

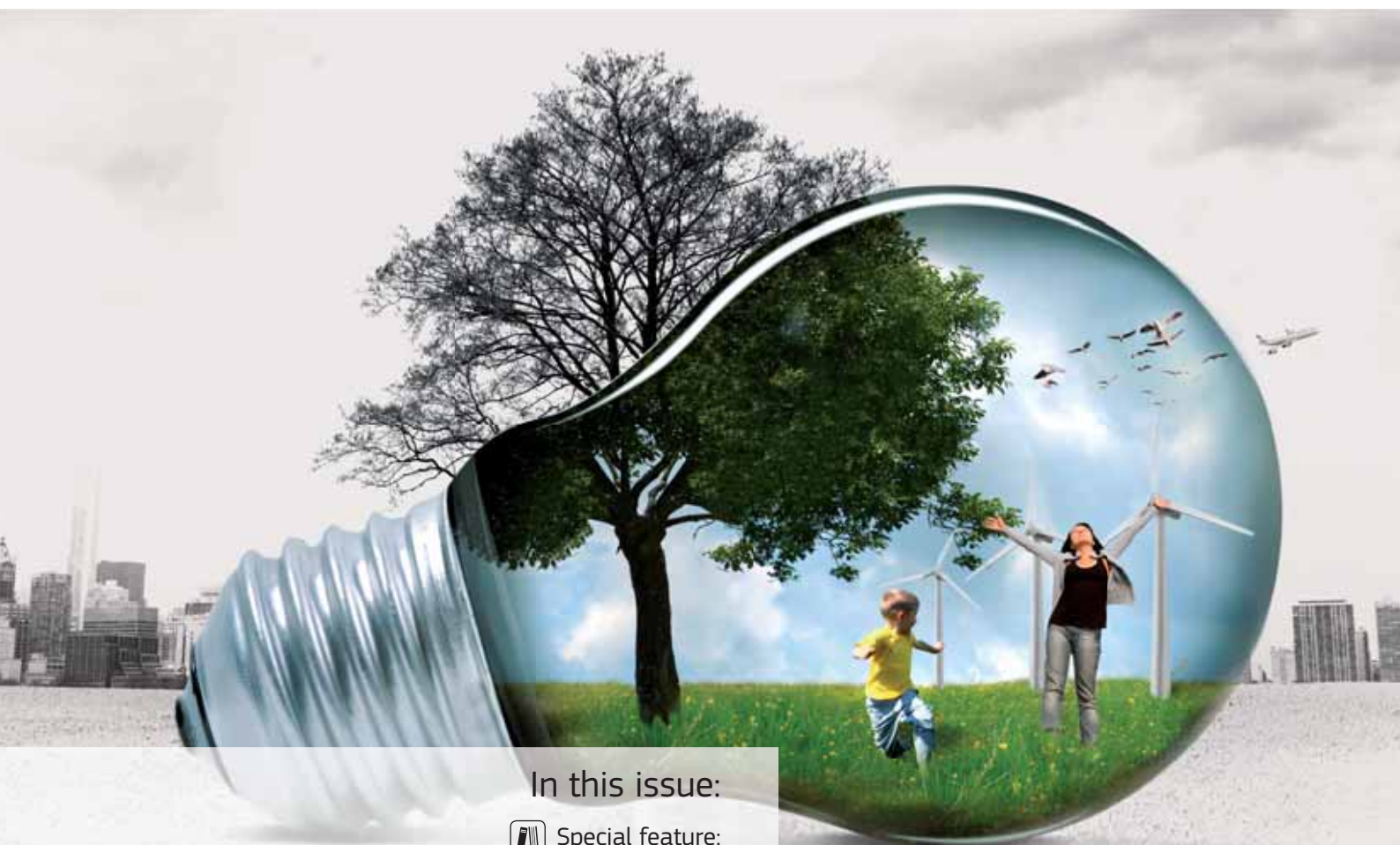


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RESULTS MAGAZINE

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'Power up! The Future of Energy' ■

Interview: Dimitrios Mendrinos of the Greek Centre for Renewable Energy

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research*eu

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Europe's need for power: driving scientific research in the EU

With its various interpretations, power is certainly what matters the most for Europe's future. First there is economic power: still number one among the world's largest economies, Europe has witnessed increased competition from new global players such as China, India and Brazil. Something these countries just happen to have in common — which Europe lacks — are natural resources, in particular fossil fuels.

Then there is the power of influence. Aiming to spearhead the battle against climate change, Europe continues to be the driving force behind international negotiations. It was instrumental in the development of the Kyoto Protocol and the UN Framework Convention on climate change. It was also the first global player to launch a 'cap-and-trade' system for greenhouse gas emissions, in 2005. Operating in 30 countries, the EU Emission Trading Scheme (ETS) — which puts a price tag on carbon emissions — has pushed European industry to continue its efforts to reduce its environmental footprint.

In this context, the future of Europe and the competitive edge of its industry certainly lie in the development of alternative, green, power sources. Reflecting the scientific community's commitment to such an endeavour, and as the EU launches the 'Worldulike' campaign, the focus of this issue of *research*eu results magazine* is 'Power-up! The future of energy!'

In this edition we interview Dimitrios Mendrinou of the Centre for Renewable Energy Sources and Saving in Greece. As programme coordinator of the Ground-Med project, he is working on the development of a 'ground-source heat pump' to harness renewable energy from the natural heat source found in subterranean rocks. We also interview Professor Liisa Viikari on second-generation biofuels.

The 'energy and transport' section continues with other examples of research into greener engines, novel energy sources and new, more efficient production techniques. These 'specials' start on page 14 with 'Eco-engine systems for ships', while others can be found in the 'industrial technologies' section.

The 'biology and medicine' section opens with an article entitled 'New light on genetics of autism', on page 6, while the feature article in the 'environment and society' section is 'Modelling land surface and atmosphere interactions' on page 24.

The 'IT and telecommunications' section, which sheds light on cloud computing and what the future Internet will look like, starts on page 33, while the 'industrial technologies' section begins with 'Metal-mediated polymerisation for smart materials', on page 40.

The issue ends, as usual, with a list of events and upcoming conferences.

We look forward to receiving your feedback on this issue and on the *research*eu* publications in general. Send questions or suggestions to: cordis-helpdesk@publications.europa.eu

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Watch this space!

Coming up in issue 18 of *research*eu results magazine* — a special dossier called 'From FP7 to Horizon 2020: tackling Europe's health challenges'.

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New study sheds light on the genetics of autism

The genetics of autism is complex and possibly influenced by mutations with very significant effects. EU genomics research has found more candidate genes that increase susceptibility to the condition.

The EU-funded Autism Molgen¹ project has completed a comprehensive study of European patients with 'Autism spectrum disorders' (ASDs). The study group consisted of around 100 extended families, in which two or more individuals were affected, as well as more than 370 examples of immediate family where one member of the family had an ASD.

Advanced genomic techniques were used to study the involvement of both previously identified associated genes as well as new candidate alleles. These techniques included linkage studies, association studies and mutation screening. Using linkage studies to help refine the position of important loci and identify possible new candidate genes, 'Logarithm of the odds' (LOD) scores were applied to linkage data. A positive score — indicating the presence of linkage — was achieved for the long arm of chromosome 2, (2q), confirming the importance of this region in ASDs.

