care, is a difficult clinical path to travel and required participants from academia

“ *In this project, we have been very lucky to have worked with highly scientific industry partners, which has enabled us to develop a drug that can possibly improve the outcome for this vulnerable group of pre-term infants.* ”



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and industry who are generous and understand each other's driving force and aims in participating in such a project. In this project, we have been very lucky to have worked with highly scientific industry partners, which has enabled us to develop a drug that can possibly improve the outcome for this vulnerable group of pre-term infants."

Moving forward, a Phase II trial is due to begin in Q1 2019, and the project's academic partners are planning a new neonatal trial aiming to improve outcomes for pre-term infants. "Overall, I'm extremely proud to have been the coordinator of a project that has seen high-quality

collaboration between academia, SMEs and 'Big Pharma' in both Europe and the United States, and now we are ready and able to conduct high-quality neonatal trials," Prof. Hellstrom concludes.

PREVENTROP

- Coordinated by Gothenburg University in Sweden.
- Funded under FP7-HEALTH.
- cordis.europa.eu/project/id/305485
- Project website: preventrop.gu.se

HEALTH

Customised minimally invasive medical devices

Minimally invasive surgery has transformed modern medicine. With the EU-funded project OPENMIND, physicians will be able to customise surgical instruments to their specific preferences as well as their patients' needs.

Easy and reliable navigation of instruments is key for successful minimally invasive surgery. Currently, surgeons have to

choose from a predefined limited spectrum of devices available from medical device manufacturers.



CUSTOMISATION OF A DISRUPTIVE INNOVATION

The OPENMIND (On-demand production of entirely customised minimally invasive medical devices) project approach involves the development of a highly flexible process chain for the on-demand production of entirely customised minimally invasive medical devices. This goal comes with a technological and economical breakthrough for medical device manufacturing companies. “Development of this innovative production system enables continuous and cost-efficient production with lot sizes down to an individual product,” explains Jonathan von Helden, researcher at Fraunhofer IPT the project coordinator.

The researchers linked together various software, hardware and metrology modules in a continuous and adaptive production system. “At the same time, a technology readiness level of TRL6 was reached for the overall process chain – a great achievement for OPENMIND,” notes von Helden.

In the context of customisation, online monitoring tools such as a database, a process model and predictive algorithms are of particular importance. Not only do they

“*Development of this innovative production system enables continuous and cost-efficient production with lot sizes down to an individual product.*”

ensure a high product quality, they also provide and predict the parameter sets for the production of individualised guidewires.

SYNCHRONISATION

During the final implementation and commissioning phase, synchronisation of different production systems developed at the laboratories of each individual partner turned out to be the key challenge. As joint project leader Jonas Dorissen explains: “Many of those systems represent special purpose machinery. Very rudimentary parameters like the process speed or material conveying speed needed to be harmonised to ensure continuous production.” Close cooperation of all project participants was the solution and permanent controlling was carried out.

FUTURE COMMERCIALISATION

Aided by EU funding, TRL6 was successfully achieved – i.e. prototype manufacture in an operational environment. Other individual TRLs have also been clocked up. “The pullwinding process including new developed online process monitoring has a technical readiness of TRL7 and can be transferred to TRL9 in due course after the project with some industrialisation effort,” explains von Helden.

An industrial application for individualised guidewires seems feasible with OPENMIND technology if some technological challenges, such as laser structuring of micro-profiles, are overcome. The consortium partner Nano4Imaging, as a potential end user of the project’s outcome, will work on developing the market interest by promoting the new technology. Some partners will keep on working to improve their respective modules, possibly by means of a future follow-up project.

FIBRE-REINFORCED PLASTICS AND MRI-GUIDED SURGERY

Development of new compatible devices and advancements in MRI technology will be the next revolution in the field of minimally invasive surgery. This is set to lead to development of completely new procedures grouped under the term interventional MRI, or iMRI.

So far, the micro pullwinding technology developed at Fraunhofer IPT has been used to manufacture multifunctional puncture needles, different types of guidewires and catheters, as well as aneurysm clips. As von Helden emphasises: “The particular characteristics all these minimally invasive medical devices have in common are the use of fibre-reinforced plastics without any macroscopic metallic components. These devices therefore have great applicability for MRI-guided surgeries.”

OPENMIND

- Coordinated by Fraunhofer EMFT in Germany.
- Funded under H2020-LEIT-ADVMANU.
- cordis.europa.eu/project/id/680820
- Project website: openmind-project.eu
- ▶ bit.ly/2tbBYqT

HEALTH

Sensor-based socket design tool improves lower limb prosthesis fit

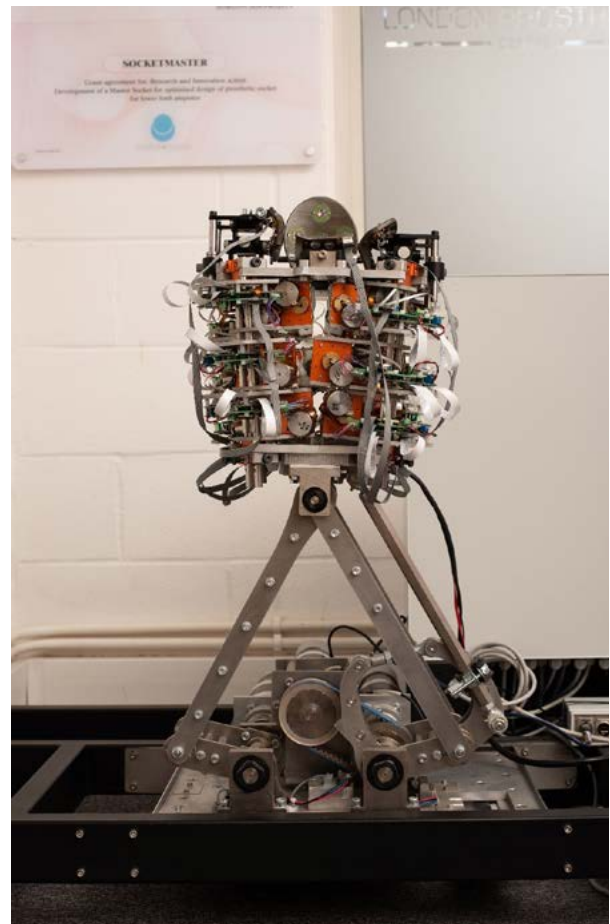
To avoid the trauma of a badly fitting prosthetic device, EU researchers developed a ground-breaking mechatronic system to optimise socket design for lower limb prostheses.

Unique to every individual, the anatomical profile of the residual limb sets the scene for the function of a lower limb prosthesis. Normally, this is a highly subjective and time-consuming process. A feel-and-touch approach is required during adjustment on the amputee where success depends on the ability of the prosthetist.

RAPID, TAILOR-MADE SOCKET IN LEAPS AND BOUNDS

The EU-funded SocketMaster (Development of a Master Socket for optimised design of prosthetic socket for lower limb amputees) project first developed microsensors for measuring pressure friction and temperature at the interface between the residual limb and the socket in both static and dynamic situations.

“ Digital 3D data allows manufacture by a rapid prototyping machine for fast fabrication, each for a specific patient. ”



© Jianxin Gao

Dedicated data acquisition firmware manages the sensors with data communication established between different modules. Included is a mainframe for hosting the residual limb and the loading apparatus to support the patient's weight. The team incorporated adjustability and an associated procedure for donning and doffing for patients.

"During simulated walking tests, the pressure, friction and loading information is processed for optimised socket design," explains Dr Jianxin Gao from TWI Ltd, the project coordinator. He continues: "The design process can be completed within two hours after activity tests, and the resultant digital 3D data allows manufacture by a rapid prototyping machine for fast fabrication, each for a specific patient." There is also a user-friendly interface for navigating the system and managing the collected database.

TRIALS AND TRIBULATIONS DURING DEVELOPMENT

The SocketMaster system was tested on six above-the-knee amputees. Patients participating in the clinical trials reported that the system is safe and easy to use, without fatigue, and the feeling of the pads on the leg were not unpleasant.

"During testing and evaluation stages, the sensor pad's adjustability to cope with different stumps had a relatively small range while some sensor pads tended to collide with each other," outlines Dr Gao. "Moreover, the loading apparatus showed unexpected tilting movements, and the communication between different modules was lost because of damaged cables." Malfunctions were fixed by tightening the screws and testing the system only in the standing position as well as replacing the broken components. "However, the time lost prevented us testing the system on more patients within this project," notes Dr Gao.

TOWARDS COMMERCIALISATION AND THE FUTURE FOR SOCKETMASTER

The team submitted a comprehensive business plan for a two-year fast track to innovation (FTI) proposal for SocketMaster-2 starting in 2019. If successful, the consortium will pursue commercial development of the technique so that, after two years, a joint venture company will be set up to take it to market. Keen interest in the technology has also been expressed by representatives from the National Health System and the armed forces in England.

In the absence of an FTI project, relevant partners will invest their own resources to carry out system improvement and further clinical trials. "With additional clinical trial results, we will be in a better position to approach venture capital entities to seek further investment," Dr Gao points out.

"Although the system is still far from commercialisation, SocketMaster demonstrated the feasibility of designing a socket within a few hours by taking into account the different load bearing capacities of different segments of the residual limb at least in a standing position," sums up Dr Gao. Details of the project work can be seen in the project video.

SOCKETMASTER

- Coordinated by TWI Limited in the United Kingdom.
- Funded under H2020-LEIT-ICT.
- cordis.europa.eu/project/id/645239
- Project website: socketmaster.eu
- ▶ bit.ly/2BolwYY

The role of law, economic narratives, and Europe's social crisis

Law is not merely a tool for resolving disputes and protecting some people's human rights; it is a mediator and an enabler. The researcher explored the workings of legal rights in the political economy of austerity through studies on odious debt and social rights against the backdrop of the Greek austerity crisis.

The EU-funded JUSECON (Legal rights and the political economy of debt and austerity in Europe) project, with a Marie Skłodowska-Curie Individual Fellowship grant, has determined the influence of the European political economy on the principles and practices of legal rights. As Prof. Margot Salomon, the project coordinator, explains: "The term legal rights includes human rights as well as the international rights of states and these underpin the two component parts of this study, state debt and social rights."

THE DOCTRINE OF 'ODIOUS DEBT'

Inspired by the idea of economic self-determination, sovereignty and democratic governance, part of the research considered the animating principles behind the concept of odious debt. This work explored the faults in the political

economy of debt and austerity in Europe today, and particularly the role of international creditors in undermining democracy and its implications.

"The sanctity of democratic governance and the related principles that animate the doctrine of odious debt are important for our understanding of what is wrong with sovereign debt today," points out Prof. Salomon. Applied in the context of the recent Greek debt and human rights crisis, the research shows how the concept of odious debt is applicable to debt incurred not only by dictators but also by democracies where international creditors are implicated in 'hostile' acts against the *demos*, or people.



A joint paper with Professor Robert Howse on the topic is just out with the Oxford University Press in a volume on Sovereign Debt and Human Rights, Ilias Bantekas and Cephas Lumina (eds). The paper concludes with suggestions on the remediation of odious debt today.

WELFARE POLICY AND CRISIS

Dr Salomon's research efforts also looked at social rights and, specifically, how welfare policy in a crisis becomes an indispensable aspect of sustaining capitalist exploitation and dispossession. Moreover, she examined how international human rights law in the area of socioeconomic rights aids this enterprise. This study will be out in 2019.

The work reflects new modes of inquiry when thinking about social rights, applied to the recent events in Greece and Europe. This approach was critical to exploring contemporary theoretical and practical problems that are implicated in the quest for justice in Europe.

As part of JUSECON, Dr Salomon along with Professor Bruno de Witte organised a workshop on 'Legal Trajectories of Neoliberalism: Critical Inquiries on Law in Europe'. The workshop drew together academics to consider the impact of neoliberalism as ideology and practice at multiple sites of legal governance. A working paper on the findings of the workshop will be released in the coming weeks.

“ *The sanctity of democratic governance and the related principles that animate the doctrine of odious debt are important for our understanding of what is wrong with sovereign debt today.* ”

Prof. Salomon summarises the significance of the JUSECON study: “This is a multidisciplinary study that explores the role of law as a means of advancing the cause of justice, while recognising that it is shaped in important ways by dominant economic narratives. This study is an exploration of that clash of narratives and its effects on justice in Europe.”

Dr Salomon, from the Law Department at the London School of Economics and Political Science, was hosted by the Robert Schuman Centre for Advanced Studies of the European University Institute for the duration of the research project.

JUSECON

- Coordinated by the European University Institute in Italy.
- Funded under H2020-MSCA-IF.
- cordis.europa.eu/project/id/703063

SOCIETY

A Ukrainian outlook on Western and Russian narratives

Crimea's annexation in 2014 was a turning point in post-Cold War geopolitics. It demonstrates the importance of investigating the impact of antagonistic narratives in post-Cold War geopolitics, which were at the heart of the STRATNARRA project.

Such investigation is very important for both researchers and policy-makers. It can help in understanding the extent and limit of each camp's ability to influence public opinion; it contributes to understanding how states actually exert influence by using the media; and it generates insights that

might help various actors in engaging and communicating more effectively with Ukraine and its citizens.

“Right now there is much talk about the ‘power’ of propaganda or disinformation, but we must look carefully to find

any effects and generate valuable insights. Only then can we effectively inform and guide policy intervention,” says Ben O’Loughlin, Professor of International Relations at the University of London and coordinator of the STRATNARRA (Russia’s strategic narrative of the West: A study of influence in Ukraine) project.

The project specifically focused on the Odessa region, because of its economic and strategic importance and the very strong polarisation of views about Russia and the West held by people in the region. Prof. O’Loughlin and Dr Joanna Szostek from the University of Glasgow collaborated with an experienced Ukrainian research company (TNS-Ukraine), conducted in-depth qualitative research on a purposive sample of Odessa residents, and made use of existing survey datasets representative of the whole Ukrainian population.

The research led to many important results. One of these indicates that Ukrainians tend to choose their favourite news sources based on convenience rather than journalistic quality. This suggests that greater support for media literacy education would be beneficial, and that accessibility and scheduling should receive more attention in projects aiming to increase the consumption of good-quality journalism.

Another key finding was how very few participants supporting the Russian narrative are trapped in ‘echo chambers’. They tend to get news from both pro-Russia and pro-Kiev sources but don’t really trust either.

Participants were also found to interpret conflicting narratives in the news through the lens of their own personal experiences, priorities and trusted acquaintances. “This

suggests that narratives are credible when they resonate with the experiences and priorities of the receiving audience and shows how important it is to conduct research that enhances our understanding of the experiences and priorities of people in Ukraine,” Prof. O’Loughlin points out.

“ *Parallels could perhaps be drawn with other situations – for example, Brexit supporters may not pay attention to economic warnings about Brexit because for them, economic growth is less important than issues such as sovereignty and stable communities.* ”

Rather than assuming that these people are ‘brainwashed’ or ignorant, Dr Szostek says it’s important to listen to them and find out why they feel alienated by narratives endorsed by the political or journalistic elite.

