



#77
NOVEMBER 2018

Research[★]eu

BRINGING YOU THE RESULTS OF EU RESEARCH AND INNOVATION



Closer to a stem cell therapy
for Huntington's Disease

Smart functionalities
to bring order to Wi-Fi chaos

Enhanced preparedness
and response plans
for pandemics

SPECIAL FEATURE
CHARGED UP AND READY TO
ROLL! ELECTRIC VEHICLES
TAKE TO THE ROAD

Editorial

A special look at electric vehicles, a robot giving evidence to the UK Parliament and more – welcome to this month's Research*eu magazine

The nights are getting longer and autumn is upon us. As the seasons shift, once again there has been heavy emphasis on the changing climate, with several recent large-scale natural weather events causing destruction and death across the world. The UN also recently warned with a new report that humanity has only 12 years to take effective action or the struggle against climate change could be lost forever.

As such, decarbonisation of our industries and the adoption of carbon-neutral new technologies is absolutely essential. Transport is one area where good progress can be made and this is why our special section focus this month is particularly timely. We're having a closer look at innovative EU-funded efforts to increase the appeal, range and functionality of electric vehicles. Whilst we primarily focus on land vehicles, we at CORDIS always like to throw in a 'wild card' project as well – this month, it's on **E-ferry**, a project working towards the first fully operational electric ferry.

We were also extremely excited by our pick for this month's **Project of the Month** feature which focuses on Pepper, a

humanoid robot working under the **CARESSES** project, who made history by being the first robot to give evidence to a parliamentary panel, specifically the UK's House of Commons Education Select Committee. Pepper provided insights on how artificial intelligence can contribute to the world's 'fourth industrial revolution'.

Finally, this month's **Life After** catches up with one of the key researchers of the now-closed **SHDS** project that has been working towards stronger earthquake defences. You can also find out about some of the most intriguing EU-funded project events and relevant international days in **EU Agenda**, and, as per usual, catch up with the latest developments in our nine regular thematic sections.

We hope you like the latest revamp of Research*eu magazine, which of course launched last month, but we value all feedback. If you'd like to send us your questions and/or suggestions, please send them to: 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

Editorial coordination
Birgit Alice BEN YEDDER

Research*eu is free of charge.

For all issues of the magazine you can:

- browse the web edition in six languages
- download the PDF version
- order single print copies
- subscribe to have every issue posted to you worldwide

Go to cordis.europa.eu/research-eu

Disclaimer

Online project information and links published in the current issue of the Research*eu magazine are correct when the publication goes to press. The Publications Office cannot be held responsible for information which is out of date or websites that are no longer live. Neither the Publications Office nor any person acting on its behalf is responsible for the use that may be made of the information contained in this publication or for any errors that may remain in the texts, despite the care taken in preparing them.

The technologies presented in this magazine may be covered by intellectual property rights.

ISSN 2599-7912 (printed version)
ISSN 2599-7920 (PDF)
Catalogue n° ZZ-AG-18-009-EN-C (printed version)
Catalogue n° ZZ-AG-18-009-EN-N (PDF)

Luxembourg: Publications Office of the European Union, 2018

© European Union, 2018

Reuse is authorised provided the source is acknowledged.

The reuse policy of European Commission documents is regulated by Decision 2011/833/EU (OJ L 330, 14.12.2011, p.39).

For any use or reproduction of photos or other material that is not under the EU copyright, permission must be sought directly from the copyright holders.

Cover photo © Smile Fight, Shutterstock

Contents

#77
NOVEMBER 2018



HEALTH

- 4** Closer to a stem cell therapy for Huntington's Disease
- 5** Paving the way to a new generation of non-invasive sensors to identify abnormal heart rhythms reliably
- 7** Could targeting our immune responses help in the fight against hypertension?



SOCIETY

- 9** New insights into the role of Coptic monasteries in the economy of late antique Egypt
- 11** More power to social enterprises in rural regions



ENERGY

- 13** Social gaming for better energy efficiency in public buildings
- 15** Coordinated ocean energy efforts herald a new industrial sector
- 17** High winds for power generation



CLIMATE CHANGE AND ENVIRONMENT

- 19** New research on carbon dioxide storage in porous rocks
- 20** From East-Asian monsoons to the jets on Jupiter, a new set of models helps interpret climate systems



LIFE AFTER...

- 22** Catching up with SHDS: Working towards stronger earthquake defences



SPECIAL FEATURE

- 01** Charged up and ready to roll! Electric vehicles take to the road



FOOD AND NATURAL RESOURCES

- 23** Benefit for consumers as authorities supporting food authenticity research collaborate more closely
- 25** A new take on resilience in food systems – a focus beyond efficiency to sustainability and vulnerability
- 26** How forest management strategies should account for their carbon sequestration potential



INDUSTRIAL TECHNOLOGIES

- 28** Better performing carbon fibres at reduced cost to profit and planet
- 30** Smart, safe and portable measurement solutions for rail, auto and steel industries
- 31** Smart robots master the art of gripping



DIGITAL ECONOMY

- 33** Smart functionalities to bring order to Wi-Fi chaos
- 34** Novel AI-based software for better musical inspiration, creativity and composition



PROJECT OF THE MONTH

- 36** A world first as EU-funded project robot gives evidence on AI in a parliamentary hearing



SECURITY

- 37** Enhanced preparedness and response plans for pandemics
- 38** Smarter drones to support Europe's police forces



FUNDAMENTAL RESEARCH

- 40** Electron stopping power showcases its potential
- 41** Surface chemistry between graphene and ionic liquids



AGENDA

- 43** December 2018



Closer to a stem cell therapy for Huntington's Disease

REPAIR-HD used Huntington's Disease as a test case for overcoming the challenges of taking stem cell therapies from the laboratory to clinical trial. Doing so develops European capacity to tap emergent therapies for a broad range of human neurodegenerative diseases.

Huntington's Disease (HD) presents a good clinical model for research into how stem cell therapy could repair the affected brain cells in a range of neurodegenerative disorders.

HD is a devastating inherited disorder which causes damage and loss of certain cells in the brain. Sufferers slowly experience progressive loss of physical coordination and mental capacity, with most requiring fulltime care in the late stages. There is currently no known comprehensive treatment or cure.

Because HD predominantly affects one part of the brain, it is a good target for neural transplantation, and due to the existence of a reliable genetic test which diagnoses it effectively, it makes a powerful model for clinical trials. HD also provides a robust test of the capacity of transplanted cells to repair neural circuits.

The EU-funded REPAIR-HD (Human pluripotent stem cell differentiation, safety and preparation for therapeutic transplantation in Huntington's disease) project set out to generate all the elements necessary for a future clinical trial of pluripotent (capable of developing into any cell type) stem cell-derived transplants for HD. The first step was to improve the process of making stem cells differentiate into striatal medium spiny neurons (MSNs), the neurons most affected in HD.

This process involved exposing the stem cells to various molecules to trick them into becoming immature MSNs, which can then mature into fully differentiated MSNs after transplantation into the brain. Out of the various pluripotent stem cells available, the team focused on human embryonic stem (hES) cells as the primary target for first-in-man proof-of-concept studies, as they are closest to clinical readiness.

TESTING HUMAN EMBRYONIC STEM CELL POTENTIAL

REPAIR-HD succeeded in developing an improved differentiation protocol for generating MSNs from hES cells and translation of that protocol for clinical application. This included gathering evidence of cell graft viability and safety, following transplantation into rodents and monkeys and validation of tools for following their progress. REPAIR-HD also developed new clinical assessments for HD patients and a fully documented protocol for a future clinical trial.

As Professor Anne Rosser further explains, "We know from foetal transplants that correctly differentiated MSNs have the capacity to repair the brain in HD. However, foetal cells are difficult to source and raise ethical issues. Stem cells are a good alternative, as they proliferate in culture and can also be made to differentiate into all adult cells of the body."

“ We advanced work across a broad front, and now have a much more sophisticated understanding of the clinical translation challenges. We have set up a new global network to facilitate data sharing and discussion of these challenges. ”

The team first studied the development of the donor stem cells in laboratory culture systems, using a wide range of methods, such as antibodies to ascertain what sort of cells had been generated and electrophysiology to examine their characteristics. They then transplanted the cells into animals (rodents and monkeys) and used behavioural tests to see how the transplants affected the animals' functioning.

Clinical assessment tools were developed and tested in HD patients across partner labs, with the most effective tools selected through a partner workshop. The tools were then put together as a new battery of tests and the whole battery was trialled in each of the clinical centres, with patients tested at the start, one month later and a year later. An added benefit is that this new battery should be useful for testing the effect of a wide range of other potential therapies for HD.

IMPLICATIONS FOR A RANGE OF NEUROLOGICAL DISEASES

REPAIR-HD's results bring closer the prospect of a therapy for one of the commonest monogenetic diseases of the nervous system. If this therapy proves effective, it will lay the groundwork for a similar approach for a wide range of other neurological diseases.

Reflecting on the project's achievements Professor Rosser says, "We advanced work across a broad front, and now have a much more sophisticated understanding of the clinical translation challenges. We have set up a new global network to facilitate data sharing and discussion of these challenges."

REPAIR-HD

- Coordinated by Cardiff University in the United Kingdom.
- Funded under FP7-HEALTH.
- cordis.europa.eu/project/rcn/109572
- Project website: repair-hd.eu

HEALTH

Paving the way to a new generation of non-invasive sensors to identify abnormal heart rhythms reliably

Abnormal heart rhythms are a major cause of cardiovascular disease and death. Sudden cardiac death accounts for 50 % of cardiac mortality in developed countries. As effective treatment can be delivered if arrhythmias are detected early, one EU project has developed a new diagnostic tool for preventive clinical practice.

Ventricular tachycardia or ventricular fibrillation is the commonest form of underlying arrhythmia. In those still going about their daily lives, atrial fibrillation is the most common form and is associated with increased risk of stroke and heart failure, particularly in the older population.

While appropriate treatment can be effective, the problem is that diagnosing the condition requires a monitor to be continuously worn over a period of time, or invasive techniques such as implantable loop recorders. These are inserted subcutaneously beneath the chest wall. Although capable



of monitoring heart rhythm for extended periods, there is considerable expense associated with the device along with hospitalisation costs and the risk of infection.

“A WASTCArD, non-invasive, long-term heart rhythm sensing device will significantly impact multiple areas of cardiac early diagnosis and treatment, as it would allow long-term recording of heart rhythms without the inconvenience and unreliability of self-adhesive gelled electrodes,” says Professor Omar J. Escalona, the WASTCArD (Wrist and arm sensing technologies for cardiac arrhythmias detection) project coordinator.

The project set out to design a new, advanced, dry-electrode based monitoring system, which will enable uninterrupted long-term, non-invasive electrocardiographic (ECG) recordings. This device takes the form of a comfortable arm-band to be used by cardiac patients with transient abnormalities of heart rate or rhythm. “It would also have a role to play in the preventive, long-term ECG screening schemes of healthy subjects with potential cardiac risks due to their occupational or sports activity. But the goal is the same: to enable early detection and diagnosis of heart disease,” explains Prof. Escalona.

A problem besetting such technology is the contamination of signals arising from ‘noise’ caused by movement or muscular activity in the arm. So WASTCArD developed an advanced, real-time signal processing technique for effective ECG signal recovery from severe noise.

“We have developed the technology required to enable a dedicated, embedded system design within a wearable ECG capture arm-band device, incorporating the use of novel dry-electrodes to reliably recover and sense the electrical activity of the heart. This works continuously, for long periods of time, in a distant and weak bipolar ECG lead disposition, mainly along the left arm,” says the professor.

Being able to record cardiac rhythm in an outpatient setting over a long time period, non-invasively, would also reduce hospital costs with savings in overnight bed stays and outpatient and emergency room attendances.



Sudden cardiac death accounts for

50%

of cardiac mortality in developed countries

“We have developed the technology required to enable a dedicated, embedded system design within a wearable ECG capture arm-band device, incorporating the use of novel dry-electrodes to reliably recover and sense the electrical activity of the heart. This works continuously, for long periods of time, in a distant and weak bipolar ECG lead disposition, mainly along the left arm.”

Prof. Escalona is swift to point out that these are valid expectations in the long term, “A second stage continuation of the project is envisaged. This would speed up the benefits that we can already identify as feasible, such as: a reduction in sudden death rates and lethal arrhythmias; pre-participation screening in sport; atrial fibrillation; telehealth and telemedicine; and in the area of cardiac palpitations.”

While these benefits are yet to unfold, Prof. Escalona is keen to see a partnership that has sprung up between two SMEs involved in the consortium behind the WASTCARD project

flourish. “This will eventually impact on company production growth, business maturity and stability in the long-term, with the impact of delivering cardiovascular healthcare solution services for the European, age-indexed, cardiovascular healthcare market,” he explains.

When it comes to the elderly population, the estimated overall market size for cardiovascular healthcare services and associated devices is about 70% of Europe’s annual healthcare cost of cardiovascular disease and its numerous co-morbidities. “Given the state of the market, a ‘smart’ and convenient product such as this will secure a high level of investment reimbursement,” says Prof. Escalona.

WASTCARD

- Coordinated by the University of Ulster in the United Kingdom.
- Funded under H2020-MSCA-RISE.
- cordis.europa.eu/project/rcn/194385
- Project website: sites.google.com/site/wastcardproject/home

HEALTH

Could targeting our immune responses help in the fight against hypertension?

Renal failure, stroke, myocardial infarction and heart failure – just some of the results of hypertension which affects one in three adults, with another 30 % at risk. One EU project has taken a close look at what role our immune systems play.

Despite extensive research, the mechanisms of most cases of hypertension remain unclear. In spite of therapies available, over 40% of treated patients do not improve on medication, and, since the mid-1980s, no new classes of drugs have been successfully developed to treat hypertension.

Noting that mice lacking T cells or monocytes are protected from severe hypertension and renal/vascular dysfunction,

the EU-supported research carried out by the ImmunoTension (Inflammation and Immunity in Human Hypertension and Vascular Dysfunction) project considered a novel mechanism for hypertension. They assessed the involvement of T lymphocytes, monocytes and dendritic cells in the condition. But the relevance for human hypertension remained unclear, so the ImmunoTension project stepped in to try and clarify what the interaction is.



“ We identified that targeting chemokines, such as chemokine RANTES, may provide a potential therapy. We can use the same medications that are used in treatment of AIDS. ”

The immune system, which seems to be an essential component in the hypertension mechanism, has been overlooked as it was not typically associated with blood pressure regulation in classical physiology.

Lead Researcher, Professor Tomasz Guzik, explains, “The aim of the project was to identify key alterations of the immune system in patients with hypertension. These were first studies comprehensively characterising immunity and inflammation, and human hypertension.”

Using tests looking at multiple cytokine levels circulating in plasma, along with studies characterising immune cells using flow cytometry techniques, Prof. Guzik identified how immune cells are attracted by vessels and kidneys in hypertension. “We identified that targeting chemokines, such as chemokine RANTES, may provide a potential therapy. We can use the same medications that are used in treatment of AIDS.”

But, as ever, there is no magic bullet. Hypertension is a disease of complex and multifactorial pathogenesis, so not all patients with hypertension have identical involvement of the immune system in pathology. “We identified that about 30% of hypertensive patients have a strong immune phenotype,” says Prof. Guzik.

To muddy the waters further, many patients are treated with potent medications that can alter the inflammatory profile. For example, the researchers found that patients receiving angiotensin converting enzyme inhibitors, exhibit a reduced inflammatory signature, which may in part explain their beneficial effects.

The identification of immune/inflammatory mechanisms of human hypertension is only the first step towards successful therapeutic use, or their use as biomarkers. “Many cardiologists are reluctant to consider immune targeted medications in the treatment of cardiovascular disease, for fear of side effects, so we need to identify specific hypertension related mechanisms that can be used for development of safer treatments.”

These studies indicate that development of novel therapies targeting inflammation is feasible and should be launched in the near future. “Another interesting finding is that targeting chronic inflammatory processes in the body – for example in the mouth (like periodontitis, gum inflammation), or in the skin (psoriasis) – may be essential in improving the control of blood pressure in hypertensive patients. The latter may indicate that dentists for example could help in the treatment of hypertension.”

For Prof. Guzik there is the additional satisfaction of seeing the research through: thanks to EU-support he has been able to provide the first clinical translation of basic findings in the field that he initiated several years before. And his work doesn't stop there.

“The project is now being developed further to address whether newly identified molecules and cell subpopulations may serve as valuable therapeutic targets in humans. I have received support from the European Research Council to continue this work and the results of ImmunoTension helped to bring this about.”

IMMUNOTENSION

- Coordinated by the University of Glasgow in the United Kingdom.
- Funded under FP7-PEOPLE.
- cordis.europa.eu/project/rcn/190002



New insights into the role of Coptic monasteries in the economy of late antique Egypt

Greater insight into the economy of late antique Egypt (fifth to eighth centuries AD) has been revealed by an EU project which examined the evidence of Coptic monastic sources from the Nile valley.

Monasteries have been a significant part of the Egyptian landscape since the beginnings of Christianity in the country, with records made primarily in the Coptic language. Although there are still many extant monasteries, and their significance within past power structures is known, not much research has been carried out into their impact on the Egyptian administrative and economic framework of prior times.

Their role in these areas has been overlooked largely because the primary sources have either been difficult to access or not attracted enough interest. “The material can only be read by specialists studying Coptic, and they are often more interested in religious or literary texts, rather than administrative documents,” explains MONASPOWER (Monasteries as Institutional Powers in Late Antique and Early Islamic Egypt: Evidence from Neglected Coptic Sources) lead researcher Dr Jennifer Cromwell.