In addition, two new candidate genes were identified among 'Single nucleotide polymorphisms' (SNPs). This finding was made possible by using the 'Transmission disequilibrium test' (TDT) to test presence of linkage between a marker and a trait. Additional association studies using seven other genes revealed susceptibility in five key genes, to be further analysed in another study.

Recent research has revealed that rare mutations may play a large role in predisposition to ASDs. A key example is neuroligins: involved in the healthy functioning of synapses, they can suffer from alterations in genes encoding which play a role in autism and other cognitive disorders. Various rare mutations with possible functional effects were identified. These included non-synonymous changes altering the position of an amino acid in a protein, as well as stop codon mutations that shorten a protein, and splice site mutations that can result in aberrant products. All types of mutation

were found both in genes associated with ASD and in other plausible candidates.

Comprehensive genetic data amassed by Autism Molgen has positively identified new susceptibility alleles for ASDs. Future research can focus on functional studies of the genes involved. Given that the incidence of ASDs is reportedly rising, the project research can contribute to the elucidation of this highly complex condition.

The project was coordinated by the Chancellor, Masters and Scholars of the University of Oxford in the United Kingdom.

1. 'Using European and international populations to identify autism susceptibility loci'.

Funded under the FP6 specific programme 'Life sciences, genomics and biotechnology for health'.
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The role of oestrogens in ageing

European scientists have studied the neuroprotective and anti-inflammatory effects of oestrogens and their role in the ageing process. The EWA project findings have direct impact on menopausal women and the validity of hormone replacement therapy.



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Reproduction in women is regulated by sex steroid hormones and their receptors. Of these, oestrogens in particular are thought to exert a protective function in the skeletal, cardiovascular and nervous systems. With increased life expectancy, women now spend more than one-third of their life in menopause – a condition where the production of sexual hormones ceases. Menopause causes vascular instability, as well as skeletal, urogenital and psychological problems.

To treat menopause and its effects, post-menopause hormone replacement therapy (HRT) is often administered. However, the risks and/or benefits of HRT remain unclear and clinical results are conflicting.

The EU-funded EWA¹ project aimed to study the physiology of female ageing while paying particular attention to suitable therapies for disorders associated with female ageing and the post-menopausal period. By reviewing the field of sex steroid hormones, in particular oestrogens, project partners generated cellular and animal models in order to study the effects of oestrogens and oestrogenic compounds in young and aged female mammals.

More specifically, EWA members investigated the long-term effect of oestrogen compounds on reproductive and non-reproductive organs. They also examined the anti-inflammatory role of oestrogens in pathologies associated with female ageing, such as diabetes, neurodegeneration and skin ulcers.

The EWA project offered important insight into the role of oestrogens in many organs and systems during ageing. The data collected strongly supports HRT for menopausal women as a means to protect them against bone, vessel, skin and brain malfunction.

The project was coordinated by the Università degli Studi di Milano in Italy.

1 'Estrogens and women ageing'.

Funded under the FP6 specific programme 'Life sciences, genomics and biotechnology for health'.
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Using Notch3 to fight cancer

A special type of molecule may hold the key to the destruction of unwanted cells, especially cancer cells. Recently, European research has uncovered some of the molecular secrets of a particularly interesting new dependence receptor (DR) — Notch3.

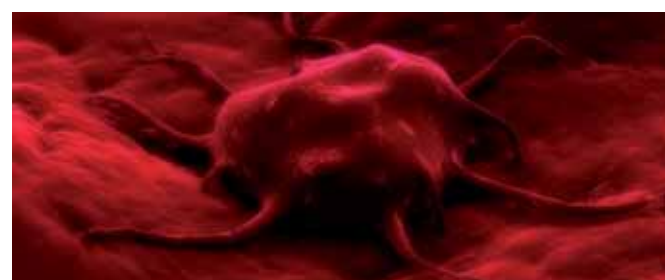
DRs hold the fate of a cell by interacting either with a ligand to survive or, in the absence of a ligand, when cell death or apoptosis is induced. Not surprisingly, there is a link between this survival function and many cancers, and DRs have therefore become a target for therapeutic strategies. Getting a cell to choose a death pathway via a DR is indeed an effective way to eliminate the cancer.

The Notch3dr¹ project investigated a newly discovered DR called Notch3. Project scientists found that over-expression of Notch3 induced apoptosis in a wide range of cancer cells. Evidence of the dual nature of Notch3 occurs when cancer cells

expressing it are cultured with cells expressing ligands. In this situation, cell death does not occur.

From the molecular point of view, the team showed that apoptosis occurs in the presence of caspases, enzymes implicated in the apoptotic pathways. They also demonstrated that caspase-9 is essential for Notch3-induced apoptosis. The link appears to be that caspases cleave Notch3 during the induction process, but the scientists aim to further test this hypothesis by using mutants without cleaving caspases.

By specifically looking at the involvement of Notch3 in lung



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and breast cancer cell lines, the researchers found links between a number of ligands. Delta like ligand-4 (DLL-4) and Jagged-2 showed correlations, with Notch3 ligands in lung and breast cancer respectively. Furthermore, Jagged-1 was observed to increase significantly in renal cancer patients and, most importantly, induced cell death when inhibited.

The way forward, according to Notch3dr scientists, is to induce Notch3 DR activity in cancer cells. Another promising approach is to develop agents

that are Notch3-specific, thereby reducing toxicity while increasing specificity.

The project was coordinated by the Centre Anticancéreux Léon Berard in France.

1 'Investigating a novel role of Notch3 as a dependence receptor and its relevance in vivo'.

Funded under the FP7 specific programme 'People' (Marie-Curie actions).
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BIOLOGY AND MEDICINE

Improved image analysis for MRI

Reliable, accurate and repeatable analysis of medical images continues to be a challenge in disease treatment. A European research initiative has developed robust and efficient computing techniques for image-data interpretation, modelling and visualisation.



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Medical imaging is a crucial tool in clinical environments, particularly in the development of image-based quantitative tools as part of cancer therapy and tumour-response measurement after therapy.

The MICAT¹ project worked on the development of new medical computation methods and a medical image analysis framework for monitoring during cancer treatment. In particular, MICAT focused on tumour response assessment and the

formation of a novel probabilistic brain tumour atlas.

Tumour segmentation from imaging data is challenging. This is due to the high diversity in the appearance of tumour tissue from one patient to another and, in some cases, their resemblance to normal tissue. The MICAT team developed a new segmentation method based on the cellular automata (CA) algorithm. Validation studies showed that the final algorithm outperformed graph cut and grow cut

algorithms with a lower sensitivity to initialisation and tumour type.

Image registration applications include combining images of the same subject from different modalities, as well as image guidance during interventions. MICAT researchers have developed a new rigid registration method based on anatomical brain landmarks to compare baseline and follow-up image volumes from a patient with a brain tumour. The new technique

involves serial contrast-enhanced T1 weighted magnetic resonance (MR) images. T1-weighted scans depict the differences in the spin lattice relaxation time of the tissue.

The new protocols mean that tumour volume and diameter-change measurements can be carried out with increased accuracy and reliability. Furthermore, MICAT are looking into new local criteria using the Lagrange deformation tensor.

To date, seven papers have been published detailing the accomplishments of the MICAT project. As the software will be made available for clinical practice, there will be increased efficiency in tumour radiosurgery and analysis of brain tumour response after treatment.

The project was coordinated by the Sabanci University in Turkey.

- 1 'Medical image analysis for cancer treatment monitoring and tumour atlas formation'.