Some participants, for instance, objected to the Ukrainian government’s negative rhetoric about Russia, because they viewed it as ‘blame-shifting’. These participants did not necessarily challenge the factual accuracy of the Ukrainian government’s narrative. Instead, they felt it was emphasising the wrong problems. “Parallels could perhaps be drawn to other situations – for example, Brexit supporters may not pay attention to economic warnings about Brexit because for them, economic growth is less important than issues such as sovereignty and stable communities,” Dr Szostek explains.

The research project generated a large amount of data, which Dr Szostek will continue to analyse and bring together for publication. She will then investigate whether civic and media literacy education can help to bridge divides and reduce tensions between supporters of different narratives in Ukraine, while Prof. O’Loughlin has already started working on a new Jean Monnet-funded project comparing EU/Russia narratives held by young elites in Ukraine, Estonia, Latvia and Lithuania.

STRATNARRA

- Coordinated by Royal Holloway and Bedford New College in the United Kingdom.
- Funded under H2020-MSCA-IF.
- cordis.europa.eu/project/id/654020



Housing crisis impacts art practice and production

Europe has been increasingly burdened by an ongoing housing crisis. EU research reveals how the issue has strongly affected artists and impacted their art production.

The HOUSREG (Social Art as a Tool for Empowerment: Housing Deprivation and Citizen Initiatives for Change) project “questioned the role of socially engaged art within the framework of housing crises in Europe,” notes project coordinator Dr Elena Marchevska. The work focused on Belgrade in Serbia and London in the United Kingdom.

Dr Ana Vilenica, a Marie Skłodowska-Curie fellow funded under this grant, carried out a one-year in-depth study of property guardian schemes for artists in London. Dr Vilenica elaborates: “Artists sign up to be guardians for a vacant property, and at the same time are requested to create a participatory artistic work that is supposed to benefit the community.”

While this provision of living/working accommodation enables artists to rent at lower-than-market prices, this

situation is a good example of housing precarity. The set-up comes at another price: the artists are deprived of tenants’ rights. HOUSREG argues that property guardianship presents deep discomfort and frustration for these individuals. “Artists are torn between the necessity of surviving within an unaffordable housing market and the wish to make art in an uncompromised way,” Dr Vilenica states.

MAPPING ARTISTS AND THEIR RELATIONS

During the fieldwork, the fellow developed a research method based on mapping the actors and their relations through hand-drawn relational maps. To validate this new theoretical approach, Dr Vilenica conducted comparative case studies in the United Kingdom and Serbia. These focused on best practices of culture-led housing

Fish is traditionally eaten on Fridays in many countries but in the modern world, there are no limitations on when you can indulge in your favourite **SEAFOOD**. Indeed, Europe’s marine and freshwater seafood will play a key role in ensuring food and nutrition security (FNS).

In our latest **CORDIS Results Pack**, we deliver up a tasty platter of EU-funded research treats, in the form of 13 projects that highlight how our marine and freshwater ecosystems contribute to food safety and healthy and sustainable nutrition in the EU (and globally). These projects are also helping to boost consumer confidence in European seafood and related products.

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© Elena Marchevska

regenerations: Balfour Tower in London, and Sava Mala neighbourhood in Belgrade.

“The results show significant differences on the meta level, especially regarding the involvement of art in housing regeneration,” she says. On the mezzo level, both studies revealed “an aggressive and imposing new narrative led by the state and private property developers.” Finally, on a micro level, the work identified in both cases conflicts between art practitioners and tenants.

IMPACT OF HOUSING PRECARIETY ON ARTWORK

Research conducted over the 2-year project established that artists have experienced increased housing precarity. At the same time, their art practice has been functionalised within the process of welfare degradation and privatisation of housing.

Some of the most significant findings were based around complex networks formed of multiple actors. These include the European Union, council authorities, activists’ groups, residents and artists. At the same time, “HOUSREG gained new knowledge on how the relationships between these actors influence the outcome of the artwork, and what kind of new relations are produced through these interactions.”

CONNECTING ART AND HOUSING

Through her novel interdisciplinary approach, Dr Vilenica has helped to establish a new field of research connecting art and housing. Introducing less-known work from an East

European context into wider academic and artistic discussions has also brought forward knowledge about less visible post-socialist cities. This has created a network of international thinkers and practitioners ready to bridge the East-West divide in knowledge production.

Outreach and dissemination included the roundtable series ‘Housing and Regeneration Struggles in South London’ and the international conference ‘Art and Housing Struggles: between art and political organising’. The team has presented various aspects of HOUSREG work at different events in eight countries.

Drs Marchevska and Vilenica are currently preparing an edited volume, ‘Art and Housing Struggles’, slated for publication in 2019. They are also collaborating on an international networking project that will continue the discussion between the United Kingdom and Serbia. This work uses socially engaged art practice to understand the complex intersection between forced migration and new placemaking strategies.

HOUSREG

- Coordinated by London South Bank University LBG in the United Kingdom.
- Funded under H2020-MSCA-IF.
- cordis.europa.eu/project/id/707848



Listening to Liszt's lost opera for the first time in 170 years

Franz Liszt is one of the most renowned composers of the nineteenth century and is celebrated in his native Hungary. In 1845, he began composing an Italian opera but abandoned the project in 1852. Scholars concluded that the score, largely written in shorthand, could never be performed due to the material being fragmentary and seemingly indecipherable.

However, one tenacious academic, Dr David Trippett, funded through the European Research Council project **DTHPS**, spent three years deciphering the 115-page manuscript, resulting in the complete first act of *Sardanapalo*, an Italian opera based on Lord Byron's Assyrian tragedy of 1821, *Sardanapalus*.

The world premiere of the opera took place in Weimar, Germany, on 19-20 August 2018 to widespread critical acclaim. Following its broadcast on Deutschlandfunk Kultur, the first recording of the work was released to the general public on 8 February 2019. Future performances are planned in America, Hungary and Serbia.

For more information, please see: cam.ac.uk/Lisztopera

DTHPS



- Hosted by the University of Cambridge in the United Kingdom.
- Funded under H2020-ERC.
- cordis.europa.eu/project/id/638241

“ Unlike unfinished art, unfinished music needs performance to be experienced as music. It works through time. Quite early on, I began working with singers from Covent Garden to try out the emerging lines, tempi and articulation, to understand how the music fits into the voice. The music was born of great ambition and it sounds like that – a unique blend of Italianate lyricism and harmonic innovation. There is nothing else quite like it in the operatic world. ”

Dr David Trippett



© Candy Welz

If you are interested in having your project featured in 'Project of the Month' in an upcoming issue, please send us an email to editorial@cordis.europa.eu and tell us why!



New technology for slaughterhouses turns waste into energy

Pig hair, as a waste by-product from meat processing, currently represents a cost to slaughterhouses for treatment and removal. One innovation turns this output into a useful input for the generation of energy.

Currently, after being processed for their meat, pigs' fur is usually dried to reduce its weight and volume, and then utilised in biogas plants or dehydrated and used as fertiliser. The cost of treating this waste, in terms of the energy required for its treatment and removal, is incurred by the slaughterhouse.

The EU-supported PigHeat (Utilizing Pig By-products as Heat Source to Save Recycling and Energy Cost) project was set up to develop a means for using pig fur as a replacement fuel for gas, diesel and electricity. The team successfully created an economically profitable machine, which is also respectful of the environment.

REDUCED ENERGY EXPENSES, FOR INCREASED PROFITS

Many slaughterhouses across Europe are already having to operate on very tight margins. This is partly because of the high amounts of energy needed for meat processing, but also additionally in part because stringent waste regulations, put in place for health and safety as well as animal welfare reasons, add to the financial burden.

"Animal slaughter generates a large quantity of products that cannot be commercialised, such as blood, bones and



hair,” project coordinator Mr Frederic Bigas elaborates. “In the case of pig fur, a lot is generated daily, so better management of its elimination reduces costs. In this, PigHeat is a good solution.”

PigHeat works first by homogenising the source material, then applying a thermal treatment, before combustion takes place to generate the energy. The resulting product is CO₂-neutral biomass with a high heating value (even higher than wood pellets).

In terms of integrating the technology into existing infrastructure, as all slaughterhouses have a system for the extraction and collection of pig hair, all that is needed is to transport that hair to the PigHeat on-site processor. After transforming the hair into fuel, the product is stored, ready to be used as fuel in a conventional solid fuel boiler to power the daily operations of the installation.

PigHeat has estimated that their method consumes 14% of the heating power of the fuel produced. As Bigas adds, “While purchasing PigHeat does incur an upfront cost, in less than two years the system’s savings will have paid for the machinery. Offering attractive payment modules, our innovative solution is likely to dominate the market swiftly.”

BENEFITING COMPETITIVENESS AND THE CIRCULAR ECONOMY

Recycling meat processing waste to generate energy at the same location reduces operating costs and contributes to the profitability of slaughterhouses. Ultimately this could benefit consumers through lowered meat prices. And with

“ We have demonstrated that energy recovery from pig hair is viable, with the resulting product not harmful to the environment. We believe that we can expand the list of products that can likewise be transformed. ”

pig hair a highly polluting residue, PigHeat also clearly offers the sector an environmentally sensitive solution.

With a processing plant already in operation close to Barcelona (Spain) processing three tonnes of pig hair per day, the team are working to further commercialise the technology by promoting it to slaughterhouses, and by exploring adaptation of the process to other industrial by-products.

“We have demonstrated that energy recovery from pig hair is viable, with the resulting product not harmful to the environment. We believe that we can expand the list of products that can likewise be transformed,” says Bigas. “We are dealing with a sector that is very interested in reducing both environmental impact and operating costs, so there is already strong interest.”

PIGHEAT

- Coordinated by Bigas Alsina in Spain.
- Funded under H2020-ENERGY, H2020-LEIT-ICT and H2020-SME.
- cordis.europa.eu/project/id/738874
- Project website: bigasalsina.com/en/pigheat/

ENERGY

An autonomous future relies on reusing waste heat

The future of autonomous machines will be full of small electronics that need to make use of waste heat. Researchers have figured out how to manufacture a material that can harness this energy.

Rising interest in artificial intelligence has put a spotlight on autonomous and self-powered low-power electronic devices. As a by-product of all thermodynamic processes,

waste heat is a valuable untapped source of energy. Pyroelectric materials can exploit this waste heat and convert it to useable electrical power.



“Due to the complexity of developing new, low-temperature pyroelectric harvesting materials, and the poor mechanical properties of single crystals, the applications are currently limited,” explains HEAPPs (Harvesting energy via aligned porosity pyroelectrics) project director Professor Chris Bowen.

The EU-funded HEAPPs initiative set out to address those limitations by developing new, high-quality pyroelectric materials with high operating temperature and good mechanical properties. The researchers developed the materials by paying close attention to some important physical properties of pyroelectric materials.

PYROELECTRIC HARVESTING

“The aim was to develop new materials with a high pyroelectric coefficient, coupled with low permittivity and thermal capacitance, to achieve good-quality pyroelectric harvesting,” says Prof. Bowen. The researchers understood that they had to use porosity to decrease permittivity and thermal capacitance, which would then work to decrease the pyroelectric coefficient.

“Understanding this complex relationship between these properties has allowed us to develop a novel pyroelectric material,” notes the Professor. Important requirements in pyroelectric harvesting are a high pyroelectric coefficient, high strength, low dielectric constant and low dielectric loss.

“*The aim was to develop new materials with a high pyroelectric coefficient, coupled with low permittivity and thermal capacitance, to achieve good-quality pyroelectric harvesting.*”

The team used a method called ‘ice templating’ to produce a cheap and strong aligned pore structure. They ran into some challenges, including the aligned pore structure causing the properties of the pyroelectric material to vary greatly.

Project members, including Dr Yan Zhang, developed a material that produced pyroelectric energy that is relatively small in the microwatt scale, which was unexpected since there was little fluctuation in temperature. “We are now trying to use this approach in applications where there are no other sources of energy for low-power electronics,” reveals Prof. Bowen.

NEW PATHS TO HYDROGEN PRODUCTION

This material also opens opportunities for new ways to produce hydrogen, as the pyroelectric effect can be used with variations in time and temperature to produce hydrogen from waste heat. “Since coupling energy-harvesting devices to electrochemical systems is becoming a hot topic, we are aiming to explore pyroelectrocatalytic water splitting to produce hydrogen.”

Prof. Bowen views pyroelectric energy harvesting from the ambient environment as a highly promising technology for the future of autonomous and self-powered electronics devices. This brings with it the potential to combine an active energy-harvesting material with storage in batteries for applications such as wastewater treatment.

HEAPPs

- Coordinated by the University of Bath in the United Kingdom.
- Funded under H2020-MSCA-IF.
- cordis.europa.eu/project/id/703950



Impact of climate change on rare species

Rare species play an important role in protecting natural ecosystems and the services they provide. An EU-funded project has investigated how they will be affected by global change, compared to more common species.

As part of the Marie Skłodowska-Curie Individual Fellowships grant scheme, the EU-funded Horizon 2020 EVOLMARIN (Rapid evolution and geographic ranges: predicting marine species persistence and distribution in a changing ocean) project investigated the relationship between species tolerance, plasticity and patterns of geographic distribution. Researchers aimed to more reliably predict marine ectotherm (cold-blooded) persistence under scenarios of ocean warming and acidification.

Marine biologists compared the capacity for trans-generational changes and rapid adaptation in rare and common sea bottom-living species from coastal habitats, specifically bristle worms (polychaetes). Researchers also modelled the species' physiological and reproductive performance as a habitat suitability index.

Scientists found that rare species are more sensitive than common species to even small shifts in environmental conditions, and thus more susceptible to climate change. As these rare species play a key role in ecosystems with high levels of biodiversity, their responses will define the structure and function of future ecosystems.

GREATER VULNERABILITY

Results showed that the rare species group was physiologically more vulnerable to ocean warming due to reduced tolerance to higher temperatures. "Rare species were unable to thrive and continue to the next generation when temperatures were raised to values mimicking ocean warming, suggesting that transgenerational phenotypic adjustments or rapid adaptation may not help rescue this group," says researcher Dr Gloria Massamba N'Siala.

Conversely, common species persisted for multiple generations under all scenarios. "Temperature increase was the main driver of the species' responses, while pH decrease did not affect their performance, probably because they are



already used to coping with pH variations in their natural environment,” explains Dr Massamba N’Siala.

Projections based on species’ physiological thermal tolerance limits and reproductive performances under ocean warming scenarios, showed a global increase in thermal habitat suitability in all species, particularly toward higher latitudes. “On the other hand, they highlight a loss of thermally suitable habitats for some of the rare species in the southern range of their potential distribution,” Dr Massamba N’Siala observes.

