



research^{eu}

RESULTS MAGAZINE

N°50
MARCH 2016

SPECIAL FEATURE

BIOMARKERS TO TRACK DOWN DISEASE



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**LONG-LASTING COATINGS
FOR OFFSHORE
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Published by

The Community Research and Development Information Service (CORDIS) managed by the Publications Office of the European Union
2, rue Mercier
2985 Luxembourg
LUXEMBOURG
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The *research*eu results magazine* is published by the Community Research and Development Information Service (CORDIS) and managed by the Publications Office of the European Union. Content is prepared using information featured on the CORDIS website, as well as original material collected specifically for this publication.

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ISSN 1831-9947 (printed version)

ISSN 1977-4028 (PDF, EPUB)

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EDITORIAL

by the editorial team

CLINICAL VALIDATION: REMOVING THE LAST BARRIER TO BIOMARKER-BASED DIAGNOSIS

Defined as 'physical, functional or biochemical indicators of physiological or disease processes', biomarkers have become one of the most prominent centres of worldwide scientific attention over the past few years.

Biomarkers can be used at each step of medical practice, from measuring health to grading disease severity, predicting outcomes, determining the best treatment and evaluating response to this treatment. They bring hope of early diagnosis test kits for infamous diseases like cancer, neurodegenerative disorders and diabetes, and they also open doors to personalised medicine by enabling clinical practitioners to classify patients in subpopulations.

While this potential cannot be argued against, it is however hindered by two major issues which see only a few biomarkers being validated for use in clinical research settings. First, diagnostic kits arising from biomarker research have to be approved as *in vitro* diagnostic tests — implying tedious validation processes

where poor reproducibility is often a problem. Then, regulators generally require that diagnostic tests and drugs are developed in tandem, as they are closely intertwined: the purpose of a diagnostic test is essentially to enable better decision-making on the use of a specific therapy. Since pharmaceutical companies and diagnostic manufacturers are subject to different regulations, the whole process can quickly become difficult.

The European Medicines Agency hopes that biomarkers will eventually contribute to faster public access to new medicines and has been taking various measures to help make this vision a reality, while

'Biomarkers bring hope of early diagnosis test kits for infamous diseases like cancer, neurodegenerative disorders and diabetes.'

research keeps moving forward. With this edition of the *research*eu results magazine*, the CORDIS editorial team wanted to highlight the potential of biomarkers by presenting some of the latest FP7 project results in this field. Early results from some Horizon 2020 projects funded under an SME Instrument call, specifically dedicated to the clinical validation of existing biomarkers and/or diagnostic devices, are presented.

This special feature is followed by eight sections providing insights into biology and medicine, social sciences and humanities, energy and transport, the environment, IT and telecommunications, industrial technologies, food and agriculture and physics and mathematics, along with a list of upcoming events hosted by or involving EU-funded research projects.

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



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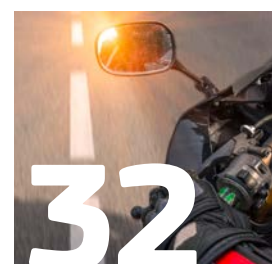


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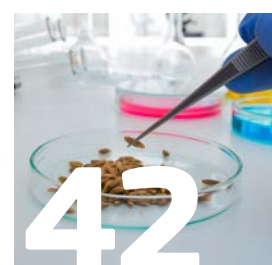
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SPECIAL FEATURE

**BIOMARKERS
TO TRACK
DOWN DISEASE**

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INTERVIEW

EARLY DETECTION TOOLS PROMISE TO REDUCE THE FINANCIAL BURDEN OF LUNG AND COLORECTAL CANCER

A team of researchers at Israeli SME Nucleix have set for themselves the objective of reducing the financial burden of lung and colorectal cancers — two of the cancer types with the highest occurrence in Europe. They are planning to bring new, non-invasive and more accurate diagnostic tools to market.

Proof of the disastrous impact of lung and colorectal cancers on citizens' health is no longer needed. With a total yearly mortality rate in the EU of around 265 000 people, lung cancer is the deadliest cancer in the EU. Colorectal cancer, on the other hand, has one of the highest annual incidence rates in the EU at around 342 000. In both cases, early detection can have a tremendous impact on the success of treatment, which is why new tools are desperately needed.

Building on the early successes of its Bladder EpiCheck product — which eases the detection of bladder cancer recurrence after treatment — in clinical trials, Nucleix is now working on Lung EpiCheck and Colon EpiCheck products focusing on early detection among populations at risk. The new tests will be based on bodily fluids (urine and blood), making them far less invasive than existing practices — colonoscopy for colorectal cancer or cystoscopy for bladder cancer.

Arnon Horev, director of product marketing at Nucleix, discusses the successes of the company's bladder cancer detection tool so far, along with its future plans now that EU support has been granted to the EPICHECK (Detection of Various Cancer Types for Screening and Diagnosis through Blood Samples with Epigenetic Biomarkers Panels) project under the Horizon 2020 SME Instrument.

★ **What is EpiCheck and what's its added value compared to alternatives?**

Arnon Horev: EpiCheck is a family of tests for the diagnosis, early detection and monitoring of cancer. Under this brand, Nucleix has developed Bladder EpiCheck — a urine test aimed at monitoring bladder cancer patients which is planned to be launched in 2016. Moreover, we are in the process of developing two additional tests — Lung EpiCheck for the detection of lung cancer in blood samples, and



© Arnon Horev

ARNON HOREV

Colon EpiCheck for the detection of colorectal cancer in blood samples.

The EpiCheck family of tests is based on the identification of methylation changes that can be observed between DNA originating from tumours and DNA originating from healthy tissues. Nucleix has developed a platform that comprises a bioinformatics tool, a biochemical platform and software algorithms for the development of proprietary markers tailored to each application. Our products rely on proprietary markers that are applied to the tested substance and analysed with our software, resulting in diagnostics.

When compared to current practices, EpiCheck stands out with: its high sensitivity and specificity; the fact that it is non-invasive; its use of methylation markers to identify

tissues and differentiate healthy ones from cancerous ones; as well as multiplexing — a technology that enables us to combine many markers

— to increase sensitivity and specificity. Last but not least, our tests are repeatable and independent of the user thanks to our proprietary software tool, whereas many of the current tests depend on the proficiency of the technician.

★ **What can you tell us about the biomarkers you developed?**

Our biomarkers are developed using two tools: a bioinformatics tool enabling rapid and systematic development of biomarker panels for a wide range of clinical tasks; and a proprietary biochemical tool for a simple, low-cost clinical assay which provides us with the ability to detect rare methylation change events.

The biomarker development process includes the use of these two tools in a reiterative process, so as to identify the best combination of biomarkers that will complement each other in order to cover more segments of the population.

It should be emphasized that all of the markers we use were developed and are owned by Nucleix.

★ **What about tests in a clinical environment?**

Bladder EpiCheck, which is based on a panel of 15 non-overlapping methylation markers at loci that were identified, developed and are owned by the company, has already undergone a successful clinical trial and will be launched in 2016 in the EU (subject to EU regulatory approval).

It was tested on a cohort of 221 bladder cancer patients who were coming for recurrence monitoring tests after treatment, and compared to the gold standard of bladder cancer detection — cystoscopy and pathology. The result of this test shows a 90% sensitivity, an 83% specificity and a 97% 'Negative predictive value' (NPV).

★ **What are the markets you target with this product?**

We will first be targeting EU markets because of its patient-oriented healthcare environment, followed by the US and other leading markets (after having obtained the certifications required such as CE and FDA).

★ **What have you learned from the feasibility study so far?**

The feasibility study is not complete yet, but it has given us great insights and optimal methods of operation in terms of the systemic approaches for screening programmes in large populations, including geographic focus, reimbursement strategy and test automation.

★ **Do you still expect your product to reach the market in Q2?**

Our first product for bladder cancer monitoring (Bladder EpiCheck) is indeed expected to reach the European market towards the end of Q2 or the early part of Q3 2016, subject to EU regulatory approval.

EPICHECK

- ★ Coordinated by Nucleix in Israel.
- ★ Funded under H2020-SMEINST.
- ★ <http://cordis.europa.eu/project/rcn/198858>
- ★ Nucleix website: <http://nucleix.com/>

"Our tests are repeatable and independent of the user thanks to our proprietary software tool."



HOW FASTER SEPSIS DIAGNOSES COULD SAVE LIVES AND CUT COSTS

EU funding has enabled European researchers to pioneer life-saving research that could lead to the early diagnosis of the deadly disease sepsis.



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The breakthrough has the potential to not only save lives but also significantly cut healthcare costs. It thus presents European high-tech SMEs with an opportunity to tap a huge market with an innovation that brings with it numerous benefits.

The work, being carried out as part of the EU-funded CE-MICROARRAY (Cavity Enhanced Microarray as an Ultra-sensitive Tool to aid Sepsis Diagnosis) project, aims to reduce the amount of time it takes to diagnose patients at risk of developing sepsis, one of the most common causes of death in hospitalised patients.

Sepsis is a life-threatening illness caused by the body's overreaction to

an infection. It can be triggered directly by infection and can also occur after medical treatment or surgery. It has been estimated that nearly 20 000 people die each day from sepsis worldwide and it is the cause of approximately half a million deaths in Europe each year.

Early diagnosis is crucial and can result in sizeable reductions in mortality rates. Unfortunately, current methods of diagnosing sepsis can take up to 72 hours. This is why the CE-MICROARRAY project's innovation could have a significant impact.

The project team has pioneered the use of 'cavity enhanced absorption spectroscopy'. This method of analysis offers more sensitive, reliable and speedier diagnoses of patients at risk of developing sepsis. The technique involves improving the sensitivity of blood tests, which are based on light passing many times through the sample. The team are hopeful that this could lead to a test that could be up to 100 times more sensitive than conventional testing.

This innovation is hoped to save health services across the world billions of euros, and there is significant market potential. In fact, the project has estimated the market opportunity to be greater than EUR 1 billion, with the potential to bring a cumulative profit of around EUR 38 million to the SME consortium over five years.

One of the SME partners in the project for example is a company specialising in novel analytical systems, which was spun out of the research pioneered through CE-MICROARRAY. Project partners are currently working on producing prototype demonstrator instruments, in order to bring the project results one step closer to commercialisation.

CE-MICROARRAY has also worked on studying the characteristics of potential biomarkers that could be used for the diagnosis of sepsis risk. A number of suitable biomarkers have already been identified. This has been another key element of the project, and will help to build the foundations of the next generation of analytical sepsis tests.

The project consortium comprises experienced SMEs from across Europe, many of which identified the healthcare and commercial opportunities of this technique but did not have the capability to undertake the required R&D to produce working prototypes. This is where EU funding has proved crucial. CE-MICROARRAY is scheduled for final completion in April 2016.

CE-MICROARRAY

- ★ Coordinated by the University of Teesside in the United Kingdom.
- ★ Funded under FP7-SME.
- ★ <http://cordis.europa.eu/news/rcn/124800>
- ★ Project website: <http://www.cemicroarray.com/>

INTERVIEW

A URINE TEST FOR EASIER AND MORE EFFICIENT DIABETES MANAGEMENT

A Marie Curie project has brought together researchers from Europe and China to create a new method for diagnosing and monitoring the evolution of diabetes. Thanks to a simple urine test, patients will soon benefit from solutions that are simpler to use, more cost efficient and more effective than any other method currently available.

While simpler than blood glucose tests, urine tests for diabetes have so far been less reliable than blood glucose level ones. Finding disease-specific protein biomarkers in urine is not an easy task, as these proteins can vary quickly and significantly due to changes in diet, metabolic or catabolic processes, circadian rhythms, pharmacology, exercise, as well as the circulatory levels of various hormones. Last but not least, environmental and

genetic factors also influence the rate of disease progression, which implies that the biomarkers of patients from different regions of the world would not necessarily have the same characteristics.

The EU-backed UROSENSE (Biomarker Applications for Nanotechnology and Imaging in Diabetes) project, which was completed in December 2015, aimed to overcome this



lack of suitable, easy and accessible urine-based test methods to combat the rapid expansion of diabetes globally. The project team — led by Dr Harry Holthofer from Dublin City University — managed to create an easy-to-use, non-invasive system thanks to a thorough analysis of high-quality standardised data.

This test, which has been trialled on patients from China and Europe, can be used as point-of-care testing at home to screen patients rapidly and help them to postpone and even completely avoid the onset of diabetes. It will eventually save pre-diabetics from hospitalisation and contribute to significant savings in healthcare expenditure.

★ **What can you tell us about the biomarkers you identified in your research?**

Dr Harry Holthofer: Our research allowed us to identify a number of useful biomarkers which can be found in the patient's urine. The new method we use to find these biomarkers, 'Hydrostatic filtration dialysis' (HFD), is by far superior to all existing practices. It's simpler, more cost-efficient, and more effective in revealing potential biomarkers.

Moreover, our method radically cuts the time needed to exploit the biomarker source in studies and is also allowing

for much simpler sample storing, for example in developing countries. This is an important aspect, as more and more sample collections for biobanks are currently being used to store samples for later analysis. Our

method reduces the need for storage capacity (freezers) to less than one tenth of what was previously required.

★ **Your main objective was to develop a non-invasive urine test to screen patients. Are you happy with the results?**

We are very happy with the new method established: it provides a vast number of potential new ways to better understand disease mechanisms as well as identify target pathways and molecules for pharmacological intervening. Moreover, it provides a new path for improved, simple home-test and mobile health applications for patients to manage diabetes easily in their everyday life. After full validation, we hope our method will result in much simpler diabetes management with a completely painless test system utilising urine.

★ **How does this test compare to previously-used methods?**

We have solid data to show that our test system can efficiently provide initial biomarker information on diabetes progress in a much simpler format. This system currently looks set to replace the costly, labour-intensive and often highly technical methods used in the hunt for biomarkers, not only for diabetes but also for other diseases, including cardiovascular, infectious and kidney diseases. So I would say that our HFD method is a highly promising new platform that can be used for many futuristic diagnostics purposes.

★ **How effective would you say the new test could be in helping to avoid the onset of diabetes?**

We strongly believe that identifying both the risk of diabetes and the risk of costly diabetic organ complications like diabetic kidney, cardiovascular, skin and eye complications

should be the future pathway for reasonable risk management at a personal, societal and national level. This will not only prevent excessively early invalidation, but also prove to be a very cost-efficient driver in future healthcare.

★ **Have you tested your method on patients yet?**

We have provided the first results in European and Chinese diabetic patients at different disease stages. We can detect typical urinary biomarker characteristics for European patients with notable differences compared to Chinese diabetes patients. As the number of diabetic patients increases rapidly in China, with already around 100 million patients, there is an urgent need to learn more about the disease traits and eventually prevent the massive costs this growth will imply in the future. This is why we have expanded, with the precious help of our UROSENSE partners in China, our network in that country. We have already seen highly encouraging exploitation of our method there, and this networking in China is expanding rapidly.

★ **How do you keep potential data quality issues under control?**

Thanks to help from our partners Tethis in Milan and Chimega Inc. in Hong Kong, quality by design, fulfilment of all relevant regulatory issues and compliance with ISO standards have been of major importance from the very beginning of the project. This approach was key to our method's potential for commercial exploitation.

When it comes to data quality of our first scientific results, we have followed all key principles of responsible research so that our results can be reproduced with ethics and other aspects being considered. The shift from lab to market was built into the research design early on and we not only provided the proof of principle in practice but also confirmed our results in various ethnicities.

This is important, as more and more study results from regions like the Far East, and most notably China, are being published. With our method, we can simplify the protocols of 'Standard operational procedures' (SOPs) to be applied all across the world and, consequently, allow results from patients coming from different geographic areas for

"Our method provides a new path for improved, simple home-test and mobile health applications for patients to manage diabetes easily in their everyday life."





© Harry Holthofer

DR HARRY HOLTHOFER

improved analysis. This is key to understanding phenotypic differences in disease biomarkers and, hopefully, will lead the way to better disease management at the local level. This all calls for controlling data quality from the very beginning.

★ **The market potential of your test appears to be huge, as it can be conducted by patients at home. When do you expect commercialisation to take place?**

We are currently working hard to overcome any hindrances to the exploitation of our method. For us, it is important to continuously progress in China due to its massive diabetes problem and also because of the easier access to this vast market. Unlike Europe, China has only one regulatory body, which has made it worthwhile putting all the effort

in during the project in order to increase visibility of our results and raise market knowledge.

Building a deeper and deeper understanding of the decision-making process and key national decision makers in China has helped a lot in proceeding to tangible first-generation products which are, hopefully, only months away from commercialisation.

★ **Where do you stand with the patenting of the project's outcomes?**

Patenting is underway, with an expected second set of patent protections progressing rapidly.

★ **What are the next steps now that the project has been completed?**

The UROSENSE project provided a strong basis for next-stage research and understanding of all necessary elements for product and market development. It also gave us in-depth knowledge of what it takes to move from cutting-edge molecular innovations to clinical verification and, all the way through, understanding target markets, regulatory aspects and products.

The benefit for diabetic patients and their right to full information on the individual course of their disease — daily, easily and painlessly — was our starting point, so that we can provide better individualised healthcare solutions in the future. We are still deeply committed to this goal. Thanks to UROSENSE, we are now much more aware of daily realities, challenges and opportunities related to such things and we will keep working hard to achieve our goals.

UROSENSE

- ★ Coordinated by Dublin City University in Ireland.
 - ★ Funded under FP7-PEOPLE.
 - ★ <http://cordis.europa.eu/project/rcn/101741>
 - ★ Project website:
<http://urosense.eu>
-

NEW BIOMARKER ASSAY OFFERS HOPE FOR PARKINSON'S PATIENTS

EU-funded researchers have developed a Parkinson's disease biomarker assay that could lead to early diagnoses and faster, more effective treatments.

Developed through the EU-funded BIOMARKERS FOR PD (Validation of diagnostic and prognostic biomarkers for Parkinson disease) project, the innovation has the potential to become the first biochemical biomarker assay capable of reflecting the underlying pathophysiology of the disease. A key component of the project has been to evaluate the business opportunities and future development path for such Parkinson's disease biomarkers.

A healthcare priority for Europe

Parkinson's disease is one of the most prevalent neurodegenerative disorders.

Around the world, more than 4.6 million people aged 50 and over currently suffer from the condition, and the World Health Organisation estimates that this number will more than double by 2030.

The condition exacts a heavy social and economic cost. It can significantly impact the quality of life, not only of patients but also of families, friends and carers. In financial terms, it has been estimated that the annual healthcare bill for treating Parkinson's disease in Europe tops EUR 14 billion.

Improving the treatment of Parkinson's disease is therefore a healthcare priority

"Results will ultimately facilitate the entry of improved diagnostics in the clinic and the market and enhance the growth potential of high-tech SMEs operating in the healthcare sector."

for Europe and a key opportunity for European SMEs and high-tech businesses in the healthcare sector. At present only symptomatic therapies are available, and

the disease is often difficult to diagnose. Misclassification, especially in early Parkinson's disease, occurs frequently. High sensitivity and specificity can only be obtained at specialised centres and after several years of follow-up.

Developing an effective Parkinson's biomarker

There is therefore a huge unmet market and need for treatments that slow or halt disease progression. One area that has shown promise has been the achievement of early diagnoses, which can improve patient outcomes.

This has been the objective of the BIOMARKERS FOR PD project. The development of an effective Parkinson's disease biomarker assay would help clinical practitioners identify the onset of the disease earlier than previously possible and thus enable them to put in place effective treatments.

Biomarkers are used in clinical practice to describe both normal and pathological

conditions. They can also have a prognostic or a predictive power, and are therefore increasingly used in medicine. Clinical validation of biomarkers is vital for the development of new diagnostics, and this is where the BIOMARKERS FOR PD project has sought to make a difference.