Funded under the FP7 specific programme 'People' (Marie-Curie actions).
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Dendritic cells bring hope of stronger immune systems

Dendritic cells (DCs) are key players in the immune system, and are implicated in both its innate and adaptive arms. Pioneers in the field of DC biology have joined forces to support the use of DC-based therapies in clinical applications.

DCs act as the specialised antigen-presenting cells of the immune system. They facilitate the presentation of antigens to T cells as well as the induction of adaptive or 'tailored' responses and immunological memory. This property makes them invaluable tools for generating immunity against HIV and cancer.

Alternatively, their regulatory activities might be exploited to overcome aberrant immune responses, such as those that lead to allergies, autoimmune diseases or transplant rejection. Consequently, the DC immunobiology holds tremendous potential for exploiting the development of specific immunotherapeutic approaches.



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BIOLOGY AND MEDICINE

The DC-THERA¹ Network of Excellence placed 25 research groups and six small and medium-sized enterprises (SMEs) across Europe under a single umbrella, with the aim of implementing an information technology (IT)-based integrated knowledge-management system and providing a European resource of databases for the field. Among the project's objectives was facilitation of the

translation of genomic, proteomic and bioinformatics information into therapeutic end points.

In line with this aim, the EU-funded DC-THERA project created an infrastructure to facilitate collaborative working among its partners and integrate expertise and resources. By generating new research tools and technological platforms, project partners were able to translate important

information from DC biology into clinical practice.

Based on its findings, DC-THERA succeeded in emphasising the importance of DCs in vaccine development against cancer or AIDS. Manipulation of the unique properties of DCs brings the hope for numerous sufferers worldwide of seeing an effective treatment of many debilitating diseases being developed.

The project was coordinated by the Chancellor, Masters and Scholars of the University of Oxford in the United Kingdom.

1 'Dendritic cells for novel immunotherapies'.

Funded under the FP6 specific programme 'Life sciences, genomics and biotechnology for health'.
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Revitalisation of neurons after damage

Neurological disorders involve the degeneration and/or death of neurons. European scientists have combined their efforts to understand the molecular basis of specific events prior to degeneration and death.



degeneration and death. The early events prior to neuronal damage were uncovered, providing significant molecular details on their features and hierarchy. Pathological situations such as inflammation were linked to the development of early-stage neuronal degeneration. Moreover, proteins and pathways involved in these procedures were characterised as potential therapeutic targets.

Neurone researchers also provided novel insights into the mechanism involved in neuronal death in HD. The role of mitochondria and a key growth factor in the development of the disease was elucidated. For the cure of PD, Neurone scientists have started developing novel optimised transplants produced by stem cells.

In addition, pharmaceutical companies within the Neurone network have developed compounds that capture excess metal ions in neurons, thereby preventing several toxic events. These compounds lower the rate of AD development in animal models, improving their cognitive skills and brain health.

Clinical studies by Neurone scientists revealed that a combination of rehabilitation treatment with chondroitinase greatly increases functional recovery in brain tissues.

Chondroitinase is already an established enzyme for the partial functional recovery after SCI.

A variety of activities were organised by Neurone for the dissemination and demonstration of its achievements. These were performed in science museums and open days at institutes, demonstrating methods and tests for assessing brain function in different neurological disorders. A DVD was produced to explain the life of people affected by neurodegenerative diseases and how Networks of Excellence, such as Neurone, promote the development of new therapeutic solutions for these patients.

Neurone established a European Network of Excellence to intensively and cohesively work at all levels of neurodegenerative diseases, linking basic research with clinical studies.

The project was coordinated by the Chancellor, Masters and Scholars of the University of Cambridge in the United Kingdom.

1 'Molecular mechanisms of neuronal degeneration: from cell biology to the clinic'.

Funded under the FP6 specific programme 'Life sciences, genomics and biotechnology for health'.
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Neurodegeneration involves the progressive loss of structure or function of neurons, eventually leading to their death. Many neurodegenerative diseases, such as Parkinson's (PD), Alzheimer's (AD) and Huntington's (HD), occur as a result of neurodegenerative processes. In spite of intensive scientific efforts to prevent or treat these malignancies, the molecular mechanisms involved in neuronal degeneration are still poorly understood.

The EU-funded project Neurone¹ aimed to facilitate the development of novel therapeutic schemes for

neurodegenerative disease and neurotrauma. To achieve this, a consortium of multi-disciplinary and multifaceted European experts was set up.

Neurone scientists focused on neurodegenerative diseases AD, PD and HD as well as amyotrophic lateral sclerosis (ALS), while spinal cord injury (SCI) was their main model for neurotrauma.

The project successfully accomplished all of its objectives, enlightening the molecular biology community with valuable findings related to neuronal

BIOLOGY AND MEDICINE

Biological coatings for a positive response to implants

Suppressing rejection of implants has been a long-time objective of medicine. EU-funded researchers are hoping to raise the bar by developing natural coatings that encourage cell activity and colonisation of implants at the same time.



scientists decided to focus on pectins, a subclass of polysaccharides. Pectins are complex sugars found in the cell walls of land-dwelling plants.

The Pecticoat project studied specific pectins called rhamnogalacturonans (RGs), in particular RG-I. They investigated the potential of modifying plant RG-I in such a way that it would stimulate cell colonisation of human implants without stimulating inflammation, immune or rejection responses.

Careful analysis of mechanisms by which cell activity is induced in host tissue helped scientists design tailor-made pectin-based molecules to improve the

biocompatibility of dental implants and other medical devices.

Co-operation with small and medium-sized enterprises (SMEs) should help bring Pecticoat coating technology to market quickly, with important benefits for patients, manufacturers and health-care systems.

The project was coordinated by Divergent SA in France.

1 'Nanobiotechnology for the coating of medical devices'.

Funded under the FP6 specific programme 'Nanotechnologies and nanosciences, knowledge-based multifunctional materials and new production processes and devices'.
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Medical devices that come in contact with human tissue must be designed with care. This is key to minimising adverse biological effects while maximising therapeutic benefits. One way of enhancing biocompatibility is the application of specialised

coatings. European researchers set out to develop biological coatings with novel bioactive properties for the surfaces of medical devices.

Supported by EU funding for the Pecticoat¹ project, some

Optimised viral-free gene therapy

Targeting genes using a viral vector during gene therapy comes with major limitations. Scientists from an EU-funded project have optimised the conditions for advantageous viral-free gene targeting.



BIOLOGY AND MEDICINE

Gene therapy is the use of DNA as a pharmaceutical agent to supplement or alter genes within an individual's cells to treat a disease. There are two major methods for transferring DNA into cells: those that use recombinant viruses and those that use only DNA (non-viral DNA). The non-viral DNA approaches overcome some limitations and disadvantages of viral DNA methods, namely immunogenicity, DNA size limit, and poor safety and toxicity profiles. On the other hand, non-viral DNA targeting compensates low efficiency and precision with the safe delivery of genes.

These advantages have created a demand for the development

of new and improved delivery strategies. Recently, two promising approaches for the delivery of genes were introduced: they involve electrotransfer (ET) and laser beam gene transfer (LBGT).

The Moleda¹ project focused on the optimisation of strategies for precise and selective gene transfer into skeletal muscle and skin. The ET and LBGT technologies, currently under evaluation, were compared and improved within Moleda. The ultimate goal was the development of an optimum non-viral DNA technology for the pre-clinical phase.