Furthermore, rare species tend to live closer to or at their optimal temperatures for reproductive performance in future scenarios. Hence, they face a higher risk of decline if warming rates continue in the following centuries. According to Dr Massamba N’Siala: “Even small temperature increases beyond the thermal optimum could cause rare species to rapidly decrease, potentially resulting in the loss of marine biodiversity.”

IMPORTANCE IN ECOSYSTEM PROTECTION

EVOLMARIN findings clearly highlighted the greater sensitivity of rare species under scenarios of ocean warming, offering a mechanistic understanding of the patterns underlying commonness and rarity in marine ectotherms from coastal habitats. Given the increasing evidence of the importance of rare species in supporting unique ecosystem functions, their

“ Even small temperature increases beyond the thermal optimum could cause rare species to rapidly decrease, potentially resulting in the loss of marine biodiversity. ”

higher sensitivity to ocean warming represents a threat to the integrity of ecosystems and the services they provide.

The patterns shown by EVOLMARIN identify not only priority targets for biodiversity conservation, but also which regions will be worst hit by changes to the oceans. “Given the complexity and variety of responses, the impossibility of testing every single species, and the limits of any experimental approach, it is crucial to provide evidence based on case studies for patterns of response to global change to help guide decisions concerning biodiversity conservation,” concludes Dr Massamba N’Siala.

EVOLMARIN

- Coordinated by the National Centre for Scientific Research in France.
- Funded under H2020-MSCA-IF.
- cordis.europa.eu/project/id/659359
- Project website: marineevolutionaryphysiology.co.uk

CLIMATE CHANGE AND ENVIRONMENT

Innovative methods to mitigate negative effects of climate change via financial solutions

Financial vehicles are needed to track the frequency and magnitude of extreme climate shocks in developing countries and provide additional financing for countries already managing their current climate risks. To do so, it's necessary to develop targeted methodologies that identify the changes in extreme events' frequency.

Most developing countries are vulnerable to climate risks. The expected increase in climate volatility will exacerbate the impact on developing countries and counteract the

investments being made by such countries to lessen, prepare for and manage current weather risks.



With methodological tools, the disbursement of climate adaptation funds to countries would be entirely data-driven over a 30-year or some long-term adaptation period. If there are no significant increases in the frequency or magnitude of extreme weather events against current climatology then no payments would be made. Where payments are made, countries would use those funds to invest in disaster risk reduction or climate change adaptation measures specified in pre-defined country-level adaptation plans. The EU-funded CaseXtreme (ChAnGES in the Statistics of EXTREMEs Events in cliMatE) project set out to “identify an appropriate metric for the statistical significance of changes in the statistics of extremes,” says coordinator Dr Marcello Petitta. “This will provide the baseline for designing innovative financial products and risk management tools.”

STATISTICAL METHODOLOGY TO TACKLE CLIMATE CHANGE IMPACT ON EXTREME EVENTS

The CaseXtreme team created a data-driven methodology to identify meteorological extremes in Africa and to

detect their future variability. “The hidden challenge of this problem was linked to the fact that the climate system already exhibits some natural fluctuations,” explains Dr Petitta. “It was then necessary to distinguish between systematic changes in the frequency of extremes and these natural fluctuations.”

Project partners began by identifying the best methodology to differentiate between the climate system’s natural fluctuations and a systematic change that hints at climate change. To define the method underlying CaseXtreme, they targeted weather extremes by using a climate index previously developed for this specific case. The index reflects the climate picture of a large region, and identifies both frequency and intensity of extreme events. It is standardised, hence it can be aggregated and compared across geographical areas. In Africa, major meteorological extremes include droughts and heat waves.

The methodology will be trialled in collaboration with the World Food Programme and monitored over a relatively short period of time. “We’re working on new potential

“*The payout scheme is a unique product in the insurance market that might open up new opportunities in the sector for climate change adaptations.*”

applications for such a financial instrument and are already in contact with potential customers,” he adds.

The scientists also defined a payout scheme for an insurance product based on such a method. This scheme is designed so that a payout is triggered only when a change in the frequency of extremes is detected. “In this sense, the payout scheme is a unique product in the insurance market that might open up new opportunities

in the sector for climate change adaptations,” says physicist and project associate Dr Sara Dal Gesso.

“CaseXtreme paves the way for a completely new form of insurance, revealing new avenues for both insurance companies working with climate index insurance and all key stakeholders in the market,” she adds. “More importantly, this novel insurance type will make a difference to populations in developing countries by providing them with the necessary financial resources for cutting-edge adaptation plans,” concludes Dr Petitta.

CASEXTREME

- Coordinated by AMIGO SRL in Italy.
- Funded under H2020-SME.
- cordis.europa.eu/project/id/739686
- Project website: climateservices.info

CLIMATE CHANGE AND ENVIRONMENT

Green cleaning boosts plastics recycling

EU-funded researchers have developed a novel, environmentally-friendly technique for cleaning mixed plastic waste, thereby dramatically increasing recycling rates.

Plastics are a mainstay of the modern economy due to their combination of unrivalled properties and low cost. They provide many benefits, but the current plastics economy has drawbacks that are becoming more apparent by the day. The primary problem is the high levels of waste and low recycling rates found in plastics manufacturing – today, globally, just 14% of plastics are used for recycling.

Increasingly stringent regulations have been introduced by the European Commission to reduce landfilling and incineration and encourage recycling and the circular economy, by increasing the taxes for waste disposal. Nevertheless, the inefficiency of current recycling technologies makes recycled plastics uncompetitive as a raw material, discouraging those who wish to convert it into useful products.



Only **14%** of plastics are used for recycling

LOW ENERGY CONSUMPTION

The Horizon 2020 EGREMPPLARE (The first eco-friendly technology for greasy mixed plastics recycling) project addressed this challenge through a high-tech process that makes recycling of mixed plastics economically viable. Their technique has increased the amount of plastics that can be recycled by 60 – 85%. “We use our proprietary cleaning process that employs a bio-based material without generating new waste streams and with a low energy consumption,” says Jan Kolijn, project coordinator and co-founder of high-tech recycling company Tusti B.V.

The Dutch SME developed lab-scale cleaning and separation techniques, which can be used for dirty, complex combinations of different plastics like mixed plastic household waste. “The goal of EGREMPPLARE is to see if there is a market for the products produced using our method, thereby strengthening the business case for separating and cleaning plastic household waste,” Kolijn explains.

Researchers used cleaning technologies and separation technology to turn plastic waste into valuable resources. The cleaning technology using biodegradable, biological cleaning liquids is patent-pending, and optimised through newer, cheaper cleaning liquids. “Separation technology is based on adapting existing technology and using it in a smart way to ensure the maximum amount of waste is used to produce new consumer products,” comments Kolijn.

LESS WASTE – MORE PROFIT

During EGREMPPLARE’s second phase, Tusti. B.V. will open a plant in 2019 to handle 10 000 tons of mixed plastics and run it at an optimised scale in 2020. According to Kolijn: “Since recycled plastics replace virgin plastics, producers need to use much less oil to produce the same quantity of plastic products. This leads to less dependence on oil and reduced CO₂ emissions and therefore fewer environmental impacts.”

The project also offers major economic benefits to companies, suppliers and customers. “Currently, suppliers must pay up to EUR 200 per tonne to get rid of mixed plastics: we estimate that this will be reduced to zero in a few years. Our clients will benefit because they can buy recycled feedstock of very high quality for a lower price than virgin materials,” Kolijn points out.

EGREMPPLARE

- Coordinated by TUSTI in the Netherlands.
- Funded under H2020-Societal Challenges, H2020-SME and H2020-Industrial Leadership.
- cordis.europa.eu/project/id/816636
- Project website: tusti.nl





SPECIAL FEATURE

NUCLEAR POWER, THE UNDERDOG OF EUROPE'S ENERGY MIX

Editorial

Is there still a future for nuclear?

The word 'nuclear' evokes strong emotions and many of these, if we're being completely honest, are tied up around the notion of nuclear warheads and nuclear conflict. In today's increasingly unstable world order, citizens are regularly exposed to rolling news coverage about nuclear proliferation issues, a recent example being the failed February summit between the United States and North Korea that took place in Vietnam.

Even when moving away from the bomb and thinking about nuclear power as a viable and acceptable component of Europe's current and future energy mix, opposition to nuclear energy can still be fierce. Of course, probably the incident that remains in the minds of older Europeans is the terrible disaster at Chernobyl in 1986, but the more recent 2011 Fukushima nuclear disaster in Japan also wasn't exactly great PR for the nuclear power industry, especially in Europe. In the aftermath of Fukushima, the German government decided to accelerate its plans to close all of its nuclear power stations by 2022, the Italian population voted against the expansion of nuclear power in a referendum and even France, long dependent on nuclear energy to provide up to 75% of the country's domestic energy needs, announced it would aim to cut its nuclear output by a third over 20 years.

But nuclear power is, and will remain, an important contributor to Europe's energy mix for the foreseeable future. The EU depends on nuclear power for more than a quarter of its electricity needs, and a higher proportion of base-load power, according to the World Nuclear Association. Importantly for the EU's ambitious climate goals, nuclear power provides over half of the Union's low-carbon electricity. Combined with the fact that the EU is the world's largest energy importer and a large amount of time has been spent in recent years on how

to increase its energy independence, through initiatives such as the Energy Union, policymakers cannot afford to overlook the positive benefits that nuclear power can still provide.

Of course, the keyword is safety – nuclear power will only be fully embraced by Europeans as an acceptable energy source if they are convinced that policymakers and engineers have taken every step necessary (and more) to ensure the robustness of all the nuclear power plants dotted around the continent. And this is an important issue – with the ghosts of Chernobyl and Fukushima still hovering overhead, several European countries that heavily rely on nuclear power, such as Belgium, are also saddled with ageing plants that need to be either fully overhauled and modernised or replaced completely.

Flowing naturally from this, several of the projects featured in this month's special feature focus on new innovations to increase safety standards whilst modernising the technology used to harness nuclear power. But whilst safety factors are crucial, we don't just stop there – because the debate over the pros and cons of continuing to rely on nuclear power is complex and multi-sided, we have taken pains to examine the debate from other angles as well. This includes projects that have encouraged greater regional efforts to increase nuclear cooperation between European countries, as well as diving into the social sciences to explore how nearly 75 years of nuclear power has profoundly affected and influenced European civil society and its attitude towards current and future energy sources.

We look forward to receiving your feedback. You can send questions or suggestions to: editorial@cordis.europa.eu

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A self-sustaining heat removal system for safer nuclear power

sCO₂-HeRo safely, reliably and efficiently removes residual heat from nuclear fuel, independent of external power sources, offering a viable backup cooling system for the reactor core or spent fuel storage.

Even once their fuel's chain reaction has stopped, reactor cores in nuclear power plants still generate 'decay heat'. This radioactive residual heat has to be transferred to a heat sink (e.g. cooling towers). Removal systems usually depend on external power supplies, active triggers (such as temperature levels or manual operation) and water availability.

The EU-supported sCO₂-HeRo (The supercritical CO₂ Heat Removal System) project avoids these dependencies, making its heat removal process more efficient, more reliable and safer. Powered by the decay heat itself, independent of external power supplies, sCO₂-HeRo is automatically activated and self-sustaining. Additionally, as the highly compact cooling system uses supercritical (fluid) carbon dioxide and air for the heat sink, it doesn't rely on water.

PUTTING THE SYSTEM THROUGH ITS PACES

sCO₂-HeRo's innovative idea was to actually harness the waste heat from power plants to enable its own removal. Project partners were assigned system elements to build and test. The compact heat exchanger, turbomachine and sink heat exchanger were all finished, tested and validated, using numerical simulation tools to ensure component quality.

One challenge which the team addressed was how to start the system without battery power. They did so by using a pressurised reservoir which stores CO₂. Release of the pressure turns the turbomachine, which drives the cycle.

For further testing, the components were integrated into a demonstrator glass model, with positive results. Additionally, to investigate the system's ability to deal with accident scenarios, the project started to apply the German ATHLET nuclear code, which simulates the flow of heat and water/steam in a nuclear power plant.



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“These successful tests demonstrated that the sCO₂-Heat Removal system transfers the decay heat to the ambient air, keeping the reactor cool and safe. As long as this cooling chain is maintained – from reactor core to air, via the cooling loop of the sCO₂-Heat Removal system – the heat will be removed from the core, buying time for further measures such as re-connection to the grid or bringing equipment to the plant,” says project coordinator Prof. Dieter Brillert.

CONFIDENCE BOOST

While nuclear power offers a promising energy pathway that could significantly reduce CO₂ emissions, acceptance will be determined in part by public confidence in its safety. sCO₂-HeRo’s heat removal activation, independent of reactors, helps build this. Furthermore, the team is confident that the system will extend the period of safe heat removal during a station blackout, with its ability to also generate electricity proving extremely valuable.

“As long as this cooling chain is maintained – from reactor core to air, via the cooling loop of the sCO₂-Heat Removal system – the heat will be removed from the core, buying time for further measures such as re-connection to the grid or bringing equipment to the plant.”

To take the technology forward, team members are currently undertaking a follow-up project, sCO₂-4-NPP (selected for funding by the European Commission), which will improve thermal hydraulic system codes. A highlight will be the use of a nuclear plant simulator of a pressurised water reactor, which is a 1:1 copy of the control room of a nuclear power plant, with all signals in real time. A virtual model of the sCO₂-HeRo will be attached to a pressurised water reactor to evaluate heat removal.

Although the team have so far applied the system to existing reactors (Generation 3), its design allows for integration into future (Generation 4) reactors.

“Once we have demonstrated the system’s ability during accidents, we will work with national safety authorities and nuclear power plant operators for implementation,” says Prof. Brillert. “There is a long way to go, but our iterative approach means that we have already integrated stakeholder feedback, saving time later.”

SCO₂-HERO

- Coordinated by the University of Duisburg-Essen in Germany.
- Funded under H2020-Euratom.
- cordis.europa.eu/project/id/662116
- Project website: sco2-hero.eu

How the history of nuclear energy could define its future

Nuclear power has suffered a significant backlash from civil society over the past few years. While its future may be compromised in Europe, lessons from its history can be learned to better integrate societal concerns in the debate around future energy sources.

Civil society has always had an ambivalent relationship with nuclear power: mastering the atom may have been one of the greatest scientific breakthroughs in history, but it’s also the one we seem to be the least at peace with.

But how did this all start? What were the events triggering changes in opinions, and how can this history help us shape the current debate on future energy sources?



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The EU-funded HoNESt (History of Nuclear Energy and Society) project is one of the most important scientific attempts at answering these questions while also highlighting how context-dependent they are. The consortium: used an interdisciplinary approach to look into the history of nuclear energy and its interactions with civil societies in 20 European countries since 1945; applied social science tools to analyse perceptions and engagement practice; and undertook stakeholder engagement research to understand the set of principles guiding fruitful interaction with society. By sharing its findings with industry, associations, policymakers and representatives of civil society, the consortium aimed to help improve future energy policy decisions.