Clinical validation of existing potential biomarkers has also been sought. The project team is looking for evidence of: high analytical validity; appropriate sensitivity and specificity; and clinical validity/utility. Results will ultimately facilitate the entry of improved diagnostics in the clinic and the market and enhance the growth potential of high-tech SMEs operating in the healthcare sector.

'We are grateful for the support from the EU,' says Dr Gunilla Osswald, CEO of project coordinator BioArctic Neuroscience AB. 'The development of a sensitive and specific biomarker that also could mirror the treatment effect would bring an enormous advantage in the development of new disease modifying therapeutics.' The BIOMARKERS



FOR PD project is scheduled for completion in March 2016.

BIOMARKERS FOR PD

- ★ Coordinated by BioArctic Neuroscience in Sweden.
- ★ Funded under FP7-SME.
- ★ <http://cordis.europa.eu/news/rcn/124803>

PREDICTIVE BIOMARKERS FOR BREAST CANCER

European researchers have discovered novel biomarkers for breast cancer that will help predict the response to specific therapeutic regimens.

Breast cancer is the most common cancer in women, with more than 1 million new cases every year. Though curable at early stages, about 50% of patients present with stage II or III tumours at diagnosis. The implementation of molecular diagnostic approaches would facilitate a more personalised therapeutic approach. However, there are very few biomarker tests established in the market necessitating high-throughput research towards biomarker discovery.

The primary aim of the EU-funded RESPONSIFY (Genome-based biomarkers leading to validated molecular diagnostic tests for response prediction in breast cancer) project was to conduct large-scale screening studies to identify and validate new biomarkers. Considerable effort went towards the discovery of genes capable of modulating the expression of the 'Human epidermal growth factor

receptor 2' (HER2). HER2 is one of the key genes associated with breast cancer development.

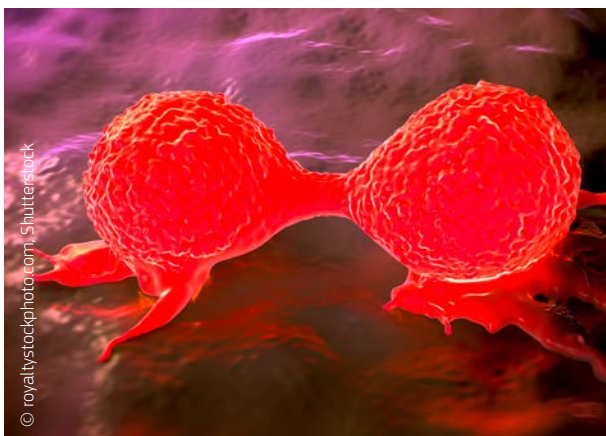
Researchers used breast cancer cell lines and biobanked patient samples to carry out whole-genome screening for biomarkers predictive of the response and resistance to anti-HER2 directed therapy. In addition, they evaluated serum markers for response to anti-angiogenic therapy and immunological alterations. This work led to the development of an mRNA-based immune predictive test (ImmunoPredict) that can monitor changes in immunological status in breast cancer tissue.

Scientists discovered that tumour-infiltrating lymphocytes are indicative of an active intra-tumoural immune environment and can be predictive for a response to anti-HER2 treatment. In contrast, PIK3CA mutations serve as a marker for reduced response to double anti-HER2 treatment. Screening for these two parameters has already been included in the German breast cancer guidelines. Additional biomarkers derived from screening approaches of RESPONSIFY have been transferred to a RT-PCR based test platform with promising results that merit further validation.

Overall, assays and tools for a better patient stratification will not only improve breast cancer patient outcome, but should also offer socioeconomic benefits.

RESPONSIFY

- ★ Coordinated by Charité — Universitätsmedizin Berlin in Germany.
- ★ Funded under FP7-HEALTH.
- ★ <http://cordis.europa.eu/result/rcn/147349>
- ★ Project website: <http://www.responsify-fp7.eu/>





INTERVIEW

ICELANDIC SME DEVELOPS THE BEST RESPIRATORY ANALYSER TO DATE

There is growing concern among sleep researchers that the current medical framework for 'Obstructive sleep apnea' (OSA) diagnosis is critically limited in scope. Icelandic company Nox Medical is offering to solve this problem with a technology that will assess the quality of each patient breath during the night.

OSA, a condition where repeated episodes of partial or complete blockage of the airway occur during sleep, is on the rise. It has reached the staggering prevalence rate of over 35% in people over 40 years old. Worse still, up to 82% of men and 92% of women who have moderate or severe OSA have not been diagnosed yet.

Other forms of 'Sleep disordered breathing' (SDB), such as snoring and laboured breathing, cannot even be detected. They continue to cause increases in cardiovascular disease, diabetes, stroke, cancer, risk of accidents, growth and mood disturbance, as well as a tiredness that can significantly decrease quality of life and functional capacity. Women, and in particular pregnant women, are especially sensitive. This all represents a huge financial burden for society which needs to be addressed.

Currently OSA is diagnosed by counting the number of times a patient stops breathing when breathing is severely reduced. Diagnosis is based on around 100 night breaths. For other, more subtle cases and to detect

other forms of SDB, Nox Medical will soon provide a diagnosis using all of the approximately 8 000 times we breathe overnight. The technology can identify the underlying cause of SDB in patients, which could mark the end of current one-size-fits-all treatment.

Svenni Hoskuldsson, CTO at Nox Medical, details the technology's status, as Phase 1 funding for the RESPIRATORY ANALYZER (Validation of calibrated RIP based biomarker for diagnosis of SDB and the identification of an accessible screening solution) project just came to an end.

★ How does your system work exactly?

Svenni Hoskuldsson: The system is based around the current products offered by Nox Medical, the Nox A1 and Nox T3 sleep monitoring devices.

A fundamental part of the systems are the 'Respiratory inductance plethysmography' (RIP) belts. The RIP belts accurately measure the breathing movements of the thorax and abdomen. By analysing the breathing movements, the patient's respiratory

drive, the patient's intention to breathe can be measured. With further analysis, the respiratory drive can be divided into a flow contributing part, breathing, and breathing movements which are lost to overcome obstruction in the airway. The ratio of flow contributing breathing movements to the respiratory drive gives the breathing efficiency of each breath.

We have shown that, even when the Tidal Volume is maintained throughout the night, the breathing efficiency can be severely reduced during some parts of the night. These drops in breathing efficiency may indicate that the patient suffers from SDB even though he shows no signs of OSA.

★ What are your main target markets?

The main target market for the technology is traditional sleep clinics and specialists, where the technology can be used to augment current diagnosis schemes. The technology lends itself to being easy to use and it is easy to interpret the results, so expansions into new markets such as cardiologists, paediatricians and dentists — where sleep is important but not the main speciality of the practitioner — are envisioned.

★ Why opt for a pay-per-use solution?

The pay-per-use solution is tailored to the needs of the occasional user of sleep diagnostics. At Nox Medical, our mission is 'Sleep for All'. It is our goal to bring sleep diagnostics and sleep medicine to anyone who needs them.

We are working towards this goal from two ends: On the one hand we are developing better diagnostics paradigms, and on the other hand we are working on improving access to sleep diagnostics devices. A key step in being able to offer sleep diagnostics to a larger user base is to have a diagnostics protocol that can be applied by practitioners who are not sleep specialists. This is where the



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new biomarker plays a key role. A second key step is offering a solution, device and software that can be accessed without having to invest heavily in infrastructure.

★ **How did you proceed to identify your biomarker for SDB screening?**

The biomarker has been under development for some time. During the Phase 1 period of the project, we ran two pilot studies to test the feasibility of using the biomarker as a surrogate measure of SDB and to see if it had any clinical significance.

One pilot study compared the performance of the biomarker to a standard measure of SDB. This standard measure

is based on threading a pressure sensor through the patient's nose into his oesophagus. The preliminary results show that the biomarker is correlated to the standard measure of SDB. Then, a second study was performed by comparing breathing efficiency to clinical outcomes in teenage patients. The results from the study show that the biomarker is a better predictor of clinical outcomes than standard OSA diagnosis methods.

★ **What kind of reactions are you getting from stakeholders?**

The results from these two pilot studies were presented at the WorldSleep 2015 conference organised by the World Sleep Federation and the European Sleep Research Society. The results from the pilot studies attracted much attention from leading scientists and physicians.

During the conference, Nox Medical formally started a collaboration with the best scientists and physicians in the field of sleep research and SDB. The research consortium that will carry out the clinical validation of the biomarker includes researchers from Harvard Medical School, Imperial College London, NeuroScience Australia, University of Sydney, Charité University in Berlin and others.

★ **How else did you benefit from funding under Horizon 2020?**

An important aspect of the Phase 1 project was that it forced us to think through the whole project, set up a plan, and really go for it. In the industrial environment, it can be difficult to carve out the resources needed to

“Nox Medical will soon provide a diagnosis using all of the approximately 8 000 times we breathe overnight.”

follow through with a large, long-term research project.

At Nox Medical, 50% of the staff work on R&D and out of those 20% work only on research. Even with this heavy R&D focus, starting a research project of this scale requires much support from the outside.

★ **What are the next steps now that Phase 1 is completed? Will you be applying for Phase 2?**

Nox Medical will now complete the clinical validation of the biomarker. We will apply for Phase 2 to finish the work we have started. Researchers and physicians are eagerly waiting to start the clinical validation and one way or another we will carry on with the project.

The feasibility study from Phase 1 sparked great interest in the technology, yet many questions are still to be answered.

RESPIRATORY ANALYZER

★ Coordinated by Nox Medical in Iceland.

★ Funded under H2020-SMEINST-1.

★ <http://cordis.europa.eu/project/rcn/197036>

★ Project website:

<http://www.noxmedical.com>

TRANSGLUTAMINASE ENZYME — ROLE IN DISEASE

EU-funded researchers have studied the role of ‘transglutaminase’ (TG) enzymes in disease to develop novel diagnostic methods and therapies for ‘coeliac disease’ (CD) and neurodegenerative disorders.

Deregulation of enzyme activity disrupts cellular homeostasis and often leads to diseases such as Alzheimer's, Huntington's and CD. TGs are a group of enzymes that catalyse the post-translational modification of proteins, especially the formation of isopeptide bonds that make proteins more resistant to hydrolysis.

The TRANSCOM (The commercialisation of transglutaminase) project investigated the involvement of TGs in the pathogenesis of CD, neurodegenerative disorders and catheter-associated infections such as ‘Methicillin-resistant *Staphylococcus aureus*’ (MRSA).

A significant achievement was that researchers developed a novel lateral flow test that can detect IgA and IgG deamidated gliadin peptide antibodies for diagnosing CD. Benchmarking revealed that unlike other point of care

tests, this test detects all CD cases. The incorporation of such CD biomarkers in new point of care tests could obviate the need for invasive diagnostic procedures.

Scientists also identified a major CD autoantibody-binding epitope in TG2 as well as monoclonal mouse anti-TG2 antibodies that could be used to treat CD. The TG2 inhibitors in particular have shown great promise in prohibiting the pathological effects of CD antibodies.

TRANSCOM generated TG mutants as well as TG inhibitors and developed cell culture models to test their neuroprotective effects in neurodegenerative disorders. They demonstrated the feasibility of small compound inhibitors blocking Factor XIIIa activity in preventing catheter fouling and associated MRSA infections.



Other interesting discoveries include the potential utility of TG2-inhibitors in blocking vascular endothelial growth factor-induced angiogenesis and TG2 with certain amino acid mutations in treating TG2 related diseases such as liver fibrosis.

TRANSCOM's impressive accomplishments resulted in the publication of 21 research papers in peer reviewed journals, media press releases and the filing of a patent on TG2 inhibitors.

TRANSCOM provided insight into the biological relevance of TG activity. Given the lack of effective therapies against CD and neurodegenerative disorders, project findings show considerable promise for the development of alternative treatment approaches.

The market for these diseases is worth billions of dollars and successful commercialisation should enhance the competitiveness of participating businesses.

TRANSCOM

- ★ Coordinated by Aston University in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/92213>
- ★ Project website:
<http://www.mariecurie-transcom.org/>

INTERVIEW

TOWARDS CONTROL OF MORTALITY FROM HCC IN DEVELOPING COUNTRIES

With liver cancer cases in Africa expected to double by 2050, established solutions for screening, early detection and treatment are desperately needed. The PROLIFICA project has made a case for such developments thanks to a large case study conducted in West Africa. The team is now working on the development of biomarkers for a dipstick test.

Some 25 to 30% of the 250 million individuals affected by Chronic 'Hepatitis B virus' (HBV) infection are expected to die from 'hepatocellular carcinoma' (HCC). This situation is of particularly high concern for developing countries like those in West Africa, where HCC is a leading cause of premature death, ageing is expected to double its incidence, access to screening and treatment programmes is severely limited, and tailored HBV treatment guidelines don't exist.

"Screening and treatment for hepatitis B virus infection would result in a major reduction in the number of cancer cases within five years."

The EU-backed PROLIFICA (Prevention of Liver Fibrosis and Cancer in Africa) project sought to evaluate the burden of liver disease and liver cancer from HBV infection in this region and to demonstrate that community-based screening and treatment are feasible, effective and cost-efficient.

To do this, the project team conducted a study on over 9000 patients in The Gambia, Senegal and Nigeria with three main objectives in mind: identifying the main risk factors for HCC in a West African population using a case control clinical study design; demonstrating that the treatment of chronic HBV infection is feasible and effective; and providing evidence that HCC can be detected early and treated effectively thanks to simple diagnostic tests.

Prof. Mark Thursz of the Imperial College of Science Technology and Medicine, UK, who coordinated the project, details the main project findings.

★ Why did you choose to focus your project on Africa?

Prof. Mark Thursz: Africa is one of the areas of the world with the highest prevalence of chronic hepatitis B virus infection and consequently the highest incidence of hepatocellular carcinoma. I have collaborated with investigators in West Africa for many years on projects looking at the natural history of hepatitis B virus infection and genetic factors that influence the outcome of this infection. Treatment for hepatitis B virus infection is widely available in Europe and America but there were no treatment programmes in Africa. We were motivated

to explore whether it would be feasible to set up a programme to screen and treat hepatitis B in order to prevent patients from progressing to end-stage liver disease.

PROLIFICA was set up with two platforms: the first was a case control study in hepatocellular carcinoma which was designed to provide samples and data for biomarker development. The second was a population-based screening programme to determine whether we could effectively identify people infected with hepatitis B and provide them with treatment to prevent complications in the infection.

★ You aimed to show that HBV, a major cause of liver cancer, can be detected early and treated efficiently. How did you achieve that?

The main objective was to look at the efficacy and cost-effectiveness of detecting chronic hepatitis B virus infection at an early stage so that treatment of the infection would prevent liver cancer. As the infection is invariably asymptomatic until end-stage liver disease occurs, we needed to go out into the community to perform screening using a point-of-care test for HBsAg — a serum marker for chronic infection.

Patients who tested positive were then invited for full assessment, and treatment was provided for those who met international criteria.

★ **You have screened over 9000 patients from The Gambia and Senegal. What are the most important things you learned from that work?**

No previous study has looked at the uptake of screening in the community for viral hepatitis. We were pleased to see that the uptake of screening was around 70% and that those who tested positive were effectively linked into care. We were surprised to find that only 5% of patients with chronic hepatitis B virus infection actually needed treatment. This is probably good news as the number of people with this infection worldwide is daunting at over 250 million. If only 5% require treatment, this makes it a much more manageable number.

We have also shown that screening and treatment turns out to be cost effective. This data has been shared with the HIV & Hepatitis group at the World Health Organisation and will form the basis of future recommendations on population screening.

★ **How would you proceed to reduce the number of cancer cases in Africa?**

We have now used the data from PROLIFICA to model the impact of various interventions to control hepatitis B virus infection and to reduce the number of deaths from hepatocellular carcinoma. The models verify how effective hepatitis B vaccination programmes have been in preventing

new infections, but this has had no impact on the deaths from end-stage liver disease.

In fact the results show us that cancer deaths will continue to climb and persist at high levels for another 30 years without alternative interventions. Screening and treatment for hepatitis B virus infection would result in a major reduction in the number of cancer cases within five years.

★ **How do you expect your project to impact local policies?**

Initially we expect a limited uptake of the screen and treat strategy as there is little political momentum to tackle hepatitis B when there is still a focus on HIV, TB and malaria. However, some governments in Africa have expressed an interest in introducing public health measures to control hepatitis B in order to reduce the rate of liver cancer.

★ **What would you say are the most interesting biomarkers you identified and why?**

We identified a number of patients with hepatocellular carcinoma in our clinics and obtained biological samples for proteomic and metabolomic analyses. The proteomic analysis identified four proteins with changes in serum levels in hepatocellular carcinoma. We are now waiting for further analyses to determine how useful these might be in screening or diagnosis.

We have also identified and verified a panel of metabolites in urine which are modified in patients with hepatocellular carcinoma. These are particularly interesting because they



PROF. MARK THURSZ

may, in the future, provide us with a simple urine dipstick test to identify patients with a high risk of disease. In addition, some of the metabolites such as acetylcarnitine indicate a potential therapeutic target for future drug discovery.

★ **What are your next plans now that the project has been completed?**

Further work is required to develop the urinary metabolite panel into a practical test. At the moment we have set up a mass spectrometer in the MRC's Laboratories in The Gambia to measure metabolites and see if we can provide 'real-time' diagnostic information. If this is validated, then we would look to see how the format of the test could be simplified and potentially even turned into a dipstick test.

With regard to the screen and treat strategy for hepatitis B, we are beginning to look for funding to do a full-scale country-wide demonstration project to definitively demonstrate the impact on cancer and cirrhosis-related deaths.



© PROLIFICA

PROLIFICA

- ★ Coordinated by the Imperial College of Science Technology and Medicine in the United Kingdom.
- ★ Funded under FP7-HEALTH.
- ★ <http://cordis.europa.eu/project/rcn/98355>
- ★ Project website: <http://prolifca.eu>

NEW BIOMARKERS TO PROVIDE CARDIOVASCULAR DISEASE EARLY WARNING

EU-funded scientists have identified biomarkers linked to early signs of cardiovascular disease, something that could lead to quicker diagnoses.

The long-term goal of the EU-funded EU-MASCARA (Markers for sub-clinical cardiovascular risk assessment) project has been to apply these new biomarkers in a way that aids clinical practitioners in risk prediction and early intervention. The most robust biomarkers will be implemented in novel biochip based assays for clinical use.

By detecting very early stages of cardiovascular diseases that are not yet causing symptoms, these markers could help medical staff to assess a patient's risk for developing symptomatic disease and thus facilitate earlier preventive treatment. This will help to cut healthcare costs and ultimately save lives. Cardiovascular disease, which can lead to heart attacks, heart failure and stroke, is among the leading causes of death worldwide.

The consortium has been heavily supported by contributions from SMEs in key areas of high-tech research such as biomarker testing, data handling and analysis and assay development. While healthcare R&D is an expensive and often time-consuming activity, the potential market opportunity for new analytical tools that offer accuracy and cost reductions is huge.

The project team is now working on combining these new biomarkers with more established ones in order to develop a cohesive predictive model. This will help to achieve more integrated analysis of complex data related to cardiovascular disease. Certain factors such as increased blood pressure and high cholesterol have often been linked to a higher risk of cardiovascular disease, but a precise assessment of these parameters — and thus a precise means of predicting cardiovascular health — has not been fully achieved.

This then has been the goal of the EU-MASCARA project. Blood and urine samples from 350 patients with and

without hypertension were analysed in order to select molecules that could be used to identify cardiovascular disease risk. Data from another cohort of 800 patients was also used to identify biomarkers.