Moleda scientists successfully determined the optimal conditions

for the delivery of plasmids into skin and muscle tissues for both methods. The performance of tissue-specific and ubiquitous promoters in each tissue was studied meticulously. Safety issues were addressed to ensure that no tissue damage, inflammation or any other malignancy would be caused by the treatment. Furthermore, new, highly efficient plasmids were constructed and tested by Moleda researchers.

The achievements of this project have set up the fundamental tools and resources for the development of successful gene therapies which are free from side effects. In particular, Moleda scientists focused on the treatment of Duchenne

muscular dystrophy, chronic renal failure and anti-tumour-passive immunisation.

The project was coordinated by the Institut National de la Santé et de la Recherche Médicale in France.

1 'Molecular optimisation of laser/electrotransfer DNA administration into muscle and skin for gene therapy'.

Funded under the FP6 specific programme 'Life sciences, genomics and biotechnology for health'.
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Genetic link to stroke

A European consortium has examined a large cohort of twins to find a genetic association of the clotting process and a predisposition to stroke. Project findings could be used to develop novel diagnostic methods and identify potential therapeutic targets.



— the master protein involved in the clotting process — which increase vascular risk. Studies on twin subjects have shown a substantial genetic component in the clotting pathway.

The EU-funded Euroclot¹ project aimed to identify and validate potentially therapeutically useful genes associated with thrombotic stroke. In particular, the project focused on uncovering the genes that control the end-stage of the coagulation process which leads directly to clot production. Accumulation of clots causes vascular obstruction and tissue death.

Euroclot partners studied 3 000 twins from the GenomEUtwin project and subjects from the GAIT2 (Spain) and EuroHead (Finland) studies. The genes identified by Euroclot were subsequently validated in tissue samples from stroke cases, including those from the large European MORGAM study.

Differences in gene allele frequencies and their impact were examined among different European populations.

Environmental factors, such as smoking, BMI and fasting insulin and glucose levels, showed no significant influence on gene expression.

The Euroclot study of twin subjects provided the first genetic link between stroke and the process of blood clotting. Project results are expected to pave the way for delineating the involvement of the thrombotic pathway in stroke and identifying potential targets for therapy.

The project was coordinated by the King's College London in the United Kingdom.

1 'Genetic regulation of the end-stage clotting process that leads to thrombotic stroke'.

Funded under the FP6 specific programme 'Life sciences, genomics and biotechnology for health'.
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Stroke is a serious cause of morbidity and mortality in Europe, affecting over 650 000 people annually. However, the complex involvement of various processes in stroke pathology has

hampered the development of an effective therapy.

Clinical studies so far point towards alterations in fibrin structure and function

ENERGY AND TRANSPORT



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Interview: rethinking energy from the ground up

Geothermal energy is renewable energy from the heat of subterranean rocks or water. Southern Europe has both geothermal resources and very specific challenges in terms of energy use. Dimitrios Mendrinou is leading an EU-funded research project to address both.

The Ground-Med¹ project is developing new geothermal 'Ground-source heat-pump' (GSHP) systems in order to demonstrate them in eight locations around the Mediterranean. The project has brought together 24 organisations — from research and educational institutes to heat-pump manufacturers, national and European industrial associations, and end-users — mainly from southern Europe, and won EU funding of EUR 4 million for their five-year programme.

*Research*eu magazine* asked Ground-Med's coordinator, Dimitrios Mendrinou of the Centre for Renewable Energy Sources and Saving in Greece, to explain the project in a little more detail.

The Ground-Med project is coordinated by the Centre for Renewable Energy Sources and Saving in Greece.

What is the aim of Ground-Med?

The Ground-Med project concerns the development and demonstration of a new generation of ground-source heat-pump systems addressing the high-energy-efficiency market.

The main objective is to demonstrate that a 'Seasonal performance factor' (SPF) of above five is feasible. The SPF is the ratio of useful heating and cooling energy delivered to the building against the electricity consumption necessary. A typical SPF in currently existing commercial equipment would be in the range of three to four.

What is new or innovative about the project?

The innovation of this project is that we are looking into, and trying to maximise, the heat-pump SPF, instead of the 'Coefficient of performance' (COP) which

was considered in previous projects. The COP is the ratio of the heating or cooling provided by the heat-pump against the electrical energy consumed, a measure of the useful heat movement per work input at a given instance, and varies throughout the heat-pump operation depending on the conditions (temperature, load, etc.) affecting the heat pump.

The SPF, on the other hand, is determined not only by the heat-pump unit, but also by its operating conditions due to the ground-heat exchanger and the building's heating and cooling system. In the Ground-Med project, we are also looking into all system components, namely the borehole heat exchangers, the pumps, the heat pump (designing it for improved seasonal efficiency), the fan-coil units, the air-handling units, the system control and the thermal storage.

ENERGY AND TRANSPORT

We needed to design borehole heat exchangers and heating/cooling systems that could operate with minimum temperature difference between them. We also sought to develop system components — such as the fan-coil and air-handling units — for minimum power consumption.

What first drew you to research in this area?

Ground-Med is a continuation of two previous European projects: Groundhit and Geocool.

Groundhit concerned technology development and demonstration of high-efficiency ground-source heat-pumps optimised for heating, while Geocool focused on optimising such heat-pumps for cooling. Both aimed at optimising the heat-pump unit itself in terms of COP at peak-load conditions.

But the real challenge lies in addressing the SPF, which equates to the year-round average of the COP, as a heat pump runs at part load for 80% of the time, and in southern Europe heat pumps will be used for both heating and cooling. SPF is a measure of the overall energy performance of the heat pump while it is providing heating, cooling or hot water to a building throughout the year, in contrast to COP, which is a measure of heat-pump performance in specific laboratory conditions.

What are some of the difficulties you have encountered?

Although we developed the technology and installed the systems quite efficiently, we are now faced with the challenge of developing a real-time online monitoring system for all eight demonstration sites, publicly accessible

through the web. Our efforts now are focusing on making the various items of modern electronic hardware compatible with each other and correcting all the little bugs that escaped the quality control done by the manufacturers of the commercial heat and power monitoring equipment we are using.

How do you go about solving these difficulties?

We have assigned the task to dedicated experienced researchers who are in contact with the equipment manufacturers and survey the market for the latest conversion technologies.

Additional coordination efforts are also being made in this direction. We have had two meetings for this purpose: one in June and another in late September. We should be able to complete the online monitoring by the end of this year.

What are the concrete results from the research so far?

We have developed eight super-heat-pump prototypes, new fan-coil unit prototypes of extremely low electricity consumption, and an air-handling unit prototype using condensing heat, as well as having tested innovative PCM nodules for cold storage.

We are now testing new control algorithms that include temperature compensation. All Ground-Med heat-pump systems are now in operation, providing heating and cooling in eight buildings at different locations in southern Europe: the Coimbra regional authority administration building, the Valencia Polytechnic campus building, La Fabrica del Sol in Barcelona, CIAT local distribution offices near Marseille, the HIREF

factory near Padova, the Benedikt municipal cultural centre, the University of Oradea campus building, and EDRASIS offices near Athens international airport.

What are the advantages of participating in an EU project?

We have access to financial resources and to experts from a wide range of competencies, which are not available at the local or national level.

What are the next steps of the project?

The next steps for the Ground-Med project are to monitor online all eight demonstration systems for at least one whole year and evaluate the developed technology.

Publications:

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- 1 'Advanced ground source heat pump systems for heating and cooling in Mediterranean climate'.