NUCLEAR ENERGY: ESSENTIALLY A POLITICAL ISSUE

“Perhaps one of the most revealing aspects of our research is the enormous difficulty that most stakeholders have in considering the complexity of the nuclear energy issue,” says project coordinator Prof. Albert Presas from Pompeu Fabra University. “This translates into a radicalisation of discourse and positioning, with some actors within the nuclear sector finding it difficult to accept the role of society in nuclear development. However, nuclear energy is essentially a political issue rather than a strictly technical or economic one.”

In other words, public perceptions matter, and these have been shifting both nationally and at European level based on environmental, social, political and historical events.

By dismissing these perceptions as being mostly emotional, the sector has been making a big mistake.

Let’s take a concrete example: the anti-Americanism that grew with the Vietnam War, with youth protests and anti-capitalism movements. It played an important role in intensifying concerns over nuclear power which were far from purely emotional: “The emotional argument doesn’t withstand the facts. Anti-nuclear activists progressively gathered ample expertise – ironically often from US scientists critical of nuclear energy – and this technical and scientific knowledge ended up spreading across borders,” Prof. Presas explains. Where differences between perceptions from one European country to another emerged, these were essentially due to the unique history of each country, as well as the level of trust in government and public institutions.

A NUCLEAR CONTRIBUTION TO THE ENERGY MIX CONVERSATION

With the project now completed, Prof. Presas hopes stakeholders, including Euratom and entities responsible for energy transition at national and European level, will take note. “In our democratic societies, the energy transition will fail if all affected groups are not considered equally,” he says. “The methodology and results of HoNESt can help these stakeholders identify successful modes of dialogue and postulate the foundation of a new communicative relationship between nuclear energy, new energy sources and society.”

Meanwhile, the HoNESt consortium will keep promoting the transdisciplinary consideration of energy issues, but also focus on other sectors where such consideration may be relevant. Prof. Presas also plans to analyse how historical experience related to nuclear energy and society is considered in designing the transition to new energetic paradigms. “I imagine we will have some surprises,” he coyly concludes.

HONEST

- Coordinated by Pompeu Fabra University in Spain.
- Funded under H2020-Euratom.
- cordis.europa.eu/project/id/662268
- Project website: honest2020.eu

How does radiation impact nuclear reactors' structural materials over time?

The safe, long-term operation of light-water reactors has become a critical challenge in Europe. Thanks to work under the SOTERIA project, the understanding of radiation effects on nuclear structural materials, which strongly affects a reactor's longevity, has been deepened.

The future of nuclear energy in Europe may be hazy, but the current need for it is hard to deny. Nuclear power plants (NPPs) still account for about one quarter of the EU's electricity production capacity, and until industry can compensate for such loss with renewable energy sources, prolonging the already extended life of NPPs has become a priority.

Ensuring the safe, long-term operation of existing power plants, however, is a different story. It requires an in-depth understanding of the role of material ageing phenomena in NPPs, as well as the translation of this knowledge into both reliable tools and methods for industrial end-users, and guidelines for policy-makers.

SOTERIA (Safe long term operation of light water reactors based on improved understanding of radiation effects in nuclear structural materials) aimed to provide such understanding, with a focus on ageing phenomena taking place in reactor pressure vessels (RPVs) and internal steels, caused by neutron irradiation. The project, which builds upon the findings of its PERFECT and PERFORM60 predecessors, combined advanced modelling tools with experimental data to investigate the impact of such irradiation – over time and at different doses – on nuclear components made of complex industrial materials.

SMART EXPERIMENTS TO DETERMINE SAFE NPP OPERATION

“Safe NPP operation depends on many factors, including material-related issues,” explains Dr Christian Robertson, coordinator of the project of the French Alternative Energies and Atomic Energy Commission (CEA). “Critical NPP components tend to undergo time-dependent evolutions due to material ageing mechanisms, and safe prolonged lifetime can only be accurately guaranteed provided we thoroughly understand the causes and extent of these mechanisms.”

SOTERIA essentially consisted in the combination of smart experiments and physical modelling, specifically designed for well-characterised internal and RPV materials. All in all, the consortium: conducted a deep microstructural

examination of irradiated RPV steels, austenitic stainless steels and model alloys; studied the impact of material inhomogeneity on RPV steels' mechanical properties; investigated the effects of helium and hydrogen charging on damage susceptibility and oxidation, respectively; and developed models to assess RPV and internal components under irradiation.

“We have several important project outcomes. One of them is new data on material response variability and their relation with well-controlled ageing conditions, which we now understand material ageing causes for a representative selection of nuclear material cases. Moreover, our modelling tools can address the variability of complexity of actual nuclear materials in critical NPP components. This tool will be disseminated through a user-friendly computational platform,” says Dr Robertson.

TRAINING THE NEXT GENERATION OF EXPERTS

SOTERIA also had an educational purpose: communicating project results to the nuclear engineering and research community to improve and harmonise the knowledge of ageing phenomena in NPPs across Europe.



A SOTERIA Training School, for instance, was held in September 2018 to transfer and preserve the project's knowledge on nuclear RPVs and internal material degradation mechanisms. A total of 60 participants from 29 organisations in 13 countries – students, post-docs, early career professionals, scientists and engineers – attended the event.

This is probably the most important mission of SOTERIA. Although the project will run until August 2019, Dr Robertson is confident that its influence will keep being felt even beyond this deadline. “The innovative, cost-effective and informative surveillance methodologies developed under the project, adapted to critical nuclear

reactor components, will be of much use for the community over the coming years,” he says.

SOTERIA members are already looking into the creation of a new consortium under the next Euratom call, to further investigate material ageing mechanisms.

SOTERIA

- Coordinated by CEA in France.
- Funded under H2020-Euratom.
- cordis.europa.eu/project/id/661913
- Project website: soteria-project.eu

In-vessel retention for high-power nuclear plants

In-vessel retention (IVR) is already implemented in some medium-power nuclear power reactors to prevent corium from leaking out of the vessel in the case of a meltdown. Thanks to research under the IVMR project, this approach can now be assessed for higher-power reactors as well.

The nightmare of nuclear energy stakeholders around the world has a name: corium. This man-made lava flow – the result of a nuclear meltdown in a reactor's core – can stay radioactive for centuries, so its release into the environment in the case of major accidents must be prevented at all costs.

GETTING ON TOP OF CORIUM

IVR is one of a few available solutions for avoiding such a disastrous scenario, its main advantage being corium retention within an identified and limited space. But whilst the strategy has been assessed and implemented

for relatively small power reactors, many uncertainties regarding its use in higher-power reactors (around 1 000 MWe) have yet to be cleared.

“The higher the reactor power, the lower the safety margin with respect to the risk of failure of the vessel,” says project coordinator Dr Florian Fichot from IRSN. “If this residual risk becomes larger than 10%, the benefits of implementing an IVR strategy become questionable.”

Thanks to funding under the IVMR (In-Vessel Melt Retention Severe Accident Management Strategy for Existing and Future NPPs) project, a 23-strong consortium led by IRSN analysed the applicability and technical feasibility of IVR for high-power reactors, with a focus on existing VVER 1000 type 320 units in Europe and future reactors of the PWR or BWR type. They used the most advanced tools, knowledge and computer codes to come up with a new methodology addressing IVR implementation.

“Our methodology has a larger scope than its predecessor and allows for including phenomena that had been neglected before, for example the possible inversion of stratification between oxide and metal in the corium pool. Another advantage is that it is not only a probabilistic approach: It also includes more deterministic



evaluations, which helps avoid inconsistent assumptions,” Dr Fichot explains.

IT'S NOT JUST REACTOR POWER THAT'S RISKY

The consortium discovered, among other things, that reactor power is not the only factor determining residual risk. They also found that the larger the ratio of the mass of steel structures in the corium to the mass of fuel is, the more IVR becomes a viable option. “This is why reactors like AP1000 or HPR1000, which are designed for IVR, include large steel structures,” Dr Fichot explains.

Another important observation made under IVMR is related to the amount of water available to delay the moment of complete melting of core materials: if it can be delayed by 12 hours, conditions become more favourable for IVR even in high-power reactors. The VVER-1000 design includes such favourable factors, which makes it a good candidate for ‘retrofit’ implementation of an IVR strategy according to project findings. Dr Fichot remains cautious on this point though, as complete evaluations of risks – including risks

not related to corium only – must be done before definitive conclusions can be drawn for VVER-1000.

The project also made some technical breakthroughs on the likes of external cooling efficiency improvement, the study of simultaneous in-vessel water injection and spray cooling of the vessel.

“The feedback has been quite positive, in particular from industry partners involved in the project – EDF, Fortum, Paks and Framatome. We’ve also witnessed interest from organisations overseas, particularly Chinese, Russian, South Korean, Japanese and Ukrainian organisations which have officially joined the project in order to share results,” Dr Fichot concludes.

IVMR

- Coordinated by IRSN in France.
- Funded under H2020-Euratom.
- cordis.europa.eu/project/id/662157

Watertight safety assessment for liquid-cooled nuclear reactors

Europe currently hosts three promising demonstration sites of fast reactor technology, and with them the hopes of safer, more sustainable and more competitive nuclear energy production. The SESAME project focused specifically on safety, with new evaluation methods and a set of best practice guidelines.

One of the most important arguments in favour of fast reactors lies in how safe they are. By using liquid metal coolant, fast reactors benefit from metal’s very high thermal conductivity. In theory, a liquid-metal cooled fast reactor can shut itself down without surpassing temperature limits.

Designing reactors for use with liquid metals, however, requires a complete understanding of their thermal hydraulics which the EU-funded SESAME (thermal hydraulics Simulations and Experiments for the Safety Assessment of MEtal cooled reactors) project aims to provide. The project focused on the Lead-cooled Fast Reactor (LFR) and Sodium-cooled Fast Reactor (SFR) – both considered as the most promising nuclear technologies for next-generation reactors by the Generation-IV International Forum (GIF).



“The goal was to improve the safety of liquid metal fast reactors by making new safety-related experimental results and improved numerical approaches available.”

“The goal was to improve the safety of liquid metal fast reactors by making new safety-related experimental results and improved numerical approaches available,” says Dr Mariano Tarantino, project coordinator. “These will allow system designers to improve the safety-relevant equipment, in turn leading to enhanced safety standards and culture.”

The project team focused on four European demonstrators: ASTRID (industrial prototype aiming to confirm innovation options for Sodium Fast Reactor (SFR) technology), ALFRED (Lead cooled Fast Reactor (LFR) demonstrator in Romania), MYRRHA (multipurpose fast neutron spectrum irradiation facility and to serve as experimental pilot plant for the lead technology in Belgium) and SEALER (a Swedish small lead cooled reactor designed for commercial power production in Canada). They specifically aimed to take on the pre-normative, fundamental safety-related challenges these demonstrators have been facing.

SESAME delivered various numerical approaches for the design and safety evaluation of these advanced reactors. Among other things, it provides a deeper understanding of turbulence in fuel assemblies, mixing and temperature fluctuation phenomena taking place inside a reactor pool with a database of properties and advanced turbulent heat flux models.

The project: considered several thermal-hydraulic scenarios for the reactor core, where the highest temperatures are expected; successfully validated computational fluid dynamics (CFD) approaches under different scenarios; designed a

stand facility for experiments related to natural convection and freezing of lead in a pool-type geometry; and assessed the thermal-hydraulic performance of an LBE pool-type facility during a Protected Loss of Flow Accident (PLOFA).

DETAILED RECOMMENDATIONS AND A TEXTBOOK

Another important project outcome consists in a set of guidelines, including recommendations for verification, validation and uncertainty quantification of the use of numerical tools in liquid metals. “A textbook has also been compiled and published, highlighting major outcomes of the SESAME project but also including international input and perspectives. This textbook should serve as a good starting point for young professionals and students in this particular field,” says Dr Tarantino.

All in all, SESAME provides the knowledge basis required for building liquid metal fast reactors, as well as support to the regulatory bodies and technical support organisations in Europe. The new experimental data and the advanced simulation approaches developed within the project are expected to support interaction between stakeholders and civil society on nuclear reactor safety, while the project’s knowledge base will allow the EU and its Member States to develop and implement robust safety policies.

SESAME

- Coordinated by ENEA in Italy.
- Funded under H2020-Euratom.
- cordis.europa.eu/project/id/654935
- Project website: sesame-h2020.eu

Multinational effort to develop Gen4 nuclear technology for the Visegrad region

What do you do if you are a smaller country without the resources to fully exploit the next generation of nuclear energy? As one project has discovered, the answer could lie in smart regional collaboration.

The VINCO (Visegrad Initiative for Nuclear Cooperation) project was set up to help the Visegrad 4 (V4) countries (Czech Republic, Hungary, Poland and Slovakia) collectively benefit from the next generation of nuclear power

(Gen4). As an EU-funded Coordination and Support Action, the project built capacity amongst the V4, by pooling expertise and knowledge. Its activities complement the work of the V4G4 (Visegrad 4 for Generation4) Centre

of Excellence, established by research and engineering organisations from across the V4 to advance Gas-Cooled Fast Reactor (GFR) technology.

To find out more, CORDIS caught up with Prof. Jacek Jagielski, Director of the Material Physics Department at the National Centre for Nuclear Research in Poland and coordinator of the project.

What role does nuclear power play in the Visegrad region and what are the hopes for the future?

Prof. Jagielski: In the Czech Republic, Hungary and Slovakia, nuclear power plants have been successfully and safely generating electricity for decades. Poland is planning to build water-cooled reactors for electricity generation and to develop High Temperature Reactor (HTR) technology for chemical companies. There is a consensus amongst the V4 that nuclear power will become a vital element of the energy mix, particularly for countries which rely on coal as their primary energy source.

Why are Gas-Cooled Fast Reactors important to Gen4 technology?

GFRs, like other breeder reactors, have a tremendous capability to increase the amount of energy that can be extracted from uranium ore. The current generation of reactors uses the isotope ^{235}U , with a concentration of only 0.7% natural uranium. Fast reactors can transform the ^{238}U isotope, which is 99.3% rich in natural uranium, into fissile plutonium (^{239}Pu) which is then used to generate energy.



Prof. Jacek Jagielski
Project coordinator of VINCO
© Marcin Jakubowski, NCBJ

“*Ultimately, the aim is to transform the V4 countries from being only users of nuclear technology, to becoming suppliers.*”

The project also looked at HTR reactors, as, while sharing some characteristics with GFRs (such as helium cooling), they are closer to industrial implementation. HTRs are, literally, a hot property at the moment as they offer the only nuclear option likely to produce the heat needed for installations such as for the chemical industry, with steam temperatures typically reaching 550 °C or for hydrogen production with temperatures around 1 000 °C. They are of major interest in Poland, where we need to replace old coal-fired boilers in the chemical industry and don't want to resort to importing gas.

How does VINCO help address the V4's nuclear power ambitions?