GATHERING THE EVIDENCE

MONASPOWER set out to study the economic position of Coptic monasteries during late antique Egypt based on the neglected evidence from two sources: the monastery of Apa Thomas at Wadi Sarga and the corpus of non-literary Coptic texts in the collection of the University of Copenhagen.

“I wanted to provide material that would enable a more realistic understanding of the economy of late antique Egypt (the fifth to eighth centuries) by focusing on the evidence from Coptic sources from monasteries in the Nile valley,” says Marie-Curie Fellow Dr Cromwell. Letters, legal documents, accounts, lists, receipts, of the type considered by the project, provide evidence about the reality of day-to-day life. “They give us an insight into personal relationships, disputes, food, property, wealth, health – the good and the bad of actual life.”

To build up a clearer picture, Dr Cromwell benefitted from the documents found during the excavations of the Wadi Sarga monastery in central Egypt, in 1913-1914. A few hundred short texts were published in 1922, but many more were not. One of the project’s goals was to publish and study the entire corpus.

Ceramic wares from the site, along with textile fragments, terracotta figures and wooden, metal and bone objects were also brought back and now form part of the British Museum’s collection. This archaeological record complemented the textual record, to produce a better understanding of life at the monastery. “Combining specialist skills from a range of individuals working on this material was one of the goals. It highlights the need for collaborative effort in order not to neglect potentially vital information,” says Dr Cromwell.

MONASPOWER also drew on the unpublished papyrus documents in the Papyrus Carlsberg Collection, in Copenhagen.

As a result of the project, hundreds of unpublished Coptic documents have been translated and are currently being submitted to open access journals for publication.

AN UNPRECEDENTED FOCUS

Dr Cromwell is happy to acknowledge that by presenting a holistic study of the economic reality of Coptic monasteries, her findings can now be used in wider studies of the economy of the antique Mediterranean world. The project has also produced a volume on monastic economies in

“*In future studies of social and economic life in Egypt, the evidence from monasteries cannot be overlooked, doing so omits part of the picture and generates a skewed image of the ancient world.*”

Egypt, Jordan and Palestine. Currently under review, it is the first effort to examine these geographic areas collectively through this lens.

MONASPOWER also brought together a diverse group of specialists across a range of disciplines, for the first time. “The project’s multidisciplinary approach generates new perspectives on the topic and brings to the fore material that is often overlooked by historians – archaeology (including theoretical approaches), art history, palaeobotany (the study of ancient floral remains), Greek texts, Coptic texts, literary and non-literary approaches,” says Dr Cromwell.

The scholars contributing to the volume on monastic economies, themselves came from a wide variety of backgrounds, in terms of both nationalities (across Europe, the US, Egypt and Israel) as well as career stage (doctoral students, early career researchers and professors).

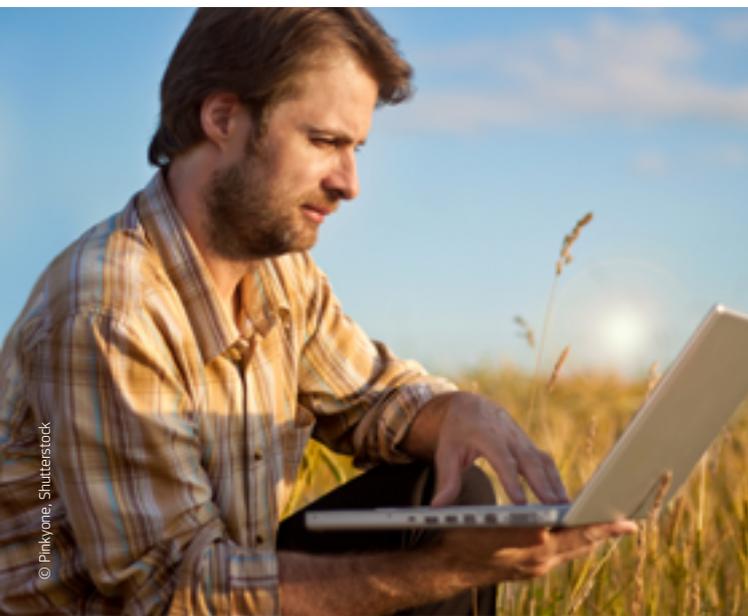
MONASPOWER has helped to reveal the extent to which Coptic monasteries contributed to the economy of late antique Egypt; underlining the fact that monasteries should not be considered solely as spiritual institutions reflecting specific forms of religious experience. Dr Cromwell explains, “In future studies of social and economic life in Egypt, the evidence from monasteries cannot be overlooked, doing so omits part of the picture and generates a skewed image of the ancient world.”

MONASPOWER

- Coordinated by the University of Copenhagen in Denmark.
- Funded under MSCA-IF.
- cordis.europa.eu/project/rcn/195207

More power to social enterprises in rural regions

Social enterprises can bring about positive change to underdeveloped rural regions across Europe. A recently developed toolkit with best practices, along with a policy brief, can help further this noble concept.



© Pimkyone, Shutterstock

Rural regions in many European countries face considerable challenges today. They experience a brain drain of young and qualified people especially, and a lack of opportunities for qualified jobs and higher education, and suffer from a declining provision of public and private services. At the same time, social enterprises are appearing as a new type of organisation that operates in a space where the state and the market tend to withdraw, developing novel solutions to initiate social changes and fostering social innovation.

In a world where there is limited awareness regarding rural social enterprises and unfavourable institutional conditions, the EU-funded RurInno (Social Innovations in Structurally Weak Rural Regions: How Social Entrepreneurs Foster Innovative Solutions to Social Problems) project aimed to improve knowledge on how rural social enterprises develop innovative solutions for social challenges.

“Little is known about how rural social enterprises operate, what challenges they address, how they innovate and what impact they have,” says Dr Ralph Richter, researcher and project manager.

EMPOWERING SOCIAL ENTERPRISES AND ENTREPRENEURS

An additional project aim was to strengthen the skills and innovative capacity of rural social enterprise staff members. “Many rural social enterprises lack specialised training and education required to bring about the desired social change,” explains Dr Richter. In parallel, part of the project’s efforts focused on raising awareness around rural social enterprises to encourage enabling environments so that these enterprises can achieve their goals.

The project brought together academics from two research institutes and practitioners from four rural social enterprises across Europe. The team conducted in-depth field research, interviews and analyses, in addition to providing training. “Staff members of the social enterprises have spent six months in the research institutes in order to enhance their innovative capacity, develop strategies for empowering

“ *Staff members of the social enterprises have spent six months in the research institutes in order to enhance their innovative capacity, develop strategies for empowering people in rural communities, and improve skills in communicating products and services.* ”

people in rural communities, and improve skills in communicating products and services,” highlights Dr Richter.

RurlInno has brought considerable knowledge and skills not only to the four social enterprises within the project but also to others through workshops, field trips and raising awareness regarding best practice examples. It developed a toolkit that addresses six main barriers typically encountered in establishing a rural social enterprise. “The toolkit motivates social enterprises to overcome hurdles and deal with challenges, even if these seem insurmountable at the beginning,” the project manager reveals.

DEMONSTRATING POSITIVE OUTCOMES

The project has shown that social enterprises effectively address social challenges by interconnecting remote regions with supra-regional networks and institutions on other spatial scales. “This mobilises new ideas, extending resources and support for rural communities that would otherwise be hardly available,” affirms Dr Richter. To illustrate, one project partner has helped open technology labs in villages and small towns in Austria to foster creativity and attract talented people. Another built a theme village in Poland that focuses on local traditions and handicraft to foster tourism, while integrating people with special needs into the labour market.

Overall, RurlInno has raised awareness of the innovation potential of rural social enterprises by publishing a comprehensive policy brief, developing the toolkit with best practices, meeting with EU policymakers, and spreading relevant ideas through the media. It has enabled several social enterprises to bring their work to the public through better communication strategies, providing a wealth of open-source material that can inspire adopters and creating role-model social enterprises.

RURINNO

- Coordinated by the Leibniz Institute for Research on Society and Space in Germany.
- Funded under H2020-MSCA-RISE.
- cordis.europa.eu/project/rcn/199946
- Project website: rural-innovations.net

NOW ON CORDIS: Bio-based innovation builds Europe's bioeconomy

Bio-based innovation is bringing a paradigm shift to the bioeconomy by moving beyond biomass processing to harness nature's biological processes and principles. Scientists are now working to overcome current limitations in bio-based technologies and better understand mechanisms and processes at the genetic and molecular levels, enabling them to learn from nature and create or improve industrial processes.

This CORDIS Results Pack highlights 16 EU-funded projects, 4 of which are implemented via the Bio-based industries Joint Undertaking (BBI JU) – a public private partnership of the EU and the Bio-based Industries Consortium (BIC).

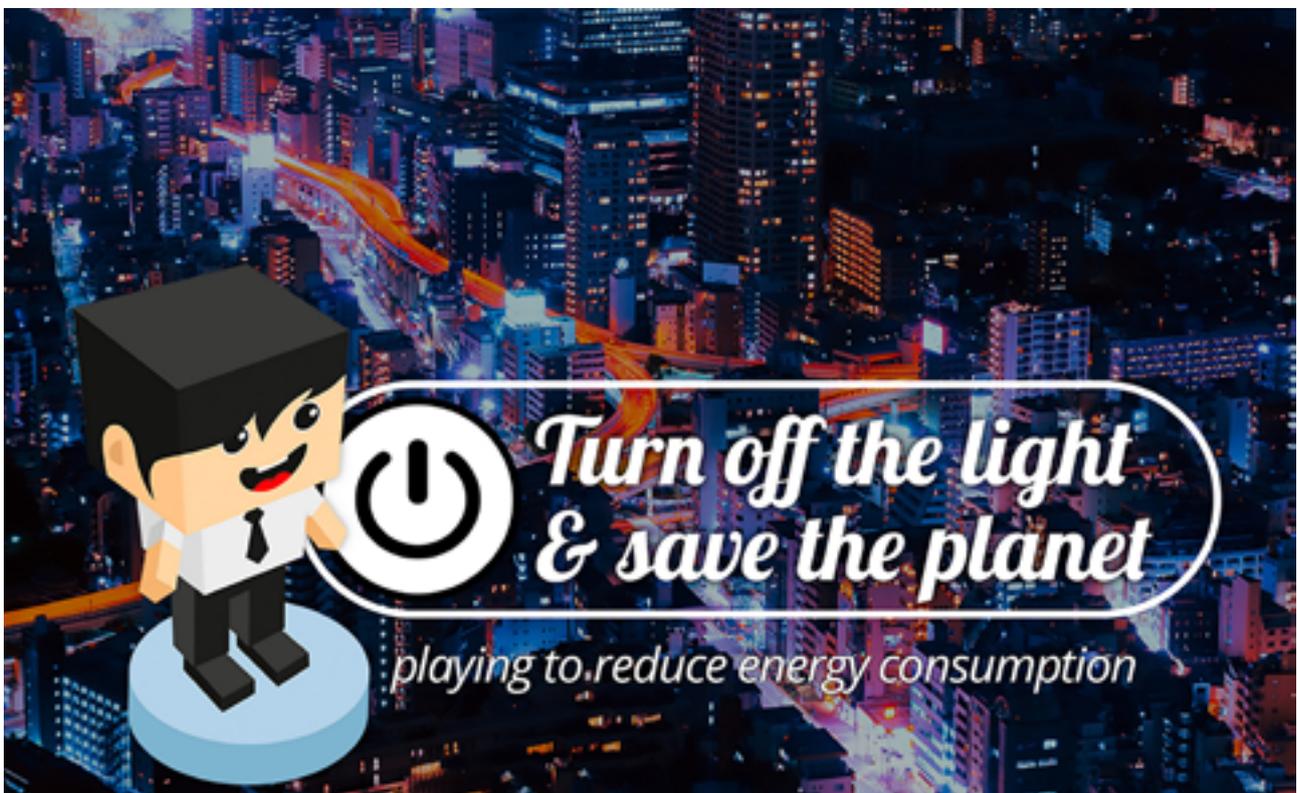
Please see the following link for more information:
cordis.europa.eu/article/id/400949





Social gaming for better energy efficiency in public buildings

Tackling the energy inefficiency of public buildings, TRIBE developed a mobile game to educate and change behaviour. Its simulation draws on real data to demonstrate the human aspects of building use, such as ingrained attitudes and the pursuit of comfort.



© TRIBE

According to European Commission figures, approximately 40% of energy consumption comes from buildings, which are also responsible for 36% of the EU's CO₂ emissions. Currently, around 35% of buildings in the EU are more than 50 years old, with almost 75% of the stock deemed energy inefficient.

One method for tackling this inefficiency is through renovation. However, the EC has calculated that only 0.4-1.2% of building stock across the EU is renovated each year.

Another approach, taken by the EU-funded TRIBE (TRaining Behaviours towards Energy efficiency: Play it!) project, is to encourage building users to change their behaviour.

TRIBE created a management pack, which included an energy audit, a virtual pilot's design (energy model of the real building), an ICT deployment plan, user engagement campaigns and funding schemes. Perhaps the most innovative aspect was the creation of a social game, available for iOS and Android devices, linked to data collected from five European pilot buildings, including a university, public offices and social housing.

THE MULTIPLE STRANDS OF EFFECTIVE ENGAGEMENT

Players of the TRIBE game adopt the role of an energy consultant responsible for changing the behaviour of



Buildings are responsible for around
40 % of energy
consumption in the EU

people working in, visiting and using public buildings. They decide how electric devices and equipment are used, as well as budget to select and implement energy measures. Throughout, players must balance increased energy efficiency against the need for occupant comfort.

The team faced two significant challenges; one technical, the other human. Firstly, it had to define the framework for game conditions, which involved collating and filtering data from a range of sources and expertise. The project brought together raw scientific data on energy use, with calculations necessary to design the simulations, alongside information on user behaviour from social science.

Secondly, TRIBE faced the challenge of engaging a very wide target group – the general public. However, as project manager Mr Eduardo Cembrano Burgos explains, “In a sense this challenge was also our greatest asset. In the end, we all use public buildings and therefore nearly everyone could relate to TRIBE.”

The vigorous engagement campaign included printed materials and training sessions but was especially active through social media, achieving nearly 20 000 game downloads and more than 24 000 substantive views on YouTube.

Recalling the project aims Cembrano summarises, “One of the most important features of the game is its replicability. The tools and methodology used can be adopted, using open software principles, for other games, projects and initiatives. The content itself can also be expanded, for example by introducing new buildings.”

The project had to be underpinned by data, which fed an assessment of the best energy management principles. TRIBE’s ICT monitoring plan collected data from the buildings, transferring it to the game through a simulation engine developed for the project incorporating a

client-server solution, a library of mathematical and logical tools, alongside user behaviour and electricity simulation.

By including real data alongside historic data, the simulation engine could create the energy baseline for the buildings. It also enabled real-time feedback to players on the actual impact of their energy efficiency measures, selected out of the 250 available from the online library.

THE SOCIAL ASPECTS OF INNOVATION

Improved energy efficiency of buildings generates a range of economic, social and environmental benefits. It contributes to increased health and wellbeing for occupants, which also benefits the economy through reducing sick days induced by building conditions. More efficient buildings are also clearly less polluting to the environment and improve housing affordability.

Reflecting on the project, Cembrano concludes, “TRIBE successfully demonstrated that applying technology solutions is not the only way to enhance energy efficiency in buildings. There is a significant gap in influencing user behaviour, which also needs to be addressed.” By using plausible scenarios with real data, TRIBE took energy efficiency out of a purely virtual sphere and made it real, prompting discussion and engagement for users within their daily lives.

Taking the work forwards, the team will continue promoting the TRIBE game and TRIBE Pack and are actively involving public authorities in these solutions.

TRIBE

- Coordinated by CIRCE (Research Centre for Energy Resources and Consumption) in Spain.
 - Funded under H2020-ENERGY.
 - cordis.europa.eu/project/rcn/194617
 - Project website: tribe2020.eu
- ▶ bit.ly/2P1Lnuu

“ *TRIBE successfully demonstrated that applying technology solutions is not the only way to enhance energy efficiency in buildings. There is a significant gap in influencing user behaviour, which also needs to be addressed.* ”

Coordinated ocean energy efforts herald a new industrial sector

Despite its remaining mystery, the ocean is a complex working environment, widely used for fishing, shipping and recreation; but so far largely untapped for energy generation. OCEANERA-NET seeks to give the industry the boost it needs.

The European Union coastline runs to around 66 000 kilometres. This vast stretch holds a largely unexploited potential for ocean generated electricity, calculated to be around 380 GW by DG MARE (the EU Directorate-General responsible), constituting a significant contribution to the EU's 2020 targets for renewable energy.

Presently, there are a number of Member States funding research and development in ocean energy technology. However, these efforts are not coordinated and so not the game-changers they could be.

The EU's OCEANERA-NET (The coordination of national research activities of Member States and Associated States in the field of Ocean Energy (ERA-NET)) project provided support for collaborative research projects, managed by consortia of trans-national companies and research institutes which focused on overcoming the key challenges faced by developers of ocean energy technologies.

Alongside the funding framework, the project also enabled the generation and sharing of knowledge and expertise. Project results will enable reliability, efficiency and cost



reduction in ocean energy technologies, bringing them closer to commercialisation and deployment.