Funded under the FP7 specific programme Cooperation, under the theme 'Energy'.
For further information see the project website:
<http://www.groundmed.eu/>



© Ground-Med project

Dimitrios Mendrinós (front, centre) with members of the Ground-Med project team

ENERGY AND TRANSPORT



Real-time monitoring of exhaust gases

Using well-established techniques in novel ways, EU-funded researchers have developed a fibre-optic-based exhaust sensor. The technology provides drivers with real-time feedback regarding the pollutants they emit.



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Gone are the days of the single-car family. Most families now have at least two cars, one for each parent, and some may even have more if children of driving age are still living at home. In addition to the growing number of cars on the road, the demand for global products has led to ever-increasing freight, traffic as well.

One of the ways to decrease pollution caused by the burning of fossil fuels is to ensure efficient combustion processes. Careful

monitoring of exhaust gases with real-time feedback would enable corrections in a timely fashion.

With funding for the Opto-Emi-Sense¹ project, a European consortium of four academic institutions, a small company and a car manufacturer set out to develop fibre-optic sensing technology to quantify emissions of the most important exhaust gases.

Exhaustive research on optical sensors led to development of a

fully integrated system for numerous pollutants. The system was based on the 'gas filter correlation' (GFC) technique, which minimises cross-sensitivity, and the common phenomenon of interference between multi-component gases.

The sensor detected nitric oxide and nitrogen dioxide (NO and NO₂, respectively), carbon monoxide and dioxide (CO and CO₂, respectively) and numerous hydrocarbons as well as exhaust-gas temperature.

The Opto-Emi-Sense system was installed in the trunk of a test car specifically selected for its technical characteristics, including a catalysed diesel particulate filter required for maintaining sensor integrity. The fully operational demonstrator produced results in excellent correspondence with those delivered by commercial instrumentation.

Marketing of the Opto-Emi-Sense system will enable drivers to receive real-time feedback on exhaust gases and thus facilitate timely service in the case of pollutant emission. Reducing emissions and burning fuel more efficiently could have important benefits for consumers and help the EU reach its goal of sustainable surface transport.

The project was coordinated by the University of Limerick in Ireland.

- 1 'Optical fibre sensor based intelligent system for monitoring and control of exhaust emissions from road vehicles'.

Funded under the FP6 specific programme 'Sustainable development, global change and ecosystems'.
<http://cordis.europa.eu/marketplace/search/offers/9335>



Eco-engine systems for ships

Ageing and outdated combustion engines that power ships benefited from a complete redesign for green, efficient and cost-effective performance thanks to the work of a large EU-funded consortium.

When thinking about reduction of exhaust and pollutant emissions, cars, trucks and even aeroplanes generally come to mind. The shipping industry, on the other hand, is rarely mentioned and there is a good reason for that. Large and often ageing ships benefit from

greener technologies, with sustainable shipping and increased engine life cycle leading to major cost reductions.

The Hercules¹ project was initiated by European researchers to develop advanced technologies for

marine vessels. The goals were to significantly reduce gaseous and particulate emissions while increasing engine efficiency and reliability.

The consortium consisted of manufacturers and suppliers, academic and research institutions and world-class shipping companies commanding 80% of the world marine engine market and thus possessing the best available technology.

Comprehensive and collaborative research was conducted with regard to combustion processes under extreme conditions. Scientists evaluated and tested engine materials and components for operation under extreme conditions. They developed thermo-fluid-dynamics models to simulate combustion processes and emission formation, and performed experiments related to the same concepts. They also studied and

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developed concepts for increasing engine efficiency.

Different emission measures were developed. Emission-reduction techniques were studied, resulting in the development of prototype systems to reduce emissions either during combustion or as a result of after-treatment.

'Smart' materials that respond to changes in their local environment have led the way to technological advances in many fields. The Hercules consortium developed new designs for a variety of engine components by using smart materials to reduce engine friction and thus increase efficiency and life-cycle time.

Scientists also investigated adaptive engine control for computerised optimisation of function according to prevailing conditions. They developed and conducted on-board tests

of a self-learning system to provide various schemes for goal-oriented engine performance.

The Hercules project made tremendous progress in developing technology that increases marine engine efficiency, reduces emissions and enhances the lifetime of components. Innovations resulted in over 30 patent applications. Full-scale shipboard testing provided a window on the next generation of marine vessel engines.

The project was coordinated by Ulema E.E.I.G in Germany.

- 1 'High efficiency engine R&D on combustion with ultra-low emissions for ships'.

Funded under the FP6 specific programme 'Sustainable development, global change and ecosystems'.
<http://cordis.europa.eu/marketplace> > search > offers > 9338



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Uplifting aircraft power systems

EU-funded researchers have developed a novel one-step design and simulation tool for aircraft power systems. The software enables import of older paper wiring diagrams and promises to significantly improve design and maintenance.



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'Computer-aided design' (CAD) has become ubiquitous in most manufacturing fields over the last 20 years. The aircraft industry is among those to benefit from significant cost reductions.

Extension of CAD abilities for new designs, along with the capability of importing paper plans from older designs, would prove a tremendous boon to manufacturers and those

working in the maintenance sector.

European researchers have initiated the FRESH¹ project to take on this ambitious task for the specific case of electrical distributions in aircraft power.

Currently, CAD is used to generate wiring plans. The CAD files are then employed in the design and optimisation of the harness. This

two-step process is a waste of time and effort.

FRESH scientists developed recognition algorithms to convert paper wirings into CAD wiring diagram format, thereby enabling the system to account for an entire fleet, including older equipment.

In addition, they developed a module to translate CAD-format wiring diagrams into a universal language, called 'PIVOT'. This language was used to transfer wiring diagrams into the automatic design of the electrical harness.

The integrated FRESH system enabled one-step electrical wiring and harness design, including simulation of the physical behaviour of electrical harnesses for performance verification and optimisation.

The system enables error-free conversion of wiring diagrams

from paper to digital format, a significant reduction in design time, and more efficient design, manufacturing and maintenance.

Both large manufacturers and small and medium-sized enterprises (SMEs) involved in aircraft maintenance have expressed interest in the FRESH system. Commercial application has the potential to decrease costs while increasing airline safety, benefiting industry and consumers alike.

The project was coordinated by the Laboratoire en Ingénierie des Processus et des Services Industriels (LIPSI) of the Ecole Supérieure des Technologies Industrielles Avancées in France.

- 1 'From electric cabling plans to simulation help'.

Funded under the FP6 specific programme 'Aeronautics and space'.
<http://cordis.europa.eu/marketplace> > search > offers > 9320

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Optoelectronics based on novel molecular combinations

EU-funding has enabled a multidisciplinary consortium to develop novel optoelectronic devices based on the combination of supramolecular chemistry and metal-oxide semiconductor technology.

Thin-film metal oxides are growing in importance in the electronics industry, due to significant efforts to create smaller, lighter-weight and higher-performance devices. The oxides are deposited in a way that facilitates crystal growth in an organised way.

The latest trend is the use of metal-oxide nanostructures and their versatile application for fields as diverse as sensors, batteries, solar cells and energy storage.

European researchers formed a consortium consisting of leading scientists in supramolecular (based on assemblies of two or more molecules) photochemistry, nano-structured inorganic materials science and optoelectronic device physics. Their goal was to develop novel supramolecular devices for integration

into nanocrystalline metal-oxide electrodes.