Peptides were developed to be measured in urine, and the project team was able to demonstrate their efficacy in predicting cardiovascular events such as heart attacks. This means that these peptide panels have the potential to pick up very early stages of cardiovascular disease, where there would still be time to prevent further progression of the disease.

Patients were also monitored for cardiac function, with special focus given to renal disease as a high risk factor for cardiovascular disease. Genetic markers and factors related to cardiac structure, function and inflammation have also been investigated for their predictive potential.

Finally, health economic analyses have been conducted in order to inform policy makers and stakeholders of the economic and societal value of biomarker assessment. The results of the EU-MASCARA project, scheduled for completion in May 2016, will be presented at prominent symposia and will continue to be published in relevant cardiovascular journals.

EU-MASCARA

- ★ Coordinated by the University of Glasgow in the United Kingdom.
- ★ Funded under FP7-HEALTH.
- ★ <http://cordis.europa.eu/news/rcn/124801>
- ★ Project website: <http://www.eu-mascara.eu/index.php>



BIOLOGY AND MEDICINE

TOOLS TO HELP HEALTH PROFESSIONALS MAKE BETTER TECHNOLOGICAL CHOICES

EU-funded researchers have created tools to promote cutting-edge health technology and ensure that hospitals have the means to select only the best.

A new database along with a handbook and toolkit covering 'Hospital-based health technology assessments' (HB-HTAs) will help health professionals manage new technological innovations better, increasing operational efficiencies and ultimately benefiting patients.

These tools, pioneered by the EU-funded ADHOPHTA (Adopting Hospital Based Health Technology Assessment in EU) project, are designed to ensure that only technologies with added value for hospitals will be invested in, freeing up resources to ensure optimal quality of care.

'The key for managers is to be able to choose health technologies based on comprehensive and contextualised assessments that are tailored to the needs of each hospital,' explains project coordinator Dr Laura Sampietro-Colom from the Fundacio Privada Clinic per a la Recerca Biomedica, Spain.

'The tools that we have developed are aimed at helping these decision-makers manage their technology requirements better, ensuring that hospitals invest only in the most useful innovations. We have already received a lot of interest from potential users, with requests to translate the tools into other languages.'

The handbook includes principles for good practices, and an accompanying

toolkit provides guidance on how to implement these. Both the handbook and toolkit were approved by an international expert panel, representing experts from 10 countries on four continents.

The project began with a literature search on informational needs and decision-making processes for the adoption of technology in hospitals, followed by the development of an open questionnaire. The results were then used to design a large-scale, web-based survey sent to 339 hospital and clinical managers.

Case studies were then conducted to characterise the decision-making process for adopting different types of health technologies, including medical devices, medical equipment, drugs and procedures. In parallel, a business healthcare excellence model was selected and adapted to HB-HTA in order to build a framework for principles that should govern good practices.

Prior to the three-year ADHOPHTA project, which was completed at the end of November 2015, there was no consolidated body of knowledge on HB-HTAs. Information had previously been scattered, and in any case based only on informal interactions among HB-HTA units around the world. This project has therefore addressed a need

articulated by healthcare professionals for tools that would make the selection and management of health technologies more streamlined.

Ahead of their finalisation, a workshop brought together experts from hospital management, hospital-based and national HTAs, patient representation groups and industry. Furthermore, access to the online HB-HTA database is now available, which project partners hope will be widely used and indeed added to by health professionals, following the project's completion.

'We would now like to pursue further research in gap areas that the ADHOPHTA project enabled us to identify,' says Sampietro-Colom. 'To this end, we are exploring available funding at the EU level, but the most immediate step has been to make the database available online, in order to allow hospitals across the world performing HB-HTAs to include information about their assessments.'

ADHOPHTA

- ★ Coordinated by Clinic Foundation Barcelona in Spain.
- ★ Funded under FP7-HEALTH.
- ★ <http://cordis.europa.eu/news/rcn/124470>
- ★ Project website: <http://www.adhophta.eu/>

MOLECULAR THERAPIES FOR HEART FAILURE

A European consortium has investigated the molecular events that take place in the heart before failure. The results have the potential to lead to novel molecular-based intervention strategies.

Heart failure constitutes a primary cause of hospitalisation and death in developed countries. Sustained pathological hypertrophy seems to be one of the major predictors of sudden cardiac death and is driven by alterations in transcriptional and post-transcriptional regulation.

Recent studies indicate that genome-encoded single-stranded small RNAs known as 'microRNAs' (miRs) play a central role in heart development and failure. miRs inhibit gene expression through translational repression and their selective modulation can provide therapeutic benefit in preclinical models. This evidence strengthens the idea for using miR modulators as candidate therapeutics.

The scope of the EU-funded PATCH (Targeting the miR-106b~25 cluster in pathological cardiac hypertrophy) project was to understand what factors are responsible for cardiac hypertrophy. Considering recent evidence implicating deregulated miRs in heart failure, researchers focused on the miR-106b~25 cluster, which decreases during pathological hypertrophy in mice. Loss of the

miR clusters — miR-106b~25 and miR-17~92 — leads to embryonic death as a result of severe cardiac defects, indicating their essential role in heart development.

The consortium performed a bioinformatics screen to identify potential direct downstream targets of the miR-106b~25 cluster that may play a role in pathological cardiac remodelling. They discovered a network of genes implicated in pathological hypertrophy in addition to a series of new genes.

Project findings underscore the importance of the miR-106b~25 cluster in heart pathologies and have opened up new avenues for therapies to prevent heart failure.

PATCH

- ★ Coordinated by the International Centre for Genetic Engineering and Biotechnology in Italy.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/173676>

NOVEL ANAEMIA THERAPY OPENS OPPORTUNITIES FOR PHARMA SECTOR

A new therapeutic drug for treating serious complications linked with kidney disease has been shown to be both effective and safe in EU-funded trials.

The trials with human volunteers were conducted through the EU-funded EUROCALIN (EUROpean consortium for antiCALINs as next generation high-affinity protein therapeutics) project and demonstrated the efficacy of the new drug, called PRS-080, in the treatment of 'Anaemia of chronic disease' (ACD). This condition affects millions of Europeans and leads to poor health prospects and a lower quality of life.

PRS-080 has been developed by partners from four EU countries. It works by targeting and antagonising hepcidin, a small peptide that circulates in the human body and is thought to be a key negative regulator of iron. The EUROCALIN project also enabled the consortium to establish a viable manufacturing process, and has helped bring the new therapeutic drug one step closer to eventual commercialisation, to the benefit of both patients and the pharmaceutical sector.

Positive results from this Phase I study will now enable project partners to progress with the drug to the next stage. 'We expect to soon initiate the dosing of anaemic patients with chronic kidney disease undergoing haemodialysis, for whom elevated hepcidin is strongly associated with the severity of anaemia,' says Dr Louis Matis, Chief Development Officer of project coordinator Pieris.

A key benefit of the new anti-hepcidin therapy is that it reduces and even eliminates the need for potentially risky iron replenishing techniques for ACD patients. The management of ACD using intravenous iron and assorted stimulating agents has in fact been shown to be ineffective in many patients, with some experiencing severe adverse effects.

This has driven medical researchers to find new safer therapies, and the findings of the EUROCALIN project therefore have the potential to benefit patients, both in Europe and around the world, and create a market opportunity for Europe's pharmaceutical sector.

ACD is the most frequent anaemia found in hospitalised patients, and develops in subjects suffering from infections, inflammatory and autoimmune disease, cancer and chronic kidney disease. Indeed, patients with 'End stage renal disease' (ESRD) almost invariably develop anaemia. ESRD occurs when kidneys stop working well enough for patients to live without dialysis or a transplant.

The PRS-080 drug works by blocking hepcidin and mobilising iron trapped in iron storage cells. This increases the availability of iron in the body's circulation, heightening haemoglobin levels in patients suffering from ACD.



Significant progress was made during the project's first three years, which brought the drug to the point of clinical study. Proof-of-concept in reversing anaemia by inhibiting hepcidin was first demonstrated in animals. A 28-day toxicity study then established the safety of the drug, before the green light was given for the successful round of patient trials.

The clinical results of the EUROCALIN project, which was completed at the end of November 2015, were recently presented at the 57th Annual Meeting of the American Society of Hematology (ASH) in Orlando, Florida.

EUROCALIN

- ★ Coordinated by Pieris Pharmaceuticals in Germany.
- ★ Funded under FP7-HEALTH.
- ★ <http://cordis.europa.eu/news/rcn/124505>
- ★ Project website: <http://www.eurocalin-fp7.eu/>

HELPING PUBLIC AUTHORITIES DRIVE HEALTHCARE R&D FORWARD

A pioneering tender process has shown how public authorities can shape healthcare R&D to suit their needs, saving them money and boosting innovation.



Launched in 2012, the EU-funded SILVER (Supporting Independent LiVing for the Elderly through Robotics) project has identified new technologies at the pre-commercial stage that can assist elderly people in their everyday lives. Innovative solutions that enable independent living will achieve cost savings for the homecare sector and open up a new market for assisted living tools that is only expected to grow.

In addition, public authorities across Europe must cope with budget cuts while providing care for an ageing population. The SILVER project is pioneering a cost-effective procurement technique that will help identify precise technologies needed while encouraging innovation.

The project began with the launch of an international 'Pre-commercial procurement' (PCP) process. Some 33 tenders were received, of which a

total of seven promising proposals were identified by SILVER's panel of healthcare and robotics experts, before being whittled down to three and then finally one — the 'Lean elderly assistant' (LEA) robot.

This robot is designed to enable the elderly to live independently in their own home. Even when relatively mobile and with no cognitive impairment, elderly people can still suffer from age-related symptoms. In these cases, LEA can offer help with daily routines and housekeeping, and assists elderly people in staying active by offering support while walking, sitting down and standing up. The device can also pick up objects, helping elderly people with general muscle weakness and tremors.

Cognitive software has been added in order to enable LEA to remember and recognise objects, faces and places. The robot will soon be able to recognise actions and protocols, helping to monitor daily routines like eating, sleeping and exercising.

Recent trials with end users demonstrated the safety and usability of the innovation, enabling SILVER healthcare and robotics experts to provide the contractor with detailed feedback on how to improve their solution further in order to meet end-user needs and fulfil their market potential. Final tests will take place during the spring and summer of 2016 in Denmark, Finland, the Netherlands, Sweden and the United Kingdom.

The trialling and adoption of innovative healthcare technologies was facilitated through the project's promotion of the PCP process. This process is designed to stimulate innovation by allowing public authorities to identify promising technologies early and steer the final development of these innovations towards their own specific requirements.

Indeed, a key aim of the project has been to demonstrate the effectiveness of this approach in addressing societal and governmental needs. By acting as first buyers of new R&D with important technological needs, public procurers can drive innovation from the demand side, creating opportunities for European high-tech SMEs to take international leadership within new markets.

In the long term, the project hopes that familiarisation with the PCP process will enable public organisations to take full advantage of this procurement strategy, improving services and boosting the market for European technology at the same time. On completion of the project in August 2016, there will be a fully documented PCP process in place, capable of being run as a joint cross-border PCP call for tender.

SILVER

- ★ Coordinated by the Technology Strategy Board in the United Kingdom.
- ★ Funded under FP7-ICT.
- ★ <http://cordis.europa.eu/news/rcn/124523>
- ★ Project website: <http://www.silverpcp.eu>

THE GENETICS BEHIND PARENTAL CARE

Complex interactions between parents and their offspring drive the evolution of family life, and revolve around the allocation of parental care. EU-funded research has built on recent theory underlining co-adaptation within families in relation to offspring demand for and parental supply of care.

Research has offered a number of interesting ideas on parent-offspring interactions. Parents increase offspring fitness (survival and future reproduction) by providing care, such as food. Offspring often engage in solicitation behaviours that elicit care by their parents — for example, begging by nestlings of birds. Co-adaptation has to do with offspring demand and parental supply and the possible fitness costs if this relationship is disrupted.

The project FAMILY AFFAIRS (Parental care: Shaped by parent-offspring conflict and co-adaptation) has enhanced

knowledge regarding the fitness implications and underlying genetics of parent-offspring conflict and co-adaptation. Focusing on wild blue tits (*Cyanistes caeruleus*), the study integrated approaches from behavioural ecology and quantitative genetics in an ecological setting.

Blue tits have extensive bi-parental care. Both parents provide food to the offspring, and they also readily accept nestboxes for breeding. This makes it relatively easy to study parental provisioning and offspring begging behaviour in a natural setting.

The team conducted a large-scale experiment in a free-living population of this common songbird. They tested 184 broods during two consecutive breeding seasons. Study findings point to an absence of fitness effects for cross-fostered broods when compared with non-cross-fostered broods. This confirms the use of cross-fostering as a standard approach and valid method for assessing the relative importance of genetic and environmental influences. Cross-fostering of broods is the laboratory practice of removing offspring from their biological parents at birth to be raised by surrogates.

However, some males did lower their provisioning while caring for another brood, while females compensated for the reduced provisioning efforts of the males. This can be considered a possible explanation for the absence of fitness effects in cross-fostered offspring. Overall, the findings raise questions regarding the factors at play in reduced male provisioning behaviour.

Project results were presented at international scientific conferences and will be published in peer-reviewed scientific papers. Ongoing research on the study population has also been presented to a broader audience through various outreach activities, including a popular science lecture and a brief feature on television.

This research offers an improved understanding of how evolutionary conflict and co-adaptation shape social interactions



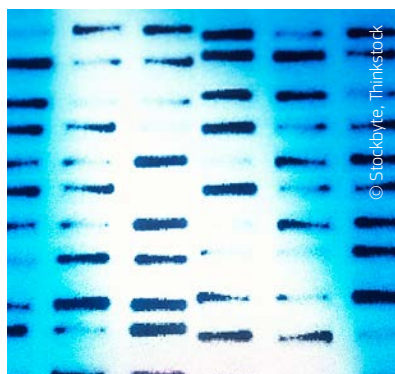
within families. Future studies in the field will be better able to assess the relative influence of genetics and the environment on development and behaviour.

FAMILY AFFAIRS

- ★ Coordinated by the University of Groningen in the Netherlands.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/174929>

NEW PERSPECTIVE FOR HUMAN GENOMICS TOOLS

The global research community has dedicated a great deal of time and money to deciphering the human genome. An EU-funded project has applied the knowledge and tools gained in this effort to the life sciences beyond *Homo sapiens*.



Elucidating the human genome did not produce the miracle results expected by some, such as disease cures. However, a large body of information, software tools and know-how was generated as a result. Bioinformatics, the application of IT to biological data, is a rapidly expanding field requiring data analysis pipelines that are dynamic. The goal is to develop flexible and adaptable bioinformatics pipelines.

The pipelines that were developed, for instance, can also be useful in studying non-human genomes. The EU-funded ALLBIO (Broadening the bioinformatics infrastructure to unicellular, animal,

and plant science) project has gone further and extended the study of genomics data to plants, animals and unicellular organisms.

The research results will be used to coordinate efforts to make human genome related technologies applicable in fields such as microbial, plant and livestock bioinformatics. This is crucial in growing areas such as agriculture, all types of biotechnology and non-human pharmaceuticals and biochemical industries.

The project was part of the wider ELIXIR (European life science infrastructure for biological information) initiative, which aims to build an electronic infrastructure that will give biologists better access to relevant data and tools.

ALLBIO adapted the pipelines for non-human studies, an integral part being to provide training for all parties involved in the process. They brought together almost 20 communities of researchers and bioinformaticians in different fields related to non-human genomics, who then presented 14 real-world test cases to ALLBIO for further study via hackathons.

Hackathons refer to events where programmers collaborate on software projects to produce new tools and web services. Four hackathons were held where participants used the test cases as starting points to develop non-human genomic workflows. Indirectly, hackathons also provided an opportunity for collaboration and knowledge gathering involving different groups of scientists, for example, synergies between wet and dry labs. Three software packages have also been developed as a result.

Altogether, ALLBIO partners organised 53 events — including workshops, seminars, training schools and tutorials bringing together nearly 2000 participants from 36 countries. Thirteen publications are in print and an AllBioCatalogue with more than 4000 entries relating to tools and services is now available in the life sciences arena.

ALLBIO

- ★ Coordinated by the Swedish University of Agricultural Sciences in Sweden.
- ★ Funded under FP7-KBBE.
- ★ <http://cordis.europa.eu/result/rcn/147357>

SOCIAL SCIENCES AND HUMANITIES

THE HOMINIDS OF AIN HANECH

An EU team of scientists from CENIEH, Spain studied early hominid occupation and adaptation in North Africa around 2 million years ago. Results pushed the date back to an earlier time than previously thought for the region, and revealed details of early hominid behaviour as well as the prevailing climate and environment.

Ain Hanech is a palaeoanthropological site, located about 100 km inland from Algeria's Mediterranean coast on the eastern High Plateaus. The sedimentary basin contains the oldest archaeological evidence of inhabitants in North Africa.

The EU-funded PALEONORTHAFRICA (Studies of early hominid adaptation and dispersal into North Africa: Archaeological investigations at the Plio-Pleistocene site of Ain Hanech, Algeria) project aimed to investigate early hominid behaviour in North Africa. The study involved determining the timing of early human habitation and detailing their behaviour, including subsistence activities and the role of stone tool technology enhancing diet. The research was also intended to reconstruct the palaeoecology of the area. Finally, the team aimed to study site formation processes and to survey new sites. The techniques used for dating the site included palaeomagnetism, electron spin resonance and large mammal biochronology.

Results showed that early hominids were present in the area earlier than previously believed, between 2.3 and 1.7 million years ago. The date was also the earliest known for hominid habitation anywhere in North Africa. The environment at the time was a relatively dry, open grassland, in transition to a drier climate. The change would have affected hominid food foraging activities, with the river network providing valuable food and other resources.

The stone technology used was simple, and virtually identical to that known about in other contemporary hominid sites in East Africa. The tools would have been sufficient for butchering animal carcasses and for obtaining bone marrow. Bone surface modification studies showed evidence of such meat processing.

The researchers also raised the possibility of hominid migration to Europe via North Africa.

Other project activities included training local university students in archaeological

and palaeontological fields and laboratory techniques. Several PhD students studied Ain Hanech artefacts and fossil bones for their theses. The project therefore helped modernise palaeoanthropological studies in Algeria by exposing local students to international researchers.

The project also helped establish connections with several Algerian agencies, including a permanent hominid exhibition at Bardo National Museum. Such a relationship should benefit local and European research.

The PALEONORTHAFRICA project resulted in a new understanding of hominid habitation in North Africa. Its work also clarified the environmental and technological skills of the time.

PALEONORTHAFRICA

- ★ Coordinated by Consorcio CENIEH in Spain.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/173709>

A NEW APPROACH TO DEMOCRACY AND HUMAN RIGHTS

EU-funded research has considered views of liberal theorists of democracy and anti-liberal thinkers, seeking to develop an alternative model. The work focused on advancing a better approach to the plight of refugees and immigrants in relation to democracy and human rights.

The project RECAMP (Rethinking the status of refugees beyond the camp: a Lefortian response to Agamben's critique of democracy and human rights) sought a French alternative to ideas of rights and democracy. It drew on the innovative theory of philosopher, activist and political theorist Claude Lefort, and subsequent work of his students Marcel Gauchet and Pierre Rosanvallon. The former is a French historian, philosopher and sociologist, the latter a French intellectual and historian dedicated to the history of democracy and social justice in contemporary societies.

Working on the premise that the radical anti-liberal view is as problematic as the liberal view, research expanded on Lefort's work and his legacy. Through various publications and conference papers, project work outlined how the French alternative is more convincing regarding human rights and democracy.

Lefort's ideas were applied to the status of the stateless and the state of nature. This particular line of work has been published and presented to different audiences in both Belgium and Canada.