POOLING RESOURCES

The ocean energy industry in Europe is planning to create 100 GW of electricity production capacity by 2050. This equates to meeting 10% of demand, supplying the daily electricity needs of 76 million households. This initiative will also mean the creation of a new European industrial sector with, it has been estimated, 400 000 skilled jobs generated along the supply chain. However, before getting to this point a number of technical challenges have to be overcome.

By their very nature, the maritime areas with the highest energy resources are also the most difficult within which to work and the environment also presents additional problems such as corrosion. Added to which, wave size and direction, as well as levels of turbulence, are highly variable. As project coordinator Ms Karen Fraser explains, “A balance needs to be found between potential energy capture and reliability and survivability during storm conditions and over long-term operations.”

Despite a lot of exploration and technical experimentation, leading to a number of promising technologies, the sector’s innovations remain at the pre-commercial stage. More innovation and testing of demonstration devices are needed to bring down costs to the point where ocean energy becomes more competitive and deployable more widely.

The wave, tidal stream and ocean thermal energy conversion (OTEC) research which OCEANERA-NET supports is developing new energy devices, hydrodynamic modelling and resource measurement tools to improve efficiency of devices. Advanced materials, as well as key components such as power take-off, control systems, electrical connections, moorings and a robotic arm for use in offshore operations, are also under development.

WIDESPREAD BENEFITS

OCEANERA-NET’s efforts will help open up global markets to European companies and has the potential to create a whole new European industrial sector. As Fraser sums up, “This in turn will create job opportunities, more likely to be concentrated in coastal areas and within remote communities, and so contribute to social objectives around the expansion of opportunities for a wider range of people.”

Being ocean generated, the energy itself will align well with EU strategies for renewable energy and CO₂ reduction targets, alongside the creation of decarbonised energy systems.

To continue the work, a selection of projects has just been concluded under the follow-up OCEANERA-NET COFUND project, which will see a significant investment in wave, tidal and OTEC demonstration projects, supported by the European Commission and national or regional agencies. This complements other national and regional activity undertaken as part of the Implementation Plan for Ocean Energy developed by the Commission’s Strategic Energy Technology Plan.

OCEANERA-NET

- Coordinated by Scottish Enterprise in the United Kingdom.
- Funded under FP7-ENERGY.
- cordis.europa.eu/project/rcn/111295
- Project website: oceaneranet.eu
- ▶ bit.ly/2NlPgZo

“ *A balance needs to be found between potential energy capture and reliability and survivability during storm conditions and over long-term operations.* ”

High winds for power generation

Renewable energy sources hold great promise for a future free of fossil fuels, but some forms of renewable energy remain out of reach. Researchers have developed a new kind of wind turbine that can produce clean energy from previously untapped winds at high altitudes.

Climate change needs to be addressed by innovative, efficient systems designed to generate power from a range of renewable energy sources. These new systems need to provide enough low-cost energy to satisfy current and future demands; however almost all countries still rely on coal and oil.

The EU-funded Skypull (Harnessing the power of high altitude winds – the biggest energy resource yet unexploited by humankind) initiative set out to revolutionise power generation by wind, determined to tap into the uncharted

high-altitude winds of the atmosphere. The Skypull team hope that their technology can help lower the cost of energy from wind power compared to conventional wind turbines and fossil fuels.

PERFECTING THE 'AWE TECHNOLOGIES' DREAM

“Skypull belongs to the so called ‘AWE (Airborne Wind Energy) Technologies,’” says Chief Operating Officer Marcello Corongiu. “In the late 1970s, Miles L. Loyd had the idea of building a wind generator without a tower, using a flying wing connected to the ground by a tether, much like a kite.” The Skypull team have created one such device of their own design but they have figured out how to



overcome factors that have hindered this type of energy generation up to now.

The researchers designed their high-altitude wind power generation system by perfecting aerodynamic performances of the flying device, incorporating autonomous operation, and deploying a reliable system. They designed a ground-breaking new type of flying device by creating a 'box wing' drone, which maximises lift with minimum drag, at a lower weight and cost. Each of the drone's wings can change configuration to resemble the wing of a commercial airplane during take-off and landing.

Reduced materials' cost and higher energy production also give Skypull's design a high energy return on energy invested (EROEI). This means the system is well on its way to replacing conventional wind turbines with much lower masses and better generation performances.

SURVIVING THE 'VALLEY OF DEATH FOR START-UPS'

Skypull faced a number of challenges as 'AWE Technology' involves many engineering domains such as aeronautics, materials, autonomous control and robotics. None of these issues has stopped them, however, as they have developed an efficient, working energy generation system. "The bigger struggle remains finding the financial resources to carry on with the project, as we do not sell anything yet and we are in the middle of the 'valley of death' of start-ups," says Corongiu. "In this regard, the EU SME programme represented a significant and valuable help!"

BETTER THAN A WIND TURBINE

"We consider the lifetime of our system the same as for a wind turbine: 20 years," says Corongiu. Compared to conventional wind turbines, many of the components are the same, including alternators, composites and electromechanic parts.

“ *The system is well on its way to replacing conventional wind turbines with much lower masses and better generation performances.* ”

The Skypull team designed their system to have only one consumable: the ultra-high molecular weight polyethylene cables that they need to change periodically. The Skypull team can maintain the drone safely on the ground compared to a wind turbine that requires added logistical costs for this to be done at the hub's distance off the ground.

LOOKING INTO THE FUTURE OF ENERGY GENERATION

With the help of the EU SME programme, Skypull has validated their Business Plan and made some significant steps but a lot of work on the technological side remains. They plan to upscale the system and navigate towards market intake, which they say "may be like river rapids."

SKYPULL

- Coordinated by SKYPULL SA in Switzerland.
- Funded under H2020-LEIT-ICT, H2020-SME and H2020-ENERGY.
- cordis.europa.eu/project/rcn/213639
- Project website: skypull.technology
- ▶ bit.ly/2ywsk55



New research on carbon dioxide storage in porous rocks

Researchers at the University of Copenhagen conducted pioneering research into geologic carbon storage with the focus on how gas, solid and fluid interactions influence the structure of the pore rock.

Geologic carbon storage techniques can play a big part in our efforts to limit the risks of global warming. The idea behind this technology is to capture the emitted CO₂ before it enters the atmosphere, and then store it deep underground at high pressure, inside porous rocks.

“Knowing how the pore structure evolves over time is critical to safely and effectively store carbon because this affects the sealing integrity, the ability to inject CO₂ and the storage capacity at a geologic site,” points out Dr Yi Yang, the funded fellow of OMNICS (Observing, Modelling and Predicting in situ Petrophysical Parameter Evolution in a Geologic Carbon Storage System), a Marie Skłodowska-Curie Action project. Progress in the field relies on overcoming characterisation challenges and reducing the high computational costs of current modelling approaches.

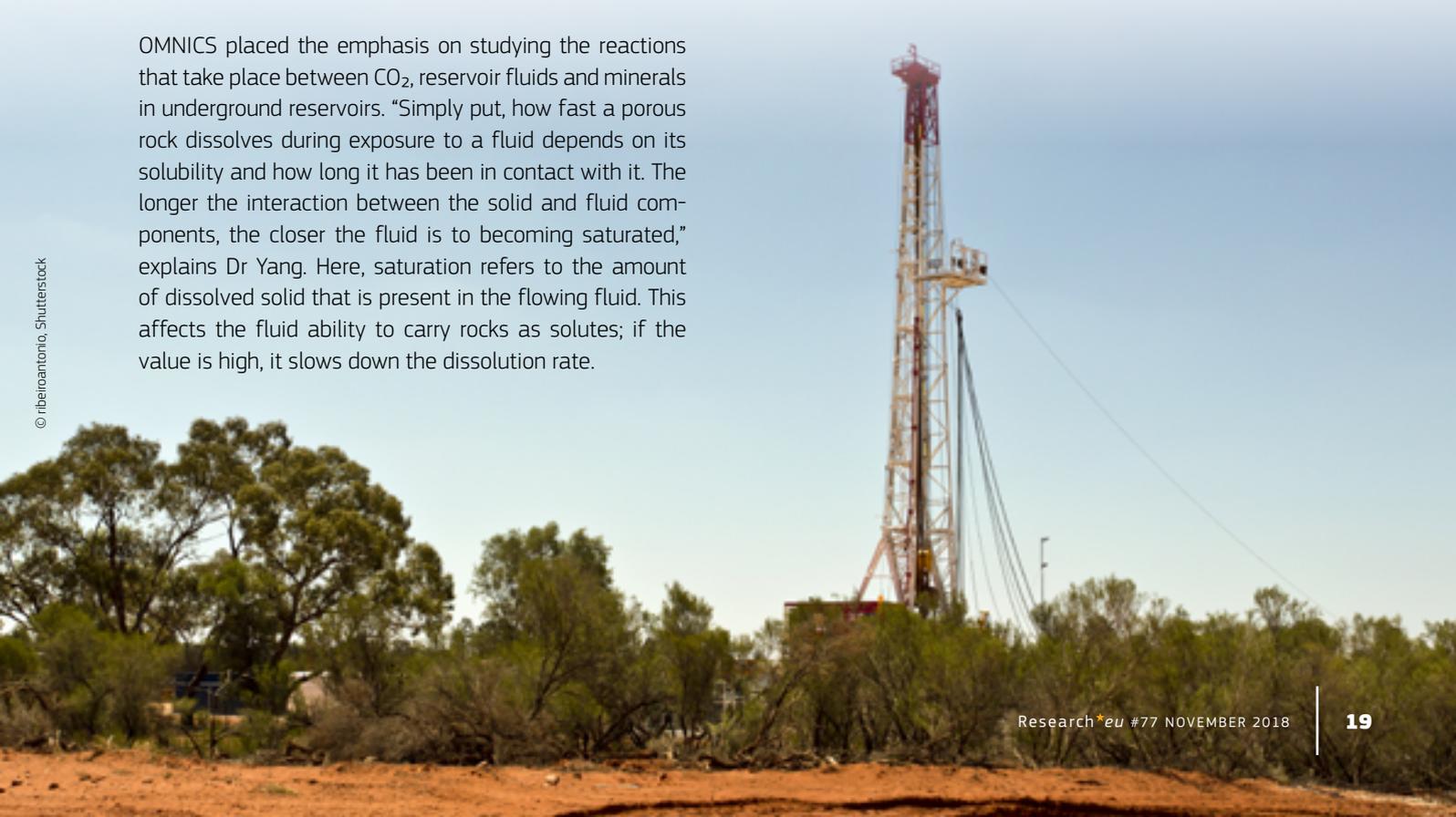
STUDYING THE SATURATION MECHANISM

OMNICS placed the emphasis on studying the reactions that take place between CO₂, reservoir fluids and minerals in underground reservoirs. “Simply put, how fast a porous rock dissolves during exposure to a fluid depends on its solubility and how long it has been in contact with it. The longer the interaction between the solid and fluid components, the closer the fluid is to becoming saturated,” explains Dr Yang. Here, saturation refers to the amount of dissolved solid that is present in the flowing fluid. This affects the fluid ability to carry rocks as solutes; if the value is high, it slows down the dissolution rate.

As Dr Yang explains, after CO₂ is pumped underground, the gas acidifies the water and dissolves minerals. The reactive fluid flows through the more permeable region and dissolves its minerals, making it even more permeable.

THE RICH GET RICHER

This self-enhancement of the flow discharge leads to spontaneous fluid channelisation. The phenomenon is similar to the Mathew effect in sociology, where an economic inequality leads to the ‘rich-get-richer and the poor-get-poorer’ mechanism. In this analogue, aqueous CO₂ is the ‘fortune’ and the inherent petrophysical and chemical heterogeneities in the natural porous materials are the inequalities. During this dynamic process, certain microstructural features ultimately determine the entire flow field of the fluid.



SEEING THROUGH X-RAY EYES

The underlying mechanism of how this blend of acidic gas and water erodes rock formations creates a new scenario of self-organisation in nature and sets the stage for OMNICS. “The idea is to generate realistic pictures of the evolution of rock microstructure, while CO₂ rich water creates new flow channels,” notes Dr Yang.

In the first stage, researchers built a sample vessel that mimics the conditions in a typical reservoir. The use of synchrotron X-ray computed tomography enabled researchers to observe microstructure evolution of natural porous media at very small scales. With the aid of computational fluid dynamics, the team could also trace what the pore surfaces ‘see’ as the CO₂ rich water travels through the pore architecture.

The use of a new reactor network model allowed researchers to study the development of flow networks in geological carbon storage. This helped them relate the network’s topological and statistical features to its capacity for ‘digesting’ anthropogenic CO₂.

Combining mathematical equations with the tomographic structure did not come without its challenges. A big one was to compensate for the great amount of information lost when it comes to segmenting greyscale data. “In our model, the greyscale intensities are used to parameterise each voxel as an individual reactor. Thus, the model preserves geometric information accessed by 3D imaging and modifies the governing equations to optimise the numerical simulations,” explains Dr Yang.

The reactor network model significantly reduces computational costs for predicting the evolution of pore structures over time. To date, OMNICS research has led to four peer-reviewed papers.

OMNICS

- Coordinated by the University of Copenhagen in Denmark.
- Funded under H2020-MSCA-IF.
- cordis.europa.eu/project/rcn/194840
- Project website: nanogeoscience.dk/projects/omnics/
▶ bit.ly/2P6ePzz

CLIMATE CHANGE AND ENVIRONMENT

From East-Asian monsoons to the jets on Jupiter, a new set of models helps interpret climate systems

Understanding the possible impact of global warming on the large-scale circulation of the atmosphere and ocean is crucial to strategies such as mitigation and preparedness. One project has managed to come up with a new approach to make modelling more robust.

Earth’s climate is very complex, and very complicated models have been developed to simulate it. However, these models can be as difficult to understand as the climate itself, so little is gained. On the other hand, very simple

and understandable models may be unrealistic and not relevant to the real world. The solution to this is to build a hierarchy of models, from the simple to the complex. Using this hierarchy, the EU-supported AtmosOcean (Response of

the Atmospheric and Oceanic Circulation to a Warming Climate) project has been able to gain a greater understanding of the climate system, and model it accurately.

Their findings revealed that, as regards global warming, changes in the circulation of the atmosphere are much harder to predict than changes associated with temperature. As lead researcher Dr Geoffrey Vallis explains, “We know with great certainty that the planet will warm and that this will have consequences, such as polar ice-melt. What we don’t know is what the impact of this will be on regional climate and weather, as these are associated with changing circulation patterns.”

THE RIGHT TOOLS FOR A VITAL JOB

Developing the hierarchy of models was challenging on a variety of fronts. There were software challenges, as “building reliable, robust software is difficult and time-consuming,” says Dr Vallis. He adds that deciding how models of varying complexity fit together was highly challenging scientifically.

On a day-to-day basis, the project also faced logistic and funding hurdles. “Funding agencies are reluctant to fund such an activity since the short-term payoff is not evident, however funding was necessary to hire the talented people to design the software and work out how everything fits together. We were very grateful for the support we got from the EU.”

But the project overcame all these hurdles and Dr Vallis was able to hire some talented, young scientists who helped

“ Our aim was to build a better understanding of Earth’s atmosphere and its circulation, how that circulation might change in the future with global warming, and what the relation of Earth’s circulation is to the circulation of other planetary atmospheres. I’m delighted we managed to achieve this. ”

the project to build their novel model framework. “We have used this framework to understand features as diverse as the monsoons in East Asia and the jets on Jupiter!”

MODELLING FOR OTHER PLANETS

“Our aim was to build a better understanding of Earth’s atmosphere and its circulation, how that circulation might change in the future with global warming, and what the relation of Earth’s circulation is to the circulation of other planetary atmospheres. I’m delighted we managed to achieve this,” says Dr Vallis.

However, that was only stage one of AtmosOcean. “We need to go much further in model development, and also apply tools we have built to new situations – to the climate of Earth’s distant past, and to the atmospheres of Venus, Jupiter and other planets,” he adds.

AtmosOcean also had the collaborative aim of engaging other researchers in the field, such as those at the UK Meteorological Office in Exeter and institutions around Europe. This was necessary in order to understand diverse approaches to the problem, and to gain expertise from the best scientists in related fields. The network of experts developed over the life of the project will help to reveal more secrets of the complex mechanisms driving atmospheric dynamics.

ATMOSOCEAN

- Coordinated by the University of Exeter in the United Kingdom.
- Funded under FP7-PEOPLE.
- cordis.europa.eu/project/rcn/186768



© Dariusz Leszczynski, Shutterstock



LIFE AFTER...

Catching up with SHDS: Working towards stronger earthquake defences

To mitigate the destruction caused by earthquakes, engineers have been developing building materials which adapt to seismic vibrations, prioritising performance rather than sheer strength. The SHDS (Seismic-resistant Highly Deformable Structures) project was set up in 2015 to develop building materials based on the reinforced High Deformability Concrete (HDC), which uses rubber particles recovered from waste tyres, designed by another EU-funded project, ANAGENNISI.

SHDS developed coupling beams, designed to be the first element in a building to absorb earthquake damage, thus protecting the remaining structure. Their design makes them easily replaceable, minimising costly repairs, while speeding up community re-occupancy.

Last year, project coordinator and Marie-Curie Fellow Dr David Escolano (now based at the Department of Mechanical Engineering, Polytechnic University of Madrid) told us that the team had tested more than 300 cylinders/cubes, before finding the optimum mix capable of resisting similar loads to traditional counterparts while exhibiting four times more deformation capacity. At that time, the project was not ready for commercialisation, so what has happened in the intervening time?