With EU-funding of the Heteromolmat¹ project, the consortium pursued the development of three innovative hetero-supramolecular (based on two or more different molecules) devices: 'Hybrid light-emitting diodes' (HyLEDs), light-coupled chemical sensors and 'near-infrared' (NIR) light-to-energy conversion devices.

HyLEDs using metal oxides have numerous advantages over both standard and strictly organic LEDs. Metal-oxide technology encompasses many technical benefits as well as low-cost mass production. The developed HyLEDs demonstrated increased efficiency and should provide an attractive alternative to organic LEDs.

Heteromolmat scientists successfully designed and synthesised supramolecular structures capable of 'recognising' specific toxic substances, such as mercury, in a sample. The molecules bound easily to metal-oxide films thanks to specially incorporated binding groups. Interaction of supramolecular structures with the toxic substance changed the optical properties of the molecules, resulting in a light-coupled chemical sensor.

Finally, researchers produced record-breaking NIR solar-to-electric energy conversion devices based on the synthesis of novel supramolecular NIR dyes. Given the tremendous amount of energy available and the very low volume currently being exploited, the solar energy field is poised for a revolution. Perhaps it will get a boost from Heteromolmat technology.

Thanks to its interdisciplinary expertise, the Heteromolmat consortium was able to develop important nanocrystalline

supramolecular semiconductor materials. They applied these materials to optoelectronic devices with great success, especially for LEDs, light-emitting chemical sensors and light-to-electrical energy conversion devices. Using low-cost and easily scalable metal-oxide semiconductor technology as a foundation, these innovations are likely to be commercialised rapidly.

The project was coordinated by the Fundacio Privada Institute of Chemical Research of Catalonia (ICIQ) in Spain.

1 'Nanocrystalline hetero-supramolecular materials for optoelectronic applications'.

Funded under the FP6 specific programme 'Nanotechnologies and nanosciences, knowledge-based multifunctional materials and new production processes and devices'.
<http://cordis.europa.eu/marketplace> > search > offers > 9332





SMEs empowered by an energy-saving approach to cloud computing

Green, sustainable design is the new watchword among architects. Buildings that save energy and minimise environmental impact are needed around the world, but they are not easy to design — location, geography, climate, cost and many other factors need to be taken into account. A pioneering start-up company is on track to solve the problem thanks to advances in cloud computing developed with EU funding.



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Collaboratorio, an Italian think-tank for architects and civil engineers, has set up Green Prefab to provide collaborative cloud-computing services and applications that would help architects, engineers and contractors around the world to design, model and analyse the environmental impact of buildings. The start-up is a direct spin-off from Collaboratorio's involvement in the VENUS-C¹ project, an initiative supported by EUR 4.5 million in funding from the European Commission. The project is helping researchers and SMEs working in many scientific disciplines access open, industrial-quality cloud-computing infrastructure.

'Green Prefab is one of the top VENUS-C success stories as it demonstrates an entrepreneurial spirit coupled with small-scale funding support at regional government level and through private investment to help kick-start this new company,' explains Andrea Manieri, the

VENUS-C project director from ICT group Engineering Ingegneria Informatica in Italy.

The Green Prefab platform enables architects to determine what type of building design best fits local environmental and urban contexts, with tools that can model and visualise its environmental impact and life cycle. Thanks to cloud access to powerful, distributed computation, software and storage resources provided by Microsoft Azure, the platform enables Green Prefab researchers to identify trends in building design, perform extrapolation studies and provide advice on common challenges related to environmental impact.

'The very first prototype was for 3D rendering visualisation, and we are now integrating eco-efficiency tools,' explains Collaboratorio CEO Furio Barzon. 'We feel like pioneers heading

in the right direction to a still untouched gold mine.'

Collaboratorio is one of seven project partners working on specific cloud applications in specific domains, alongside 15 pilot projects that received seed funding from the VENUS-C team to support a user-centric approach to developing interoperable, easy-to-use cloud infrastructure.

Molplex, a start-up based in the United Kingdom, is using VENUS-C's cloud-computing infrastructure to carry out molecular computations for drug discovery, speeding progress on the development of new medications that could save lives.

'This application allows us to quickly estimate the activity of new chemical compounds in the human body,' says Molplex co-founder Vladimir Sykora. 'Thanks to the VENUS-C platform in a few weeks we will be able to do molecular computations that would

have taken a year to complete on our own servers.'

Saving processing and computing time is not the only benefit of the cloud infrastructure. For DFRC, a small Swiss company, the key issue is scalability. Using resources enabled by VENUS-C, the company is involved in an EU flagship project called PERSEUS aimed at improving the security and safety of Europe's maritime borders, combating illegal immigration, crime and smuggling through improved real-time access to shipping and maritime data.

For SMEs in particular, perhaps the biggest benefit of cloud computing is cost and accessibility. There is no need to buy banks of servers and computers, purchase expensive software or struggle up a steep learning curve, as with some other distributed computing approaches. Instead, cloud resources can be used as and when needed for relatively little cost and accessed through an easy-to-use web browser interface.

One test case in the VENUS-C project demonstrated a 10-fold acceleration in processing speed compared to an SME running the software by themselves, using resources that cost about EUR 1,000 monthly. Put simply: 'Computer resources can be scaled as required without committing to large capital purchases, which is critical to the success of our small business,' says Molplex's Mr Sykora.

The collaborations are clear examples of the advantages of an accelerating trend toward 'open science'.

'Open science is beginning to gain traction as a new way of doing science, sharing >

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and accessing research results early on, accessing scalable computing resources on easy-to-use and cost-effective commercial clouds,' explains Dr Fabrizio Gagliardi, Microsoft Research Connections, chair of the Project Management Board of VENUS-C. 'This new approach means that

researchers can build on the findings of other researchers and make new discoveries that were not possible before. Microsoft Research believes in this approach and has invested considerable resources from Azure, its cloud computing platform, to help VENUS-C to succeed with

the support of its European innovation centres.'

The project was coordinated by King's College London in the United Kingdom.

- 1 'Virtual multidisciplinary environments using cloud infrastructures'.

Funded under the FP7 specific programme 'Capacities', under the theme 'Research infrastructures'.
<http://cordis.europa.eu/marketplace> > search > offers > 8558

Novel noise-reduction concepts for aircraft

Aircraft jet engines generate a significant amount of noise. EU-funded researchers have developed concepts for reduction of engine noise that is radiated through the exhaust system.

The exhaust gas of a gas turbine jet engine is used for propulsion. To achieve adequate thrust, the exhaust gases are accelerated through a propelling nozzle.

Radiation of turbo-machinery noise (created by the engine turbine and fan) through bypass and core nozzles is an important

source of noise for modern aircraft, yet it has been largely overlooked. European researchers focused on this issue with EU-funding of the Turnex¹ project.

The consortium concentrated on experimental methods and numerical modelling to enable prediction of fan- and turbine-noise

radiation. Enhanced understanding of the physics of noise generation related to specific component geometries, engine specifications and airflows would facilitate reliable evaluation of noise-reduction concepts.

Turnex scientists experimentally tested model-scale geometries of

conventional engine exhaust systems. They also studied innovative noise-reduction concepts, including novel nozzle configurations. The data gathered enables a solid framework for validation of models.

The consortium made significant advances in numerical modelling and conducted a parametric study of geometry and flow-parameter effects on a full-scale engine configuration.

Finally, using models and validation data, the consortium evaluated various methods to measure noise levels. Results should benefit European fan-noise test facilities.