A third research strand was dedicated to exploring and resolving four possible objections to Lefort's theory. This was achieved for three of the four objections, and presented in articles and research presentations. The fourth objection featured at a conference presentation on Gauchet's philosophy of history.

Project work resulted in a text book, four papers, four book chapters and the submission of at least another two papers.



Participation in many international conferences as well as extensive library and archival research greatly expanded research in the particular area. At the same time, new networks were realised both inside and outside the European Research Area (ERA).

With a major focus on the refugee crisis, RECAMP has contributed an alternative approach for Western democracies dealing with refugees, asylum seekers and illegal immigrants.

RECAMP

- ★ Coordinated by KUL in Belgium.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/173723>

THE IMPACT OF EUROPEANISATION ON CIVIL SOCIETY

New research offers insight into 'Civil society organisations' (CSOs) involved in debates concerning the rising political Islam and Kurdish identity claims in Turkey.

A new framework in Europeanisation studies is examining the impact of the EU's and other institutions' norms and policies related to European integration on a politically mobilised civil society such as the one in Turkey. An EU-funded project — EURO CIV (Europeanisation of public debates and civil society in Turkey) — has explored this further.

In the process, EURO CIV looked at how and in what ways the EU-required legal and constitutional reforms on the freedom of association and assembly have affected the political/structural conditions

of CSOs in Turkey. It also examined the reactions of CSOs and the ways they used the EU/European context in a manner that would benefit their political agenda. Various discourses regarding the EU and Turkey's integration into Europe were mapped out. They exhibit the politically mobilised engagement within the concept of Europeanisation.

This new framework for analysis was geared toward a better means of comprehension of how European integration affects societies. In so doing, there was also an attempt to redefine and reposition the scope and boundaries of Europeanisation on a wide sociological spectrum.

Results have yielded publications of academic articles, research papers and

online briefs. Work has also been presented in several academic conferences, and a short documentary and website have been created.

EURO CIV has served to extend research into the impact of Europeanisation on civil society in an EU candidate country. Beyond that, it has presented a comprehensive analysis of civil society's presence in seminal public debates.

EURO CIV

- ★ Coordinated by Istanbul Bilgi University in Turkey.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/173656>

"Various discourses regarding the EU and Turkey's integration into Europe were mapped out."

ENERGY AND TRANSPORT

LONG-LASTING COATINGS FOR OFFSHORE RENEWABLE ENERGY

EU researchers have developed an innovative and environmentally-friendly new, aluminium-based coating to provide protection for offshore energy installations.

The EU-backed ACORN (Advanced Coatings for Offshore Renewable Energy) project has developed a new protective coating that will extend the lifetime of marine structures to 20 or more years and avoid the need for supplementary cathodic protection.

The result will be an entirely new, non-paint solution for the protection of offshore renewable energy steel structures including docks, buoys, and oil and gas rigs. Once successful, the coating will boost the competitiveness of the industry and help trigger a widespread roll-out of the different offshore technologies.

Corrosion, fouling and cavitation represent a huge challenge for the industry, especially since offshore structures cannot be dry-docked to fix these problems.

Use of a pure aluminium coating

The project involved the creation of a highly differentiated and patentable technical solution that could even be extended in the longer term. It uses 'Thermally sprayed aluminium' (TSA) — a substance with proven long-term corrosion resistance — to provide a matrix coating with a lifespan of 20+ years.

This porous mix is then dotted with environmentally-friendly active antifouling substances in very tiny concentrations (< 1 %) which will be gradually exposed at the active surface of the coating as the TSA corrodes away at a rate of 10 µm per year.

Project scientists chose a 99.5 % pure aluminium coating applied with the twin arc spraying method. The eco-friendly anti-fouling substances were then chosen for their performance, commercial availability and regulatory approval for use in EU waters.

Scientists also evaluated the inert anti-foul carriers for stability in seawater, hydrophobicity and low processing temperatures to

protect the anti-fouling agents. Barnacle resistance tests were then undertaken in marine trials off the coast of Sweden.

Coatings for tidal power to boost lifespan

ACORN is also developing a corrosion and cavitation-resistant coating with a 10+ year design life for tidal energy generators which operate in high-velocity environments.

Three coatings were selected: a tungsten carbide containing alloy, an aluminium oxide and an iron-based alloy. They were chosen for their behaviour under cavitation conditions, compatibility with the substrate material, corrosion performance, a lack of heavy metal content, environmental safety and, finally, cost and manufacturing considerations. The three substances were coated onto initial test coupons and assessed for resistance to both cavitation and seawater corrosion.

Computer simulations supported the studies on hydrofoils and model turbine blades in a cavitation tunnel to fully assess each coating's performance under expected service conditions.

Now that the project is working on the commercialisation of the new coating, it is hoped that this will make a major contribution to providing environmentally safe solutions as global energy demands and a shift towards renewable energies will likely see the construction of more offshore energy installations over the coming decades.

ACORN

- ★ Coordinated by TWI in the United Kingdom.
- ★ Funded under FP7-SME.
- ★ <http://cordis.europa.eu/news/rcn/124743>
- ★ Project website:
<http://www.acorn-project.eu/>

NOVEL SYSTEM REMOVES DEBRIS FROM COMPRESSOR

All-electric aircraft feature unique system architectures such as that of an electric 'environmental control system' (ECS) that eliminates the use of bleed air. EU-funded scientists have successfully developed an air filter for this system.

Modern aircraft are equipped with an ECS that provides air supply, thermal control and cabin pressurisation for the crew and passengers. However, it is one of the largest consumers of electrical energy since it uses bleed air. In such configurations, external air is bled from the fan or from the low/intermediate pressure stage of the compressor. For this reason, aircraft manufacturers are increasingly turning to electric ECS solutions that get fresh air directly from the atmosphere.

In an electric ECS pack, the outside air is injected directly into the compressor via a scoop air inlet located on the aircraft's belly fairing. To protect the turbo-compressor and electrical pack from debris and consequently ensure reliable performance, it is necessary to filter the outside air. Within the ELECFILTER (Design of compressor air inlet protection for electrical ECS) project, scientists successfully developed a reliable protection system for the compressor air inlet.

The solution is a multi-stage filtration system that includes a pre-filtering retractable flap, an inertial vortex separator, a

coalescence filter and a medium filter. To successfully develop the system, researchers firstly performed a computational analysis of the air and particle flows around the scoop and inside the system.

No-bleed electrical system architectures lead to increased efficiency gains in terms of reduced fuel burn. The newly developed filtration system is ensuring that the probability of losing

fresh air supply to the cabin stays within the set limits.

ELECFILTER

★ Coordinated by the Polytechnic University of Valencia in Spain.

★ Funded under FP7-JTI.

★ <http://cordis.europa.eu/result/rcn/173701>

★ Project website: <http://www.elecfilter.org/>



ADVANCED BEARINGS OPEN DOOR TO MORE FUEL-EFFICIENT AIRCRAFT PROPELLERS

EU-funded scientists have developed new bearing technologies designed to support the manufacture of cutting-edge propeller blades.

The positive results — achieved through the EU-funded SNRPBBEARING (NTN-SNR Proposal for Propellers Blades Bearings Design and Manufacturing) project — will now facilitate the development and testing of rapidly rotating turbopropellers for civil aviation purposes, which need

advanced bearings in order to minimise friction.

The aerospace sector is one of the EU's key high-tech fields, providing more than 500 000 jobs and

generating turnover of close to EUR 140 billion. The EU is a world leader in the production of civil aircraft, including helicopters, aircraft engines, parts and components, and the

SNRPBBEARING project is part of an overall EU objective of ensuring that the sector remains at the cutting edge.

An aircraft propeller is a heavy piece of advanced machinery that consists of a rotating hub with radiating blades. These produce thrust by pushing air. The new blade design, developed as part of the EU's Clean Sky programme, aims to increase air flow and thrust and thus crucially reduce fuel consumption and emissions.

In order to make this design a reality however, advanced blade bearings are needed for load management and blade angle control. Launched in February 2013, the SNRPBBEARING project identified and evaluated various designs before pursuing the concept that offered the most potential in terms of withstanding large loads and high temperatures.

Innovative sealants to keep both lubricants in and pollutants out were also investigated. Following a successful

"The blades are the key deliverable of Clean Sky's 'Sustainable and green engine' (SAGE) Integrated Technology Demonstrator."

preliminary design review, the team then worked on design improvements based on comments from manufacturers.

By the end of 2015, the SNRPBBEARING project was able to deliver 26 bearings for these propellers at a technology readiness level of five, which means thorough testing of the prototype in a representative environment has been carried out. The bearings are therefore ready for testing in a suitable full-scale realistic scenario, partially integrated with other systems.

There are other challenges to address, such as integrating novel engine and aircraft systems and addressing noise emanating from unshielded propellers. But when the demonstrator finally takes flight, the SNRPBBEARING project will have played a significant role in making this possible. In this way, the project will have contributed towards more sustainable air travel with reduced fuel consumption and emissions.

The blades are one of the latest design concepts under development within the EU's ambitious Clean Sky research programme, which aims to ensure that European aerospace remains globally competitive. The blades are the key deliverable of Clean Sky's 'Sustainable and green engine' (SAGE) Integrated Technology Demonstrator, which specifically aims to advance engine technologies for all sectors of the civil aerospace market.

Clean Sky is one of the largest European research programmes ever, with a budget estimated at around EUR 1.6 billion for projects launched between 2008 and 2013. The objective of this unique public-private partnership has been to speed up technological breakthrough



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developments and shorten the time to market for new solutions tested on full-scale demonstrators.

SNRPBBEARING

- ★ Coordinated by NTN-SNR Roulements in France.
- ★ Funded under FP7-JTI.
- ★ <http://cordis.europa.eu/news/rcn/124606>

PIONEERING ONBOARD BRIDGE DESIGNS TO IMPROVE SAFETY AT SEA

EU-funded researchers have developed an adaptive bridge design methodology that improves onboard efficiency and minimises the risk of accidents at sea.

Drawing directly from the experience of seafarers and cross-discipline collaboration, and using innovative modelling and simulation techniques, the EU-funded CASCADE (Model-based Cooperative and Adaptive Ship-based Context Aware Design) project has developed its Adaptive Bridge System that recognises, prevents and recovers from human error by improving the interaction between a ship's bridge crew and electronic equipment.

There has been a marked increase in the number of maritime accidents in and around EU waters, with an estimated 80% of collisions and vessel groundings taking place due to a failure of bridge systems and/or their usage by crew members. The new system will improve onboard information sharing and, as a result, overall maritime safety.

The project utilised a Cooperative System Design Methodology, a holistic perspective which allowed for the

detection and resolving of potential problems or conflicts (such as human error), inconsistencies and redundancies (e.g. of information presented on bridge computer screens) during the design phase.

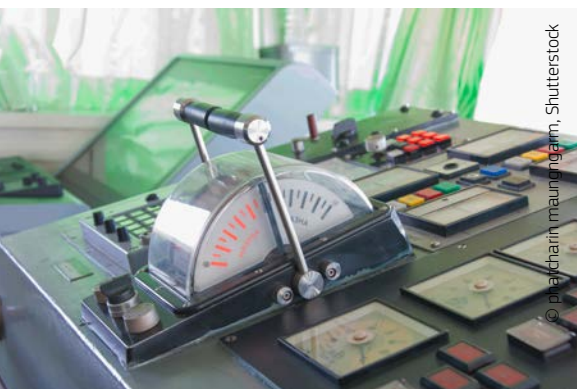
One of the key elements of the new design methodology is a touch screen 'Shared Display' that is intended to aid communication and cooperation amongst the bridge crew. To ensure flexibility, the screen is completely customisable and shows multiple sources of information in a configuration best suited for any particular situation. Particular functions of the new 'Shared Display' include the ability to graphically annotate maps and charts, leave notes for other crew members and compile electronic checklists.

The CASCADE console was integrated with tools used by ship pilots in 'Portable pilot units' (PPUs). Firstly, the project developed a protocol to share pilotage routes between the PPU and the ship's electronic charts. Secondly,

a link was established between the PPU and the bridge screens to allow the mirroring of information from the PPU screen, enabling crew members to see extra information normally only available to the ship's pilot.

All of these new tools were tested by the project on both a physical ship simulator (used for training purposes) and a Virtual Simulation Platform (a software-based simulation of a ship's bridge), focusing on a number of situations encountered daily by seafarers, such as navigating traffic on busy sea lanes. This allows for the

"All of these new tools were tested by the project on both a physical ship simulator and a Virtual Simulation Platform."



possibility of testing new bridge designs at the earliest stages of development and ensuring a maximum level of interoperability between the various bridge systems and consoles.

Although the project ended in December 2015, the development of CASCADE's Adaptive Bridge System, and its emphasis on simulating human-machine interaction at the design phase as a means to minimise the risks posed by human error, is an

important step forward in improving overall maritime transport safety.

CASCADE

- ★ Coordinated by Offis in Germany.
- ★ Funded under FP7-TRANSPORT.
- ★ <http://cordis.europa.eu/news/rcn/124642>
- ★ <http://bit.ly/1Q5aH10>

GROUND-BREAKING RESEARCH FOR EFFICIENT LONG-LIFE LIGHTING

Thanks to their good electroluminescence efficiency, there is increasing interest in organic 'Light-emitting electrochemical cells' (LECs) as solid-state luminescence sources. New research reveals how to further improve efficiency and what limits the lifetime of this optoelectronic device.

Generating light from either electrical energy or chemical reactions, LECs hold great promise for diverse applications such as large-area lighting. Despite the technology's high potential for smarter energy management compared to incandescent light bulbs, limited device lifetime and efficiency hold back widespread use.

Within the EU-funded LEOLAC (Towards long-lived and efficient organic light-emitting electrochemical cells) project, scientists thoroughly studied factors affecting the position of the illumination zone, which is key to understanding what limits organic LEC lifetime.

The team prepared LECs using several different light-emitting polymers, seeking to understand why light emission usually takes place close to the cathode. They concluded that the LEC emission position largely depends on the negatively

charged carriers in the light-emitting polymer. For example, for a polymer containing oxygen elements, light emission takes place close to the cathode. For another polymer containing only hydrogen and carbon, light

emission takes place at a different position — in the middle of the two conductive electrodes.

Scientists demonstrated a novel approach to improve the efficiency of white-light organic LEC devices by incorporating protein polymers into the device. They successfully prepared a novel light-emitting device, where emission stemmed from a very thin layer of fibrils containing emissive metal complexes. Photophysical experiments shed further light on the exact protein function. As organic LEC technology features novel form factors such as flexibility and large-area emission, this newly developed method is compatible with printing processes.

Project work took a step closer to understanding the charge-generation mechanism in organic solar cells. Scientists measured the cell open-circuit voltages at

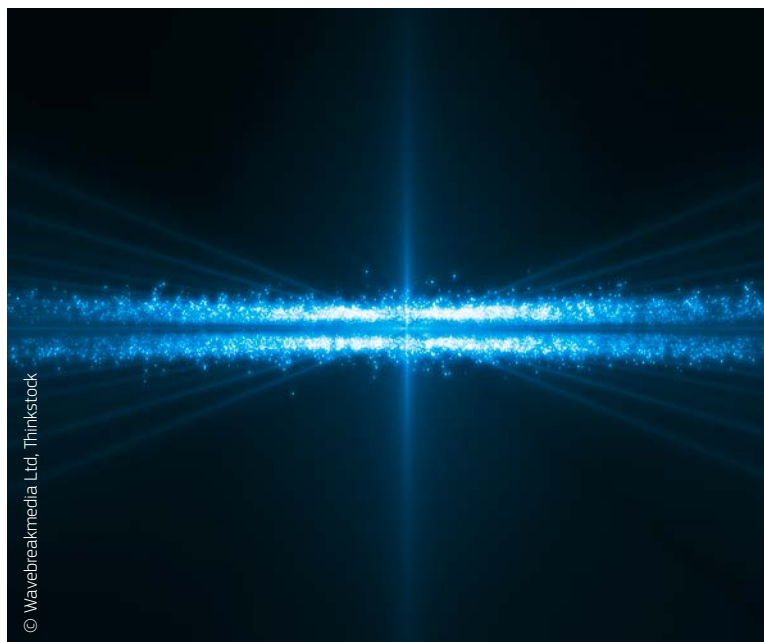
different temperatures and compared different donor-acceptor interfaces. Results demonstrated a decrease in open-circuit voltage at low temperatures. Reduced charge separation at low temperatures accounted for this decrease.

LEOLEC findings should help research reach a point where LEC energy efficiency and lifetime will make them useful for commercial applications. Findings are also expected to increase European Research Area (ERA) competitiveness in the organic LEC field.

LEOLEC

- ★ Coordinated by Linköping University in Sweden.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/173682>

"The team prepared LECs using several different light-emitting polymers, seeking to understand why light emission usually takes place close to the cathode."



ENVIRONMENT AND SOCIETY

EU STUDY SUGGESTS A 'RIGHT POLICY MIX' FOR THE FUTURE ETS

Can the EU Emission Trading Scheme (ETS) be considered as a success? Using comprehensive data from regulated companies and plants across Europe, a team of EU scientists tried to find out. The ENTRACTE project results pinpoint stumbling blocks, identify room for improvement and provide recommendations to policy makers.

With COP21 now behind us, the time has come to reflect on the best ways to reach carbon neutrality by 2050, as the 195 parties taking part in the conference committed to. In Europe, key to this reflection are the future evolutions of the EU ETS in light of lessons learned since it was first launched in 2005.

'We needed to assert that the EU ETS has achieved its core objective: reduce emissions of the covered installations,' says Dr Olivier Schenker, who coordinated the EU-backed ENTRACTE (Economic iNsTuments to Achieve Climate Targets in Europe) project for the Centre for European Economic Research (ZEW) in Germany. 'The economic crisis reduced demand and thus emissions. So it is not that straightforward to identify

the level of emission reductions caused by the EU ETS.'

ENTRACTE aimed to fill this knowledge gap, showing for instance that, in France, regulated plants reduced their emissions by an average 15.7% compared to non-ETS plants between 2005 and 2012. While this could be interpreted as proof of the ETS success, the project team prefers to remain cautious. It highlights the potential major impact of carbon leakage, and chose to focus on aspects of the ETS where there is substantial room for improvement.

A too lenient system

The ETS was not without drawbacks. One of the issues studied under ENTRACTE was the surplus of emission allowances:

Having built up since 2009 due to the economic crisis and its impact on industrial activity, this surplus is still paralysing the EU ETS to this day, with a total surplus of over 2 billion allowances.

'The main reason why the EU ETS has so far not exploited its full potential and has not fulfilled its intended role of flagship of the EU climate policy, is a cap that has turned out to be too lenient — and insufficient political will to correct this fundamental flaw,' says Dr Schenker.

While the carbon price system has been proven to work, he underlines that only scarcity on the allowance market can ensure its effectiveness, which requires a strong political commitment. Similarly, a carbon tax can only be as effective as its level allows it to be: 'The carbon pricing tools currently

“Policy instruments do not so much affect the achievement of the climate goal as they do its cost.”

implemented in the EU fall short of exploiting their full potential. While there is some room for improving their design, the main reason for this underperformance is a lack of political will.

The Market Stability Reserve (MSR), which intends to make the annual supply of allowances flexible by providing the EU with the means to adjust the supply to be auctioned, is welcomed by Dr Schenker, although he does not believe this is enough to solve the problem. ‘The recently adopted MSR is a step in the right direction, but appears too modest to deliver a sufficiently strong carbon price signal soon enough,’ he says.

A key learning from ENTRACTE in this regard is the evidence that compliance in Member States varies greatly due to differences in underlying principles of enforcement strategies, institutional settings and funding. Such a lack of compliance in one or a few Member States may indeed harm the functioning of the ETS in its entirety. ‘A consistent implementation of monitoring and enforcement across all participating states is crucial to the integrity and the success of the EU ETS,’ Dr Schenker says.