Speaking to Dr Escolano recently for 'Life After', he points out that, "Innovations in the construction sector, and especially in

structural engineering, are difficult to apply, since we are dealing with the structural integrity of buildings and infrastructures." In practice, this means a necessarily rigorous testing process, "To answer critical questions such as durability, bond, long-term performance – including creep and fatigue – and response to accidental actions, such as fire and impact," as Dr Escolano elaborates.

Towards this end, the team are currently analysing the data which came from the tests, which will enable them to "develop analytical and numerical constitutive models for HDC and optimise the design of Highly Deformable elements," as Dr Escolano puts it. This will provide crucial input for the creation of the guidelines, which will feed into the building standards and codes that must be developed in tandem with any new materials and engineering solutions.

In the meantime, to reach commercialisation Dr Escolano



Dr David Escolano
Project coordinator of SHDS
and Marie-Curie Fellow
© David Escolano

“ We are disseminating our results in professional forums and have found a lot of interest from fellow scientists and practising engineers, which greatly spurs us on towards being market ready. ”

explains, "We are disseminating our results in professional forums and have found a lot of interest from fellow scientists and practising engineers, which greatly spurs us on towards being market ready." So whilst there is still a way to go to reach commercialisation, there has been definite positive progress since the formal end of the SHDS project!

SHDS

- Coordinated by the University of Sheffield in the United Kingdom.
- Funded under H2020-MSCA-IF.
- cordis.europa.eu/project/rcn/195573
- Project website: sites.google.com/a/sheffield.ac.uk/shds/home



© SHDS



SPECIAL FEATURE

CHARGED UP AND READY TO ROLL! ELECTRIC VEHICLES TAKE TO THE ROAD

Editorial

Is the electric vehicle era finally closing in?

There are always two sides to the same coin, and the electric car market is no exception. On the one hand, you could say the glass is half full, with European sales having soared by 40% in the first half of 2018. But the downside is that electric cars still account for only 2% of all new registrations... So if the future is indeed electric, it's not here yet – not by a long shot.

Still, there have been some signs pointing in the right direction as of late. While ever-stricter EU emission standards have been weighing in automakers' plans for a while, the so-called 'dieselgate' has also pushed European cities' agenda on getting rid of diesel-powered cars and even gasoline-powered ones in a not so distant future. Cities like Paris, Copenhagen and Oxford have all committed to this objective, and this will undoubtedly provide an unprecedented boost to electric vehicle (EV) sales.

For research centres, car manufacturers and SMEs, now would be the time to overcome current obstacles to a wider market adoption – namely a lack of infrastructure (charging stations), limited and inconsistent driving

range, and practicality. Whilst the first two are obvious enablers, the third is particularly important in the scenario where cities will be first to massively adopt EVs: customer response will largely depend on how handy it is to drive an EV in cities where congestion is a growing problem and parking space becomes ever scarcer.

This month's issue of the Research*eu magazine prominently features means to these ends. These include research focused on making less greedy heating systems, temperature-resilient batteries, fast-charge solutions for e-buses, semiconductor technology to make EVs more efficient, a new generation of electric light vehicles (ELVs) and innovative hybrid powertrains. Last but not least, and as reminder that the electric revolution will touch upon all transportation sectors, we look into a brand new, fully-electric ferry.

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

Contents



SPECIAL FEATURE

CHARGED UP AND READY TO ROLL! ELECTRIC VEHICLES TAKE TO THE ROAD

02

Electric light vehicles
just got handier
and smarter

03

Hybrid powertrain
innovations
set the bar higher
for the sector

05

Sailing towards a fully
electric ferry

07

Semiconductors for
higher efficiency,
comfort and affordability
of electric vehicles

08

Heating up the electric
vehicle market

10

New fast-charge system
makes e-buses a more
appealing solution
than ever

11

Towards temperature-resilient EVs

Electric light vehicles just got handier and smarter

A consortium of 14 partners has developed technology demonstrators for what the compact and efficient electric vehicles of the future could look like. The three light vehicles, developed under the supervision of Piaggio and KTM, anticipate new design approaches for the sector.

Compact electric vehicles (ELVs) may be a cornerstone of the transition towards smart and green mobility in EU cities, but they are not quite ready for mass appeal. Besides a lack of infrastructure, the vehicles themselves are still not convenient enough for use in cities, and they are also restrained by expensive batteries with reduced range and long recharging time. To thrive, the sector needs to reduce production and use costs, as well as provide a more enjoyable experience to drivers.

The ELV prototypes designed under the RESOLVE (Range of Electric SOLUTIONS for L-category VEHICLES) project aim to meet these requirements. These four-wheel scooters revolve around low-cost, modular and scalable LV-specific electric powertrains and battery architectures, and they have been designed specifically with urban use in mind.

The prototypes are safer, more dynamic and quicker to recharge thanks to the possibility of easily swapping



© RESOLVE

“ *The user can easily interact with the vehicle even while moving (via controls on the handlebar), to get real-time information that will help him/her improve the ELV efficiency and riding experience such as regenerative braking and tilt angle.* ”

batteries, require less energy and cost less than existing ELVs. The icing on the cake is that they also include a multi-wheel vehicle control algorithm that improves handling and stability, along with an innovative, user-friendly HMI that addresses ‘range anxiety’.

“The project has delivered an exciting and attractive ELV driving experience by proposing two new concepts of tilting four wheelers (narrow track), while keeping the vehicle energy consumption at a very low level,” explains Serena Fruttaldo, RESOLVE Communication and Dissemination Manager at RE:Lab – one of the project partners in charge of user interface development and dissemination.

The user can easily interact with the vehicle even while moving (via controls on the handlebar), to get real-time information that will help him/her improve the ELV efficiency and riding experience such as regenerative braking and tilt angle. “Besides, our Smart Range Management function allows an active role of the user over the vehicle performance, but ensuring the target destination is reached in any case,” Fruttaldo adds.

Each four-wheeler demonstrator (L2e and L6e category) has its own engine installation, which helped the project team evaluate the pros and cons of each approach. One uses a single powertrain with mechanical differential and final transmission, while the other has two on-wheel powertrains coupled by an e-diff and no transmission. The two approaches resulted in clear advances in terms of functionality, ease of use, dynamic behaviour and safety, although Fruttaldo says that each one brings a different answer to urban mobility challenges.

“We can proudly say that we reached our initial objectives, and even went further with the development of a third prototype to increase our range of solutions. This additional tilting three-wheeler, which is also in the L2e category, has a single powertrain. What it loses in functionality (but not safety), it compensates for with a reduced production cost,” says Fruttaldo.

Now that the project is completed, Fruttaldo expects the technologies developed (batteries, powertrains, HMI, tilting suspension and vehicle dynamics solution) to be ready for commercialisation within the next few years.

RESOLVE

- Coordinated by Piaggio in Italy.
- Funded under H2020-TRANSPORT.
- cordis.europa.eu/project/rcn/194881
- Project website: resolve-project.eu
- ▶ bit.ly/2CNIUBH

Hybrid powertrain innovations set the bar higher for the sector

Pan-European efforts under the ECOCHAMPS project have led to the development of five hybrid vehicles boasting reduced CO₂ emissions, higher efficiency and powertrains with reduced weight and volume.

The current focus on electric vehicles as the cornerstone of future urban mobility shouldn't make us forget that their hybrid counterparts have a future too – and that this future is now. With electric vehicle range and a lack of charging infrastructure still being a problem, hybrid vehicles are likely to become the preferred solution for travelling beyond city limits, but on one condition: the development of easy to integrate, cost-efficient hybrid powertrain technology.

The ECOCHAMPS (European Competitiveness in Commercial Hybrid and AutoMotive PowertrainS) project was created with this requirement in mind. Since May 2015, the 25-strong consortium – which includes light- and heavy-duty vehicle manufacturers FIAT, Renault, Daimler, Iveco, MAN and DAF Trucks – has been working on solutions to improve powertrain efficiency by up to 20%, reduce powertrain weight and volume by up to 20% and, broadly speaking, make hybrid vehicles more cost-effective.



Mr Guus Arts
Project coordinator of ECOCHAMPS
© Guus Arts

“ *The vehicles developed in ECOCHAMPS all share a common trait: they combine highly efficient combustion engines with a rightsized e-motor and battery.* ”

The results of the project, which include a modular system and standardisation framework for hybrid electric drivetrain components and auxiliaries for commercial vehicles (available on the project website), a set of electric components for hybrid powertrains, and optimised drivelines, have been demonstrated in two light-duty and three commercial vehicles at TRL 7. These vehicles are a FIAT 500X, a Renault Megane, a medium-duty commercial truck, a city bus and a heavy tractor.

Guus Arts, coordinator of the project on behalf of DAF Trucks, discusses its outcomes and importance for the future of mobility in Europe.

What would you say is the way forward in powertrain innovation?

Current powertrains with combustion engines are highly efficient already. Further improvements without the addition of new technology such as, for instance, electric machines in the case of a hybrid powertrain, are hardly possible.

What would be the advantages of such hybrid powertrains?

Hybrid powertrains, as developed within the ECOCHAMPS project, can use green (locally produced) electrical energy, have zero emission driving capability for urban areas and still have enough range for longer trips. Furthermore, they currently have a more attractive cost premium compared to full electric battery powered vehicles due to their smaller, optimised battery size.

Can you tell us more about the technology you developed?

The vehicles developed in ECOCHAMPS all share a common trait: they combine highly efficient combustion engines with

a rightsized e-motor and battery. In addition, the three heavy-duty vehicles created during the project use standardised hybrid electric components which are, as much as possible, based on high-volume passenger car technology. Furthermore, the standards developed in the project, which help cost-effective hybrid component development, are publicly available for adoption by the European automotive industry, standardisation institutes and their technical committees.

You worked on five different demonstration vehicles. How did you select them?

The variety of vehicle applications was one of the main criteria, to assure maximum know-how transfer between the different market segments. We also wanted to show the various ways a plug-in hybrid powertrain could be specified and optimised to meet the needs of the end user.



What would you say were the most important outcomes of these demonstrations?

Certainly the increased powertrain efficiency, the enhanced vehicle functionalities and the reduced cost premium for the hybrid powertrains. The latter was achieved, in part, since the powertrains are based on optimal specifications in general, standardisation where possible and the use of passenger car technology for heavy-duty vehicles in particular.

What are your expectations in terms of performance and environmental impact?

Plug-in hybrid vehicles should be specified to meet the needs of the end customers. For the ECOCHAMPS hybrid vehicles, their performance in general has been improved to comply with customer needs as defined in the beginning of the project.

Hence, the vehicles must provide the full electric driving range required for the desired operating distance in urban areas, and positively impact air quality at the lowest possible cost.

In cases where vehicles are driven almost exclusively in cities, a full electric vehicle might be a better alternative. But the vehicles developed within the ECOCHAMPS project have increased functionality, to allow both urban and non-urban operation, giving flexibility to their users.

What are your follow-up plans, notably with regards to commercialisation?

It is always difficult to speak about exact dates when it comes to commercialisation. As the ECOCHAMPS powertrains are developed at TRL 7, the project can be seen as a stepping stone towards market introduction, meaning that

the powertrain concepts can be expected on the market in the mid-term.

But the learning from the project goes beyond just the technology demonstrators. The experience gained and new standards and processes devised during the project are already finding application in the next round of vehicle development activities.

ECOCHAMPS

- Coordinated by DAF Trucks in the Netherlands.
- Funded under H2020-TRANSPORT.
- cordis.europa.eu/project/rcn/194871
- Project website: ecochamps.eu
- ▶ bit.ly/2AlIjeb

Sailing towards a fully electric ferry

The Danish island of Aroe, located in the Baltic Sea, is one of the few islands not connected to the mainland by a bridge. As a result, it is dependent on car ferries. Aroe also has another distinction: it aims to become 100 % carbon neutral by 2025. Although it has already made big strides towards achieving this goal via a comprehensive solar and wind powered infrastructure, its dependence on conventional car and passenger ferries sits as a significant roadblock.

To overcome this barrier, the EU-funded E-ferry (Prototype and full-scale demonstration of next generation 100% electrically powered ferry for passengers and vehicles) project is designing, building and demonstrating a fully electric, zero-emissions vehicle and passenger ferry. The state-of-the-art ferry will be able to travel 22 nautical miles (equivalent to approximately 40 km) between charging, which is seven times longer than any currently operating electric ferry in the world.

To learn more, we sat down with Project Coordinator Trine Heinemann.

What is the project's main objective?

The project aims to show that a green alternative can make economic sense for ferry fleets and provide an efficient service for passengers. Our prototype is very near completion and will soon be put into operation. Once finalised, I believe we will have created a fully electric ferry that not only supercedes existing electric ferries in terms of distance covered

between charging and battery capacity, but also proposes alternative solutions to some of the challenges and barriers that have discouraged operators from taking the step towards electrification.





Ms Trine Heinemann
Project coordinator of E-ferry
© Trine Heinemann

“ *The project aims to show that a green alternative can make economic sense for ferry fleets and provide an efficient service for passengers.* ”

How is the E-ferry charged?

During daily operation, the ferry will only dock for the average 20-25 minutes it takes to load and unload cars, cargo and passengers. This means it is crucial that charging begin as soon as possible and continue until the very last moment before the ferry leaves.

The E-ferry charger can supply up to 4.4-megawatt (MWh) DC current to the vessel and is fully automated so that charging initiates as soon as the vessel is connected to its docking ramp. To accommodate the fact that the position of a vessel in the dock is always contingent on tides, weather conditions and the weight of its cargo, the project chose a charging solution that is placed on the ramp, rather than on the shore. As the ramp basically moves in the same manner as the vessel, this means the male plug on the ramp should always be able to connect with the female plug on the ship regardless of tidal, weather or loading conditions.

Can you tell us more about the battery?

The large capacity of the battery bank is required for the E-ferry to operate at a frequency of up to seven trips per day. Such ‘sizing up’ isn’t a problem for land-based battery installations, but for maritime use, it introduces a range of challenges that need to be addressed. For example, batteries are heavy, and the more capacity needed, the heavier they get. The batteries onboard the E-ferry weigh about 56 tonnes. As more weight is added, more energy is needed to operate the ship.

How did you address the issue of weight?

The E-ferry prototype is designed with both weight and energy savings in mind. For instance, the ferry’s hull and superstructure were designed to reduce resistance both above and below the waterline. The result is a long and relatively slender vessel with compact passenger and crew accommodations. Furthermore, lightweight materials have been used wherever possible, including an aluminium

bridge and deck furniture made from recycled paper. Another key weight-saving measure can be found in the specially-designed electrical propulsion system, which is extremely compact and light, weighing only 750 kg for the largest propulsion engine.

We are also able to save significant weight by charging the ship’s electric system with DC current, rather than the AC/DC typically provided by an on-shore grid. However, battery systems that run on DC need to be converted between the on-shore grid and the batteries themselves, which requires the use of drives, converters, filters and controls – all of which are traditionally placed onboard a vessel. However, on the E-ferry the current is converted on-shore and the vessel is charged with DC. This means that the many large and heavy components required for the conversion can be placed on-shore instead of onboard the vessel, allowing for a significant savings in weight.

Batteries can be flammable. How did you address the fire risk?

We simply designed a battery system specifically for maritime use. It features a foam fire suppression system that will automatically inject an organic foam into a specific part of the battery when a thermal incident occurs in one of the vessel’s 840 batteries. The foam works not only to extinguish any potential fire in the affected battery, but also to cool down the surrounding batteries so the thermal incident does not spread.

What can we expect once the E-ferry takes to the water?

Once finalised, the E-ferry will represent a game-changing approach to medium-range ferry connections. First and foremost, the E-ferry is expected to reduce emissions by 2000 tonnes of CO₂, 41 500 kg of NO_x and 1 350 kg of SO₂ annually compared to a conventional ferry of the same capacity. It will also be quieter and have a smaller wake, thus further reducing its environmental impact while also improving the quality of life of those living around ports and not least the passengers and crew members on-board the ferry.

E-FERRY

- Coordinated by Aero Kommune in Denmark.
- Funded under H2020-TRANSPORT.
- cordis.europa.eu/project/rcn/193367
- Project website: e-ferryproject.eu
- ▶ bit.ly/2CwFu4V

Semiconductors for higher efficiency, comfort and affordability of electric vehicles

Electric cars are increasingly complex and frequently recalled. But does it necessarily have to be that way? A post-market in-vehicle diagnostics system and semiconductor-based technologies developed under the 3Ccar project promise greater integration of car systems, as well as constant monitoring and updates to prevent failures.

3Ccar (Integrated Components for Complexity Control in affordable electrified cars) is all about addressing complexity. Its ambition is to increase comfort and make electric cars more affordable, all this while paving the way to what many stakeholders believe to be the future of mobility: connected and automated cars. “To put it simply, we counter the increasing complexity of electrical cars – which is due to the growing number of requirements targeting higher functionality, efficiency and comfort in affordable smart electrified cars – with semiconductors,” says Reiner John from Infineon Technologies, coordinator of 3Ccar.

Getting there was, however, not as easy as it sounds from this short description. The project took three essential components of electric vehicles – powertrain, battery and fuel-cell systems – and redesigned them completely to include highly innovative semiconductors able to increase their energy efficiency, cost effectiveness and reliability. They subsequently bridged these components by means of functional, thermal-electrical, electro-mechanical, electronic and nanoelectronic component integration.