Knowledge generated by the Turnex consortium should be particularly important to aerospace manufacturers, helping them to design quieter systems for less noise pollution.

In addition, less noise pollution from aeroplanes, particularly during take-off and landing, could help win public approval for the construction of new airports, providing a boost to job creation in the air travel sector.

The project was coordinated by the University of Southampton in the United Kingdom.

- 1 'Turbo-machinery noise radiation through the engine exhaust'.

Funded under the FP6 specific programme 'Aeronautics and space'.
<http://cordis.europa.eu/marketplace> > search > offers > 9349





Hydrogen in conventional combustion engines

EU funding and transatlantic cooperation have enabled scientists to optimise green energy concepts. Modifications to standard combustion engines may help them use hydrogen instead of fossil fuels to produce chemical energy.



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Many governments have acknowledged the necessity to reduce dependence on fossil fuels. Hydrogen is an alternative energy source that is already providing clean, renewable and efficient power.

Hydrogen fuel cells, perhaps the most well-known devices, have run into numerous stumbling blocks. They require certain improvements including major reductions in cost before widespread use is conceivable.

In the meantime, 'Hydrogen internal-combustion engines' (HICEs) may bridge the gap. Such engines benefit from the mature

technology of 'internal combustion engines' (ICEs) and, with some modification, could allow an engine to run on both natural gas and hydrogen.

Although the first HICE was produced for industrial use in 2004, widespread implementation has progressed slowly. European researchers set out to change this with funding for the HYICE¹ project.

The project included transatlantic co-operation with Ford and its American associates, pioneers in the HICE field, to ensure maximum benefit and minimal duplication of efforts.

Project goals were to enhance the efficiency of HICEs and provide smaller engines with equivalent performance compared to standard ICEs running on fossil fuels.

HICEs convert chemical energy to mechanical energy by burning hydrogen. Efficient mixing and stratification of layers within the mixture are important parameters affecting the overall efficiency of the engine itself.

Scientists evaluated two promising processes for mixture formation. However, in order to develop concepts, they needed a suitable 'computational fluid dynamics'

(CFD) tool to model mixture formation and combustion incorporating specific properties of hydrogen. As such a tool was lacking, the team developed one, providing an important project outcome on its own.

The consortium also built a mixing-chamber test bed with advanced imaging capabilities. Its use enabled, for the first time, detailed insight into the workings of an HICE.

Overall, the HYICE consortium provided an answer to the demand for greater fuel efficiency and engine performance at a reasonable price. The HYICE technology opens the door to a rapid deployment of mass-produced hydrogen vehicles as soon as infrastructure and decision-makers are ready.

The project was coordinated by BMW Forschung und Technik GmbH in Germany

1 'Optimisation of hydrogen powered internal combustion engines'.

Funded under the FP6 specific programme 'Sustainable development, global change and ecosystems'.
<http://cordis.europa.eu/marketplace> > search > offers > 9336

Optimised crowd and traffic management: QED!

On the occasion of the European Mobility Week (16-22 September 2012), cities were encouraged to take initiatives to promote sustainable urban mobility. Noise and air pollution have become sources of concern in many urban areas and — since populations grow and infrastructure has to cope with rising demand and increased traffic congestion — major European cities have to take crowd and traffic management ever more seriously.

Wouldn't life be easier if planners could look at a traffic solution and say, 'This is the best possible approach', with

real certainty? That is what Dr Paola Goatin, of France's Institut National de Recherche en Informatique et en

Automatique (INRIA), who was awarded a Starting Grant from the European Research Council in 2010, hopes to achieve.

'Pedestrian and traffic-flow modelling are societal issues,' explains Dr Goatin, 'but currently, they tend to be modelled using a "microscopic" approach, simulating the trajectory of each vehicle and individual.' This has several drawbacks: the number of parameters needed to model every vehicle or pedestrian leads to



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huge demands on computing resources; and this approach is more suitable for simulating traffic, rather than for quantifying effects or optimising results.

Dr Goatin's TRAM3¹ research project is developing a 'macroscopic' approach which could change this by using models derived from fluid dynamics that treat traffic in similar ways to waves. 'We can get a view of the whole flow and density of the traffic, instead of how individual vehicles interact,' she says. By treating traffic and crowds as a fluid, their behaviour can be described using just a few equations, with the parameters obtained from real-world data.

While macroscopic models have been used in traffic management before, they have difficulties in handling some realistic scenarios. 'Usually we want to find the minimum travel time

under a particular arrangement,' Dr Goatin continues, 'but the mathematical solutions display discontinuities, such as moving traffic arriving at the back of a static queue, and this makes it impossible to apply standard minimisation techniques.'

In other words, the classical mathematical tools cannot be used directly to produce mathematical proof of which traffic arrangements are best for many real-world cases, and simulations can only help planners observe the behaviour of a few vehicles. In addition, there has been much less work on pedestrians and crowd management.

'We have specific situations we would like our models to be able to reproduce,' says Dr Goatin, 'such as a crowd exiting a door in a room with columns.' One of the biggest problems to solve is how to describe both

the distribution of this crowd and the various velocities and directions of their movement.

'Our final goal is to harness our new methodology to produce optimisation results for real-world problems,' says Dr Goatin. 'For example, we want to be able to prove mathematically the optimum position of the columns in order to maximise the crowd's flow through exit doors. We are collaborating with UC Berkeley in the US for empirical traffic data and are using video analysis of crowds in the Paris Metro provided by another research group at INRIA.'

After only two years into the project, the team have already published several papers, and have preliminary predictive results using INRIA's computer model. 'We have chosen to invest considerable time on this particular platform as it has a lot of flexibility and

good prospects for handling optimisation problems,' she explains. 'Now we can move on to validation.'

As the project continues, she hopes this research will lead to reliable predictions and optimised approaches for handling traffic queues, emergency exits and other real-world applications.

The project is coordinated by the Institut National de Recherche en Informatique et en Automatique (INRIA) in France.

1 'Traffic Management by Macroscopic Models'.

Funded by the European Research Council under the FP7 specific programme 'Ideas'. <http://erc.europa.eu> > project and results > success stories





Synergy of wastewater and biomass technologies

In line with the EU commitment to renewable energy, a European project has investigated the use of wastewater to supply nutrients and irrigation to crops for biomass production.



environmental objectives. A total of seven work packages determined the system requirements as well as designing and organising evaluation of the prototypes. Another unit prepared the plantations.

An important criterion was to monitor and apply a wastewater dose for optimal cropping while observing critical pollutant loads in the effluent in order to prevent environmental contamination. To achieve this ambitious combination, the system incorporated a combined sensor, detector and dosage applicator.

The performance of the system was evaluated using existing clones of willow and poplar saplings under varying climatic conditions. Results

of the Wacosys project were disseminated using a website, conferences, brochures and booklets.

The combination of biomass and wastewater technologies has been shown to reduce the cost of fuel for heat and power production. The optimised system could very well sharpen the competitive edge of SRP production against other fuels while complying with environmental legislation.

The project was coordinated by Hydro-Air GmbH Jüterborg in Germany.

The Wacosys¹ project aimed to develop and test an automated system to irrigate 'short rotation plantations' (SRPs). Fast-growing tree species such as willow can be cropped in one to five years for a clean source of heat energy,

and SRPs avoid pollution from the wastewater applied.

The Wacosys consortium brought together representatives from industry and academia to identify the social, technical and

- 1 'Monitoring and control system for wastewater irrigated energy plantations'.