He adds that, while monitoring and enforcement is crucial, it also comes at a cost. “Monitoring, reporting and verification” (MRV) has costs for the regulated firms and installations which may affect overall effectiveness of the EU ETS. Our analysis of these transactions showed a substantial impact on average costs, in particular for “Small and

medium enterprises” (SMEs). This indicates a passive, compliance-oriented behaviour of these emitters, merely accepting the cost of allowances as another operating expense rather than seeking improvements in their carbon efficiency.’

The team couldn’t find any supporting evidence that economy-wide productivity has been either increased or decreased by ETS regulation, or any concrete information on the innovation it has triggered within the market.

The right policy mix

ENTRACTE not only points at existing problems, it also proposes concrete solutions. To help increase carbon prices and reduce volatility, the researchers developed a model of the ETS including an adjustment allocation mechanism for allowances — similar to the MSR. Then, in order to reduce transaction costs for SMEs, they suggested allowing some smaller firms to opt out of the scheme, by focusing regulation on the carbon content of fossil fuels, rather than measuring end-of-pipe emissions at the installation level.

Learning-by-doing and learning-by-using externalities also need to be addressed. The team suggests a market premium (or a renewable portfolio standard) on top of the wholesale electricity price which would compensate RES-E producers for their contribution to reducing cost. They go on to say that a learning-by-searching externality has to be considered, since the generation of knowledge through R&D is partly a public good.

Several market failures that hamper the uptake of energy-efficient technologies were also identified. However, ‘these market failures are very specific and have particular effects on different consumers. Thus, successful policies need

to be very well calibrated in order to reduce distortions. The risk of doing more harm than good is certainly high,’ Dr Schenker warns.

Still, the project results show that ‘in addition to a price on carbon, there is a positive rationale for using a policy mix that addresses specific market failures beyond the climate externality,’ Dr Schenker insists that appropriately targeted complementary policies would not be distorting, but rather potentially cost-reducing. ‘A particularly interesting finding is that the need for these complementary policies diminishes over time as the effects of spill-overs, learning-by-doing, scale economies, and breaking of informational or other barriers, are realised,’ he says. ‘More particularly, measures related to innovation and technology adoption can reduce costs by as much as one third when compared to a “pure” price approach.’

Since the project was completed in September 2015, the team has published a Joint-Policy Brief in cooperation with its sister project CECILIA2050. Schenker is confident that the project’s findings have increased ETS understanding among policy makers in Brussels and EU Member States.

‘I hope our work will make them fully aware of the complexity and unintended side effects that policy making in this complex web of regulation and institutions can have,’ he concludes.

ENTRACTE

- ★ Coordinated by the Centre for European Economic Research (ZEW) in Germany.
- ★ Funded under FP7-ENVIRONMENT.
- ★ <http://cordis.europa.eu/project/rcn/104143>
- ★ Project website: <http://entracte-project.eu>

COST-EFFECTIVE MONITORING TO HELP PRESERVE FOREST DIVERSITY

New methods for monitoring the genetic diversity of forests will help ensure cost-effective management and more targeted conservation policies.

Protecting genetic diversity is essential to ensuring that European forests have the flexibility to adapt to future environmental conditions and societal demands. A newly developed monitoring protocol designed to assess genetic diversity at the European scale — and fully applicable to different tree species — could bring significant benefits to forest administrations, forest managers and staff from forest research institutes across EU Member States.

Preserving forests is also an economic issue. Forest-based industries represent about 7 % of EU manufacturing GDP, and provide nearly 3.5 million jobs across over 400 000 companies, most of which are small and medium-sized or micro enterprises. Raw material used by the forest-based industries provides income to around 16 million forest owners in the EU.

‘Genetic monitoring means checking temporal changes in the genetic variation and structure of tree populations, in order

to assess how well genetic diversity is maintained over time, and how it evolves as a result of climate change and management practices,' explains EU-funded FORGER (Towards the Sustainable Management of Forest Genetic

Resources in Europe) project team member Dr Bernd Degen, head of the Institute of Forest Genetics at the von Thünen-Institut, Germany. In a new short film, Degen presents his institute laboratories

"The guidelines developed offer forest managers cost reductions of around 30% compared with conventional monitoring techniques."

where tree samples are examined, and reveals the hands-on work behind genetic monitoring.

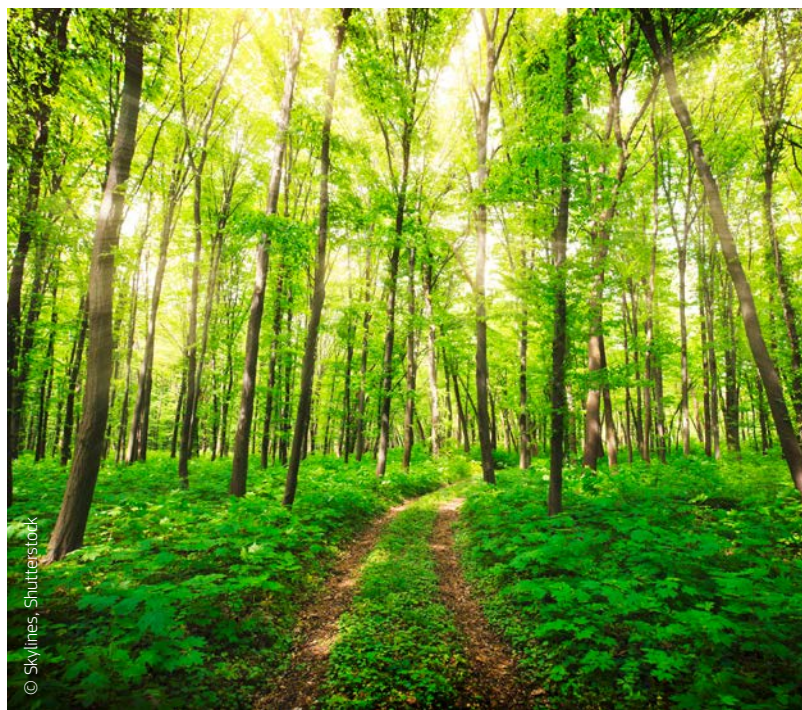
'We recently completed experimental monitoring work in selected forest plots, and analysis of the data has enabled us to formulate recommendations for an improved protocol for genetic monitoring on a European-wide scale.'

The guidelines developed offer forest managers cost reductions of around 30% compared with conventional monitoring techniques, through focusing on two rather than three stages of individual tree development (adults, seedlings and saplings) in each plot selected for monitoring. Following completion of the test phase, the protocol will be further evaluated and compared with alternative approaches, within the framework of a new EU-funded project, scheduled to start in early 2016 (GENTREE).

'In Germany, we plan to expand our ongoing genetic monitoring approaches to include the recommendations from the pilot study carried out in FORGER,' adds Degen. 'The project will continue to develop recommendations for an optimal approach, applicable at a European-wide scale.'

The FORGER project has also produced a range of materials to disseminate its research results to as wide an audience as possible, ranging from factsheets to multimedia products. 'We wanted to have a real impact on the management of forests with our project findings,' says Degen.

Impressive scientific progress has been made in detecting patterns of genetic diversity in recent years, and there has been increased awareness at the policy-making level of its economic and environmental importance. What has been missing however has been an efficient EU-wide forest monitoring scheme. The FORGER project has taken steps to fill this



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gap, and its findings will have a positive knock-on effect in other research areas.

For example, genetic monitoring is an important topic for a current phase of the European Forest Genetic Resource Programme (EUFORGEN). 'The development of a system for monitoring genetic diversity will be an invaluable tool for forest protection and sustainable management, which is why this theme has been considered as a priority for this multi-country collaborative programme,' says Degen.

The FORGER project was completed in February 2016.

FORGER

- ★ Coordinated by DLO in the Netherlands.
- ★ Funded under FP7-KBBE.
- ★ <http://cordis.europa.eu/news/rcn/124526>
- ★ Project website: <http://www.fp7-forger.eu/>
- ★ <https://goo.gl/iM9c3y>

INTERVIEW

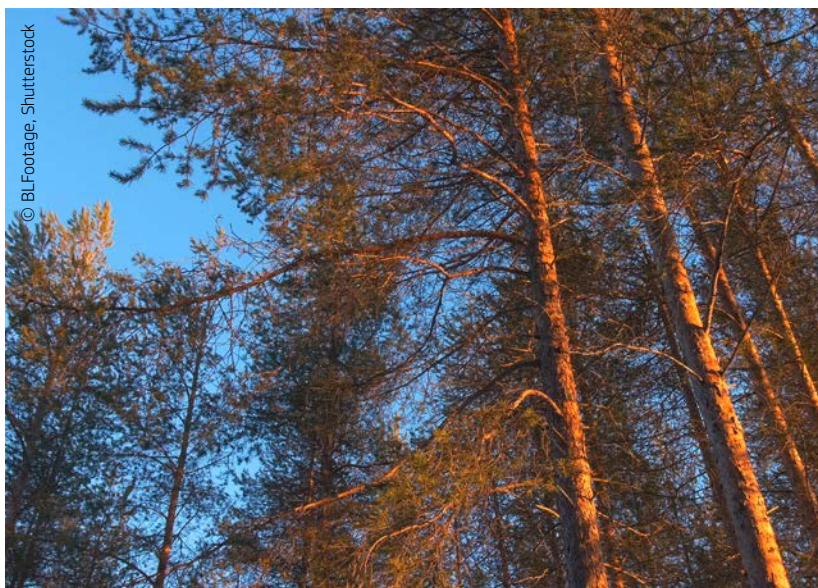
SOWING THE SEEDS OF MORE GENETICALLY ADVANCED CONIFER BREEDING

While biotechnology has been used for decades to improve tree characteristics and accelerate their growth, a better understanding of their adaptive response genetics is necessary for enabling breeding programmes to cope with climate change. An EU-funded project has collaborated with scientists from across the world to create the tools and data needed.

As the largest, tallest and longest living non-clonal terrestrial organisms on Earth, conifers have immense ecological importance, dominating many terrestrial landscapes and representing the largest terrestrial carbon sink.

They are of great economic importance, as they are key to the production of timber, paper and biomass. But first and foremost, the fact that their genome has diverged from that of angiosperms over 300 million years ago means that they

provide a different view of plant genome biology and evolution. Some 30% of conifer genes have little or no sequence similarity with plant genes of known function, and they have developed very efficient physiological adaptation systems.



With this tremendous value in mind, the team from the PROCOGEN project (Promoting a functional and comparative understanding of the conifer genome — implementing applied aspects for more productive and adapted forests) focused on bringing breeding programmes started 50 to 70 years ago to a whole new level, by addressing the genome sequencing of two keystone European conifer species.

★ **PROCOGEN specifically addresses the genome sequencing of Scot's pine and Maritime pine. Why this choice?**

Carmen Diaz-Sala | MARIA TERESA CERVERA: PROCOGEN provides information about the genome sequences of *Pinus pinaster* and *Pinus sylvestris*. These are two European pine species of important ecological and economical value, with contrasting geographical distribution and adaptive capacities.

During the project, we analysed the molecular control of the adaptation processes in different European model conifer species that have developed adaptive mechanisms, such as those related to growth in changing environments, as well as responses to drought stress (*Pinus pinaster*) and cold acclimation (*Pinus sylvestris* as well as *Picea abies*).

★ **What would you say are the most important things you achieved during the project?**

One of the main goals of this project was to establish collaborations with other worldwide initiatives on conifer genomics, so as to be able to increase our knowledge about conifer genome structure, function and evolution. This collaboration effort has been facilitated by the participation of

PROCOGEN members in different conifer genome sequencing and characterisation initiatives.

Comparative studies based on genomics and transcriptomics provided us with information on unique features of conifer genomes. They allowed us to identify gene families with differentially expanded gymnosperms and angiosperms, to infer a slower evolutionary rate in conifers using 'Conserved orthologous set' (COS) markers, as well as to analyse the role of gene expression and natural selection in shaping the evolution of protein-coding genes belonging to conifer gene families (genes related to reproductive biology, stress-related genes, etc.).

Additionally, the results of the comparative genetic mapping helped us to reassess the static view of conifer genome evolution, which was inferred essentially from comparisons of *Pinaceae* species. These results support a new hypothesis of substantial chromosome rearrangements between conifer families: through a different number of fusions, these rearrangements would have shaped the 12 chromosomes of modern *Pinaceae* species and the 11 chromosomes of modern *Cupressaceae* species.

★ **You mentioned international cooperation. Can you tell us more about the other projects you linked up with and their added value for your research?**

PROCOGEN linked up with EC-funded projects such as EVOLTREE, NOVELTREE, TREEBREDEX and FORESTRAC, as well as other projects on conifer genetics, genomics, breeding and forest management. This quest for synergies also led us

to North America and Canada, where other similar projects are ongoing.

This cooperation brought benefits at both ends. PROCOGEN gained precious information about conifer breeding populations and experimental trials, research needs, practical issues and challenges related to the implementation of forest tree gene conservation. This collaborative work helped us to identify candidate genes contributing to economically and ecologically important traits.

Once we had integrated this information, we provided new reference pine genomes, a vast catalogue of genes involved in adaptive responses, an identification of the adaptive value of allelic variants, and information derived from the comparative genomic studies. This resulted in integrated conifer database generation.

In order to further improve the collaboration with other worldwide initiatives on conifer genomics (in Australia / New Zealand focusing on *Pinus radiata* and Japan focusing on *Cryptomeria japonica*), PROCOGEN participants also organised open meetings for other conifer initiatives. This integrative project greatly contributed to strongly reinforcing the competitive edge of European research on conifer genomics and bioinformatics.

★ **Apart from the information database you just mentioned, what kind of tools did you create during the project?**

Different tools have been developed under PROCOGEN, for example analytical tools for basic and applied research in both breeding and conservation programmes.

We also developed a wide range of molecular tools and techniques: Exome capture systems designed for targeted conifer species; a set of conifer COS genes and their associated markers; a reference map of pine tissue transcriptional activity and adaptive responses (including expressed gene catalogue and transcription regulatory elements such as transcription factors, sRNAs and epigenetic elements); dense genetic maps based on orthologous markers;

"The outcomes of this project will contribute to the sustainable development and long-term competitiveness of the EU forest sector."

pre-breeding tools (i.e. genotyping arrays for pedigree reconstruction, etc.) and exome capture; as well as 'Genotyping by sequencing' (GBS) approaches for high-throughput SNP genotyping. The latter enable us to assess genomic diversity at the natural range scale of the species and redefine core collections.

Our bioinformatics tools include a portal for structural and functional expert annotation and data exchange of gymnosperm genomics/transcriptomics information. We also integrated PROCOPEN information into the in-house, online comparative platform PhylomeDB to infer pre-computed phylogenetic trees for each gene.

★ **How and when will stakeholders be able to make use of the data and tools you created?**

Regarding data on genome variability, profiling and regulation of transcriptional activity associated with development and environment, tailor-made molecular tools can already be designed to study growth and adaptation of conifer genetic resources.

Pre-breeding arrays are available, and simulation and prediction tools for practical breeding are under development. Simulation tools have been developed to optimise the integration of genomic data into practical breeding, and they have already been tested. Additional tools are still under development, and are in the latest phase before application. Information about tool availability can be found on the PROCOPEN website.

★ **What kind of impact do you expect PROCOPEN to have on the effectiveness of tree breeding programmes?**

Most breeding programmes of conifer species in Europe were implemented in the past so as to improve trees for production and quality traits. PROCOPEN's tools build upon this tradition with new selection criteria and advanced, faster breeding thanks to four advances.

First, we can now identify candidate genes with traits that will be responding to climate change. We can also determine the breeding potential of their allelic variants, develop pre-breeding arrays for precise selection of conifers showing the best adaptive responses and, finally, ensure high levels of genetic diversity — a key strategy to cope with uncertainty in future risks from climate change. Molecular control of plasticity on woody species has also been addressed.

All in all, the outcomes of this project will contribute to the sustainable development and long-term competitiveness of the EU forest sector by providing conifer breeders and managers of forest gene resources with information. Our advanced tools will lead to forest-reproduction material, more tolerant towards expected changes or particularly fit for specific conditions, to be used for forest regeneration and artificial plantations.

★ **What are your plans now that the project has been completed?**

PROCOPEN is strongly committed to advancing knowledge of conifer genomes and their function, as well as technology transfer. Our next priority in this regard is

to conduct further functional analysis of conifer genomes and to study the regulation mechanisms of genes controlling economically and ecologically important traits in model conifer species.

The technology transfer considers not only the transfer of knowledge and methods generated or validated during the project, but also the enormous effort required to translate basic genomics results into practical applications in order to enable genome-assisted breeding and resource management.

PROCOPEN

- ★ Coordinated by the University of Alcalá in Spain.
- ★ Funded under FP7-KBBE.
- ★ <http://cordis.europa.eu/project/rcn/101672>
- ★ Project website: <http://www.procofen.eu>



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BIOTECH SOLUTIONS OFFER GREENER PLASTIC WASTE RECOVERY

By using bacteria to break down plastics, scientists hope to reduce environmental damage and boost business by opening up new opportunities in waste.

The new biotech process, developed by the EU-funded BIOCLEAN (New BIOTEchnologiCaL approaches for biodegrading and promoting the environmental biotransformation of synthetic polymeric materials) project, will mitigate the effects of plastic pollution in sensitive environments, help the plastics sector achieve production efficiencies and provide recovery and recycling experts with guidance on the most effective options for breaking down different plastics.

The project began by isolating and selecting microbes from plastic waste lifted from the sea, landfills, composting facilities, anaerobic waste treatment plants and contaminated industrial sites. Bacteria and fungi were then assessed and

those shown to be effective in breaking down, detoxifying and valorising plastic waste isolated.

Promising bacteria were combined with chemical pre-treatments and tested on a range of plastics. This process was then scaled up at the municipal composting facility of Chania on the Greek island of Crete, which demonstrated its ability to enhance the natural biodegradation of plastics in organic waste composting.

Inserting plastics into the so-called circular economy — where materials are valorised and reused after the end life of a product — will therefore greatly benefit the environment and create business opportunities in the waste recovery sector. Scientists have known that synthetic plastics do biodegrade in certain



marine environments as well as in landfills, compost and soil, but the processes and conditions required have to date not been well understood.

BIOCLEAR has helped to deepen scientific understanding of this process, and shown that biotech solutions for effectively and sustainably disposing of plastic waste are feasible. In particular, the consortium focused on PVC, polystyrene, polypropylene and polyethylene, which are widely used in industry and responsible for a great deal of plastics waste.

This processing breakthrough could bring benefits to the plastics industry, which is seeking to reduce its impact on the environment and achieve production efficiencies through higher recycling rates. Plastic products are extensively used in numerous industries ranging from automotive and electrical appliances to building materials and food packaging.

The flexibility of plastic means that it is used extensively in high-tech innovations applications, and this trend is predicted to grow. However, while plastic recycling has increased since the 2008 crisis brought home the need for greater economic efficiency, more could be done.

Plastic, a non-biodegradable disposable material, has begun to seriously pollute oceans across the globe. Minuscule plastic pieces have a structure that due to their small size, concentrate contaminants like sponges along with other chemical pollutants.

A lack of waste collection points at ports has severely hampered attempts at marine plastics recycling, and, as a result, this noxious material is often not collected and is simply thrown back into the sea. Even when this petroleum-based waste is removed from the ocean, it tends to end up in a dump or incinerated, which causes emissions that are harmful to the environment or result in contaminated land waste.

The BIOCLEAR project was completed in August 2015.

“The consortium focused on PVC, polystyrene, polypropylene and polyethylene, which are widely used in industry and responsible for a great deal of plastics waste.”