Ultimately, the aim is to transform the V4 countries from being only users of nuclear technology, to becoming suppliers. But clearly nuclear technology is too costly for small and medium-sized countries to develop alone. If the V4 are to seriously benefit from fourth generation reactor technology, they need to cooperate with one another. VINCO's Nuclear Power Strategic Task Force was a body of decision makers, from within and outside the Visegrad region. It provided a platform for exchanging knowledge, opinions and specific expertise. It also established collaborative principles about matters such as: rules of access to infrastructure, analysis of existing research, training, equipment and capabilities, setting R&D objectives and decisions about investment priorities.

What did the different country members of VINCO bring to the table?

All the participating VINCO countries came with their own specialisations. Slovakia brought expertise about design and safety concepts, the Czech Republic contributed helium technology and R&D knowledge, while Hungary came with GFR fuel expertise and Poland with that of structural materials for reactors. This allowed us to share tasks within and across the group. For example, GOSPOSTRATEG, a large project in Poland, is now benefiting directly from VINCO's results as it prepares for the implementation of gas-cooled HTR technology.



How will this work benefit the lives of EU citizens?

Clean and reliable energy supply is undoubtedly one of the main challenges faced by developed countries, partly as they adapt to EU policies on energy production and the environment. To reduce greenhouse gas emissions, reliance on coal must be reduced very soon but credible alternatives are few and far between. Gas and oil are not sufficiently available across Europe and renewable energy sources may only ever play a limited role in the energy mix, due to their intermittent supply. The only realistic alternative left is nuclear technology, which is the safest, cleanest, most reliable and, as France demonstrates, cheapest source of energy.

What are the next steps to take the work forward?

Final decisions about the development of nuclear technologies obviously remain in the hands of the respective V4 governments. But by carefully looking at the capabilities and needs of the V4 countries, VINCO has prepared the groundwork for effective regional cooperation which

could lead to the full exploitation of fourth generation nuclear technologies. Put simply, once the necessary strategic decisions are taken, we are collectively ready for the implementation phase.

What are you most proud of from the project?

Before VINCO, international contact between collaborative labs in the V4 was mostly channelled through high-level institute representatives, such as directors or professors. Bearing in mind that nuclear technology can take more than 20 years to develop, this is a concrete legacy of VINCO. We achieved something that will benefit my grandson, a future supply of reliable, responsibly sourced electricity.

VINCO

- Coordinated by the National Centre for Nuclear Research in Poland.
- Funded under H2020-Euratom.
- cordis.europa.eu/project/id/662136
- Project website: project-vinco.eu

A fresh start for Baltic cooperation in nuclear energy production

The Baltic Region, still relatively isolated from Europe's decentralised electricity grid, has also been left without nuclear power since the shutdown of Lithuania's only plant in 2009. Partners under the BRILLIANT project have been trying to close this gap by clearing the way to enhanced cooperation between research organisations in Latvia, Lithuania, Estonia, Poland and Sweden.

The project's primary goal was to lay the groundwork for successful implementation of nuclear power plant projects in the Baltic Region. It did so in two key steps. First, the consortium compiled information on experimental facilities, equipment, software, energy infrastructure, fuel cycle infrastructure, radioactive waste management and disposal options, as well as industry players which could be involved in the implementation of nuclear power projects. Then, it highlighted means to increase cooperation.

"We know that each partner country has strengths in specific areas, and the project definitely helped shed light on those. However, there is currently a lack of cooperation that prevents stakeholders from using the full nuclear energy potential of the region," says Dr Egidijus

Urbonavicius, coordinator of BRILLIANT (Baltic Region Initiative for Long Lasting Innovative Nuclear Technologies) on behalf of the Lithuanian Energy Institute.

Overcoming barriers...

Several barriers to nuclear power development in the region were identified by the project consortium. These include: inadequate and dispersed nuclear research infrastructure and competence; a lack of justification for autonomous handling of nuclear wastes; relatively small power systems; low security of energy supply; a basic technical level of heavy industry; and a diminishing number of qualified workers. A lack of public awareness and the aggressiveness



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of the coal lobby in Poland are also to blame for the lack of nuclear energy programmes in the Baltic Region.

Dr Urbonavicius is convinced that all these barriers could be easier to overcome with proper regional cooperation. The first steps towards integration were already taken in 2015, when two electricity cables were completed to link the Lithuanian grid to the Swedish and Polish ones. Likewise, Estonia is already connected to the Finnish grid via two dedicated cables.

BRILLIANT went a step further by initiating close cooperation between the main research centres in the region: LEI and FTMC in Lithuania, NCBJ in Poland, Tartu University in Estonia, the University of Latvia and KTH in Sweden. For three years, these actors have shared knowledge, learnt about their strengths and weaknesses, and looked for opportunities to work together and increase their joint competitiveness.

“Let’s say we install a high capacity power source in the small grid of a single country: It will take a prominent place in this country, but it might not be competitive with other power sources and negatively impact energy security due to its high impact on the grid,” Dr Urbonavicius

explains. “If we take a regional perspective, however, there are many more possibilities for utilising its full potential.”

... and addressing political issues

Two issues that can’t be resolved by research organisations, however, are the management of used nuclear fuel and radioactive waste, as well as risk sharing of nuclear power plant operations – which need to be dealt with at the political level.

Likewise, negative public perceptions remain a problem even in the context of enhanced cooperation. “We approached this problem by organising public events in each country to present our ideas and results, and discuss issues related to nuclear power and energy sector developments in general. These meetings were open to all interested parties. A number of experts also had the opportunity to visit facilities at Oskarshamn in Sweden, which helped overcome the issue of public awareness,” Dr Urbonavicius enthuses.

Whilst the future story of nuclear energy in the Baltic Region remains to be written, BRILLIANT undoubtedly provides an excellent starting point for effective cooperation at regional level.

BRILLIANT

- Coordinated by the Lithuanian Energy Institute in Lithuania.
- Funded under H2020-Euratom.
- cordis.europa.eu/project/id/662167
- Project website: balticbrilliantproject.eu

Europe and China unite to investigate severe accident scenarios in nuclear power plants

Europe and China have joined forces under the ALISA project to advance severe accident research for existing and advanced light-water reactors. Their efforts provide a better understanding of possible scenarios of core quenching, in-vessel and ex-vessel core melt cooling and hydrogen behaviour for different reactor designs.

ALISA (Access to Large Infrastructures for Severe Accidents) benefits both parties: China has one of the most rapidly growing nuclear programmes in the world and

ALISA was a one-of-a-kind opportunity to access Europe’s expertise and well-established experimental network. European researchers, on the other hand, were provided



access to Chinese facilities and use them to launch new research avenues.

The stakes are high. Experimental research on severe accidents is of high importance not only to proof established knowledge, but also to elucidate new phenomena. It provides data for code development and enriches guidelines for severe accident management. The problem is, such research requires international cooperation, as the nature of severe accident phenomena usually relates to high temperature and large amounts of prototypical corium, and its complex chemical and physical interactions with the environment.

“Severe accident research often relates to complex problems involving significant human and financial resources, to the point where investigation under a national programme is just not feasible,” explains Dr-Ing Xiaoyang Gaus-Liu, technical coordinator of ALISA and Head of the Severe Accident Research Group (SAR) at Karlsruhe Institute of Technology (KIT), Germany. “Thanks to ALISA, we could access a wide network of existing experimental rigs necessary to conduct severe incident research, gather research topic proposals from researchers within the network and select the best ones for experiments.”

COOPERATION FROM EAST TO WEST

ALISA was actually made up of two financially independent projects, one in Europe and one in China, which both provided a similar scale of experimental programmes for mutual access.

The selected large-scale experiments focused on remaining R&D issues related to severe accident management in light-water reactors. Most high-priority research issues, from early core degradation to late in-vessel phase melt

retention in the lower head, continuation to ex-vessel fuel-coolant interaction, and hydrogen behaviour in containment, were investigated.

A total of 12 experiments were conducted under the project, with each bringing its own valuable findings. “These experiments provide scaling data for in-vessel corium behaviour and H₂ combustion character in containment, indicate the multiple criteria for ex-vessel cooling of corium in-vessel, and highlight important thermal-physical properties of corium in different scenarios. On fuel-coolant interaction, we notably discovered a two-stage pressurisation during the release of corium in water,” says Dr-Ing Gaus-Liu.

IN FUKUSHIMA’S SHADOW

If there is one thing Fukushima has taught us, it’s that no matter how costly it is, severe accident research is well worth the trouble. The nuclear disaster also reminded Europe of the potential powder keg it was sitting on: a long list of ageing nuclear power plants posing serious security concerns.

Thanks to ALISA, research on potential accidents has been considerably advanced and severe accident management has taken a leap forward. Further cooperation with Chinese institutes is already being considered, either under a follow-up EU project or through a bilateral cooperation agreement.

ALISA

- Coordinated by KIT in Germany.
- Funded under FP7-EURATOM-FISSION.
- cordis.europa.eu/project/id/295421



Optimising crop protection with a smart pest monitoring solution

Pest insect monitoring has not changed for decades, but one crop protection project has combined monitoring information from smart field-based stations with artificial intelligence to predict pest dynamics on a completely new level.

Agricultural pest control typically involves manually inspecting traps, recording the number of catches and reporting this to a crop expert for advice. To reduce the cost of this travel and labour-intensive approach (also prone to human error), it is typically performed only weekly.

This method was developed decades ago, when crop protection was dominated by broad spectrum insecticides, with negative environmental impacts. Farmers need a more targeted, evidence-based and timely approach.

The EU-funded Trapview (Automated pest-monitoring system for sustainable growing with optimal insecticide

use) solution allows growers to remotely monitor pest insects caught in pheromone traps. The growers are also alerted in real-time when insecticide spraying is needed, based on the high number of pests detected.

THE SMART MONITORING TRAP

Trapview's traps, which can self-clean, thus ensuring high catching efficiency and consequently high data quality, send images to the cloud at least daily. These images are processed then analysed by machine learning to identify each of the insects pictured.



“*We want to introduce Trapview technology into most plant-based food production to improve people’s lives and environment.*”

To ensure accuracy, the team had trained the AI neural networks by introducing tens of thousands of images of positively identified target pests.

As project coordinator Mr Matej Štefančič explains, “Even though our traps give us reliable data, interpretation is difficult, as is finding patterns for predictions. This is where machine learning comes into play, using historical data combined with data from multiple sources.”

Pest identification is denoted by a label around the targeted insect, with a corresponding ‘trust’ level percentage, indicating identification certainty. Users only see those above certain thresholds.

The Trapview model then combines daily information extracted from the insect images, with local weather data, historical trends and forecasting, to predict pest dynamics.

“This approach is highly efficient, with over 90% identification accuracy, better on average than human. Additionally, forecasting accuracy was over 80%, better than anything else on the market,” Štefančič says. “Considering our model actually integrates the results of crop protection during the season, forecasting gives us a key competitive advantage.”

Usage in the Mediterranean basin, as well as elsewhere (e.g. Australia and the USA), also revealed that placing a lower density of the devices in a network/grid provided better understanding of pest insect populations in specific areas than a larger number in a single place.

WIDESPREAD ADOPTION FOR FOOD SAFETY AND SUSTAINABILITY

For food to be safer, insecticide residues have to be decreased, resulting in healthier food and reduced insecticide resistance. And crop protection based on informed and timely decisions, avoiding spraying that is calendar or ‘rule of thumb’ based, helps meet regulatory standards. Trapview also saves customers travel and labour costs, while crucially helping produce higher yields with better quality crops.

To date, Trapview has thousands of automated traps successfully deployed in over 40 countries on six continents. The team are now focused on key markets and crops with the highest chance of widespread adoption. They will also further develop the technology to include: predictive services for additional pests, efficient monitoring of multiple pests simultaneously, expansion of the image recognition and processing AI for a wider range of pests and even higher accuracy.

“We are leaders in our field, with a very clear path forward to retain this position. We want to introduce Trapview technology into most plant-based food production to improve people’s lives and environment,” says Štefančič.

TRAPVIEW

- Coordinated by EFOS in Slovenia.
- Funded under H2020-FOOD and H2020-SME.
- cordis.europa.eu/project/id/733979
- Project website: trapview.com
- ▶ bit.ly/2VC0SwW

Novel approach helps companies prepare EU-compliant food labels

As of December 2016, an EU regulation requires businesses selling pre-packed foods to include nutrition information on packaging. Declaring nutrient composition data for products is both complex and costly for SMEs.

Many food businesses are aware of their obligation to provide information for consumers (nutrition labelling) on pre-packaged products. However, SMEs producing fewer than 1 000 units yearly are less aware of the regulation. In addition, a small number of food businesses, especially SMEs, are in a position to chemically analyse all products for nutritional content because it's expensive, and low sample numbers or changes in formulation and production errors can render results unusable.

ROADBLOCKS TO MANDATORY NUTRITION LABELLING FOR BUSINESSES

The majority of food manufacturers calculate nutrient content, based on ingredients, using a variety of information sources. This calculation isn't straightforward. Currently, manufacturers apply different formulae for calculations, using a variety of food composition data and conversion factors, and different software and publication formats. Results are very inconsistent and could potentially mislead consumers, leaving companies vulnerable to prosecution under the EU legislation.

To address these issues, the EU-funded NASCENT (Nutritional labelling software and claims: service, training and innovation offering to SMEs and industry in Europe) project sought to develop and extend nutrition labelling software (NLS)

and services for food manufacturers including SMEs. "Based on information from Ireland and the United Kingdom, SMEs have on average 10 products that require labelling, meaning the potential market across the EU and associated countries is significant," says project coordinator Paul Finglas. "However, extending the existing successful business model to such countries depends on human capacity to harmonise approaches and enhance software tools as well as to identify the requirements and networks for development and exploitation."

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“Consumers will have at their disposal accurate information on food labels, enabling them to make informed choices about what they eat.”

SOFTWARE TOOL CALCULATES NUTRITION CONTENT

NASCENT examined the potential for extending an internet-based nutrition information service to Belgium, Switzerland, the Czech Republic, Germany, Italy and the Netherlands. This service would offer accreditation for NLS more widely and bespoke support for SME food businesses. It goes beyond many of the automated services available today that lack transparency and authority. The project also explored the potential of developing an NLS certification scheme, based on project leader EuroFIR AISBL and other European standards for food information.

Lastly, the project team created content materials for online NLS training modules and self-assessment. The goal is to support users from different market sectors, including SME food business operators (FBOs) and hotel, restaurant and catering industries, although labelling isn't mandatory in this sector yet.

NASCENT offers several benefits to end users with limited resources and technical know-how, and for which the demands of complying with changing legislation could be a critical moment in their continued success.

"For FBOs, calculating nutrition content values for labelling will be made easier and more certain in terms of both when it's appropriate to calculate values and when it's not, and whether the numbers are correct," explains Finglas. "They are legally responsible for the information on labels, regardless of whether they calculated them or even understand what they mean."

"Software providers will ensure that their product does what they claim using gold standard approaches," he adds. "It would provide both these sectors – technology and manufacturing – with appropriate tailored training." Finglas concludes: "Consumers will have at their disposal accurate information on food labels, enabling them to make informed choices about what they eat."