“It’s a completely different mindset, moving away from the traditional E/E architectures to a domain-organised architecture and the integration of all subsystems,” John explains.

Let’s take the battery example: whilst they could be considered as the heart of electric cars, the 3Ccar project aimed to make them their brain, too. In comparison with standard battery packs, the 3Ccar system is more cost-effective over its entire life cycle: built-in micro-controllers allow each cell to know about its current state and ‘talk’ to its peers and other devices in the car. If any problem arises, the cell

“ *It’s a completely different mindset, moving away from the traditional E/E architectures to a domain-organised architecture and the integration of all subsystems.* ”



© Chesky, Shutterstock

will simply decouple itself from the cluster, and the car will keep working. Moreover, whilst one defective battery cell used to involve the replacement of the whole battery, it will now be possible to replace only the malfunctioning cell.

In other words, the greater integration targeted by the project also implies higher system partitioning. According to 3Ccar consortium members, such partitioning is crucial to achieve higher robustness, simplicity, higher fail-safe redundancy, cost reduction and simplified maintenance independence from suppliers. Through this vision, the project actually challenges the conventional approach of a multifunctional centralised body computer overseeing all car systems.

Instead, each in-car system is now able to monitor sensor data while allowing for real-time evaluation and remote programming. This is made possible by model-based algorithms which can determine the lifetime and operability status of each electric vehicle component.

“Our approach is proving to be successful, and starting to see industrial adaptation. The requirement of availability and continued operation even after sub-system failure is now widely accepted, notably for highly automated cars in categories L4 and L5,” says John.

With electric, connected and automated (ECA) cars expected to become mainstream in 2030, technologies developed under the 3Ccar project will certainly be quick to find their way to commercial applications.

3CCAR

- Coordinated by Infineon Technologies in Germany.
 - Funded under H2020-LEIT-ICT.
 - cordis.europa.eu/project/rcn/197903
 - Project website: 3ccar.automotive.oth-aw.de
- ▶ bit.ly/2Sb9IFk

Heating up the electric vehicle market

The EU-funded MAXITHERM project has developed an alternative heating system for electric vehicles that reduces energy consumption, increases range and ensures passenger comfort.

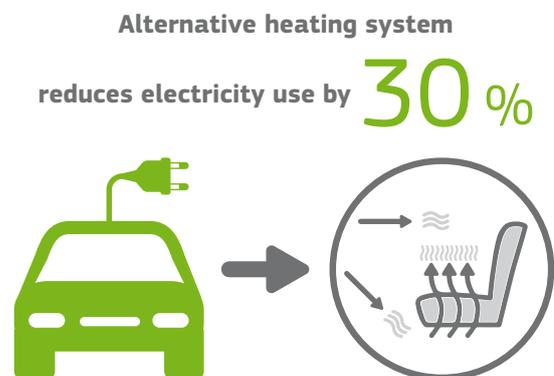
When driving your car on a cold winter day, you probably don't even think about staying warm. You simply start the engine, adjust the heat and set off. The reason you don't freeze while driving is that the car's internal combustion engine produces residual heat that warms up the inside of the vehicle.

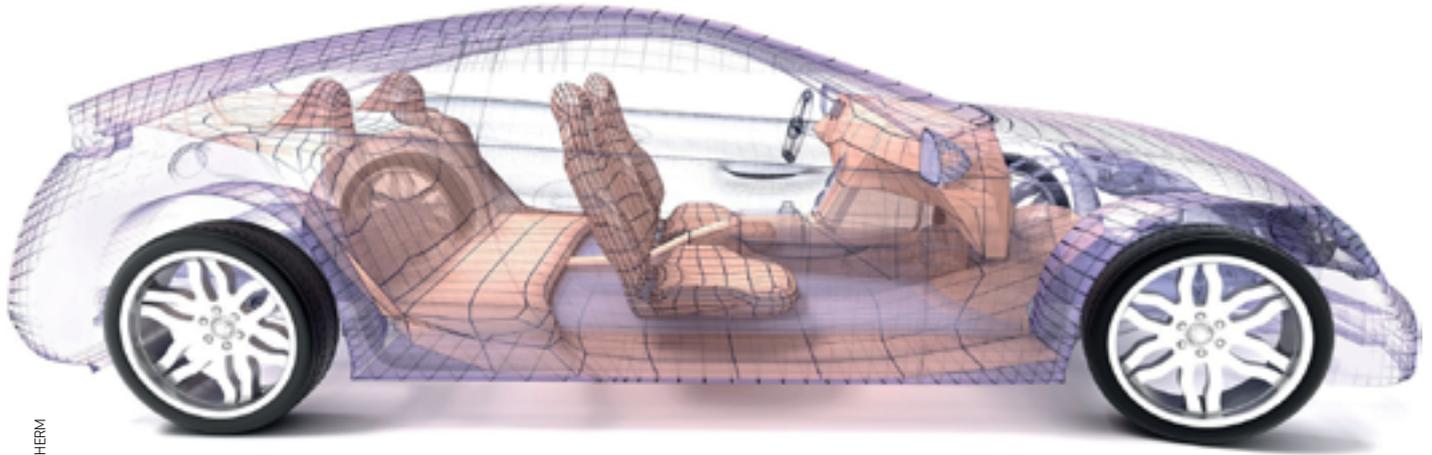
But as the market shifts towards the electric vehicle (EV), a new problem arises.

Lacking an internal combustion engine, EVs are unable to generate residual heat – leaving drivers and passengers in the cold. “To warm up the cabin, energy must be extracted from the car's batteries, which greatly affects the electric vehicle's range,” says Ute Maxi, who coordinates the EU-funded MAXITHERM (Innovative textile-based heating system for technical applications with a special focus on Electric Vehicles) project. “This limited range – especially in cold weather – is a significant roadblock to the mass uptake of electric vehicles in Europe.”

HOT MATS FOR EVS

To overcome this barrier, MAXITHERM researchers developed an alternative heating system for EVs that reduces electricity use by 30%, increases overall range during cold weather





© MAXITHERM

and maintains passenger comfort. “The MAXITHERM heating system integrates a technical fabric comprised of both electrically conductive and non-electrically conductive fibres directly into the vehicle’s structure,” explains Rafik Maxi, the project’s technical manager. “The system provides direct and fast heat to passengers and is more cost-efficient than any solution available on the market today.”

MAXITHERM heating mats utilise MaxiTex, a patented heating system owned by one of the project’s partners. MaxiTex consists of a special control system and a textile capable of dissipating heat homogeneously over an entire surface. The MAXITHERM mats are placed under a vehicle’s roof and carpets, into the seats and seat backs and along the door panels.

“With this system, it is possible to control the heating intensity and the maximum temperature independently,” says Rafik Maxi. “The temperature threshold can be set up for each area of the vehicle separately, providing you with maximum flexibility in terms of setting temperature preferences for each occupant.”

AN ATTRACTIVE SOLUTION

Ute Maxi notes that the prototype vehicle has proved successful, offering high-efficiency and low energy consumption. “We are now monitoring its behaviour under real driving conditions, and this autumn and winter we will be able to measure real values in Germany’s harsh weather conditions,” she says.

“*The system provides direct and fast heat to passengers and is more cost-efficient than any solution available on the market today.*”

The project is currently working with a number of automotive manufacturers who are interested in installing the system (or parts of it) into their vehicles. The team is also seeking additional funding to support further upscaling and marketing of the MAXITHERM system.

“To a critical extent, we successfully developed a system that could serve as a solution for driving electric cars – or any other means of electric transportation – in cold weather without losing range,” concludes Rafik Maxi. “As our solution helps EVs overcome the issue of limited range, MAXITHERM is attracting the attention of some global players in the automotive industry.”

MAXITHERM

- Coordinated by MaxiTex GmbH in Germany.
- Funded under H2020-LEIT-ICT, H2020-SME and H2020-TRANSPORT.
- cordis.europa.eu/project/rcn/205262
- Project website: maxitherm.eu

New fast-charge system makes e-buses a more appealing solution than ever

The replacement of diesel bus fleets by electric ones will only become possible when the latter can compete in terms of operation time, comfort, weight and cost. Heliox has found a single solution to all these problems in a new fast-charge technology.



© Heliox

You may not have heard of Heliox yet, but if you are a European citizen or live in Chile, Japan, Singapore, India or New Zealand and commonly use public transport, chances are that you have already hopped in an electric bus powered by their cutting-edge charging solutions. Furthermore, they are just getting started: the company's new fast-charging system can power an electric bus in just two to five minutes.

The technological leap is substantial: currently, e-buses require overnight cell balancing and charging and can only be operational for so many hours a day. A Heliox fast charger, on the other hand, includes a fully automated contacting and fast-charging system that enables 'opportunity charges' during operation. With the recent commercialisation of batteries that do not need explicit overnight cell balancing, this means that a 24/7 e-bus service is now within reach.

“*To really become attractive, electric buses should therefore have an equal, if not lower, total cost of ownership (TCO) vis-à-vis that of their diesel counterparts, as well as carry at least as many passengers without compromising on comfort.*”

“When you charge an electric bus slowly overnight, not only is it not operational, but the range it can cover in operation is limited by the size of the battery pack. As soon as the battery pack is empty, a new time-consuming charging

cycle needs to be completed,” says Mark Smidt, Director of Business Development at Heliox. “If we add this problem to the fact that the battery pack is by far the most expensive component in the bus, that it is considerably heavy and requires space that should rather be used for transporting passengers, these are blocking issues preventing a large-scale commercial success.”

To really become attractive, electric buses should therefore have an equal, if not lower, total cost of ownership (TCO) vis-à-vis that of their diesel counterparts, as well as carry at least as many passengers without compromising on comfort. This is the mission Heliox set for itself when it kick-started the CONCEPT (CONductive fast Charge system for Electric buses in Public Transport) project in August 2016.

The vision behind the company’s technology is that faster charge will ultimately enable a substantial reduction in the onboard battery pack capacity, therefore decreasing bus weight, saving cost and increasing available space and operational uptime. The system can be connected to both LV (Low Voltage) and MV (Medium Voltage) electricity grids, and also comes with an optimised cooling scheme to increase lifetime and lower TCO.

“Customer feedback has been very positive so far. We have a lot of interest from not only bus original equipment manufacturers (OEMs), but also public transport operators all over the world,” Smidt says.

Now at the end of its second phase, Heliox’ support under Horizon 2020’s SME Instrument has notably enabled the realisation and demonstration of a certified, cost-effective and proven system that has managed to convince stakeholders of its operational excellence.

“We still have two pilots running that have been serving basically two goals: the first is to bring the system performance to the maturity and robustness required in the public transport market; the second is to demonstrate and prove the performance of the system to relevant stakeholders in the market,” Smidt explains.

Market rollout has already begun, and Heliox expects a strong market response in 2019. The company is also looking into regional expansion, not only in Europe, but also in the US with deliveries starting in Q2 2019.

CONCEPT

- Coordinated by Heliox in the Netherlands.
- Funded under H2020-LEIT-ICT, H2020-SME and H2020-TRANSPORT.
- cordis.europa.eu/project/rcn/205012
- Project website: heliox.nl

Towards temperature-resilient EVs

The OSEM-EV project has come up with an entirely new concept of heat management for electric cars. These advances should enable a new generation of EVs with a greater and more predictable driving range.

Limited driving range is widely acknowledged as being the main obstacle to electric vehicle (EV) market growth. And whilst increased capacity could seem like the most natural way forward, it wouldn’t solve the other, closely related problem EVs are currently facing: unpredictable range due to fluctuations in temperature.

When subjected to extremely cold or hot temperatures, batteries tend to lose up to half of their initial capacity. Achieving temperature resilience would considerably boost confidence in ELVs, and it therefore comes as no surprise that an 11-strong consortium has made its

priority improved mileage and predictable range, without adding further cost and weight, since 2015.

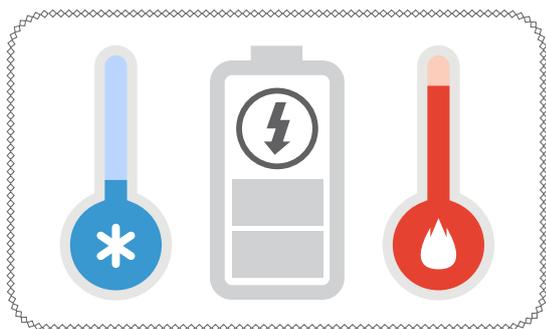
“ *The technology was successfully demonstrated in two different classes of electric vehicles: one in the A-segment and one in the C-segment.* ”



“Our core objective under the OSEM-EV project was to make battery temperature resilient by using heat from the car, and cooling or heating it up thanks to a heat pump,” says Reiner John, coordinator of the project on behalf of Infineon Technologies.

All in all, the project has developed a range of thermal management solutions including insulation, thermal energy storage, innovative heating and cooling approaches, electronic control of electro-thermal energy and power flows, increased energy efficiency of electrified components and subsystems, energy substitution as well as energy harvesting functions. But its heat pump concept and the mobilisation of waste heat from other subsystems is what truly makes OSEM-EV (Optimised and Systematic Energy Management in Electric Vehicles) stand out.

Batteries tend to lose up to
50%
 of their capacity when exposed
 to extreme **cold** or **hot** temperatures



Thanks to the in-depth quantitative understanding of energy flows in electric vehicles they gathered over the duration of the project, the consortium was able to design and optimise the vehicle’s energy architecture and to develop control algorithms for effective coupled electro-thermal energy management. These improve not only the energy efficiency of the powertrain, but also the reliability and lifetime of every subsystem in the car.

The technology was successfully demonstrated in two different classes of electric vehicles: one in the A-segment and one in the C-segment. These two segments were selected due to their very different requirements and topologies and, most importantly, for their high market potential.

Whilst commercialisation plans are still being discussed, John points out that Daimler will follow up on its own prototype and intends to include the novel components in future models. IFEVS, on the other hand, will follow up on their own demonstrator (a small truck devised for food delivery) and has made detailed plans available to all project partners.

One thing is certain: sooner or later, a new generation of electric cars working under almost all weather conditions will be on our roads, boasting minimal use of energy to keep the passenger and battery compartment thermally conditioned, as well as a radical reduction in self-discharge and energy use.

OSEM-EV

- Coordinated by Infineon Technologies in Germany.
- Funded under H2020-TRANSPORT.
- cordis.europa.eu/project/rcn/194883
- Project website: osem-ev.eu



Benefit for consumers as authorities supporting food authenticity research collaborate more closely

Wait up, just what exactly is in that sausage? That question gets easier to answer thanks to the work carried out by an EU-supported project to make sure that methods for authenticating food products are not carried out in isolation, but through collaboration and information-sharing.

The horsemeat scandal of 2013 resulted in the launch of several major initiatives to counter food fraud and assure the integrity of the food supply chain. The European Commission has established a Food Fraud Network made up of competent authorities involved in identifying and communicating food fraud issues in EU countries.

Industry and Government are involved in a number of initiatives aimed at providing cost-effective procedures for assuring the integrity of the food supply chain. But in order for these systems to work, knowledge and know-how needs to be shared between agencies, across borders. This is where the EU's AUTHENT-NET (Food Authenticity Research Network) project steps in.

The AUTHENT-NET Concerted Collaboration and Support Action was devised following early dialogue with national funding bodies, through a survey and workshop, before the project started. From those results it was clear there would be immediate benefits in just bringing the funding bodies together to share experiences and establish networks. "Very few of the attendees at the workshop were aware of each other, and the only collaborations were through existing EU activities such as SUSFOOD," explains project coordinator Professor Paul Brereton, Director of Strategic Alliances at the Institute for Global Food Security in Belfast.

They acknowledged that much could be gained by merely providing an inventory of current information on what has



been done, where and by whom, in terms of research and development in Member States.

The project identified a set of urgent needs from a food authenticity control/detection perspective. These included: better harmonisation and sharing of research activity at an EU level to support issues around standardisation of methods (i.e. 'fit for purpose methods'); improved access to reference standards, databases and reference materials; and the sharing of tools available for detection. As Prof. Brereton puts it, an EU network on food authenticity research was acknowledged as the best way forward.

CONCERTED ACTION MORE EFFECTIVE THAN A FRAGMENTED APPROACH

AUTHENT-NET's overall objective was to facilitate sustainable cooperation between national and international research funding bodies in the area of food authenticity, to improve the competitiveness of the food supply chain and the consumer confidence in it, by means of better coordinated, cost-effective R&D.

"We achieved this by ensuring all mechanisms and tools were co-created with the national funding bodies through a series of meetings/discussions, to ensure they were fit for purpose. For example, templates for collection of national data on research conducted within a Member State were co-designed, tested within one country (UK) and then revised slightly before being used by 13 more (as of July 2018)," says Prof. Brereton.

Similarly, the central information repository, the Food Authenticity Research Network Hub (FARNHub), was co-designed with the funding bodies in order to ensure it met their needs. Consolidated information from each EU country is now freely available and accessible through the FARNHub.

"I think the bringing together of people from different Member States, and getting them to think collaboratively, was the biggest achievement. A close second would be the tools that we have provided for doing that and for sharing their information."

MANY PLAYERS LEAD TO CERTAIN CHALLENGES

It wasn't always easy for AUTHENT-NET to establish precisely who was in charge of funding food authenticity work in each country. In most, authenticity/anti-food fraud was horizontally integrated across a number of research councils and government bodies with no overarching coordination. It was therefore necessary for the project to investigate the content and structures of various EU countries more intensively than was originally envisaged.