BIOCLEAR

- ★ Coordinated by the University of Bologna in Italy.
- ★ Funded under FP7-KBBE.
- ★ <http://cordis.europa.eu/news/rcn/124520>
- ★ Project website: <http://www.biocleanproject.eu/>

NEW OBSERVATION NETWORK TO DETECT AND MEASURE NON-CO₂ GAS EMISSIONS

EU-funded scientists have developed a sophisticated observation network that allows for the accurate measurement of non-CO₂ gas emissions. It will substantially contribute to the goals of the EU's climate and environment policy.

Following the conclusion of the EU-backed INGOS (Integrated non-CO₂ Greenhouse gas Observation System) project, involving research institutions from 14 participating countries, scientists have been able to enhance Europe's observational capacity to record non-carbon dioxide (CO₂) greenhouse gas emissions.

Whilst there are now well-established methods for recording industrial CO₂

emissions, it had proven much more difficult to effectively measure the emission contributions from other potentially harmful gases, such as nitrous oxide and methane.

Previously, only educated calculations on the exact quantity of emissions of these gases could be made, due to the fact that they originate from many different sources, from waste landfill sites to food production.

New atmospheric observation system developed

To address this challenge, the INGOS project implemented a network of atmospheric observation stations across Europe as a means to specifically collect and combine measurements for these gases and cross-reference them with other data.

The infrastructure project works on standardising the measurements, strengthening

the existing observation sites into super-sites, allowing for capacity building in new EU Member States and preparing for integration with other networks already in place or currently being set up (such as ICOS, the carbon equivalent of INGOS).

“INGOS has already been able to identify several new gases that were previously unknown, or newly introduced to the market.”

This sophisticated observation system, which generates data to help in detecting emission source ‘hotspots’, allows for a much more comprehensive understanding of how these gases influence the ecosystem and contribute to overall greenhouse gas emissions.

The observation stations were also redesigned to detect potential new greenhouse gases, even if they are emitted in very small concentrations. INGOS has already been able to identify several new gases that were

previously unknown, or newly introduced to the market (as a means to replace conventional industrial gases). This is due to the sensitivity of the observation network being able to pick up very small concentrations of emissions.

The particular case of methane detection

One of the key non-CO₂ gases INGOS focussed on has been methane. Methane molecules retain much more heat than CO₂ and therefore contribute relatively more to global warming. The concentration of methane in the atmosphere has displayed a highly variable trend, with years of strong increase followed by years of stability, followed again by increases.

Methane is formed naturally by bacteria in wetlands and from livestock, but human activity currently releases more into the atmosphere than natural resources. The INGOS project used its large measurement tower in Cabauw, the Netherlands, to conduct for the first time detailed measurements of methane with high time resolution. This made it possible for the project team to determine whether methane is created by natural bacteria or fossil fuels.

Future impact of the project

The success of the project is now likely to support informed policy decisions on climate change and international reduction protocols for non-CO₂ greenhouse gases and research strategies. It is expected that emission reduction in non-CO₂ greenhouse gases will be more cost-effective than measures taken to reduce conventional CO₂ emissions.

The observation capacities developed by INGOS will now allow for the independent verification of claimed emission reductions, thus contributing to both the development of European environment and competition policies, as well as the increased public trust in the measures taken to address global climate change.

INGOS

- ★ Coordinated by the Energy Research Centre of the Netherlands.
- ★ Funded under FP7-INFRASTRUCTURES.
- ★ <http://cordis.europa.eu/news/rcn/124604>
- ★ Project website: <http://www.ingos-infrastructure.eu/>



IT AND TELECOMMUNICATIONS

SMART HELMET AND GARMENT TO HELP SAVE MOTORCYCLE RIDERS IN THE EVENT OF A CRASH

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Motorcycles are the only transport mode for which accidents have been on the rise over the past 10 years. While e-call systems have already cut response time, real-time vital signs monitoring could be used to prepare for an appropriate emergency response. The EU-funded I-VITAL project has created such a system that can be seamlessly integrated into helmets and garments.

The I-VITAL (Smart Vital Signs and Accident Monitoring System for Motorcyclists Embedded in Helmets and Garments for eCall Adaptive Emergency Assistance and Health Analysis Monitoring) system is made of two main parts or, as we call them, kits, along with a smartphone application,' says project coordinator Rafael Maestre Ferriz, Director of the Electronics Department at CETEM, Spain. 'Kit I is the I-VITAL system for the helmet, whereas Kit II is the I-VITAL system for the garment.'

Both kits can be used independently or in combination. They share similar sensors for vital signs monitoring and accident detection, a circuitry for data acquisition and processing, as well as 'Bluetooth low energy' (BLE) technology to provide a wireless connection to the user's smartphone.

'The smartphone runs a dedicated application. It gathers information from the kits about the health status of the user and detects crash events. When an

accident occurs, the smartphone app automatically triggers an eCall. The user can communicate his situation without any need for further action. But more importantly, the system automatically sends out the basic required accident-related information along with additional health information which is I-VITAL-specific,' Maestre explains.

Even though they share the same technology, all elements have been customised for their specific kit — bearing in mind physical constraints and limitations. Information collected includes 'Heart rate monitoring' (HRM) and 'Heart rate variability' (HRV), temperature and humidity. On top of that, the garment can sense respiration rates, while the helmet includes electronics for consciousness detection in the case of an accident.

As all these sensors need continuous energy supply, the consortium chose to move away from standard battery technology and to develop energy-harvesting capabilities specific to each kit. The

helmet includes a wind power generator, while the garment integrates solar cells.

A technical breakthrough

Unlike car accidents, which have benefited from a long history of R&D and safety measures, motorcycle crashes are very unpredictable. 'In many accidents, there is no consistent correlation between the damage done to the motorcycle and the injuries of the rider. In some instances, the rider even separates from the bike and the detection of an impact on the motorbike has nothing to do with what happens to the rider,' Maestre says.

These facts contrast with the specs of state-of-the-art eCall systems. The latter usually rely on sensors placed on the motorbike only, whereas another system called Schuberth RiderEcall combines this mode of detection with another one placed in the helmet.

'The problem is that a severe impact to the body of the rider may not be

spotted on either the helmet or the motorcycle. Since the rider's status is of greater concern than that of the motorcycle, accident detection and severity estimation has to be linked to the rider and it should monitor both body and head,' he continues. 'This is precisely where I-VITAL stands above other solutions: In other systems, if no voice can be heard, emergency services will not know whether there is a technical problem or how badly injured the user is.'

Another key addition compared to other market offerings is I-VITAL's capacity to provide real-time information about the vital signs of the user. This information can also be found on the I-VITAL app, and the user can benefit from it in various ways: for example, if the heart rate exceeds certain levels, the driver will be warned to slow down. Similarly, if the driver's heart rate is too low, a warning to stop will be issued.

Finally, features have been added for pure entertainment, such as an estimation of the level of joy of the rider during the trip. This information can be checked when the rider takes a break.

New funding, new opportunities

The project may have been completed in October, but the consortium still has many plans in the pipeline. 'We are looking for new funding sources to take I-VITAL from prototypes to real final products,' says Maestre. 'European projects are one of the first options that we will explore, but the most desirable one would be to get a big name in the industry to support this effort.'

He also points out that there remains work to be done and that the technology still has room for improvement. 'For example, some additional processing can be done over the vital signs, in order to find secondary parameters that can be used to determine the level of stress and attention of the driver. These algorithms are proprietary and cannot be yet disclosed.'

'We also identified smarter ways of doing things while achieving even more benefits. However, this will imply more efforts and investment, and we

have to admit that some extra work has to be done before reaching the market. Fortunately, most of the project partners believe it is worth the effort.'

Two of the project partners, helmet and garment manufacturers NZI and Lookwell, have been exploring the different exploitation routes and commercialisation alternatives. 'They have already approached major manufacturers and brands, but this is something that has yet to become a reality and cannot be disclosed at this time. All in all it will all depend on the funds available and the interest of potential customers, but a realistic date for commercialisation could be around early 2018,' Maestre concludes.

I-VITAL

- ★ Coordinated by CETEM in Spain.
- ★ Funded under FP7-SME.
- ★ <http://cordis.europa.eu/project/rcn/109489>
- ★ Project website: <http://www.i-vital.eu>

ACCESS TO OPEN DATA DRIVES SMART CITY APP INNOVATIONS

An open data platform will help developers create new urban apps that benefit citizens and contribute towards the achievement of Smart Cities.

The EU-funded ICITY (Linked Open Apps Ecosystem to open up innovation in smart cities) project — which was extended last year to run until September 2015 — offers public authorities and innovative urban-focused start-ups everything they need to create apps that boost business, improve public services and attract investment. Although the project is now officially completed, the iCity Platform will continue beyond 2015, helping developers to create innovative services of public interest through the sharing of ideas and information.

The project has created a single point from which to access public information systems from numerous cities, along with app-building guidance and tools. This will facilitate efficient collaboration between cities, organisations and developers, and means that anyone interested in developing urban-focused apps now has easy access to open data from numerous cities.

For example, a recently completed iCity Platform app is ParkFinder from SEAT. The automobile company partnered with developers to produce an app that facilitates parking, by collecting information about free parking spots across the city. Local talent will also find it easier to develop their ideas, as highlighted by a recent project-led competition for locally developed apps in Genoa. A platform integrating different systems to monitor air quality was the winner.

The iCity App portal was launched earlier this year, and contains all the developed apps together with their corresponding download links. There is also information about their developer, functionalities, advantages and indications of the cities where the app is available.

Newly developed apps include one that monitors and scores your recycling and waste management habits, an app that supports people's mobility in several cities by informing them about possible obstacles and an app for runners in London that provides temperature and wind speed details. There is even an app that allows people to create an inventory of their personal belongings.

The iCity Apps site also contains an Ideas Exchange section where users and developers can share inspiration and see what is going on elsewhere. The project team believes that this will be especially useful for developers looking for new



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ideas because they can find what kind of services or apps users believe are missing in their cities.

There is also a general website, which offers all reports and information developed through the lifetime of the project. This provides the general public with a user-friendly interface, and makes it easier for developers to access the data and technology they need to build new apps. Since it has been created with end users in mind, the interface is simple and modern. The navigation has been designed to be intuitive and practical and provides filtering systems, allowing the user to focus his or her search on specific areas.

The pioneering four-year project focused on the cities of Genoa, Barcelona, Bologna and London. The guiding principle

throughout has been to help make Europe's cities Intelligent, Integrated, Innovative, Inclusive and Internet-enabled (the so-called five I's). During the project's lifetime for example, Genoa City Council integrated eight information systems into the platform along with its own open data portal.

ICITY

- ★ Coordinated by IMI in Spain.
- ★ Funded under CIP.
- ★ <http://cordis.europa.eu/news/rcn/124522>
- ★ Project website: <http://www.icityproject.eu/>

EMF EXPOSURE INDEX IDENTIFIES OPPORTUNITIES FOR INNOVATION

More accurate perceptions of 'electromagnetic field' (EMF) exposure will dispel unfounded fears and drive technological development, say researchers.

The three-year EU-funded LEXNET (Low EMF Exposure Future Networks) project, which was completed in October 2015, sought to directly address persistent public concerns about EMF exposure by establishing an index assessing the average exposure of Europeans, along with their attitudes and beliefs.

The results will have implications for policy makers and network providers by helping them to optimise their operations, identify where EMF exposure could be effectively limited and improve their communications about perceived risk. This will in turn lead to a better informed public.

Wireless systems based on EMF have transformed mass communication in just a few decades. No adverse health effects have been established as being caused by mobile phone use and all telecommunications in Europe must comply with the RTTE Directive that requires products to comply with the European Council's 1999 recommendation on EMF exposure.

In spite of existing protection limits however, public concern still exists. A recent Eurobarometer survey for example revealed that 70% of respondents thought mobile phone masts affect their health.

However, a key finding of the LEXNET project was that while base stations for mobile telephony are consistently seen as the most intensive EMF exposure source, it is in fact the WLAN-connected laptop that is the dominant EMF exposure source for most people.

Focusing on the perceived EMF threat from base stations is therefore not the most cost-effective or efficient way of reducing exposure. As a result, the research suggests that network companies and innovators could play a much bigger role in this respect, and that a potential market exists for developing low-exposure technology. Indeed, smaller-scale network technology innovations could have the most significant impact.

The project team also concluded that risk perceptions of the general public tend to be guided by subjective EMF-impact models, which underestimate near field exposure (such as from your laptop) and overestimate far field exposure (such as from a mobile phone mast). This explains why people are more concerned about the existence of base stations than about EMF exposure from their daily office work tools.

In addition to these source factors, the project found that EMF risk perception is also influenced by demographic and social factors along with personal attitudes and beliefs. Of most importance is the country of residence and a person's attitude towards technical innovation.

Several communication conclusions have been drawn from these findings. First, because the country of residence is decisive for risk perception, communication must be tackled as a culturally sensitive issue. Risk communicators should therefore take into account cultural factors that provide the context in which EMF sources are evaluated.

Furthermore, risk communication should try to correct the erroneous assumptions that risk is related to the physical

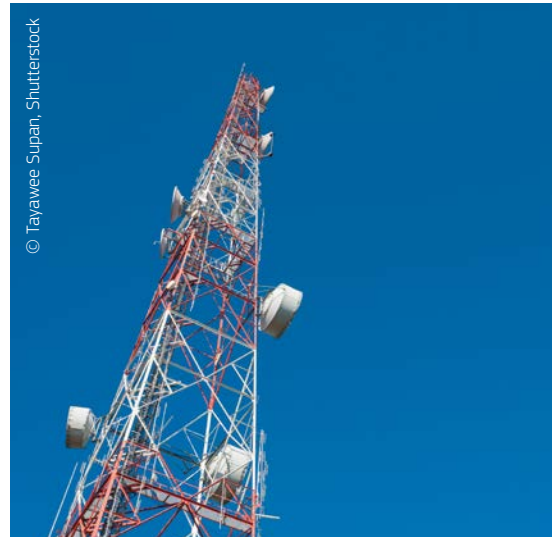
size of the exposure source and to the time of the day exposure takes place (referring to the understanding that people think that the body is more vulnerable to EMF exposure at night).

LEXNET

- ★ Coordinated by Orange in France.
- ★ Funded under FP7-ICT.
- ★ <http://cordis.europa.eu/news/rcn/124451>
- ★ Project website: <http://www.lexnet-project.eu/>

"Risk perceptions of the general public tend to be guided by subjective EMF-impact models, which underestimate near field exposure."

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NEW PLATFORM TO HELP BUSINESS TAP FULL POTENTIAL OF BIG DATA

EU-funded researchers have constructed and tested an online platform that will enable businesses to more effectively process big data.

The EU-backed JUNIPER (Java platform for high-performance and real-time large scale data management) project was launched in December 2012 to develop, test and evaluate prototype technologies that could aid big data analytical software applications.

Final industrial evaluations of the platform were assessed just before completion of the project at the end of November 2015, and the project team believe that the finalised platform has the potential to contribute positively to supporting projected growth of data streams and stored data. Financial and web streaming case studies were used to provide industrial data and data volumes and to effectively evaluate the newly developed technologies.

The results of the project could be of significant benefit to a number of sectors. The term 'big data' describes streams of information that are so large and complex that traditional data processing applications often cannot cope. By finding patterns through using advanced analytics however, new business opportunities and smarter applications could be opened up in numerous fields.

For example, patterns in big data can be analysed to better understand customer behaviour and preferences by including social media data, browser logs and text analytics. Retailers can use big data analytics to optimise their stock based on social media-generated predictive models, while big data analytics can also help machines and devices become smarter and more autonomous (in operating self-driving cars, for example).

There is therefore huge business potential in effectively handling big data. A key issue up to now however has been how to effectively manage such large and complex information streams, with online information outstripping network capacity. The internet now performs millions of tasks, from online banking to tsunami monitoring, and data traffic volumes are expected to grow 12-fold by 2018.

Typically big data has been processed by two main components. Firstly, a data generator to produce large streams of information that need to be filtered prior to storage in order to reduce volume, and secondly, an application that can



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reply to an end user's request; a financial transaction seeking authorisation from a banking database, for example. However, real-time constraints are often placed on big data streams and on processing, i.e. the user needs an answer quickly.

The JUNIPER project sought to address this challenge by developing a real-time platform capable of supporting a wide range of high-performance big data applications. The ultimate goal has been to ensure that demands for information from end users can be met through the real-time exploitation of streaming data sources and stored data.

The project brought together a number of leading industrial organisations involved in the development of products and services that utilise big data systems, leading software developers and technology companies operating in the field of advanced computing systems.

JUNIPER

- ★ Coordinated by X/Open Company in the United Kingdom.
- ★ Funded under FP7-ICT.
- ★ <http://cordis.europa.eu/news/rcn/124601>
- ★ Project website: <http://www.juniper-project.org/>

BETTER REMOTE CONTROL OF HUMANOID ROBOTS

Robots are transforming applications in diverse fields ranging from space and sea exploration to national security and biomedicine. New research has improved the control of dual-arm robot systems to more realistically mimic the human arms of their remote operators.

The EU-funded training project H2R (Bringing human neuromotor intelligence to robots) increased fundamental understanding of human neuromotor control and exploited it to optimise robot performance. The ultimate goal was improved control strategies for teleoperation of dual-arm robots in which a human operator

remotely controls the motion. The ability to jointly optimise the 'intelligence' of a remote human operator and of the robot itself will extend performance capabilities and open the door to exciting new applications.

Scientists developed a task-space hybrid adaptive mechanism to move a robot

arm and end-effector in response to an external disturbance at any place in the robotic system. The mechanism exploited both force and impedance sensors and a fuzzy logic-based scheme to select the best tuning gain. The gain, an increase (positive) or decrease (negative) in output as a result of a feedback control algorithm, is critically important for fine



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adaptive control of the robot arm and end-effector.

In parallel, the team created new knowledge regarding multiple-arm coordination in the context of multi-agent systems, including theoretical studies of uncertain couplings. Scientists also investigated hand gesture-based control in teleoperation of humanoid robots (iCub and Baxter). Work employed two commercially available haptic or 3D touch devices (the PHANTOM Omni and the Novint Falcon) for force feedback.

H2R has contributed important increased understanding of the technical requirements for optimal teleoperation of a human-robot system. The team has delivered advanced mechanisms relying on pattern recognition

and adaptive gain tuning that attempt to match the telerobot's controller with the human operator's motion pattern. Excellent collaboration with other Chinese institutes and with universities in the United Kingdom has ensured that knowledge transfer will pollinate new ideas and discoveries beyond the project's duration.

H2R

- ★ Coordinated by the Beijing Institute of Technology in China.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/173689>
- ★ Project website: <http://www.h2rproject.eu>

E-HEALTH APP GUIDELINES DEVELOPED TO IMPROVE ELDERLY CARE

EU-funded researchers now have a better idea of how e-health applications can boost health literacy and improve quality of care among the elderly.

Growing demand for elderly e-health applications — the delivery of healthcare and services by electronic means — and m-health applications — the delivery of healthcare services via mobile communication devices such as Smartphones — has created an opportunity for SMEs to develop innovative internet, mobile phone and tablet-based solutions along with video games that can improve the health of older people.

The EU-backed IROHLA (Intervention Research On Health Literacy among Ageing population) project trialled several of these promising technologies with elderly participants — including those with low health literacy — in order to assess market feasibility and to create a set of development guidelines. One of the main conclusions was the need for active and continuous collaboration between application developers, healthcare professionals and researchers.

Other matters that should be taken into consideration when designing elderly health apps include simplification of content and use, and the ability to set short-term, personalised goals. One pilot project for example sought to improve participants' knowledge about physical activity and healthy nutrition. The app enables participants to set their own dietary and physical activity goals and assess them at the end of a specific period. The system then generated personalised messages.