NASCENT

- Coordinated by European Food Information Resource in Belgium.
- Funded under H2020-SME.
- cordis.europa.eu/project/id/739622

FOOD AND NATURAL RESOURCES

Forestry vehicles with a soft touch

The need for increased productivity and the growing fragility of forest soils do not get on well. To solve both problems at once, the OnTrack consortium has built a new generation of forwarder and a monitor to minimise impact.

Climate change hasn't exactly been sparing the forestry sector. Milder and wetter climates have weakened forest soils, to the point where traditional machines are now difficult to operate without inflicting damage. Forest administrators have had no other choice than to restrict access to machines in particularly sensitive areas, while the rationalisation of wood supply has created the need for expensive specialist machines that require high levels of production to pay off. All in all, fewer machines are expected to produce more, in a shorter time.

The OnTrack Forwarder answers this challenge with a better distribution of machine load to the ground. Its fitted tracks reduce ground pressure to 50 kilopascals for a 14-tonne load, allowing the machine to keep operating on low-bearing capacity grounds long after conventional machines would have caused serious wheel rutting.

"The tracks are made of reinforced rubber instead of steel, meaning that they are more gentle on tree roots, that the operators are subjected to less vibration, and that they

“ *The tracks are made of reinforced rubber instead of steel, meaning that they are more gentle on tree roots, that the operators are subjected to less vibration, and that they are able to cross roads and cycle paths without damaging them.* ”

are able to cross roads and cycle paths without damaging them,” explains Rasmus Astrup, research manager at NIBIO and coordinator of the OnTrack (Innovative solutions for increasing efficiency and reducing environmental impacts of future wood supply) project. “This makes the OnTrack Forwarder particularly useful in forests with much public access.”

The Forwarder is not only gentle to the ground: It's also smart. An integrated set of laser scanners – the OnTrack Monitor, which can be retrofitted to any other forest machine – evaluates the soil and scans the ground surface ahead and behind, all this while a central control unit calculates the depth of any wheel rutting the machine might have caused. The information is then provided to the operator and, thanks to a GPS and online router, can also be transmitted to the forest manager and mapped on a ground plan of the harvesting site.

As Astrup explains, “The maps indicate where severe rutting has occurred, provide information on the state of the site after operation, and can be used as a basis for follow-up studies. These can focus on the growth rates of young trees planted in wheel paths compared to those outside these paths, or define how other management tools such as depth-to-water maps match the actual rutting.”

Both the OnTrack Forwarder and Monitor were exposed to rugged field testing during the second project year. Selected forest contractors were given free rein to test them in normal operations for at least one month in Sweden, Latvia, Finland, Germany and Norway, and their feedback was used in reengineering and improving the products.

“Stakeholder reactions have generally been very positive,” Astrup enthuses. “Besides, we have noticed increased attention to the issues we highlighted, through articles and discussions in relevant publications, but also with the acceleration of parallel efforts to reduce ground pressure among machine, tyre and track manufacturers.”



Whilst the project is now completed, manufacturing partners Ponsse Plc and Prinoth SpA are still looking into the feasibility and timeframe of constructing a modified prototype, building on the experiences gained from field testing. Meanwhile, options for commercialising the Monitor have diversified, and include a low-cost industrial version at coarser spatial resolution (10 m x 10 m), a high-resolution (sub-metre) and mobile research version for field studies, and a back-pack mounted version for measuring site disturbance after harvesting operations are complete.

ONTRACK

- Coordinated by NIBIO in Norway.
- Funded under H2020-FOOD.
- cordis.europa.eu/project/id/728029
- Project website: [linkedin.com/pulse/ontrack-ontrack-project](https://www.linkedin.com/pulse/ontrack-ontrack-project)



New recovery processes for high-performance and low-cost rare earth-magnesium alloys

EU-funded researchers successfully created high-performance magnesium alloys – a low-cost and sustainable alternative to existing metals. Lighter and stiffer than aluminium, they cost no more than prime magnesium.

Regulations are now demanding greater fuel efficiency, and designs for aerospace and automotive structures are becoming more complex. Meeting expectations for components of higher performance can therefore be challenging.

The lightest of all metal elements, magnesium, requires less energy during production, and designs can be more sophisticated without sacrificing strength. The metal can be cast into various mechanical parts and used for virtually any structures that need to be lighter and stronger. However, its poor corrosion and creep properties as well as service temperature hinder its wide market acceptance.

Funded by the EU, the goal of REMAGHIC (New Recovery Processes to produce Rare Earth -Magnesium Alloys of High Performance and Low Cost) was to recycle magnesium

metals from industrial waste and combine them with secondary rare-earth elements (REEs) to produce higher-performance alloys compared to prime magnesium. “Our motto, ‘high-performance rare earth-magnesium alloys at the cost of prime magnesium’ successfully reflects our mission,” notes project coordinator Blanca Araujo. The team tried out different mixtures containing magnesium and REEs that are suitable for engineering applications and that can be recycled in an eco-friendly manner to solve the price problem.

FOSTERING A RECYCLING CULTURE

The combined effort of the project teams led to a closed-loop recycling process for magnesium alloy production. This is key to improving Europe’s sustainability to reduce



© Blanca Araujo

“ Our motto, ‘high-performance rare earth-magnesium alloys at the cost of prime magnesium’ successfully reflects our mission. ”

its dependence on raw materials, supporting a circular economy model of reusing and recycling rather than discharging materials as waste.

Project members developed different techniques for the recovery of both REEs and magnesium, reclaiming these useful elements from industrial waste residues, and dross/scrap piles, respectively. In particular, they reported various processes including mechanical processing, hydrometallurgy, solvometallurgy and pyrometallurgy for extracting and separating REEs from lamp phosphors, cathode-ray tubes and nickel–metal hydride batteries. “The final recovery route we selected reached technology readiness level 5. We succeeded in recovering very high percentages of yttrium oxide from lamps, as well as of lanthanum and cerium oxides from batteries,” notes Araujo.

The team also demonstrated improved low-cost techniques for recycling magnesium that require very low energy. “Magnesium recycling can be more dangerous than casting given that the material is highly flammable. We showed how magnesium foundries can recycle their own scraps instead of directly re-melting them in the crucible which ultimately creates more impurities,” adds Araujo.

Another project achievement was the manufacture and validation of an industrial facility specifically targeted at recycling magnesium alloys. The facility producing ingots at 240 kg/h in full production can be plugged to any magnesium foundry.

PRACTICAL APPLICATIONS

As part of REMAGHIC, a prototype of a tailgate was designed to show how magnesium alloys could be used in the automotive industry. In addition, an aircraft’s pivot fitting was redesigned to demonstrate that the combination of recycled magnesium and primary REEs is cheaper and lighter when compared to titanium.

The biomedical field is another area where magnesium and its alloys can play a major role. The material holds promise for use in medical implants. Compared to titanium, which is widely used, it is more similar in strength to bones and it biodegrades. “If you had a screw made of magnesium in your wrist, you wouldn’t need a second surgery to remove it,” says Araujo.

REMAGHIC

- Coordinated by the CIDAUT Foundation in Spain.
- Funded under H2020-LEIT-ADVMANU.
- cordis.europa.eu/project/id/680629
- Project website: remaghic-project.eu

INDUSTRIAL TECHNOLOGIES

Breaking the mould of light metal part production

Intelligent lightweight construction can further reduce the weight of future electric vehicles without jeopardising safety and comfort. Lighter metal structures are now possible thanks to a new gas-assist technique that produces hollow sections out of thick metal parts.

Lightweight design concepts are at the heart of the upcoming electric vehicle revolution. Forcing molten metals into a mould at high speed and pressure – high-pressure die

casting – provides manufacturers with the flexibility to create complex components. Besides being lightweight, these are also strong and tolerant. The considerable



© Marcel Op de Laak

increase in the use of light metal castings such as aluminium or magnesium presents a growth opportunity for the relevant industries.

The EU-funded MAGIT (Magnesium and Aluminium Gas Injection Technology for High Pressure Die Casting) project provided the necessary solution for this structural change. Researchers implemented a versatile alternative to more traditional injection moulding techniques called gas-assist injection moulding. “The steadily increasing demand for die casting of light materials, faster cycle times and lower production costs makes gas-assist injection technology a special process with enormous potential,” notes Marcel Op de Laak managing director of TiK-Technologie in Kunststoff GmbH.

GAS INJECTION MAKING ITS MARK ON METALS

Utilising high-pressure air to displace and push material in mould cavities, gas injection is an innovative method that was originally used in plastic processing to produce parts with hollow sections. With proven success in one field, project partners capitalised on the potential of this process for die casting.

“Our new gas injection technology called MAGIT allows the manufacture of high-pressure die-casting parts with a hollow section inside without putting any cores inside,” notes Op de Laak. The technology makes it possible to

inject gas into an aluminium or a magnesium part by pushing out the still molten mix into a spill-over cavity. Importantly, the manufacturing of complex hollow parts does not require additional upstream and downstream processes, an option which is not offered in conventional injection moulding where lost cores are used. Furthermore, the technology does not cause any sink marks and voids or any dimensional distortion, thereby allowing new levels of freedom in the design of thick-walled, hollow components.

ENHANCED DESIGN

This innovative gas injection system design consists of four main components, and appears to be on track to deliver superior performance and high compression. This repeatable and reproducible process is suitable for industrial applications. In particular, the core element of the system, the compressor, contains all relevant systems for control, gas and hydraulic pressure. The accumulator next to the mould shortens the routes to the die module, while the latter takes charge of the gas supply, hydraulics and cooling water line. All these modules can be mounted on a conventional die casting machine without any modification except from providing an interface of some machine signals.

Furthermore, an injection module processes the gas directly to the injector. Gas injection is triggered by a signal provided by two metal front contact sensors in the die’s gate area. Additional die sensors are used for monitoring and evaluating the injection process. Through a tablet, the operator can control and monitor the actual injection process in real time.

Die casting is an efficient and economical process, offering a broad range of component parts that are strong, light and have a long service life for the automotive industry as well as other applications. “The MAGIT system can be used in all ranges of aluminium and magnesium parts that have thick sections and reduce their weight. The hollow section could also be used as a media duct,” concludes Op de Laak.

MAGIT

- Coordinated by TiK in Germany.
- Funded under H2020-Societal Challenges, H2020-SME and H2020-Industrial Leadership.
- cordis.europa.eu/project/id/815971
- Project website: tik-center.com/



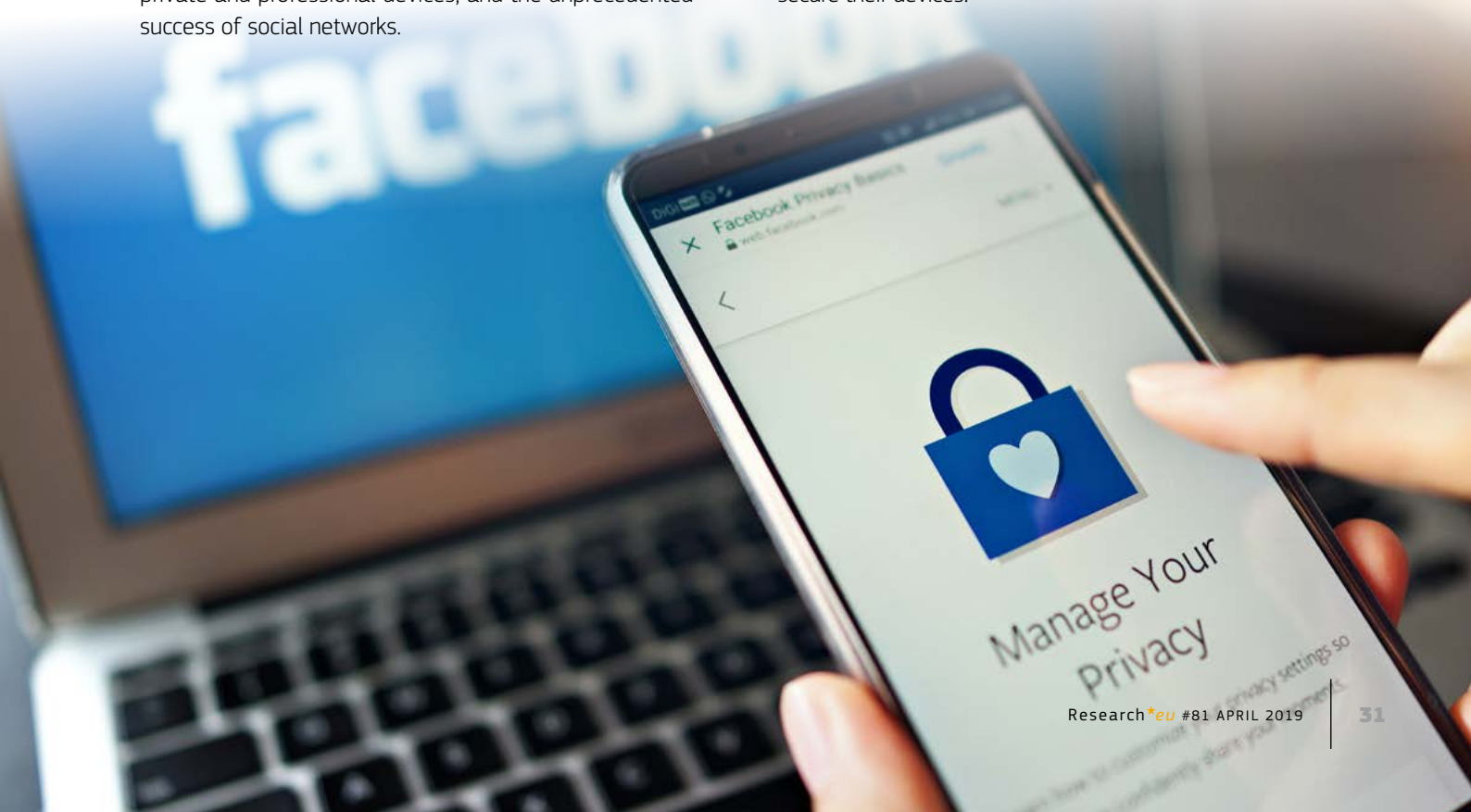
Online security assessment framework helps businesses cope with increased use of personal devices

Employees increasingly access sensitive company data remotely, often from personal devices where social media networks hold a prominent place. Easy targets for cyber criminals? Members of the DOGANA consortium believe so, and they have devised a risk assessment framework to help businesses alleviate this threat.

Working anytime, from anywhere. This could easily be an advertising slogan for the increasingly widespread corporate culture of telecommuting. And who would argue against it? Working from home cuts down on company expenditures, increases productivity, makes employees happier, and even helps tackle issues such as congestion and CO₂ emissions.

But this new philosophy also does raise a few questions, a good one being related to security. Whilst industries have always been vulnerable to cyberattacks, the risk has considerably increased with the blurring line between private and professional devices, and the unprecedented success of social networks.