Prof. Brereton feels this aspect fed into the project's most significant outcome, "I think the bringing together of people from different Member States, and getting them to think collaboratively, was the biggest achievement. A close second would be the tools that we have provided for doing that and for sharing their information."

EUROPE NOW BENEFITS FROM MORE EFFICIENT FOOD AUTHENTICITY/ ANTI-FRAUD CAPABILITY

The sharing of information and knowledge among Member States, and the concomitant increase in collaboration, is good news for EU citizens as both tax payers and consumers. There will be less duplication in research, thereby saving money, and enhanced protection against food fraud.

"Personally," says Prof. Brereton, "as coordinator of the project, I am most proud of the consortium members. The commitment and ingenuity of the members of the consortium was great and resulted in over-delivery in many areas. FARNHub is a good example, where all of the fruits of our labours have been consolidated into one, open and accessible hub of information that will be sustained for at least three years after AUTHENT-NET finishes."

AUTHENT-NET

- Coordinated by Fera Science Limited in the United Kingdom.
- Funded under H2020-FOOD.
- cordis.europa.eu/project/rcn/200196
- Project website: authent-net.eu

A new take on resilience in food systems – a focus beyond efficiency to sustainability and vulnerability

Food and nutrition security is a challenge facing us all. One EU project has been examining how disparate factors combine to impact on our food demand and supply.

How do climate, economic reach and market structure, supply and demand, geo-political shifts, consumer preferences and consumption patterns come together to affect global and European food demand and raw material production? The TRANSMANGO (Assessment of the impact of drivers of change on Europe's food and nutrition security) project set out to examine the impact of these, and other factors, to assess the vulnerability and resilience of European food systems.

Dr Erik Mathijs, the project's coordinator, explains, "Food and nutrition security not only involves access to sufficient food, but also implies healthy diets and sustainable ecosystems in order for the food system to be resilient. Europe is experiencing increasing problems relating to food and nutrition security, rising obesity and endangered natural ecosystems."

Our focus in Europe is on efficiency, explains Dr Mathijs, which means there is a lack of attention paid to vulnerability and resilience. TRANSMANGO aimed to address this gap.

HOW WILL OUR CURRENT APPROACH TO FOOD SUPPLY HOLD UP IN THE FUTURE?

Researchers investigated 18 case studies addressing various issues such as food assistance, school meals, access to land, and community-supported agriculture, across Europe. The vision and strategies of these case studies were considered in the light of future European food systems. "We brought together a variety of stakeholders to consider ways of meeting new demands," Dr Mathijs says.

TRANSMANGO's case studies were analysed using system-thinking tools, such as causal loop diagrams, which visualise the interdependence between the driving forces affecting food system outcomes, as well as feedback loops and unintended effects of policies and actions.

They found that the transformative cases aiming at making food systems more resilient were characterised by five principles. The first principle is to recognise the right to food of both traditional and also newly emerging vulnerable groups, such as refugees. A second principle is that resilient initiatives connect sustainability to human health, i.e., they seek to organise food systems and diets in a way that is good for the environment and for human health.

Thirdly, initiatives make stronger links between urban and rural actors and activities, thus benefiting from mutual exchange of ideas and resources. A fourth principle is that



resilient initiatives use both technological innovations (such as apps) and social innovations (new ways of collaboration) to underpin their activities. Fifthly, these initiatives take a different perspective on resilience, giving much more attention to diversity rather than to efficiency.

“The project established,” says Dr Mathijs, “a conceptual model of the food system that captures its systemic, dynamic, political and uncertain character.” The research team set out future scenarios at both EU and national level, capturing the main uncertainties the EU food system is facing. They also developed a set of systems-thinking, modelling tools and games to analyse complex food systems.

“Looking at complexity and resilience requires interdisciplinary approaches. TRANSMANGO has successfully developed approaches integrating various disciplines, such as economics, sociology and geography.”

The researchers’ insights have contributed to various stakeholders’ processes. One example is the ‘Common Food Policy Vision’, which was produced by the International

“ Looking at complexity and resilience requires interdisciplinary approaches. TRANSMANGO has successfully developed approaches integrating various disciplines, such as economics, sociology and geography. ”

Panel of Experts on Sustainable Food Systems, and its partners, to prepare the EU Food and Farming Forum held on 29-30 May 2018.

TRANSMANGO

- Coordinated by KU Leuven in Belgium.
- Funded under FP7-KBBE.
- cordis.europa.eu/project/rcn/110107
- Project website: transmango.eu
- ▶ bit.ly/2MqjJWK

FOOD AND NATURAL RESOURCES

How forest management strategies should account for their carbon sequestration potential

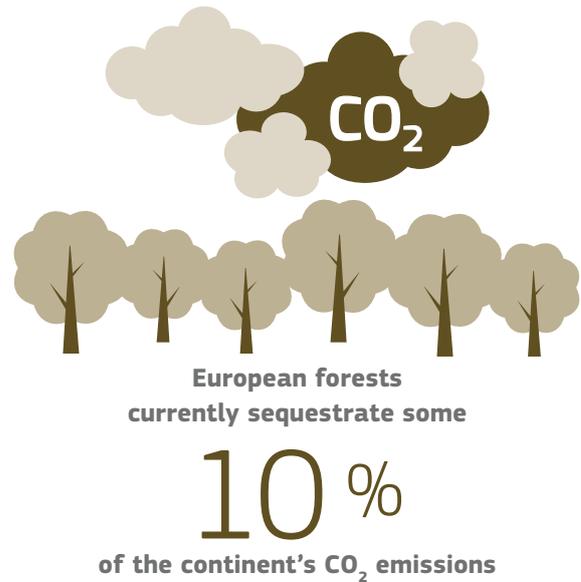
European forests currently sequester some 10% of the continent’s CO₂ emissions. The FORMIT project aimed to incorporate this forest function into management practices, so that forest managers can better face the consequences of climate change without compromising on biomass and wood production.

If there is one battle in the greater fight against climate change that Europe seems to be winning hands down, it’s certainly the safeguarding of its forests. Whilst woodlands are shrinking dangerously in other regions of the world, in Europe they have been growing by the equivalent of 1 500 football pitches every year. This is great for biodiversity, of course, but also potentially for carbon sequestration and wood industries.

The real question is, how should we manage these forests to make the most of their potential? The FORMIT (FORest management strategies to enhance the MITigation potential of European forests) project aimed to answer this question. They developed a ‘forest growth simulator’ based on various climate change scenarios, and obtained estimates of carbon storage and fluxes at forest sites above and below ground. They could also estimate the



© PlusONE, Shutterstock



amount of harvested wood products and forest biomass used for energy under chosen climate scenarios, as well as for different forest management scenarios.

One of their observations is that European forests are ageing, but it doesn't mean that forest managers can sit back and relax.

“Carbon sequestration by forests continues to be of extreme importance, and we see a continued increase in interest in this role. There is also a continued interest in the potential role of biomass for energy, although it is often argued that the latter is very inefficient and very scale-dependent,” says Prof. Frits Mohren who coordinated the FORMIT project. “To put it simply, we need to increase the growth to maintain the storage of carbon when we want to use some of that increment for bioenergy. Any use of biomass for energy that leads to a substantial decrease in carbon storage is not carbon neutral, and should be avoided.”

All in all, the team assessed carbon storage by EU forests, the effects of forest management strategies on this storage, the contribution of forest products to carbon storage and mitigation, and the socio-economic aspects of forest management for carbon storage and mitigation. Finally, they developed scenarios and pathways including measures and management strategies taking into account regional differences in Europe, potential climate change impacts, and changes in species composition.

Whilst Prof. Mohren admits that the actual impact of these strategies on forest management practices is difficult to assess, he says that, “all partners are engaged in national debates on adaptive forest management to contribute to

climate change mitigation, and the forest management strategies developed within the project are clear options that are being discussed. The FORMIT results are not necessarily unique in this, as we stayed close to current practices in forest management.”

In the near future, FORMIT's results should also prove helpful to other projects in which forest inventory data are being used to make carbon mitigation assessments.

Meanwhile, the team members are pursuing their work. “We have started new PhD projects at Wageningen University looking into forest management strategies, for example with respect to climate change impacts on competition between tree species, and adaptive forest management strategies for Dutch forests. The same holds for most of the FORMIT partners, who continue to work in this area. Also, we are working on carbon relations of tropical forests, for example through Life Cycle Analysis of the management of tropical forests,” Prof. Mohren points out.

FORMIT results are also being used in new pilot projects which form part of the Dutch climate-smart forestry programme, to investigate and demonstrate the potential of forest management in the fight against climate change. Similar actions are being taken elsewhere in Europe.

FORMIT

- Coordinated by Wageningen University in the Netherlands.
- Funded under FP7-KBBE.
- cordis.europa.eu/project/rcn/104508



Better performing carbon fibres at reduced cost to profit and planet

Carbon fibre reinforced composites (CFRC) are 80 % lighter than steel and 50 % lighter than aluminium, while delivering at least twice the strength and stiffness. NEWSPEC set out to overcome the cost and safety barriers to their widespread adoption.

Despite being typically only 5-10 micrometres in diameter, carbon fibres (CFs) have many desirable properties such as high stiffness and strength, coupled with low weight and high tolerance to temperatures. This makes them of interest to the aerospace, civil engineering and military industries.

However, CFs remain expensive when compared to alternatives, and the manufacturing process comes with significant challenges, including the fact that the polymer resin, polyacrylonitrile (PAN), used as the precursor in 90 % of carbon fibres, raises safety and environmental concerns.

The EU-funded NEWSPEC (New cost-effective and sustainable polyethylene based carbon fibres for volume market applications) project explored the properties of polyethylene (PE) as a precursor for low cost CF production. The team designed, developed and tested working prototypes for continuous CF processing which included: melt-spinning equipment capable of semi-industrial manufacturing of PE fibres, gas phase sulfurisation equipment, double-spot plasma equipment for CF surface functionalisation and a remote Raman probe for in-line monitoring of the CF's mechanical features.

INTRODUCING INNOVATIVE PROCESSING TECHNIQUES

Explaining NEWSPEC's interest in exploring PE as a carbon fibre precursor, NEWSPEC project coordinator at Warrant Group EFD Dr Matteo Falasconi says, "It presents interesting technical features such as a high carbon yield and suitability to produce medium performance carbon fibres. It is also relatively flexible and easy to process at a very competitive cost of around two euro per kilogram. Compared to PAN, that is a precursor cost saving of up to 70 %."

After testing, then discounting oil-based and recycled PE, the project found Bio-PE derived from dehydration of bio-ethanol to ethylene – and then polymerisation to PE – offered significant advantages. It is widely available, as a by-product of annual food crops, is of good purity and consumes less energy (about 70 %) compared to petrochemical alternatives. Crucially, it is also sustainable, renewable and ecological, as producing 1 kg of Bio-PE captures 2.5 kg of CO₂ from the atmosphere.

In order to prepare the PE polymers for conversion into CFs, they undergo a process known as stabilisation which strengthens them for high temperature manufacturing. NEWSPEC introduced an original dry method using solid elemental sulphur assisted by electron beam curing (EBC) that introduces heteroatoms at the precursor stage, to replace the usual wet (acidic) process associated with safety and environmental concerns.

However, as Dr Falasconi explains, "This innovative gas phase sulfurisation process had never been attempted before on a pilot scale, so our challenge was to design and develop such equipment for PE precursor stabilisation and carbonisation. This we successfully accomplished, calling the equipment 'SULFI'."

“ *The polyethylene carbon fibres could provide the highest performance/cost ratio than any other precursor currently under investigation.* ”



NEWSPEC also reduced graphitisation or the temperature at which the stabilised PE polymer starts to convert into the crystalline carbon structure. It did so by introducing nano-agents (such as cellulose nanocrystals) into the polymer matrix.

Additionally, for carbon fibres to become good material composites they undergo a process called surface functionalisation, which is an essential step to improve the compatibility of the fibres with different resins. NEWSPEC used atmospheric plasma technology for this, finding it to be environmentally friendly and flexible (suitable for all types of chemical groups), while being applicable for continuous production from start to finish.

SUSTAINABILITY BENEFITS ACROSS MULTIPLE INDUSTRIES

NEWSPEC applied both Life Cycle Costing (LCC) and Life Cycle Assessment (LCA) to its production and performance innovations. It found strong evidence of reduced environmental damage, with the precursor changes. The LCA also showed the positive effect of introducing

atmospheric plasma for surface treatment, leading to a 5% reduction in environmental impact.

As Dr Falasconi summarises, “The polyethylene carbon fibres could provide the highest performance/cost ratio than any other precursor currently under investigation.”

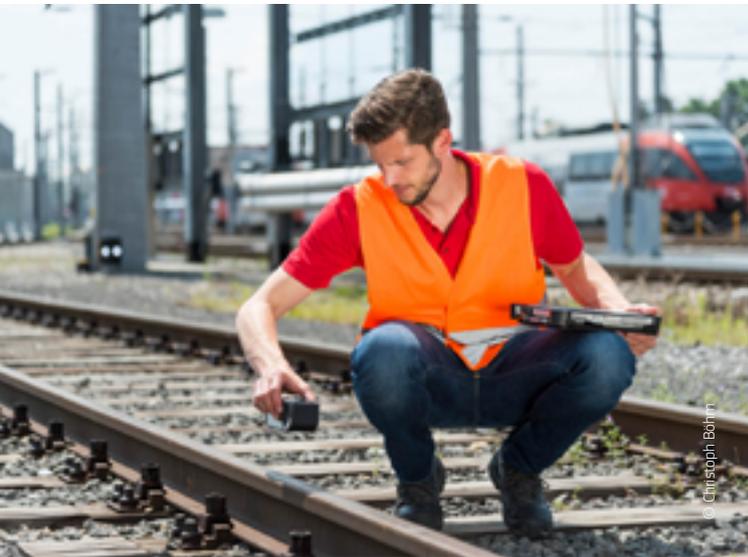
Besides the civil and industrial infrastructure sectors, the use of CFs for more efficient wind energy blades, especially in offshore areas, is projected to be the first and largest application sector by 2020. Retrofitting already installed (smaller) turbines is also of considerable interest to energy companies.

NEWSPEC

- Coordinated by Freni Brembo in Italy.
- Funded under FP7-NMP.
- cordis.europa.eu/project/rcn/110858
- Project website: newspec.eu

Smart, safe and portable measurement solutions for rail, auto and steel industries

Using a handheld, wireless device in the steel, railway and automotive industry is a fast and cost-effective solution that an EU initiative wants to share with the world.



NEXTSENSE GmbH is a leader in industrial measurement and inspection solutions based in Austria. Most of the company's customers for its wireless handheld measuring gauges are railway companies and automobile manufacturers in Europe and Asia. Now the plan is to take its innovative technology to the rest of the world.

THE BUSINESS JOURNEY ABROAD

Thanks to EU funding, the CALIPRI Smart (The easy to use and failsafe handheld optical gauge for 2D-profiles) project has opened two new foreign subsidiaries in Shanghai, China and Atlanta, the United States. The market expansion is going hand-in-hand with an organisational expansion. "The new subsidiaries enable us to be closer to our customers and sales partners," says project coordinator Marina Mošmondor. "Thanks to this proximity, we're able to respond to customer needs better and quicker."

Mošmondor laid down the reasons for the evolution. The increased demand through acquisition of new customers and faster response to customers' needs contributed to the increase in the number of employees and the overall organisational growth of the company.

CALIPRI Smart products are wireless handheld devices for the 100% contact-free measurement of profiles, gaps and design lines. The software allows high-precision measurements. They have a huge potential for disrupting the market for measurement gauges intended for 2D profile evaluation.

The key is the embedded software in the all-purpose technology that can be customised for a large number of applications in diverse industries. The most important markets are railway companies, the auto industry and rolling mills (steel).

Some of the main applications of CALIPRI Smart products are safety and quality checks, and maintenance of railway vehicles. The product makes the measuring process at least two times faster and more cost-efficient than mechanical gauges. The software can be easily adapted to the individual needs of the customer. High-volume production can offer competitive prices.

GLOBAL SHOWCASE FOR TWO PRODUCTS

The market expansion was accompanied by product growth. Two new products entered the scene. CALIPRI Hot, the only portable solution for the profile measurements of hot steel, and the CALIPRI C42-single-app, a standalone solution developed with the aim of substituting a mechanical gauge.

“The merger with a strong partner with a global presence will enable NEXTSENSE to accelerate product innovation and company growth, while providing even better support and services to existing rail and automobile customers.”

“CALIPRI Hot enables workers in the rolling mills to obtain the qualitative measurement data directly on the hot steel,” explains Mošmondor. “Since this allows for checks of the product’s dimensional accuracy during the rolling process, the customer is expected to benefit from considerable time and cost savings.”

CALIPRI C42-single-app delivers digital profile measurement data of railway wheels quickly and with high precision. Mošmondor believes this should gradually replace the less accurate mechanical gauges. The product plays an important role in safety of transportation of goods and people. It also makes the work of people in railway workshops, car manufacturing plants and rolling mills easier and faster.

POTENTIAL IMPACT

The use of CALIPRI Smart products removes the need for dangerous measuring procedures and decreases the number of accidents. It’s also very difficult to manipulate data. The high reliability of the measured data results in better public safety, especially in the railway industry, where dangerous damage to wheels, brakes and rails can occur.