Just as importantly, the project team reported that while senior citizens reacted positively towards e-health and m-health applications, studies found that socio-economic status plays an important role in determining the depth of understanding of new technology. This factor should not be ignored when designing e-health and m-health applications, in order to ensure that e-health tools are of benefit to all, irrespective of socio-economic group, says the project team.

Indeed, in the EU, health literacy — the level at which people can access, understand and communicate information in order to have good health — is an area in need of

improvement. This is evident from a recent survey that showed that between 30 and 50% of the population is limited in this area, with the elderly particularly vulnerable.

The guidelines developed by the IROHLA project will help Europe's healthcare sector to tap the potential of e-health and m-health innovations, in order to boost health literacy among senior citizens, provide immediate contact with care givers and enhance informed decision making. It is also hoped that IT health innovations will facilitate more targeted public health and medical interventions, as well as remote diagnosis and monitoring.

Indeed, the team is confident that the project, which was completed at the end of November 2015, will contribute towards improving health literacy among the elderly and boost e-health services in Europe. 'What I hope is that older adults with low health literacy in Europe feel like they are in charge of their own health,'

says project team member Professor Louise Meijering, from the University of Groningen, the Netherlands. 'They should be able to see the skilled professionals they need to, and be able to ask questions. The end result would be that older adults make informed choices about their health.'

"The app enables participants to set their own dietary and physical activity goals and assess them at the end of a specific period."

IROHLA

- ★ Coordinated by UMCG in the Netherlands.
- ★ Funded under FP7-HEALTH.
- ★ <http://cordis.europa.eu/news/rcn/124486>
- ★ Project website: <http://www.irohla.eu/home/>

INDUSTRIAL TECHNOLOGIES

LIGHTWEIGHT METAL COMPONENT PROCESSING OFFERS COMPETITIVE ADVANTAGES

New, cost-effective and lightweight milling technology looks set to help the automotive and aerospace industry develop more energy-efficient vehicles.

Lightweight components offer the aerospace and automotive industries the means to reduce energy consumption and emissions through the development of lighter vehicles, and provide other industrial sectors with flexible materials to develop new innovative tools. Manufacturing such high-quality lightweight components however has consistently been a challenge; vibration and pressure during the milling process often means that manual labour is required to finish off production, thus ramping up costs.

The EU-funded DYNAMILL (Dynamic manufacturing of thin-walled work pieces by milling process) project, completed in October 2015, therefore sought to develop a cost-effective and safe means of mass-producing lightweight thin-walled parts ideal for sectors with good market growth potential such as transport, power generation and medical technology.

The end result of the three-year project is a new technology platform that offers complete process planning, new adaptive clamping devices and improved cutting conditions. Process control is focused on high damping and low excitation of work piece vibrations, while planning is strongly supported by cutting-edge software tools, including models for dynamic simulations of

oscillation as well as computer-aided manufacturing.

Novel systems in the process include magnetic clamping, and a clamping device for manufacturing large turbines. Complex thin-walled structures have been combined with high-strength materials, perfect for industries with very high safety and quality requirements such as aviation.

A total of five demonstration projects were carried out in order to show the potential benefits of the new DYNAMILL process for the industry, and to highlight the broad-sweeping applicability of the platform. For example, the energy sector can benefit from better production of large and medium-sized turbine blades made of a steel alloy. Small turbine blades made of titanium can be efficiently produced for aircraft, while a satellite component, knee bone prosthetic and print media part were also successfully — and efficiently — produced.

The results of these five demonstration projects were then analysed. Improvements included a 30% reduction in production time and costs, an 80% increase in process stability, a 30% reduction in power, compressed air and coolants and an impressive 70% reduction in wasted raw materials

during set-up. The cost-efficiency of the new process, once fully commercialised, will significantly enhance the competitiveness of Europe's milling industry and have a knock-on effect across numerous industrial sectors.

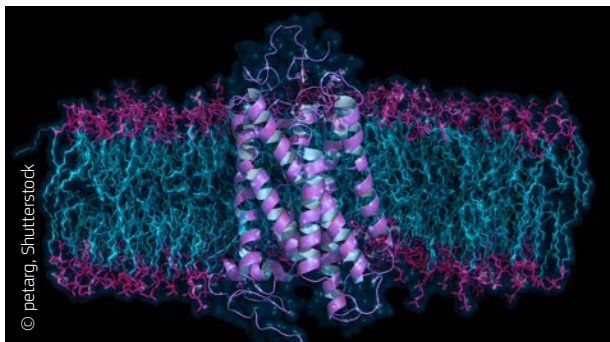
Aerospace for example is one of the EU's key high-tech sectors, providing more than 500 000 jobs and generating turnover of close to EUR 140 billion (2013). The EU is a world leader in the production of civil aircraft, including helicopters, aircraft engines, parts and components. EU-funded projects such as DYNAMILL will help ensure that the sector remains at the forefront of what is a competitive global industry.

The results of the DYNAMILL project were made possible thanks to the effective collaboration of two research institutes, four manufacturers of key technologies (CAM software, machine tools, clamping devices and tools) and four end users.

DYNAMILL

- ★ Coordinated by Fraunhofer in Germany.
- ★ Funded under FP7-NMP.
- ★ <http://cordis.europa.eu/news/rcn/124463>
- ★ Project website: <http://www.dynamill.eu>

PLANT-BASED ENZYME TO PROVIDE NEW OPPORTUNITIES FOR EU INDUSTRY



An EU-funded project has pioneered a new enzyme that will herald major benefits for the European chemicals industry.

The overall objective of the KYROBIO (The discovery, development and demonstration of biocatalysts for use in the industrial synthesis of chiral chemicals) project was to broaden the toolbox of single enantiomer chiral chemicals manufactured in Europe using biotechnological routes. The main focus was to enable the industrial application of the lyase class of enzymes that would be applicable to a number of industrial processes and purposes.

The KYROBIO project has employed a supradisciplinary approach, including enzyme development, chemistry, molecular biology, fermentation and innovation isolation techniques, in order to overcome the bottlenecks to applying this new technology.

One of the key promising results from the project has been the discovery of a new 'hydroxynitrile lyase' (HNL) enzyme which is highly suitable for industrial application. The enzyme originates from a simple white rabbit's foot fern plant.

Ferns and other plants, including stone fruit and almond trees, use an HNL enzyme to release molecularly stored hydrogen cyanide in order to protect their young buds from feeding pests.

Project partner the Austrian Research Centre of Industrial Biotechnology (ACIB) used a web tool developed by

KYROBIO and found that the fern's enzyme had no similarity at the sequence level with any previously known HNL.

This is important as the reverse reaction of HNL enzymes, the enantiomer, is highly useful in industry, as they are able to bind cyanide to different molecules that can be used in a number of industrial practices.

One such example is its ability to recycle unwanted cyanide wastes, which are generated during the production of acrylonitrile. Acrylonitrile is used not only in adhesives but also in textile manufacturing, as it is an important raw material for the production of acrylic fibre. Industry also gains valuable building blocks for pharmaceutical agents from the enzyme.

Project researchers are confident that the enzyme will have a good basis for industrial utilisation. They report that it is more efficient and simpler to handle than previous HNLs because it benefits from being a small, uncomplicated enzyme.

Some of the applications they believe it will be suitable for include crop protection and the production of insect repellents.

ACIB has now already filed a patent and is currently in negotiations with a potential industrial partner to commercialise the new enzyme. This is a significant step for the project, as one of its core aims was that promising candidate chemicals would be market-ready within three years of the project's completion.

Though the KYROBIO project has now officially ended, it has made a strong contribution in placing the EU's chemical industry at the forefront of efficient, sustainable and environmentally friendly manufacturing.

KYROBIO

- ★ Coordinated by C-Tech Innovation in the United Kingdom.
- ★ Funded under FP7-KBBE.
- ★ <http://cordis.europa.eu/news/rcn/124679>
- ★ Project website: <http://www.kyrobio.eu/>

EU RESEARCHERS DEVELOP EFFICIENT NEW NANOWIRE ANALYSIS TECHNIQUE

A new time-efficient technique for determining nanowire polarity could help speed up the development of cutting-edge nanosensor equipment in the EU.

Researchers working through the EU-funded NANOWIRING (Semiconductor nanowires: from fundamental physics to device applications) project have developed a new, cost-effective and time-efficient technique for determining the individual polarity of semiconducting nanowires. This is a vital step in the fabrication of nanomaterials, since the polarity — whether nanowires are positively or negatively charged — defines the properties of any device made from these cutting-edge structures.

Semiconducting nanowires are just tens of nanometres in diameter with a typical length-to-width ratio of around 1 000; like a human hair, only a thousand times smaller.

Due to their size and almost one-dimensional nature, interest in fabricated semiconductor nanowires has been growing steadily. For example, they are the smallest dimensional structures that allow optical guiding and electrical contacting simultaneously. Their large surface to volume ratio also enhances their interaction with the environment, turning them

into optimal chemical and biological sensors.

In addition, their geometry makes their optical and electrical properties dramatically dependent on their orientation, allowing their use as polarisation-dependent sensors. To this end, the project studied possible applications in quantum information processing and novel optical-electronic devices. 'Light-emitting diodes' (LEDs) based on single nanowires were developed, and were shown to offer highly efficient conversion of electron-hole pairs into photons.

The new technique developed by NANOWIRING uses an atomic-strength microscope and a Kelvin probe to detect minuscule forces and measure the electrical characteristics of the sample's surface. When combined with advanced data analysis, these measurements reveal the polarities of hundreds of nanowires at the same time.

Up until now, determining polarity required nanowires to be analysed one-by-one as part of a complex and time-consuming process. This means that what used to take days can now take a matter of hours, without any damage to the sample.

This development has been a key result of the NANOWIRING project, the overall objective of which has been to create a

European network of experts to provide assistance to early stage researchers. Starting in 2010, a pool of postgraduates and young researchers were embedded in multidisciplinary research and development activities, focused on tapping the industrial potential of semiconductor nanowires.

An advanced school on semiconductor nanowires covering a broad range of topics from fundamental physics to device applications was held in 2013 in Italy. International experts provided a comprehensive overview of fundamentals, recent progress and approaches to solving open questions in the growing field of semiconductor nanowires.

The scope of this project, which has now been officially completed, has also been

very much driven by industrial needs, such as achieving scalable and low-cost nanowire production. Industrial partners have been involved throughout in order to ensure that research and results are as market-focused and applicable as possible. Furthermore, interaction with associated industrial partners will enhance the employability of researchers through exposure to the private sector.

NANOWIRING

- ★ Coordinated by the University of Göttingen in Germany.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/news/rcn/124559>
- ★ Project website: <http://www.nanowiring.eu/>

VACUUM INSULATION PANELS TO FILL GAP IN RETROFITTING MARKET

EU-funded researchers have developed environmentally friendly and affordable vacuum insulation panels that offer excellent thermal performance.

The next stage is for industrial partners involved in the EU-funded VIP4ALL (Highly Sustainable and Effective Production of Innovative Low Cost Vacuum Insulation Panels for Zero Carbon Building Construction) project to fully commercialise the new, all-natural insulation panels, which are manufactured from minerals and renewable organic by-products. The target market is low-budget renovation and retrofitting projects, jobs which are often carried out by SMEs (indeed SMEs make up more than 99% of the EU construction sector).

Buildings in Europe currently account for approximately 40% of annual energy consumption and carbon dioxide emissions. Low-cost, eco-friendly insulation technology pioneered by projects like VIP4ALL will enable European SMEs to retrofit buildings effectively, and in doing so, help Europe meet its environmental commitments through saving energy efficiently.

The panels have been recognised for their excellent thermal insulation properties (achieving lambda value 7 mW/mK) at a thickness of less than one third of conventional air-filled insulation panels. In addition, the new panels offer excellent fire resistance, which is vital for building application acceptance.

Another key strength of the panels is their cost-effectiveness. This will make insulation retrofitting much more feasible at a time when the construction industry is still reeling from a severe economic crisis. The economic downturn has made it harder for the sector to exploit expensive state-of-the-art 'Vacuum insulation panels' (VIPs) over more cost-effective conventional — but less thermally effective — solutions, and this is something that the VIP4ALL project has sought to address.

All design work for the various materials and processing technologies was fully supported throughout the project with predictive modelling tools. The team first established a comprehensive database of raw material characteristics, which led to the identification of two promising envelope systems and four hybrid core compositions. Core processing technologies were optimised and a number of formulations prepared.

The project team then began designing novel vacuum insulation panels with a new thin exterior encapsulating face layer made of cork. The new layer makes the panels much more user-friendly



in terms of handling during stock, transportation and installation on-site. The layer also acts to protect the panel, making it less likely that the VIP will be punctured and consequently lose thermal performance.

With thicknesses of between 3 and 4 cm, VIP4ALL products are designed to reach minimal thermal conductivities at common pore pressures, comparable to commercial VIPs for building applications, whilst providing superior thermal insulation to any other conventional material on the building market.

The VIP4ALL project was completed at the end of November 2015, though the project's impact on the building retrofitting industry is expected to be felt for years to come. Indeed, the project team hope that the final products will make a major contribution to the viability and competitiveness of retrofitting in the EU, a key economic and indeed environmental concern.

VIP4ALL

- ★ Coordinated by Garcia Rama in Spain.
- ★ Funded under FP7-SME.
- ★ <http://cordis.europa.eu/news/rcn/124602>
- ★ Project website: <http://www.vip4all.com/>
- ★ <http://bit.ly/1Q6Vlxh>

MAKING BETTER PHOSPHINE-BORANE POLYMERS

A team of researchers in the United Kingdom have created a reliable new method to manufacture phosphine-borane polymers, useful components in a number of modern materials.

Phosphine-borane polymers are a class of chemical compounds used in lubricants, advanced ceramics and thermoplastics. Current methods for producing these polymers rely on high temperatures and produce non-uniform final products.

The EU-funded TJIM (Dehydrocoupling of phosphine-boranes: Mechanistic studies, new catalysts, and the development of novel polyphosphinoboranes) initiative developed a new method for creating phosphine-borane monomers, oligomers and polymers.

This involved using a cheap iron-based catalyst rather than the currently used rhodium-based catalyst. Not only does this lower the cost of the reaction, it also lowers the reaction temperature to 100 °C, leading to more uniform polymers.

The researchers demonstrated the usefulness of the newly manufactured polymers by using them to create new microstructures. They also carefully described the mechanisms of the phosphine-borane dehydrocoupling (reaction loss of two hydrogen atoms) for the first time.

TJIM has made a breakthrough in synthesising phosphine-borane polymers, making them both cheaper and easier to produce. This will mean cheaper and more sustainable industrial processes in the long term.

TJIM

- ★ Coordinated by the University of Bristol in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/173679>



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INNOVATIVE OVEN TECHNOLOGY SET TO TRANSFORM THE EUROPEAN BAKING INDUSTRY

An EU-funded project has developed three prototype ovens that will reduce energy consumption and save time during the baking process.

The ovens produced by the LEO (Enabling small-to-medium sized oven technology producers and bakeries to exploit innovative Low Energy Ovens) project all use innovative infrared technology that provides an overall energy reduction during the baking process of between 20 and 40% and a gain in time of up to 70%.

The infrared technology developed by the project was first discovered to be suitable for baking purposes in the FP6 EU-FRESHBAKE project.

The LEO project was set up to further expand on this discovery, with the development of the prototype ovens and a subsequent

assessment of their suitability for commercialisation being amongst the project's key aims.

During the project's final meeting that took place in December 2015, the LEO consortium partners agreed that their final results did indeed give a powerful indication that the infrared technology has strong market potential and could transform the European baking industry.

The project has already prepared a detailed business plan for the commercialisation of the technology, working in close collaboration with all actors within the baking value chain.

The three LEO prototypes (a batch-deck oven, a batch ventilated oven, and a conveyor oven) were constructed and tested not only in a laboratory setting but also in two professional bakeries in France and Germany. This was to ensure that they would be attractive for a wide target group, including both craft and bake-off bakeries.

'Small to medium-sized enterprises' (SMEs) represent a large share of European bake-off companies, around 40%, and most of these bakeries use medium-scale ovens, similar to the LEO conveyor oven prototype.

The batch oven prototypes were constructed to specifically target small traditional craft bakers, who represent the bulk of the European baking industry (over 60% of the total market) and are the principal source of supply for fresh bread in Europe.

To guarantee the ovens' ability to save both time and energy, specialists conducted an in-depth environmental, social and



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economic life cycle assessment in line with the International Reference Life Cycle Data System.

They also conducted a relevant sensory analysis and consumer acceptance study. In addition, a bakery market study was prepared and has since become a reference document for the bakery and oven manufacturing sectors.

Although the project officially finished at the end of 2015, LEO partners will continue their collaboration to conduct new tests

on the prototypes and improve the ovens before manufacturing begins and they are formally introduced to the market.

LEO

- ★ Coordinated by Intelligentsia Consultants in Luxembourg.
- ★ Funded under FP7-KBBE.
- ★ <http://cordis.europa.eu/news/rcn/124660>
- ★ Project website: <http://leo-fp7.eu/index.php/en/>

SMART AND ADAPTIVE MATERIALS TO SET A NEW COURSE FOR THE EUROPEAN SHIPBUILDING INDUSTRY

An EU-funded project has shown how smart materials and structures can be used by the European shipbuilding industry to produce vessels that are more adaptable to a variety of maritime environments.

The ADAM4EVE (Adaptive and smart materials and structures for more efficient vessels) project, which ended in December 2015, has identified more than 20 innovative results that will pave the way for the development of new, adaptive, modern and efficient ship designs. These new designs are more in tune with ship-operating reality — which sees vessels usually spend a large part of their service life operating in situations other than what they were originally designed for. ADAM4EVE also took into account environment concerns such as carbon emissions and fuel consumption, as well as safety and passenger comfort.

Some of the project results — such as innovative glass, coatings and insulation materials — yield significant energy savings and have been deemed mature enough for commercialisation. Other results, for example adaptive hull structures, have proven to be feasible, but will require further research, development and testing before being ready for market introduction.

Key project results

One of the more promising results was the development of a pneumatically-driven adaptive stern flap that was found to improve the efficiency of RoPax vessels (designed to carry wheeled cargo) and save fuel.

The stern flap can be lowered and retracted depending on the changing operational environment of the ship. The technology also benefits from low installation costs.

Using this technology means that, unlike conventional ship hulls, a vessel's performance can be optimised under different conditions including varying cargo, shallow water, wind and waves.

Another development conceived by the project involved creating adaptive damping systems for thrusters in order to increase comfort levels on cruise vessels. Bow thrusters often produce high levels of noise and vibration, but the easily-installed active control system reduces vibrations in areas where local modes are matched with the bow thruster excitation frequency.

A new generation of refrigerated cargo ships could feature innovative decks made of composite sandwich panels containing 'Phase changing materials' (PCM). PCM embedded into the panel core allow minimised heat transfer and significant savings on cooling.

Lightweight composite panels also create significant savings in structural weight, thereby increasing the ship's cargo-carrying



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capacity. Maintenance costs are also reduced as composite materials do not corrode.

A fourth innovation devised by the project team is a new energy-saving adaptive bulbous bow for inland waterway ships. Bulbous bows are used in sea-going vessels, but not for inland water vessels due to certain restrictions including water depth and speed.

Other promising innovations

Finally, other results include adaptive windows for sailing yachts, allowing the user to adapt the transparency of the yacht's windows to increase or reduce sunlight, while an adaptive rudder-propeller can improve the manoeuvrability of a vessel. The rudder-propeller will allow the vessel to operate at design pitch when manoeuvring in port or locked at a 90-degree pitch in vertical plane in sea-going conditions.

The ADAM4EVE project has clearly shown the way in terms of how the European shipbuilding industry can adopt new designs and technology that will enable its ships to truly become more competitive, cost-effective, adaptable, greener and safer.