As Ms Francesca Giampaolo, coordinator of the DOGANA (aDvanced sOcial enGineering And vulNerability Assessment Framework) project, explains, there are different factors at play. "Not only do people increasingly use personal devices for work purposes, but they will often combine this use with that of social media whose business model consists in encouraging them to reveal and share personal information. These platforms fail to provide strong authentication mechanisms and, to make things worse, many people seem unable to avoid subjecting themselves to unnecessary risk and lack the knowledge to efficiently secure their devices."



DOGANA answers this problem with a framework delivering ‘advanced social engineering and vulnerability assessment’ to measure and mitigate the risk related to social vulnerabilities. Whilst all industries are vulnerable, the system allows for quantifying actual risks based on businesses’ ICT dependence, level of consequences following attacks, level of associated risk and other metrics.

The framework consists of: an open source toolchain for performing the vulnerability assessment (information gathering, attack and hook preparation, attack execution and reporting); a training programme including awareness methods and a set of tools for automated risk mitigation; and a law enforcement component.

According to Giampaolo, DOGANA’s main innovations include the ‘information gathering framework’ which relieves testers from gathering the information on their own, in turn reducing error rates and improving efficiency. There is also the ‘awareness framework’ offering a range of awareness methods that can be tailored to the needs of a specific company, as well as the ‘organisational policy framework’ which will provide a set of guidelines and requirements specifically for European enterprises. DOGANA is also fully compliant with the GDPR.

“The framework is designed to provide general Social Driven Vulnerability Assessments (SDVA) services, but at the same time specific parts are tailored for the four application domains that have been tested in the trial phase (defence, government, transport and emergency),” Giampaolo explains.

“Additionally, DOGANA has been designed with two distinct classes of end-users in mind, each with its own limitations and responsibilities: the SDVA Tester, responsible for tasks related to preparation and execution of SDVAs; and the Company Representative, who can access statistics and reports on the results of SDVA execution.”

DOGANA is targeting companies whose employees use a computer daily, providing a solution that can help them monitor the percentage of these employees that get tricked by phishing and social-engineering attacks in general. “We will help these companies to provide training programmes to make sure that their employees fully understand how to avoid getting tricked by emails that look very credible to an inexperienced user,” Giampaolo says.

Market offerings around DOGANA will include consulting services and training, and each consortium member will be promoting the framework to its relevant networks and partners.

DOGANA

- Coordinated by Engineering Ingegneria Informatica in Italy.
- Funded under H2020-SECURITY.
- cordis.europa.eu/project/id/653618
- Project website: dogana-project.eu
- ▶ bit.ly/2s5Lhbo

DIGITAL ECONOMY

New voice trading system makes noise in industry

For a financial market trader who spends his working day on a telephone, time spent dialling or navigating through complex user interfaces can strongly affect business performance. New technology developed under TRADECOM promises to make voice communication more effective than ever, while generating considerable savings for employers.

Huge open offices crowded out with monitors, phones ringing and constant voice outcry... This is generally how we picture a financial trader’s everyday life. The outcry

element is a particularly distinctive feature: despite electronic trading’s rising importance, there is still, to this day, nothing more reassuring than voice trading with trusted

“ Our system provides: highly resilient call routing designed to reduce the risks posed by unplanned outages; reduced development costs thanks to a development-oriented API; and a trading endpoint that combines the best aspects of existing interfaces. ”

people – particularly in volatile times or in the case of the most sensitive and complex deals. The more calls you can make, the more informed your decisions will be.

Technology may have evolved to better serve these needs and provide seamless connections, but there is still a wide gap between investment banks’ expectations and current market offerings. The sector wants to move away from legacy on-site trading communications and embrace cloud offerings with its better scalability and faster reactions to rapidly changing markets.

Currently such a shift is expensive to say the least. But that may be about to change thanks to technology developed by Speakerbus and enhanced under the TRADECOM (Trader communication, collaboration and compliance system) project: it promises not only to decrease costs, but also to provide lighter-weight, right-sized, easily implementable and scalable voice trading solutions.

“We offer a true consumption-based trader voice service model that can be adapted to the needs of our clients. Our system provides: highly resilient call routing designed to reduce the risks posed by unplanned outages; reduced development costs thanks to a development-oriented API; and a trading endpoint that combines the best aspects of existing interfaces,” explains Paul Kitchener, Marketing and Communications Manager at project-leading company Speakerbus.

The system consists of four key elements: a SIP hybrid touch and button device (AYRE®); a secure browser-based device (ARIA); the development-oriented API (iSeries CTI Service); and an enhanced server architecture (iManager Communications Server and IPv6-ready product suite).

AYRE is presented as a touchscreen in a turret: it combines hard and soft keys with gestures and finger tap control for better user interactions. ARIA, on the other hand, is a browser-based voice trading interface. Seamless integration with enterprise communications services is delivered through the iSeries CTI service API, and third-party

integration with Cisco, Avaya and Mitel is possible for effective back-office communication.

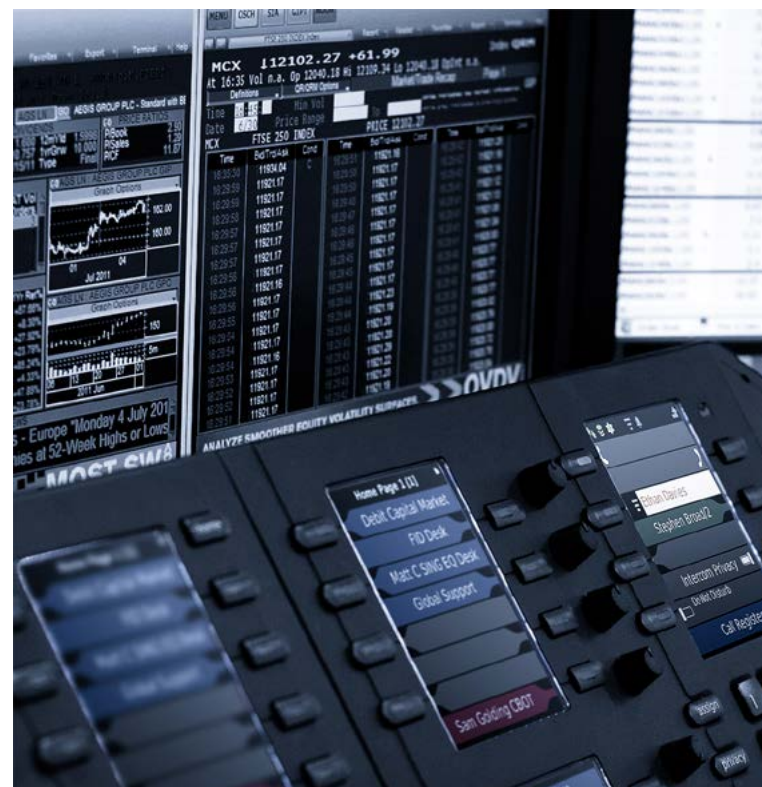
Thanks to EU funding under TRADECOM, Speakerbus improved its manufacturing process and built a unified architecture, making it possible to deploy its iManager technology on premises, in datacentres or on private clouds. As Kitchener explains, “Speakerbus have seen increased market drive towards cloud and off-site installations, and this enhanced flexibility brings new possibilities and opportunities in the financial marketplace.”

Amongst the other important advantages for customers are the possibility of tailoring AYRE and ARIA components to traders’ needs, the fact that the solution takes 17% less desk space than alternatives, a contextual interface to save time, customisable tiles and the integration of various tools, all aiming to improve team collaboration.

“Initial clients have been telling us that this innovation puts Speakerbus at the forefront within financial institutions looking to change their voice trading architecture,” Kitchener enthuses.

By successfully reaching all project objectives, Speakerbus has now become a recognised Tier 1 provider for global trader voice solutions. The company has recently

© Speakerbus



been invited to answer three RFI/RFPs for top tier investment banks, with a net worth of around GBP 50 million (EUR 56 million) over the next five years and recurring maintenance revenue of around 10% to follow per year.

TRADECOM

- Coordinated by Speakerbus Technology in the United Kingdom.
- Funded under H2020-LEIT-ICT and H2020-SME.
- cordis.europa.eu/project/id/666312
- Project website: speakerbus.com/tradecom-project

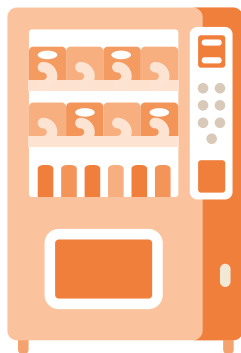
DIGITAL ECONOMY

Mobile commerce platform takes vending machines into the digital age

Vending machines sell over 90 million food and drink items every day across Europe, with over 80% of them installed in the workplace. Despite their prevalence and output, most vending machines need to undergo a digital transformation.

The automatic vending market has high operating costs because of cash management and theft. The majority of vending machines don't give any information on existing stock and hinder logistics optimisation. Operators can't collect data on customers and their purchasing patterns.

Most of the over 4 million vending machines in Europe are isolated boxes that exchange coins for products. "This doesn't make the consumer experience very engaging and limits the efficiency of the companies that operate them," says Luigi Palumbo coordinator of the EU-funded PAGITA (The platform digitizing the world of vending machines) project. "Unattended shopping or unmanned retail today can be better served by smarter machines."



Vending machines sell over **90 million food and drink** items every day across Europe

The project team designed a mobile commerce platform that allows customers to quickly make purchases from vending machines using any channel they prefer: a mobile app, a chatbot for Facebook Messenger and Telegram, or any near-field communication card. The platform also includes a hardware module that's installed in existing vending machines, and a cloud application for service management.

CLEAR CONSUMER AND BUSINESS BENEFITS

PAGITA delivers new capabilities for consumers that will transform their purchasing experience with smartphones. To make a purchase, they deposit money in a digital



“ *Unattended shopping or unmanned retail today can be better served by smarter machines.* ”

wallet managed by PAGITA using a credit card or other digital payment system. Users can even access additional product information such as allergens.

Vending operators can access an interactive dashboard that displays sales and continuous interaction with customers via geo-localised marketing messages. It analyses purchasing dynamics and creates profiles that can be used in marketing campaigns. By using the platform, businesses can reduce their cash management costs, optimise logistics for stock supply, avoid payment fraud and reduce incentives to burglarise.

DIGITALLY REVOLUTIONISING VENDING MACHINES

Project partners assessed the technology's technical and market feasibility. This resulted in a business and marketing plan to support successful distribution of the service in target markets. They re-engineered the hardware platform and are rolling it out with selected customers.

To fine-tune services for customers, team members tested the solution in Italy – the main market on account of the sheer volume of vending machines. They are currently focusing their efforts on the European market overall.

PAGITA worked with its partner companies on enterprise resource planning software integration to provide a

complete solution for its customers. “This validated our key value proposition and guided us towards the next steps for industrialising our services, including the establishment of an industrial partnership for product and service development,” explains Palumbo.

The project is poised to convert innovation into commercial success. It's collaborating with a vending machine manufacturer to develop a new vending machine line with a touchscreen interface. A contract was also signed with a company specialised in the pharmaceutical sector to develop a new service that serves this very important market.

“PAGITA transforms automatic vending machines into smart and connected points of sale that are capable of providing advanced digital services to consumers and enabling novel, more efficient business models for the industry,” concludes Palumbo. “Our vision was to retrofit these automated machines, connect them and give them new life in the digital era.”

PAGITA

- Coordinated by PAGITA S.R.L. in Italy.
- Funded under H2020-LEIT-ICT and H2020-SME.
- cordis.europa.eu/project/id/808720



SECURITY

New device helps law enforcement 'sniff out' illegal activity

Researchers with the EU-funded ChemSniff project have developed a mobile device that provides accurate, real-time detection of substances commonly associated with criminal activity.

There is an ever-increasing need to obtain immediate screening information for such security risks as explosives, drugs and human trafficking. This is particularly true in crowded areas like airports and public events. The problem, however,

is that there is currently no screening or surveillance device capable of meeting this need. The best solution available is the use of trained sniffer dogs, although their effectiveness is minimised by a short attention span and limited overall skills.



But what if we could create the digital equivalent of a sniffer dog – a screening device that detects, identifies, quantifies and alerts law enforcement about any criminally-related substances or odours?

This is exactly what researchers with the EU-funded ChemSniff (Chemical sniffer device for multi-mode analysis of threat compounds) project have created.

“Our newly developed DVLS Vitruvian Ranger is the perfect answer to providing higher safety standards in a variety of public places,” says ChemSniff project coordinator Mr Willem van Raalte. “This all-encompassing solution ensures the accurate, mobile and real-time detection of substances commonly associated with criminal activity, including chemical weapons, drugs, explosives and trafficked people.”

DIGITAL SNIFFER DOG

The Vitruvian Ranger is comprised of two key components: a lance that takes an air sample to scent, or smell, a substance related to illegal activities and a portable analytical instrument controlled by a compact personal computer. The device’s sense of smell is based on the Quadrupole Mass Spectrometry (MS) analysis technique which, when combined with a detector, allows it to detect the individual atoms and complex molecules of different substances.

As a compact screening device, the Vitruvian Ranger can be easily carried in a security guard’s backpack. To use it, the guard simply takes air samples by pointing the device’s connected lance at potential hazardous components.

“Once the Vitruvian Ranger has determined the MS fingerprint of an unknown substance, it is compared to a database of known criminal-related substances, allowing for an accurate identification of the detected matter,” explains van Raalte. “Immediately, the Ranger alerts the guard and gives an exact indication of the substance that was found.”

Van Raalte explains that the device’s inherent flexibility makes it applicable to a range of specific threats and human activity. “The sampling lance has a scenting capability of up to several metres, depending on environmental disturbances of the targeted analyses,” he says. “Thus, it can be used to inspect everything from shipping containers to people, clothing and luggage.”

TOWARDS A FULLY MOBILE SENSOR

According to van Raalte, the Vitruvian Ranger is the first step towards achieving a fully mobile surveillance sensor. Researchers are continuing to develop the device into a smaller, cost-effective sensor that will allow the number of sites to be monitored to increase exponentially.

CHEMSNIFF

- Coordinated by Da Vinci Laboratory Solutions B.V. in the Netherlands.
- Funded under H2020-SECURITY and H2020-SME.
- cordis.europa.eu/project/id/674716
- Project website: chemsniff.eu

SECURITY

No-guesswork maintenance for X-ray security checkpoints

Security checkpoint X-ray machines need maintenance, but knowing exactly when has been very difficult. A new development removes the guesswork.

X-ray systems used at security checkpoints, known technically as non-intrusive inspection systems (NIIS), have become essential to the processing of baggage and cargo by airports, customs and other NIIS end users. The systems allow convenient searching for illicit goods or substances in objects. Doing so helps deter many types of crime.

The systems work well. The problem is that the current maintenance is costly, time-consuming, and at best inefficient and often unnecessary. Over 90% of equipment failures result from conditions that can occur at any time, so the bulk of the maintenance effort makes no difference to breakdowns. Preventative maintenance instead often causes malfunctions,



© Nikoleta Genova

with up to 70% of incidents occurring shortly after servicing. As a result, NIIS suffer up to 35% downtime each year.