Shortly after the project ended, NEXTSENSE was acquired by Hexagon, a leading global provider of information technology solutions. “The merger with a strong partner with a global presence will enable NEXTSENSE to accelerate product innovation and company growth, while providing even better support and services to existing rail and automobile customers,” Mošmondor concludes.

CALIPRI SMART

- Coordinated by NEXTSENSE GMBH in Austria.
- Funded under H2020-LEIT-ICT and H2020-SME.
- cordis.europa.eu/project/rcn/204236
- Project website: nextsense-worldwide.com/en/

INDUSTRIAL TECHNOLOGIES

Smart robots master the art of gripping

The EU-funded SARAFun project has unveiled a smart solution for non-expert users to easily integrate new bimanual tasks into robotic systems. This can significantly expand production capabilities in the manufacturing industry, dramatically increasing production speed, while taking on tedious assembly line jobs.

During the last few decades, humans have increasingly relied on robots to perform a variety of tasks. Robots have been extensively used in production lines for tasks such as car assembly. However, despite their widespread success, automatic assembly still suffers from the time it takes to programme and reprogramme robots.

To address this challenge, researchers established the EU-funded SARAFun (Smart Assembly Robot with Advanced FUNctionalities) project. The project’s new solution aims to empower industrial robots with perception, learning and reasoning abilities, providing tools to automate robot programme generation and design task-specific hardware.



LEARNING BY WATCHING HUMAN BEHAVIOUR

“The system is built around the concept of a robot capable of learning and executing assembly tasks such as insertion or folding demonstrated by a human instructor,” explains Dr Ioannis Mariolis. After analysing the demonstration task, the robot generates and executes its own assembly programme. Based on the human instructor’s feedback as well as sensory feedback from vision, force and tactile sensors, the robot can progressively improve its performance in terms of speed and robustness.

SARAFun’s ambitious aim was to develop a system capable of executing new assembly tasks in less than a day. “Maintaining a humanlike reach for assembly of small parts within a very small space is critical to minimising the footprint on the factory floor. It also enables the robot to be installed into work stations currently used only by humans,” adds Dr Mariolis.

IMPLEMENTATION OF THE INTERFACE

Work heavily relied on smooth and robust user interaction with the system using the human-robot interface. The latter consists of different modules enabling the operator to teach the assembly task to the robot and supervise the learning process. In the teaching phase, the user creates the assembly task by specifying a name, selecting the parts that the robot must assemble, and defining the type of the assembly operation. In the next step, the assembly parts are placed within the camera view and the system is called to identify them. After the parts have been detected, the operator demonstrates the assembly task in front of the camera.

The recorded information is then analysed and important frames of the demonstration called key frames are

automatically extracted. Upon user confirmation, the system uses the key-frame information that includes the tracked positions of the assembly parts and the instructor’s hands and generates the assembly programme for the robot. Candidate grasps for the assembly parts are proposed along with robotic finger designs for increasing grasp stability. After adjusting the grasping positions and designing appropriate fingers to compensate for the robot’s inferior dexterity with respect to the human hand, the actual fingers are 3D printed and installed into the robot grippers.

After loading the programme for execution, the robot motions are generated using the information extracted by the key frames. The assembly operation keeps performing repeatedly until it reaches the desired level of autonomy.

ALMOST ZERO PROGRAMMING

Researchers have successfully completed many demonstrations using ABB’s dual-arm collaborative robot YuMi. Armed with its grippers, the robot uses SARAFun’s design system components – 3D visual sensors, grasp planning, slip detection, motion and force control for both arms and physical human-robot interface – to mimic bimanual tasks demonstrated by the human instructor.

“The result is a flexible assembly programme that can adapt to the working environment without specific planning by the user. Compared to state-of-the-art technology, the simple graphical interface is much easier for non-experts to use,” notes Dr Mariolis. Tested on different assembly use cases involving cell-phone parts and emergency stop buttons, the system successfully learned the demonstrated assembly tasks in less than a day.

A disruptive game changer, SARAFun’s assembly robot can significantly change industrial manufacturing all over the world and encourage a re-evaluation of assembly manufacturing. Products with short life cycles entail frequent changes of programmes. Unlike today’s robots which know only their nominal task, this smart robot for bimanual assembly of small parts is not limited in its ability to deal with regular changes in the production line.

SARAFUN

- Coordinated by ABB AB in Sweden.
- Funded under H2020-LEIT-ICT.
- cordis.europa.eu/project/rcn/194263
- Project website: h2020sarafun.eu
- ▶ bit.ly/2RmaV7e



Smart functionalities to bring order to Wi-Fi chaos

The surge in demand for Wi-Fi networks has created a need to better coordinate the immense traffic. An EU initiative introduced an architecture to reduce interference and boost performance in very congested environments.

The EU-funded Wi-5 (What to do With the Wi-Fi Wild West) project tackled the issues of inefficient Wi-Fi spectrum usage and the increasing demand for wireless networks. To do so, it developed innovative technologies to evolve access points (APs) into a new state-of-the-art Wi-Fi network.

“More APs in the same area mean that Wi-Fi signals overlap with each other, lowering the overall bandwidth,” explains project coordinator Prof. Qi Shi. Additionally, APs configured on the same channel interfere with each other’s traffic. In Wi-5, APs become intelligent networking entities. “This is a classic case whereby everyone tries to get the greatest benefit from a shared resource,” he says. “But, as demand overwhelms supply, each individual who consumes directly harms others until no one can benefit.”

TOOLS TO ENHANCE WI-FI COORDINATION

Wi-5 developed an integrated system that can automatically detect and minimise interference in Wi-Fi networks and maximise performance for users. “Our system outperforms existing commercial solutions and can be deployed on a large portion of existing hardware,” says Prof. Shi.

“Moreover, it focuses purely on the AP and back-end system, and thus requires no modification to end-user devices.”

Project partners integrated novel smart functionalities to enable coordination in helping to reduce radio interference and optimise spectrum usage. They improved packet grouping techniques for small-packet traffic such as voice services or gaming. Also, an inter-operator domain AP cooperation platform enables coordination between local APs of different operators.

The project team designed a novel suite of smart functionalities that comprehensively enhances current Wi-Fi APs and offers seamless handovers 20 times faster than the state-of-the-art. This improves the experience for users who are walking and using real-time services. Team members implemented the Wi-5 system as an open-source proof of concept and deployed it in a range of environments, including real-world systems.

The main benefit of Wi-5, stresses Prof. Shi, “is fairness for users.” A deployment of Wi-Fi APs coordinated by the Wi-5 system maximises the available spectrum and fairly distributes this to users based on their bandwidth requirements. “This means that users with a demanding application such as HD video streaming will have a similar experience to users simply checking their email or social media,” he adds.

Yet another benefit of Wi-5 is that it’s suitable for a range of deployment scenarios beyond dense environments. It’s also applicable to sparse scenarios, such as large homes with limited coverage.

TOWARDS A SMART, FLEXIBLE AND STABLE WI-FI NETWORK

The expected impacts are manifold. Wi-5 increases the efficiency of wireless communication systems and improves spectrum usage. It enhances the performance and quality of experience of emerging real-time and video applications, facilitating coordination between neighbouring APs and offering seamless vertical and horizontal handover solutions. Wi-5 can dramatically reduce wireless energy consumption through a combination of

dynamic power adaptation, load balancing and packet grouping. Its smart channel selection approach reuses channels as much as possible to ease the urgent requirement for an ever more expanded Wi-Fi spectrum.

While Wi-5 has concluded, there’s still a significant amount of ongoing work to improve the system further and generate more results. Each partner is already actively making use of Wi-5 outcomes to develop their own products and services so that some aspects of the technology will be used commercially going forward.

“Thanks to Wi-5, the developed set of smart solutions will be able to solve real-world issues with today’s Wi-Fi ecosystem,” concludes Prof. Shi.

WI-5

- Coordinated by Liverpool John Moores University in the United Kingdom.
- Funded under H2020-LEIT-ICT.
- cordis.europa.eu/project/rcn/194177
- Project website: wi5.eu
- ▶ bit.ly/2NfSvBK

DIGITAL ECONOMY

Novel AI-based software for better musical inspiration, creativity and composition

An EU initiative developed production software to create and experiment with chords and harmony. The solution will offer a unique creative experience, enabling composers to start from a simple musical idea such as a melody or bass line and then to develop it through various levels of transformation.

Building on the successful outcomes of the FP7-ICT initiative Lrn2Cre8, the EU-funded I2C8 (Inspiring to Create) project “brings parts of that research closer to market by exploiting results related to creativity and automatic music generation technologies,” says coordinator Dr Stefan Oertl. I2C8 developed a new software product for

music chord generation with intelligent and automatic features. “Simplicity and ease of use are paramount. The software was designed with quick results in mind. Our aim is to inspire those who want to compose, not to deliver complete compositions.”



COMPUTER-SUPPORTED CREATIVITY

The application comes in the form of a plug-in for MIDI sequencers in digital audio workstations. The plug-in encourages and inspires composers to explore loops through pattern definition, position locking and generation into unlocked positions. Degrees of diatonicity of generated sequences can be examined and parameters for voicing the sequences manipulated. The I2C8 software is primarily aimed at semi-pro and pro music producers of loop-based, beat-driven, bass-heavy genres of electronic dance music who want to optimise their workflow during a creative process that differs somewhat from more traditional forms of music. Genre-typical, the first-generation I2C8 plug-in governs triad logic. Future versions of the software may incorporate more complex chord types.

The software captures existing meaning in the form of a statistical model and combines it with constraints that can be defined by the composer. This is done to recommend potentially interesting chord sequences. However, the composer decides which chord sequence is used in a given musical context. The software utilises AI methods to provide full autonomy over creative processes.

UNIQUE INTELLIGENT SOFTWARE TOOL FOR MUSIC CHORD GENERATION

“We’re not aware of another application/plug-in that employs a user interface concept like I2C8,” says Dr Oertl. “We tried to make use of the plug-in as straightforward as possible.” For the structural representation of chord sequences, a simple graphical, idiosyncratic pattern language is used that enables results to be immediately viewed and listened to. This fosters an explorative and

playful method when looking for and finding new and interesting chord progressions.

“The method implemented by the plug-in clearly separates it from other tools that are already on the market,” adds Dr Oertl. “Most of these tools could be described as chord recommendation engines or chord sequence builders, whereas we generate a set of full chord sequences that satisfy a given structural pattern.” He explains that the unique selling point of the I2C8 approach is the use of a machine learning model as the foundation for chord generation. Also, user communication takes place through an idiosyncratic pattern language conveyed by the user interface and not through more or less explicit implementations of music theory.

Project partners are currently exploring the software’s benefits for DJs and producers of electronic music during their live sets. It’s entering a public beta phase soon, and a market launch is planned for the third quarter of 2018.

“The I2C8 software satisfies the need of composers and producers who want full control over their creative musical output and are not fond of robots showing them the way,” concludes Dr Oertl. “The human remains at the centre of the decision-making process.”

I2C8

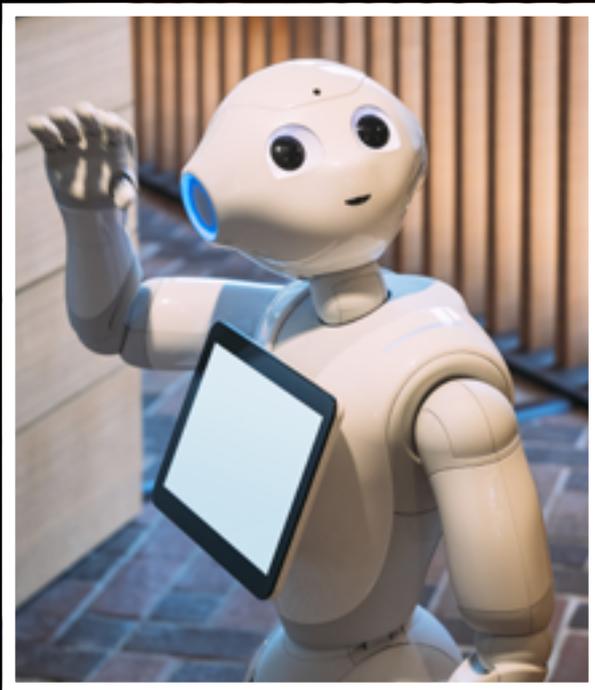
- Coordinated by Re-Compose in Austria.
- Funded under H2020-FET.
- cordis.europa.eu/project/rcn/208742
- Project website: i2c8.eu
- ▶ bit.ly/2lyKg31



PROJECT OF THE MONTH

A world first as EU-funded project robot gives evidence on AI in a parliamentary hearing

Pepper the robot made history by being the first ever robot to give evidence during a parliamentary hearing, specifically to the British House of Commons' Education Select Committee. Pepper was notably asked about the role that artificial intelligence (AI) could play as part of the 'fourth industrial revolution' and how robots can assist with learning in schools in the future.



© VTT Studio, Shutterstock

“ Robots will have an important role to play, but we will always need the soft skills that are unique to humans to sense, make and drive value from technology. As technologies fuse and are used in the ways that were not envisaged before, a new way of thinking is needed for tomorrow's workers. We will need people that can spot ideas and think across traditional sector divides to drive value from technological innovation. ”

Pepper the robot,
speaking at the UK House of Commons,
Tuesday 16 October 2018

Pepper is part of the EU-funded Horizon 2020 **CARESSES** project which is developing the world's first culturally-aware robots, aimed specifically at assisting with care for older people. Pepper currently resides at Middlesex University in the UK, where he works with final year students from the robotics, psychology, biomedicine and education fields.

After being questioned by the members of the House of Commons, Pepper received a resounding round of applause. If you want to see Pepper in action, check out the

following link: bbc.com/news/av/uk-politics-45878164/pepper-the-robot-tells-mps-about-artificial-intelligence

CARESSES

- Coordinated by the University of Genoa in Italy.
- Funded under H2020-HEALTH.
- cordis.europa.eu/project/rcn/206852
- Project website: caressesrobot.org
- ▶ bit.ly/2Ap22mH

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!



Enhanced preparedness and response plans for pandemics

A hundred years ago an outbreak of influenza (Spanish Flu) infected around 500 million people, killing 50-100 million. Should a pandemic strike now, accidentally or deliberately triggered, how ready are we? PANDHUB set out to improve our odds.

Nowadays, despite medical advances in prevention and treatment, an ever-increasing number of people travelling globally makes the risk of a major pandemic greater than ever. The spread of a disease, such as influenza or smallpox, could occur as a result of accidental exposure or of a deliberate act. Amongst the most likely hotspots for fast disease transmission are transport hubs, such as airports or railway stations.

The EU-funded PANDHUB (Prevention and Management of High Threat Pathogen Incidents in Transport Hubs) project was set up to develop tools to help transport operators and authorities, tasked with the public's health and safety, in their preparedness and response plans. The project succeeded in improving the understanding of disease transmission in these contexts by developing an IT system for data collection, a Threat Assessment tool and a framework for the identification of hotspots. It also created guidance for the protection of people and infrastructure, as well as decontamination.

A 'JOINED-UP' APPROACH THAT BUILDS SOCIETY'S RESILIENCE

PANDHUB's aim was to facilitate coordinated data collection, collation and analysis, allowing swift epidemiological investigation which could integrate a range of technologies and expertise to help authorities tackle an outbreak or release of diseases with pandemic potential.

The team first developed a conceptual framework which broke down the various stages of pandemic management. Explaining the approach chosen, project coordinator Mr Ilpo Kulmala, says, "We considered a 'cycle' of requirements for disease threat assessment, preparation, response and recovery, outlining the necessary tasks to be completed for each phase. This allowed us to then design the most appropriate tools."

For example, for the preparedness phase, modelling work was undertaken to simulate the spread of microbial



© Hinochika-Shutterstock



In 1918 an outbreak of Spanish Flu
infected around 500 million people,
killing 50-100 million

contamination and analytically evaluate the likely impact of countermeasures. For tasks addressing the response phase, IT tools for rapid data collection and sharing were developed. Evidence-based practical guidance for the protection of people was also drafted, with detailed instructions on how to minimise the risk of contracting an infectious disease in a crowded transport hub. Additionally, a decontamination and disinfection guide described suitable cleaning methods for various types of contamination.

Mr Kulmala adds, "The capability and robustness of the whole package was assured through early and close collaboration with transport staff and other end-users. Viability was also borne out by reviewing and integrating the local and national practical, legal and ethical implications necessarily involved in multinational incidents and responses."

The project catered for this international dimension of epidemiology, with varying legal and cultural settings, by incorporating participants from three European countries: Finland, the UK and France. Additionally, the stakeholder liaison group comprised representatives from other

countries, as well as from the European Centre for Disease Prevention and Control.

Sensitivity to international needs resulted in the aforementioned data collection and sharing tool offering different language options, so that the same questionnaire could be used by different countries, ensuring more accurate cross-border data sharing. Additionally, international communication protocols during a serious health hazard were reviewed for effective, timely and accurate information flows.

By building the resilience of our society to pandemics, PANDHUB has contributed to the continued upkeep of one of the central pillars on which the European Union rests – the free and safe movement of people. As Mr Kulmala summarises, "In the event of a pandemic, PANDHUB's epidemiology tools, including the tracing of infected individuals and range of effective methods for cleaning contaminated sites, will facilitate an efficient and rapid response to a cross-border incident, limiting the spread and saving lives."