ADAM4EVE

- ★ Coordinated by the Center of Maritime Technologies in Germany.
- ★ Funded under FP7-TRANSPORT.
- ★ <http://cordis.europa.eu/news/rcn/124661>
- ★ Project website: <http://www.adam4eve-project.eu/>



FOOD AND AGRICULTURE

NEW INSIGHTS ON THE SAFETY OF GM ORGANISMS

An EU-funded project has undertaken extensive feeding trials to further inform the debate on the safety of mandatory 'genetically modified' (GM) animal feeding studies in advance of an expected 2016 EU re-evaluation.

The EU-funded GRACE (GMO Risk Assessment and Communication of Evidence) project was driven by the need to reconsider the value of rat feeding trials for the safety assessment of GM plants.

The project also aimed to address the continued controversial debate on the safety of GM plants. To achieve this, it was organised around two primary work streams.

GRACE improved the interpretation of 90-day rat feeding trials, clarifying their added value and exploring alternative approaches to reduce or substitute animal trials with regards to GM plants. An additional one-year feeding trial was also conducted.

To facilitate this, the project team utilised MON810, a genetically modified maize that has been approved for cultivation across the world, including by the EU.

90-day and one-year feeding study results

When presenting their final results for the project, the team reported that they did not find any indication that a routine performance of 90-day feeding studies with whole food/feed would provide additional information on the safety of MON810 when compared to the composition of the GM variety.

Furthermore, the 90-day feeding trials conducted did not reveal any scientific trigger for extending the feeding period.

Data gathered in the course of an additional one-year feeding trial is in accordance with the conclusions made in the 90-day trials, in essence that feeding the rats MON810 did not lead to any adverse effects.

Additionally, the data collected by GRACE showed that non-targeted feeding studies could lead to significant randomly-generated differences between animals fed with the GM test material and animals fed with a controlled diet. Such results are not informative for risk assessment.

As such, GRACE data supports the scientific reasoning that feeding trials with whole food/feed may provide an added scientific value for the risk assessment of GM crops, but only if a trigger is available from the initial molecular, compositional, phenotypic and/or agronomic analyses.

Feeding trials might therefore be considered, provided that the study design can be tailored to take into account safety concerns.

Due to these limitations in rat feeding trials using GM whole food/feed, the project argues that a mandatory trial during GMO risk assessment cannot be justified in the light of the European goal to replace and reduce animal tests.

Assessing the overall debate on GM safety assessment

Regarding the project's second objective of addressing the overall debate on the safety of GM plants, researchers also

established new and more comprehensive methods for systematically collecting and assessing existing scientific evidence on environmental, health and socio-economic risks and benefits for GM plants.

“GRACE data supports the scientific reasoning that feeding trials with whole food/feed may provide an added scientific value for the risk assessment of GM crops.”

When testing these methods for the purpose of GMO risk research and assessment, it was confirmed that conclusions reached in previous assessments on insect resistant GM crops are still valid, with no effects documented on non-target organism populations, such

as beetles and butterflies, or on soil microorganisms, when compared to natural maize.

These final results from the project are now expected to provide valuable input into ongoing European debates regarding the safety and viability of GM plants and other organisms, particularly as the need for mandatory animal feeding studies in GMO risk assessment is due to be re-evaluated in 2016.

GRACE

- ★ Coordinated by the Julius Kühn-Institute in Germany.
- ★ Funded under FP7-KBBE.
- ★ <http://cordis.europa.eu/news/rcn/124740>

CREATING DURABLE GREENHOUSE PLASTICS

Europe's greenhouse industry is set to become greener with the development of 'ultraviolet' (UV)-, heat- and chemical-resistant non-toxic plastic greenhouse covers.

Plastic greenhouses are widely used in Europe for cultivating plants on otherwise unproductive land. Plastic films that cover greenhouse structures are currently not very durable, readily degrading from exposure to heat, UV light and agrichemicals like sulphur and chlorine.

The EU-funded GREENAVOID (Greenhouse solution to avoid film cover U.V. and sulphur degradation) project aimed to create new, durable plastics for greenhouses. It also developed an improved system to vaporise sulphur-based pesticide so that minimal amounts come into contact with the greenhouse cover.

Current greenhouse films contain harmful stabilisers that help to prevent plastic degradation. These include nickel quenchers that are classified as class I carcinogens, and UV light absorbers that affect hormone balance.

GREENAVOID managed to avoid using these additives by developing a plastic film with multiple protective layers made from nanocomposite materials. By researching the durability and degradation of different materials under various environmental conditions, the work resulted in heat- and UV-resistant transparent plastics.

For the final product, researchers created an upper layer that absorbs minimal light in the UV spectrum while letting in light needed for plant photosynthesis. An inner layer was designed to resist sulphur and chlorine (both chemicals used to control pests) as well as high temperatures. Finally, a middle layer provided reinforcement for extra durability.

To further protect their film, the team developed a sulphur vaporiser system that applies sulphur evenly on the crop and accumulates less in the greenhouse cover. Apart from being less damaging to the plastic, this system will result in fewer sulphur dioxide emissions and lower pollution.

By extending the one-year lifespan of current agricultural films to three years, GREENAVOID's new films will save money and energy and minimise plastic waste. The nanomaterials developed during the project can also be used in the automotive and packaging industries.

“GREENAVOID managed to avoid using these additives by developing a plastic film with multiple protective layers made from nanocomposite materials.”

GREENAVOID

- ★ Coordinated by CCPSA in Spain.
- ★ Funded under FP7-SME.
- ★ <http://cordis.europa.eu/result/rcn/173644>
- ★ Project website: <http://www.greenavoid.eu/>
- ★  <http://bit.ly/1Tc8rFz>





PHYSICS AND MATHEMATICS

INNOVATIVE TOOLS FOR OPTIMAL TAX SCHEMES

European researchers have developed novel mathematical models to examine the suitable design of benefit and tax programmes aimed at promoting employment and reducing inequality among different groups of people.

Thanks to EU funding, the project THE (Taxation, heterogeneity and employment) developed a theoretical toolbox with a broad range of policy-oriented applications. These tools enable the team to work out several multidimensional screening problems or multidimensional heterogeneity that are difficult to tackle.

Project partners supplied methods for models with intensive margin only, as well as models with both intensive and extensive margins. Examples of intensive and extensive margins are decisions on labour hours worked and decisions on whether or not to enter the labour market, respectively.

The toolkit addresses many policy-oriented issues and allows for the introduction of additional sources of heterogeneity in tax models that can be worked out and implemented with real data.

A number of optimal income tax models that consider various sources of heterogeneity were examined. One was heterogeneous income elasticities that combine different labour supply elasticities and various taxation dodging skills. The team determined how multidimensional heterogeneity in terms of skills, income elasticity and tax avoidance ability influences the optimal tax schedule. Other sources of heterogeneity included exogenous taxable non-labour income such as inherited property rents received by landlords and endogenous taxable non-labour income such as capital income.

Lastly, researchers addressed three applied economics questions that have been neglected in other tax studies. The first involved determining an optimal tax schedule over the entire earnings distribution that meets equal

opportunity requirements. The second concerned the use of workfare when labour supply is modelled along intensive and extensive margins at the same time. The final question examined how the recommended tax system is changed when distortions arise from labour market deficiencies.

THE developed an optimal income tax schedule for cases where individuals differ in terms of multiple unobserved characteristics. Its methods enable recognition of different skills and support taxable income elasticities.

THE

- ★ Coordinated by the University of Cergy-Pontoise in France.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/173711>

NEW TECHNIQUES TO TAILOR NANOMATERIALS

EU-funded scientists have successfully developed functional nanomaterials through innovative electrochemical methods that eliminate the use of aqueous solutions.

Thanks to their extremely small size, nano-structured materials are the key building blocks for fabricating complex devices with the desired functions. Being physically or chemically manipulated, they have important applications in different fields, including electronics and energy.

Instead of aqueous solutions, an international team of researchers used ambient temperature molten salts and ionic liquids to functionalise nanomaterials within the framework of the NANEL project (Functional ordered nanomaterials via electrochemical routes in non-aqueous electrolytes). By using non-aqueous solutions, a host of advantages come to the fore for certain materials. These include materials that are not stable in water or cannot be electrodeposited because of the relatively narrow water electrochemical window.

The research team successfully developed functional porous anodic oxides, including alumina and titania. To achieve this, researchers thoroughly investigated how to form highly ordered nanoporous templates and studied the electrodeposition mechanisms of non-aqueous electrolytes. In a first-ever demonstration, they deposited ionic liquid ions on a porous alumina template that was grown on an aluminium substrate without completely removing the barrier layer.

An important activity was modelling and simulating electrochemical nucleation and growth of different nanostructures. A newly developed model based on multi-ion transport and reactions helped describe the phenomena that take place during ion deposition.

Through appropriate treatment at temperatures close to their melting point, metallic nanowires are precursors for growing semiconducting nanowires. Therefore, the melting behaviour of the metallic structures in oxide templates is a key parameter for the subsequent conversion process. For this reason, researchers further explored the effect of the

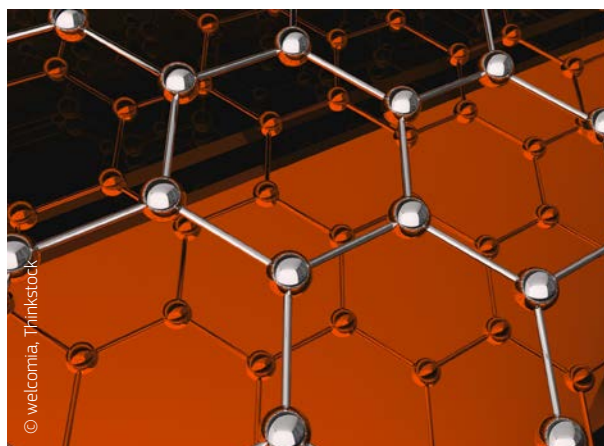
generated mechanical stress during heating on the melting point of the metal nanowires deposited on the alumina pores. According to their research, an extremely high local compressive stress appears because of thermal coefficient differences of the oxide template and nanowires inside the pores.

Another achievement was synthesising magnetic oxide nanoparticles and mixed sulphide compounds for sensors and solar cells, respectively.

Other than publications in 16 peer-reviewed journals, project results were presented at numerous international conferences. In addition, a joint workshop was organised to disseminate researchers' activities, thereby boosting networking amongst researchers.

NANEL

- ★ Coordinated by the University of Aveiro in Portugal.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/150866>



HYBRID PHOTONIC METAMATERIALS AT THE MULTISCALE

Hybrid multiscale nano-structured materials are expected to facilitate control of light on-chip propagation and pioneer new photonic devices.

The field of optics is expanding rapidly and two important areas of research concern photonics and optical metamaterials. The former studies mesoscale phenomena, where packets of light are treated much like electrons in electronics. The latter deals with structures on the nano scale, with subwavelength dimensions that impart properties not easily seen in nature.

Combining these two types of structures in a controlled way in hybrid devices could lead to unprecedented and unimagined functionalities. Multiscale models developed with EU

support of the HYPHONE (Hybrid photonic metamaterials at the multiscale) project are already aiding in the design process.

Research focused on hyperbolic metamaterials, one of the most unusual and exciting new classes of electromagnetic metamaterials. The theoretical framework describes wave propagation in inhomogeneous media consisting of hybrid-scale metal-dielectric multilayers. These media simultaneously exploit photonic phenomena and exotic plasmonic waves, unique to hyperbolic metamaterials,

produced by the coupling of electrons with light in exotic nanoscale metal-dielectric environments.

Work began with 1D plasmonic monolayers as building blocks that were combined into plasmonic multilayers

“Research focused on hyperbolic metamaterials, one of the most unusual and exciting new classes of electromagnetic metamaterials.”

and, subsequently, multilayer multiscale hyperbolic metamaterials. Scientists are currently pursuing experimental realisation of such multiscale hyperbolic metamaterials. They could lead to capabilities for label-free biological imaging and manipulation with nanoscopic resolution, pushing the boundaries of modern biology and chemistry.

Paying careful attention to maximisation of photon-electron interaction effects, 1D design principles were then extended to 2D structures based on nanoparticle lattices and microslot patterned membranes. The team discovered new photoelectric effects in nanoparticle lattices that could pave the way to novel photodetectors and solar cells as well as new methods in photocatalysis, photochemistry and photoelectrochemistry. Experimental work confirmed theoretical prediction of polarisation control properties of microslot membranes in the

terahertz range. This very high frequency range is of relevance to numerous cutting-edge applications in spectroscopy, medical imaging and security.

HYPHONE models and experimental results have closed the research gap between photonics and metamaterials, paving the way to novel devices for integrated optical applications. Along the way, the consortium has trained a new generation of scientists ready to push the frontiers of an emerging multidisciplinary field with the potential for major socioeconomic impacts.

HYPHONE

- ★ Coordinated by the Technical University of Denmark.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/173643>

A NEW TAKE ON REVENUE MANAGEMENT MODELS

New approaches in revenue management coupled with novel algorithms are promising to meet customers' needs while boosting income for firms.

Revenue management, which analyses consumer behaviour to optimise product availability, strives to sell the right product to the right customer at the right time and for the right price. This challenging objective can be achieved through better mathematical models that integrate consumer choices more effectively, potentially making industries such as hospitality and travel much more effective.

The EU-funded FLEXREV (Integrating flexible discrete choice and revenue management models) project sought to design new revenue management systems that integrate consumer choices for more effective mathematical models. One promising strategy in this respect is to exploit what is known as estimation of 'Network generalised

extreme value' (NetGEV) models, which are effective in modelling demand shifts when products become unavailable and overall trends in consumer purchasing.

In more technical terms, the project team worked on two different NetGEV models, namely multinomial logit and nested logit to predict consumer behaviour more accurately. It studied NetGEV models for choice-based samples, as well as the integration of choice-based models with capacity-based revenue management models. This was done for both single-product and multi-product environments.

The team also made progress in updating traditional Expected Marginal Seat Revenue methodology for a multi-product environment. They tested the new, emerging methods on data from two different major international hotel

chains, demonstrating how best to allocate resources to customers in order to maximise revenue. Several related allocation algorithms for different estimation methods were also developed and tested to ensure the quality of estimation and robustness.

"They tested the new, emerging methods on data from two different major international hotel chains, demonstrating how best to allocate resources to customers in order to maximise revenue."

Lastly, in addition to testing the data for applications in the hospitality industry, the project team conducted modelling for the telecommunications sector, exploiting actual data from a key firm in the field. The newly developed methods and algorithms could ultimately contribute to better revenues in the business field and make firms more competitive.

FLEXREV

- ★ Coordinated by TOBB University of Economics and Technology in Turkey.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/173708>



EVENTS

APRIL
02 ▶ 03

Eindhoven, THE NETHERLANDS

EVENT

CASSTING: WORKSHOP AND FINAL EVENT

The EU-funded CASSTING project will be holding a workshop and its final event in Eindhoven, the Netherlands, from 2 to 3 April 2016.

The workshop aims to bring together researchers working on topics related (in a wider sense) to formal methods for the automatic verification and synthesis of complex systems. The workshop will be composed of four invited talks, together with contributed talks (presenting either original or already published work).

Topics of interest include:

- games for the synthesis of complex computational systems;
- games played on complex and infinite graphs;
- games with quantitative objectives;
- games with incomplete information and over dynamic structures;
- heuristics for efficient game solving.

The workshop will be held before the 2016 edition of the ETAPS (European Joint Conferences on Theory and Practice of Software) conference. The main ETAPS conference will take place from 4 to 8 April 2016.

For further information, please visit:

<http://www.cassting-project.eu/workshop2016/>

APR.
18 ▶ 21



APRIL
06 ▶ 07

Prague, CZECH REPUBLIC

CONFERENCE

FOODINTEGRITY: ANNUAL CONFERENCE

The EU-funded FOODINTEGRITY project will be hosting its 2016 annual conference in Prague, Czech Republic, from 6 to 7 April 2016.

The conference, part of the project's third meeting, will focus on the latest research outputs on developments and strategies in the field of food integrity — safety, quality, authenticity and traceability, from both the project and elsewhere.

Topics to be discussed include:

- tools for food integrity assessment;
- gaps in current research in food authenticity;
- analytical tools for food authentication;
- demonstration how a European knowledge-base on analytical methodology and databases for food authenticity can be exploited by stakeholders.

A series of workshops will also be held along with an on-site demonstration of the approaches for food authentication developed by the FOODINTEGRITY project. This will also provide a unique opportunity to discuss with FOODINTEGRITY experts the latest developments and strategies in the field of food integrity — safety, quality, authenticity and traceability.

For further information, please visit:

<http://www.foodintegrity2016.eu/programme.html>

APRIL
07

Sweden, STOCKHOLM

WORKSHOP

PREFORMA: OPEN SOURCE PRESERVATION WORKSHOP — SERVING CULTURAL HERITAGE

The PREFORMA project will hold its Open Source Preservation Workshop at the National Library of Sweden in Stockholm on 7 April 2016.

This is the first in a series of international events planned by the project. It will feature keynote presentations from the PREFORMA team and open source community. In addition, suppliers working on the project will provide live demonstrations of three conformance checkers for electronic documents, images and AV files.

The workshop also acts as an informal networking event where delegates can share experiences and meet the PREFORMA developers. This project is conducting research for the development of a range of tools which can be used to digitally archive collections of cultural heritage.

For further information, please visit:

<http://www.digitalmeetsculture.net/article/preforma-open-source-preservation-workshop/>

EVENTS

For more forthcoming events:
<http://cordis.europa.eu/events>

Warsaw, POLAND

CONFERENCE

ALICE PLATFORM PRESENTING AT 2016 TRANSPORT RESEARCH ARENA (TRA) CONFERENCE IN WARSAW, POLAND

The European Technology Platform on Logistics (ALICE), established by the EU-funded WINN project, will be represented at the 6th European Transport Research Arena Conference in Warsaw, Poland, from 18 to 21 April 2016.

Transport Research Arena (TRA) is the most important transport research event in Europe, gathering key stakeholders every two years, including researchers, experts, operators, industry and policy makers.

The conference will contribute to innovation in the field of sustainable mobility for Europe, by bringing together all stakeholders in the transport system. Efficient mobility is a key issue for policy makers. Enabling the free movement of people and goods is crucial to economic prosperity and the quality of life.

Two representatives of the European Technology Platform on Logistics (ALICE) will present at the conference.

The ALICE Chair, Mr Ralph Keck, will take part in the 1st plenary session, entitled: 'Creating One Europe — the Role of Transport', whilst his ALICE colleague Prof. Eric Ballot, will be a panellist in the 4th plenary session entitled 'Mobility for Tomorrow'.

For further information, please visit:

<http://www.traconference.eu/>



50 issues of *Research*eu results magazine*: tell us what should come next!

In April 2011 the CORDIS *research*eu results magazine* was born from the ashes of the results supplement. The core

concept has remained the same to this very day: a special feature for each month, thematic sections and a focus on EU-funded research results.

Over the past few years however, CORDIS has put more and more emphasis on making the magazine more attractive and useful to its target audiences: the scientific community of course, but also businesses, policy makers and industry players potentially interested in exploiting the results of EU-funded projects.

These efforts have notably translated into a new layout, the advent of five new thematic sections (Social Sciences & Humanities, Space, Food & Agriculture, Physics & Mathematics, Security & Safety), as well as a whole new special feature section focusing on very specific areas of scientific research. We have also introduced the possibility for coordinators to request an article on their project, which is proving very successful.

For the CORDIS editorial team, celebrating the 50th edition of the *research*eu results magazine* is an opportunity to reflect on these accomplishments and the things we can still do to help disseminate information about your project's results. So should you have any suggestions, please feel free to send us an email at editorial@cordis.europa.eu!

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