Determining when maintenance is actually required can be very difficult. Currently, the condition of components cannot be monitored during operation. The case of maintenance being required but not provided can lead to cascade breakdowns, especially when cooling systems are involved. This means expensive repairs.

Therefore, the security industry needs a way of continuously monitoring the state of key NIIS components, to devise realistic maintenance schedules without guesswork. The EU-funded PMT4NIIS (Predictive Maintenance Tool for Non-Intrusive Inspection Systems) project investigated ways of providing the necessary monitoring and predictions.

CONTINUAL MONITORING

The project concept essentially involves collecting, logging and analysing data from sensors in NIIS. The team first developed suitable new sensors and sensor networks, which were retrofitted into existing machines. Researchers used proprietary project algorithms to search the collected data for predictive patterns of maintenance and breakdown.

During the project's first completed phase, the team's analysis detected useful maintenance patterns. This confirmed the concept's technological and commercial feasibility.

“NIIS maintenance staff will be able to monitor system performance from their offices, understand the operation, and receive intelligent assistance for the resolution of problems.”

The developments are not yet ready for commercialisation. Nevertheless, the eventual product is confirmed to be on track towards the goal of permitting continual NIIS monitoring without regular inspections or costly repair interventions.

NEW CAPABILITIES

“NIIS maintenance staff will be able to monitor system performance from their offices, understand the operation, and receive intelligent assistance for the resolution of problems,” says Nikoleta Genova, communication specialist for Danlex, the project's sole partner. Service providers will also be able to cooperate with Smiths Detection (an international screening-technology company) to swiftly carry out data-driven maintenance actions.

The commercial product will also have numerous other advantages over contemporary systems, particularly in terms of automatic data collection, interactivity and heuristic learning.

Researchers are progressing towards commercialisation, in part by introducing the new maintenance concept and its benefits to the target market. PMT4NIIS will be offered to NIIS end users in Bulgaria, Macedonia and Kosovo, to NIIS service providers around the world, and to Smiths Detection themselves. “One unexpected challenge,” adds Genova, “was the need to ensure legal and regulatory compliance in each market we enter with regard to radiation safety, data protection, licensing and intellectual property.” The team is working on such compliance, and has applied for EU funding for a second project phase.

The new concept will eliminate unnecessary NIIS maintenance and related downtime thanks to predictions and real-time monitoring of NIIS condition that enable quicker repair times. Instead, maintenance will occur only when systems need it, and therefore fewer visits to the site of NIIS will be necessary. Ultimately, the development will mean cheaper and more efficient operation of NIIS.

PMT4NIIS

- Coordinated by Danlex EOOD in Bulgaria.
- Funded under H2020-SECURITY and H2020-SME.
- cordis.europa.eu/project/id/790798



Ultracold neutral atoms helped overcome the long-standing challenge of building quantum systems

Building quantum systems with a high degree of control and coherence is still a major challenge to this day. The QuantuM-nano project has successfully used ultracold neutral atoms to achieve this, with potential applications in quantum simulations and information processing.

The quantum technology race is on. In October, the EU kick-started its quantum technologies flagship, a EUR 1 billion initiative funding over 5 000 researchers for the next 10 years. The US Congress, on the other hand, had just responded with its own USD 1.2 billion-worth quantum technologies bill as we were writing these lines.

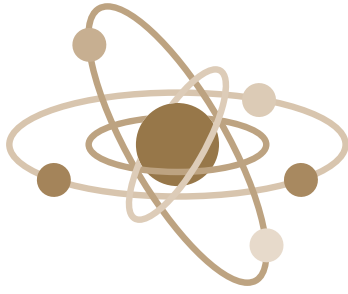
Granted, the first quantum computer prototypes already exist, but many obstacles remain even in fundamental research, one of them being the need for increased precision in individual qubit manipulation and interactions.

The QuantuM-nano (Quantum Measurements with Bose-Einstein condensates strongly coupled to nanophotonic structures) project aimed to solve this problem by focusing on ultracold neutral atoms – thereby distancing itself from the most common approach of quantum computing using superconducting circuits.

“Ultracold neutral atoms have several attractive properties. For example, all atoms of a given species are intrinsically identical, which is a strong asset when using them as qubits,” says Prof. Jakob Reichel of Laboratoire Kastler Brossel in Paris, coordinator of the project.

“Neutral atoms can also be very well isolated from the outside world: they are typically trapped by electromagnetic fields inside a vacuum chamber, which helps preserve their quantum behaviour. They are also relatively easy to handle thanks to the astounding progress of atomic physics and laser technology over the past few decades. Finally, their absence of electric charge is an asset when trying to scale the systems up by trapping many atoms within a small volume.”

Whilst the value of ultracold atoms for quantum simulations had already been investigated and acknowledged, QuantuM-nano stands out with a novel approach consisting in building chains of atomic qubits. Each atomic qubit is confined in an individual optical trap while empty



The **Quantum Technologies Flagship** is a **€1 billion** initiative that will fund over **5 000 researchers** for the next **10 years**

trapping sites are all eliminated, resulting in chains 100% free of defects. This, in turn, allows for aligning atoms in a perfectly regular order.

“From thereon, we started exploring two methods to make the qubits interact: dipolar interactions and coherent exchange of photons in a cavity,” explains Dr Sylvain Schwartz, now at Laboratoire Kastler Brossel, who worked at Harvard for two years as part of the project.

The project’s breakthroughs have enabled the creation of a large programmable quantum simulator with up to 51 atoms, with what Dr Schwartz qualifies as an unprecedented degree of control. “With this platform, we could:

explore the phase diagram of an Ising Hamiltonian; study the dynamics of various quantum phase transitions; and prepare two-atom entangled states based on Rydberg interactions with the highest fidelity reported so far – over 97%,” he says.

In the future, Prof. Reichel hopes these platforms will be used to implement quantum optimisation algorithms – where a hard-to-solve problem on a classical computer is encoded into a quantum system in such a way that the system naturally evolves towards the desired solution – even though much work is still needed. “Combined with optical cavities, these systems could also serve to create metrologically useful quantum states that would push the limits of state-of-the-art atomic clocks, which in turn could find applications in geodesy or for testing some fundamental laws of physics that are still questioned,” he explains.

The consortium now intends to extend their research from monovalent atoms with a relatively simple structure, such as rubidium, to divalent atoms like strontium – which are expected to be used in tomorrow’s atomic clocks.

QUANTUM-NANO

- Coordinated by CNRS in France.
- Funded under H2020-MSCA-IF.
- cordis.europa.eu/project/id/658253

FUNDAMENTAL RESEARCH

Mathematics shed new light on the topological phases of matter

The OATP project has considerably advanced the mathematical understanding of the topological phases of matter. Project results could prove valuable for future research on quantum computing.

The world as we experience it every day could easily deceive us into thinking that matter has only three

possible phases: solid, liquid and gas. But the truth is, there is more to it than meets the eye. As most recently

“We provide a precise mathematical framework to study topological phases, allowing one to derive properties of the anyons in a systematic manner from the underlying quantum system.”

demonstrated by research on the topological phases of matter that was awarded the 2016 Nobel Prize in Physics, there is a dizzying number of exotic phases of matter patiently waiting to be studied.

For researchers encountering a new state of matter, the first question that usually comes to mind is whether they can be listed and grouped based on their properties. “Put differently, it is interesting and helpful to be able to classify different topological phases. It helps distinguish between unknown systems, and it gives us a better idea of what can be done with these systems,” explains Dr Pieter Naaijken, the mathematical physicist who coordinated the project at RWTH Aachen University and the University of California, Davis.

This is interesting for mathematicians wanting to highlight the mathematical foundation of topological order, but also for concrete applications such as quantum computing. New topological phases are hoped to be one of the keys to making scalable quantum computers a reality, protecting them from errors due to unwanted interactions with the environment. Topological properties can be used for inherently stable memory to store a quantum state for an extended period of time, or for computations through the use of anyons – an excitation of the system that behaves like a (quasi-) particle.

To get there, researchers need a better mathematical understanding of which systems can in principle lead to anyonic reactions. What are the properties of anyons? Do their inherent stability meet expectations based on their topological nature? “One of our main results shows this is indeed true for certain models: if we perturb the system gently, the properties of the anyons do not change,” says Dr Naaijken.

On a more fundamental level, the OATP (Operator algebraic approach to topological phases) project aimed to list the different types of possible topological phases and their anionic excitations, as well as identify which ones are most suitable for use in quantum computing.

“We provide a precise mathematical framework to study topological phases, allowing one to derive properties of

the anyons in a systematic manner from the underlying quantum system. This makes it amenable to applying a wide range of powerful mathematical techniques, which are not always available when using more heuristic arguments,” Dr Naaijken explains.

According to Dr Naaijken, the project’s most important outcome is the first-ever such rigorous mathematical proof of the stability of the properties of anyons in abelian quantum double models. Concretely, the team could demonstrate that, in these models, possible anyonic excitations and their properties do not change when perturbing the dynamics of the underlying system, so long as the perturbation is not too big. “Even though our proof only holds for a limited class of models, it clearly shows a path towards generalisation to a broader class of models,” says Dr Naaijken.

With the project now completed, Dr Naaijken hopes its results will open new ways to study topological phases, particularly from the mathematical point of view. “In my view, this is essential to gain a deeper understanding of the underlying mechanisms that are responsible for the topological properties of such systems,” he concludes.

OATP

- Coordinated by RWTH Aachen University in Germany.
- Funded under H2020-MSCA-IF.
- cordis.europa.eu/project/id/657004
- Project website: pieter.naijken.nl/mariecurie





LIFE AFTER...

Catching up with GRAPHENESENS: One company's quest to push graphene from the lab to the market

*We cover graphene a lot on CORDIS. And why wouldn't we? It's the thinnest known compound but also the strongest. Graphene promises to be a hugely important material in the twenty-first century and the EU has invested big in graphene research. In our special feature on graphene in issue 70 of Research*eu magazine, we featured GRAPHENESENS, an EU-funded project that is helping to take graphene from the lab and onto the market. For this month's 'Life After', we got back in touch with Dr Pufinji Obene, Operations Director of Precision Varionic International and GRAPHENESENS coordinator.*

The **GRAPHENESENS** project originally focussed on graphene for contact sensors in the automotive industry, specifically sensors for the likes of antennas, accelerator pedals, encoders, motors and even, possibly, robotics. The benefit of adding graphene – even a very small amount – to usual production methods would see enormous benefits, such as the enhancement of the product's lifespan, increased durability and overall cost reductions.

EVERY LITTLE STEP HELPS

When we last spoke to Dr Obene in early 2018, he was enthusiastically telling us about his plans for commercialisation. "Since then, for internal testing, we've manufactured a graphene-enhanced position sensor prototype based on an existing product and tested it for like-for-like and the results were comparable in every way," comments Dr Obene. "For external testing, we manufactured 24 and 48 pulse encoder prototypes for Piher Sensing Systems, a major Spanish company manufacturing interconnect and cable manufacturers. The results show that only a few small improvements must be done

to obtain functional prototypes that fulfil the current encoder specifications, i.e. graphene screen printing and graphene coating wipers."

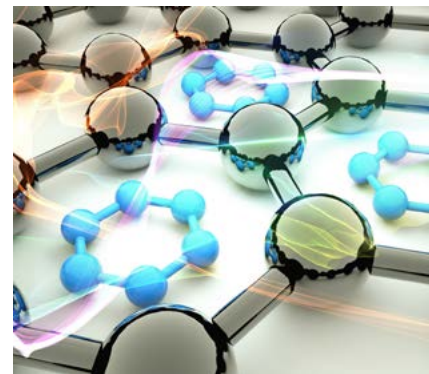
Dr Obene only predicts another six months of development to get these functional encoders ready for market introduction. In general, he's also upbeat about graphene's overall entry into the market as a crucial component of many everyday essential applications. "Graphene development into the mainstream market will be and is very challenging but now that all of the scientific hype is out of the way, the focus really is to look at the small step that will lead to larger and larger ones in terms of market penetration – and that's what we're trying to achieve."

Whilst the main focus continues to be the automotive industry, Dr Obene previously told us that they were also interested in branching out to other sectors. Has there been any progress here? "We're also now interested in the consumer sector, particularly using encoders as position sensors for joystick control and steering wheel control for the gaming market," says Dr Obene. "I'm

actually now in contact with several gaming companies in this regard and I hope something very positive will come from these discussions soon."

ON EU FUNDING OPPORTUNITIES

Discussing the impact of EU funding, Dr Obene concluded: "The project funding derived from SME Instrument 1 really focuses on looking at the market and I believe that this is an important aspect that the EU should concentrate more on in terms of funding. We are currently considering SME Instrument 2 as a next step but we really want to get everything in place first. And we really need to thank the European Commission for its contribution to helping us to really understand the market and pinpoint the best opportunities – our work continues!"



GRAPHENESENS

- Coordinated by Precision Varionic International Ltd in the United Kingdom.
- Funded under H2020-SME, H2020-LEIT-ADVMANU, H2020-LEIT-NANO and H2020-LEIT-ADVMAT.
- cordis.europa.eu/project/id/762394
- Project website: sensegraphene.com

“*Graphene development into the mainstream market will be and is very challenging but now that all of the scientific hype is out of the way, the focus really is to look at the small step that will lead to larger and larger ones in terms of market penetration – and that's what we're trying to achieve.*”

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AGENDA

MAY 2019

BRUSSELS, BELGIUM

BuyZET Final Conference

→ buyzet.eu/event/buyzet-final-event

7
MAY

16→17
MAY

BARCELONA, SPAIN

International EPRISE Roadshow

→ photonicsroadshow.eu/events/2018-07-09-barcelona

17
MAY

WORLDWIDE

World Information Society Day

21→23
MAY

PARIS, FRANCE

EMBRIC Final Conference

→ embric.eu/node/841

22
MAY

WORLDWIDE

→
International Day for Biological Diversity

27→30
MAY

BUCHAREST, ROMANIA

TandemAEROdays 2019

→ tandemaerodays19-20.eu

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28-31 MAY

LISBON, PORTUGAL

ECCA 2019 – Fourth European Climate Change Adaption Conference

The biennial European Climate Change Adaptation conference is convened by EU-funded projects on behalf of the European Commission. In 2019, the conference is being organised by the PLACARD, BINGO and RESCCUE projects. It will cover six climate-related themes and include an exhibition, poster presentations and a number of dedicated research and business-themed parallel sessions.

→ ecca2019.eu

CORDIS RESULTS PACK ON CONNECTED AND AUTOMATED DRIVING

In our newest Results Pack, we discover how eight EU-funded projects are helping to revolutionise transport mobility through connected and automated driving (CAD) to make Europe a global leader in safer and more efficient solutions for personal mobility.



European Commission
CORDIS Results Pack on
**connected and
automated driving**
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