PANDHUB

- Coordinated by the VTT Technical Research Centre in Finland.
- Funded under FP7-SECURITY.
- cordis.europa.eu/project/rcn/192353
- Project website: pandhub-fp7-security.eu

SECURITY

Smarter drones to support Europe's police forces

Drones are crucial in helping speed up rescue and recovery in critical situations where every minute counts. A new drone management solution promises to offer valuable support to decision makers in such situations.

From flash floods and forest fires to terrorist attacks, Europe has recently seen its fair share of threats. Luckily, technology is evolving rapidly to help authorities manage and even pre-empt many threats and disasters. One of the latest high-tech tools involves the operation of drones to collect and analyse data in critical situations.

Against this backdrop, the EU-funded SURVEIRON (Advanced surveillance system for the protection of urban soft targets and urban critical infrastructures) project created a novel drone-based information management system that takes the management of numerous critical situations to the next level. The system does not put the

focus of innovation on aircraft, as drones from any manufacturer can be connected and controlled from the system. SURVEIRON is not a new aircraft project, but takes advantage of all the advances in the drone market to integrate them. The real innovation lies in the scalability capabilities to introduce new drones and in the data flow to make decisions with massive information. "SURVEIRON's drone fleets can fly automatically, acquire key data, analyse it, and propose different actions safely and quickly to help decision-makers in critical situations," says Manuel Ruiz de Quintanilla, SURVEIRON project coordinator.

SMARTER DRONES TO HELP POLICE FORCES

The innovative concept helps authorities such as the police to expand the use of drones and increase their presence in daily operations. "This is especially important because, while drones represent cutting-edge technology with enormous potential, they remain undervalued and police forces have not yet exploited them very effectively," notes Ruiz.

In effect, "SURVEIRON is able to detect threats and risks and assess their magnitude," underlines Ruiz. "It can detect and locate people, fire and smoke, as well as toxic gases and radioactivity," he adds. The system provides real-time reports along with suggested actions such as number of required police patrols, ambulances and fire trucks to be mobilised. It can also produce maps of affected buildings and predict fire behaviour.

Drone use can be ideal for monitoring soft targets – i.e. vulnerable spaces which in principle shouldn't be specifically protected but are often selected by terrorists to maximise casualties, create fear and attain media coverage. This includes public spaces, hospitals, schools, religious installations, cultural centres, places of worship or transportation sites, among others. "With terrorists increasingly eyeing such unprotected places, SURVEIRON drones can be deployed very rapidly and complement police forces," explains Ruiz.



INNOVATIVE TECHNOLOGY FOR DRONE CONTROL

To achieve its aims, the coordinating company, Aeorum, a spin-off of the University of Malaga, began collaborating with the Spanish National Police and the Civil Guard. This association quickly extended the collaboration to all European Member States united in ENLETS, the European Network of Law Enforcement Technology Services.

Aeorum and ENLETS successfully converted drone technology into transversal IT technology for today's modern police force. "The biggest difference between SURVEIRON and current drone surveillance techniques is its innovative architecture," highlights Ruiz. In SURVEIRON's case, navigation control, the drones and the software are in three different locations, connected to each other through global communication networks.

"This setup allows authorities to operate drone fleets at a global level where the pilot or pilots can be anywhere in the world, regardless of physical distance from the drones," notes Ruiz. The system makes it possible to carry out different tasks simultaneously, such as detecting lost people and locating a fire, while receiving reliable information in real time.

Intensive design, testing and performance validation have created much interest among European law enforcement agencies. The project partners have conducted a real-life search and rescue mission in the woods of Lapland, Finland. The mission's pilots were in Madrid, Spain, while the software was hosted in Malaga, on Spain's southern coast. "The system detected the missing person in the forest, providing the exact location to the Finnish Police so that they could complete the rescue task," says Ruiz. The entire operation was also monitored in real time from the Executive Agency for SMEs' offices in Brussels, Belgium.

Today, SURVEIRON represents a fully functional drone surveillance solution, currently also being marketed to different police authorities. Thanks to SURVEIRON, decision makers will be able to have immediate access to critical information in real time, both locally and remotely.

SURVEIRON

- Coordinated by Aeorum in Spain.
- Funded under H2020-SME and H2020-SECURITY.
- cordis.europa.eu/project/rcn/201667
- Project website: surveiron.com
- ▶ bit.ly/2zNRZYg



Electron stopping power showcases its potential

Dealing with nuclear waste, mastering cancer radiotherapy or withstanding cosmic radiation in space could easily be mistaken for very different issues, sharing only their importance for the future of humanity. Yet, there is one process, called electron stopping, that if better understood could help solve all these problems. An EU project made fundamental progress in this regard.

As ions go through solids, liquids and gases, a process of neutralisation and energy loss takes place. This process is called electron stopping, and it's fundamental to better understanding the properties of matter, which certainly explains why it has been extensively studied for over a century and is now largely understood... At least when it comes to systems close to equilibrium.

Understanding dynamic systems is another story, as Professor Emilio Artacho from the nanoGUNE Cooperative Research Center (CIC) explains: "A deeper understanding of dynamical many-particle quantum systems is, I think, one of the important scientific challenges for the 21st century. First-principles calculations – quantitative simulation and prediction of the properties of matter by extensive use of supercomputers – make it easy to predict the properties of many solids, liquids or gases in or close to equilibrium. But these calculations are far behind when it comes to non-equilibrium situations: we have a good idea of the kinds of things that happen, but we cannot accurately predict them."

Making such predictions is well worth the trouble. Electronic stopping processes in solids are a key stage in processes of radiation damage, which are very important in understanding and controlling the likes of nuclear materials, the impact of cosmic radiations on vessels and crews, as well as some forms of radiotherapy.

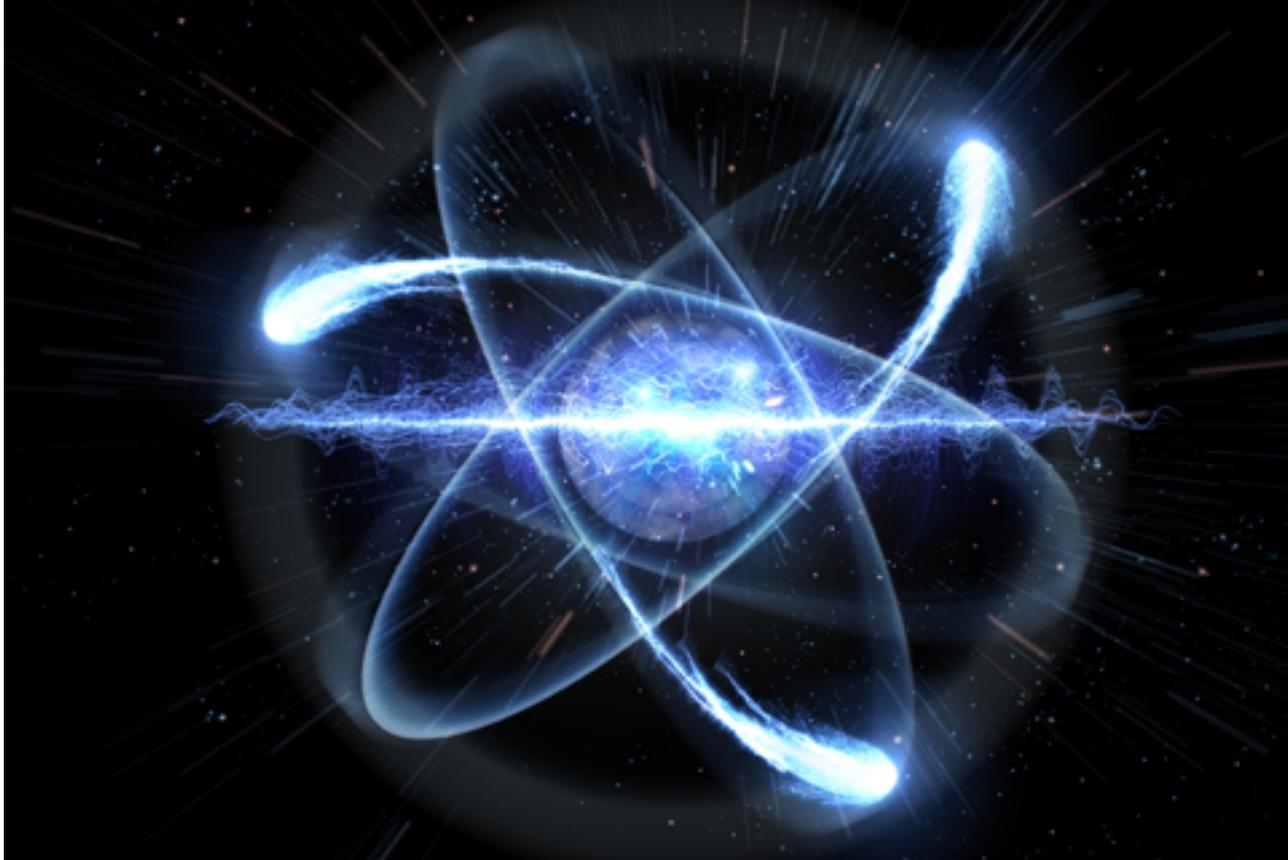
Having started a line of research on first-principles calculations for electronic stopping processes over a decade ago, the nanoGUNE CIC is a leader in the field, and the Electron Stopping (Electronic stopping power from first principles) project enabled Prof. Artacho and his team to go a step further by attempting to simulate these processes in real time.

Although much research is still needed to improve their approximations and include missing effects, Prof. Artacho says the approach can deal with very different kinds of systems, from simple metals to DNA.

The project has made fundamental, technical and applied progress, as he underlines. "From a technical point of view, we have made an interesting link between the equations we are solving on the computer and the curved spaces of general relativity, two fields otherwise widely apart. This link has allowed us to suggest new numerical techniques for improving our computations. We have also been able to characterise electronic stopping processes in varied systems, from semiconductors to transition metals, and we have explored the (low energy) response of liquid water to carbon ions, as used in ion therapy."

Alongside these advances, the project has predicted an unexpected dynamical instability in these processes. "All theories of electronic stopping so far have assumed, and expected, some kind of stationary regime by which ions lose energy in a smooth fashion. But our calculations have shown an unexpected 'flapping' effect in the deep electrons bound to a heavy projectile ion – an oscillation analogous to the flapping of a flag in a steady wind. This would have deep connections to other non-equilibrium systems."

By better understanding radiation damage processes, ElectronStopping enables researchers to control or provide better protection against them. Whilst Prof. Artacho admits that the way society will make use of the project results is difficult to foresee, he is hopeful that engineers and entrepreneurs will be quick to think about marketable products.



A follow-up project, called ESC2RAD, has already started with funding under Horizon 2020. It will see Electron-Stopping techniques be applied to the characterisation of radiation damage processes relevant to space exploration, both in vessel and under Mars conditions. Prof. Artacho and his team will also be developing new theoretical frameworks to better understand electronic stopping processes.

ELECTRONSTOPPING

- Coordinated by nanoGUNE in Spain.
- Funded under FP7-PEOPLE.
- cordis.europa.eu/project/rcn/109168

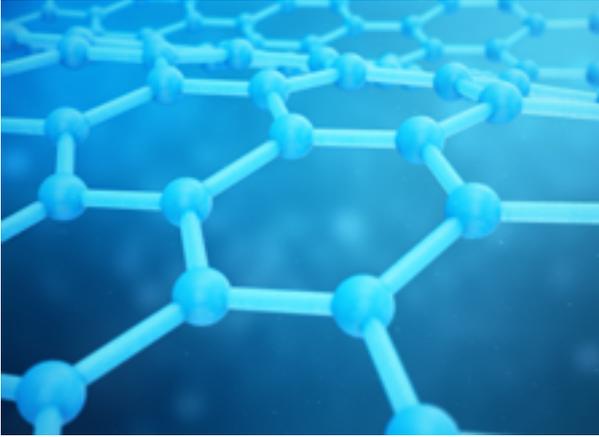
FUNDAMENTAL RESEARCH

Surface chemistry between graphene and ionic liquids

Deeper understanding of the complex phenomena underlying the interface between graphene-based electrodes and the electrolyte is crucial to increasing capacity in next-generation energy storage devices such as supercapacitors.

Graphene, a single layer of carbon atoms, is an attractive electrode material for supercapacitors because of its high surface area and high electronic conductivity. Similarly, ionic liquids are outstanding candidates owing to their high electrochemical stability. However, how the ionic liquid electrolytes interact with carbon material is still not well understood.

Within the EU-funded GRAPHIL (Exploring the Interface Between Ionic Liquids and Graphene: Elucidating Structure and Electronic Properties) project, scientists investigated how changes in the structure of ionic liquid electrolytes can affect the electronic structure of graphene, which in turn influences the efficiency of energy storage devices. "Identifying how the charged ions and length of the alkyl



chain attached to either of these ions bind to the electrode surface is very important for boosting the capacity and efficiency of energy storage systems,” notes Dr Gangamalliah Velpula.

BETTER MATERIALS FOR ENERGY STORAGE

Electrochemical capacitors, also known as supercapacitors or ultracapacitors, store electrical energy via reversible adsorption of ions on the surface of the electrodes. In these devices, the electrolyte forms an ionic conductive connection between the two electrodes. Amongst the carbon materials, graphene potentially has the highest surface area, which can significantly increase the specific capacitance. However, it is difficult to understand how ions (both anions and cations) are transported and interact with the graphene electrodes.

GRAPHIL researchers have provided fundamental insight into the detailed structure of ionic liquid thin films in contact with graphene and graphite and how they impact the electronic structure of the graphene. The study provides scientists with knowledge on how to develop more appropriate materials for energy storage devices.

In addition to their wide electrochemical window, ionic liquids possess exceptional physicochemical properties such as high thermal stability and nonflammability. These properties make them suitable electrolytes for batteries.

“Thermal runaway remains one of the most significant risks related to the use of lithium-ion batteries in energy storage or vehicle applications. Undesired reactions between the battery components and the liquid organic electrolyte causes the battery to suffer an exothermic reaction, causing more and more heat to be generated that can eventually lead to fire or explosion,” explains

Dr Velpula. Non-flammable ionic liquid electrolytes can help overcome safety concerns related to the use of lithium-ion batteries.

ANION SIZE MATTERS

Researchers mixed graphene with the ionic liquid containing negatively and positively charged ions. In the first case, the cation used was imidazolium and the anion was the large and weakly associating bis(trifluoromethylsulfonyl)imide (Tf2N), whereas in the second case, the anion was the small and strongly associating tetrafluoroborate (BF4). Using atomic force microscopy, Raman spectroscopy and molecular simulations, the team analysed the thin layer forming on graphene and graphite and assessed the influence of the interfacial structure of the ionic liquids on the electronic structure of graphene.

Results showed that the anion size can change the molecular arrangement of the liquid cations and anions on the graphene surface. For example, the combined use of Tf2N and imidazolium causes the latter to adsorb onto the electrode surface. In contrast, in ionic liquids containing BF4, both the charged particles are more likely to adsorb onto graphene.

Unlike anions, cations were found to play a minor role on the ionic liquid nanostructure at their interface with the electrode. In particular, the ionic liquid containing non-aromatic pyrrolidinium cation and Tf2N exerted a mild influence on the graphene properties; specifically, the cation with longer alkyl chains. This can be attributed to charge delocalisation, which is less common in the case of pyrrolidinium than in the case of imidazolium.

GRAPHIL’s fundamental information on the surface chemistry between graphene and ionic liquids will be valuable in the engineering of the interface structure, which in turn will affect efficiency of energy storage devices.

GRAPHIL

- Coordinated by KU Leuven in Belgium.
- Funded under H2020-MSCA-IF.
- cordis.europa.eu/project/rcn/200363



AGENDA

December 2018

WORLDWIDE
World AIDS Day
→ un.org/en/events/aidsday

**1
DEC**

BRUSSELS, BELGIUM
2nd SAYSO public workshop
→ cmt.eurtd.com/news/view/133913/2nd-sayso-public-workshop-on-4th-december-2018-in-brussels

**4
DEC**

SANTIAGO, CHILE
EULAC FOCUS: 6th EULAC-Focus project event
→ eulac-focus.net/news/6th-eulac-focus-project-event-in-santiago-chile-4th-6th-december-2018

**04→06
DEC**

WORLDWIDE
International Mountain Day
→ un.org/en/events/mountainday

**11
DEC**

MUNICH, GERMANY
BIG IoT: Future IoT Winter School
→ big-iot.eu/future-iot-winter-school-2018-december-11-14-in-munich

**11→14
DEC**

**ABU DHABI,
UNITED ARAB EMIRATES**
5G Advanced: The Next Evolution Step of 5G NR
→ one5g.eu/workshop

**13
DEC**

**MORE
EVENTS**
[cordis.europa.eu/
events](http://cordis.europa.eu/events)

**5
DEC**

BRUSSELS, BELGIUM

European Projects on Societal Security and Extremism: Exchanging Ideas and Practices

As one of the last steps in finalising the FP7 SOURCE project activities, VUB-IES is aiming at bringing together ongoing and recently finalised European projects related to societal security and extremism.

→ ies.be/node/4779

UPDATED CORDIS RESULTS PACK ON CYBERSECURITY

We've comprehensively updated this Results Pack with six new projects, showcasing even more of the most promising EU-funded projects engaged in developing innovative solutions to combat an ever-increasing threat to Europe's security.



Check out the Pack at:
cordis.europa.eu/article/id/400141



Publications Office
of the European Union



Follow us on social media too!
facebook.com/EULawandPublications
twitter.com/CORDIS_EU
youtube.com/CORDISdotEU

EN