Funded under the FP6 specific programme 'SME activities'.
<http://cordis.europa.eu/marketplace> >
 search > offers > 9385



Hydrogen fuel-cell-based generator for the home

EU-funded scientists have developed a hydrogen-based back-up generator for domestic use that employs cutting-edge ultra-capacitors to help meet peak power demand.

Dependence on fossil fuels for electricity has many drawbacks. These include uncertainty and unreliability of supply due to cost fluctuations in countries of origin, failure of ageing power grids, or increasing demand — particularly during peak times — exceeding existing supply.

Until a systematic replacement for fossil fuels is achieved, back-up domestic power generators could become increasingly important.

With funding of the DEMAG¹ project, European researchers sought to combine hydrogen fuel cell technology with ultra-capacitors for the delivery of a complete domestic back-up power system.

'Proton exchange membrane' (PEM) fuel cells take hydrogen

gas (a molecule of two hydrogen atoms bonded together), split it into hydrogen ions (protons) and electrons at one electrode and recombine the hydrogen with oxygen at the second electrode to produce water. The flow of electrons in the circuit provides current for electricity demands.

Highly dynamic loads (rapidly changing energy demands), however, shorten the lifetime of fuel cells. The ultra-capacitor comes in as an energy-storage device capable of releasing energy to supplement steady supplies and meet peak demands.

Scientists developed the DEMAG system to manage domestic power usage during steady-state and transient conditions. An intelligent controller detected power usage of each connected device. The system was capable of

switching between PEM fuel cells and ultra-capacitors, depending on load type and on disconnecting unnecessary loads. The central unit also detected mains blackouts and device failures.

In addition to commercialisation of the prototype domestic power generator, individual modules and concepts should be of interest for hospitals and emergency care centres.

The DEMAG system could also be modified to detect temperature, pressure and other parameters for intelligent control and switching in numerous applications.

The project was coordinated by LABOR S.R.L in Italy.



- 1 'Domestic emergency advanced generator'.

Funded under the FP6 specific programme 'SME activities'.
<http://cordis.europa.eu/marketplace> >
 search > offers > 9371

ENERGY AND TRANSPORT



Interview: boosting second-generation biofuels

Lignocellulosic bioethanol, a second-generation biofuel, has great potential as part of sustainable and secure European energy supplies for transport. EU researchers have been developing new production processes for hydrolysis and fermentation of lignocellulosic feedstocks.

The HYPE¹ project set out to improve enzymatic hydrolysis and ensure fermentation of all carbohydrates, as well as develop new processes and achieve high flexibility with regard to feedstocks. The results are expected to significantly improve the overall process economy through reduced process time, improved enzyme efficiency and high yield of all carbohydrates.

European research and industry are presently among the forerunners in developing lignocellulosic bioethanol. Although a number of technical breakthroughs had been achieved in the years before the project started, some key technical issues — especially concerning hydrolysis and fermentation — still remained.

As the project came to an end in September 2012, Research*eu magazine asked HYPE's coordinator, Professor Liisa Viikari of the University of Helsinki, to explain the project's work.

The HYPE project is coordinated by the University of Helsinki, Finland.

What were the main themes and objectives of the project?

The main aim of the project was to overcome some of the key bottle-necks in the production of second-generation bioethanol and thus to accelerate its implementation and commercialisation. Second-generation lignocellulosic biofuels have the potential to contribute to a more sustainable and secure European energy supply for the transport sector.

Due to the complexity of the new raw materials used for second-generation fuels, the conversion is challenging and requires novel techniques. The major targets for decreasing the production costs of lignocellulosic ethanol are to overcome the recalcitrance (resistant structure) of the raw materials and to improve the ethanol yield from the raw material.

In more detail, the goals were to develop and implement efficient pre-treatment techniques, which together with more efficient and cheaper enzyme preparations would decrease the conversion

costs. A special focus was on ethanol production and recovery, potentially contributing to decreased ethanol production costs from lignocellulose-derived sugars.

What are lignocellulose biomass and second-generation biofuels?

Today, an important aim is to use feed stocks which do not compete with food and feed production. Fuel ethanol is currently produced by fermentation of sugars originating from various annual crops (sugar cane, corn, wheat, barley). Lignocellulosic raw materials, such as agricultural and forest wastes, or even municipal wastes, offer alternative, abundant sources of raw materials for advanced biofuels.

On the other hand, these raw materials are less digestible not only for human consumption, but also for technical conversion processes. Production of fuel ethanol from lignocellulose has been shown to have significantly more positive net energy and greenhouse gas balances than ethanol produced from grain or sugar beet.

Ideally, dual crops could be used, serving as feed stocks for both food and energy use, e.g. producing both grains and straw. Dedicated high-biomass-yielding energy crops requiring low amounts of fertilisers and no irrigation could be grown on marginal lands that are not suitable for growing food crops.

What was new or innovative about the project and its approach to producing biofuels?

The approach of the project was based on a new process concept which integrated the most recent achievements in the field. The improved approach integrated efficient pre-treatment, high dry-matter liquefaction and hydrolysis, fermentation of all carbohydrates and low-temperature recovery of ethanol.

In the new process concept, efficient hydrothermal pre-treatment technologies were applied to obtain a high consistency raw material stream, which was pre-hydrolyzed (liquefied) at high temperature by identified, thermostable enzyme components. The designed and optimised thermostable enzyme mixtures also proved to be more efficient in the complete hydrolysis of the lignocellulosic raw materials studied.



Inbicon demonstration plant

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In the consolidated bioprocess, the capability of the fermenting organism (*Fusarium oxysporum*), to produce a set of lignocellulose hydrolyzing enzymes and ferment the formed C5 and C6 sugars was exploited. The amount of externally added enzymes could thus be significantly reduced. The new distillation techniques enabled us to maintain a temperature below the critical limits for the recovery of enzymes, thus extending the lifetime of the enzymes. A potential way to further reduce the enzyme costs is to reuse enzymes. Thus, the conversion was further improved by developing and applying improved thermostable enzymes better suited for recycling.

The concept of combining thermostable enzymes and consolidated bioprocessing enabled a significant reduction in process costs, as verified in laboratory and pilot tests. The development of technical process stages was supported by high-quality basic research, improving our understanding of the underlying reaction mechanism and leading the way to the further development needed.

What are some of the difficulties you have encountered in your research? How do you go about solving them?

One of the main challenges was to integrate the process stages at a practical scale. On the other hand, implementation of the results of basic research at an industrial or technical scale needs special consideration.

Some of the main practical difficulties for the project were to produce convergence in the conditions used at the large industrial and small laboratory scales; for example, hydrolysis in high-dry-matter consistency conditions in small-scale laboratory experiments, or the non-sterile conditions of fermentation at a larger scale. We were able to optimise individual process stages, however, and successfully tested them in pilot trials. Some of the tasks and process stages clearly

need further basic research and development work.

What are the concrete results from the research so far?

For converting lignocellulosic biomass into sugars, enzymatic hydrolysis is presently considered as the most promising technology. This is due to the higher yields, generation of lower amounts of inhibitory compounds and the high potential for improvement that are typical of biotechnologies. Before the hydrolysis, however, the raw material has to be efficiently pretreated to reduce the recalcitrant structure of the raw material. We have achieved significant improvements in both areas.

Various types of raw materials were hydrothermally converted to produce a high consistency, easily hydrolysable feedstock. The performance of the enzymes studied was improved in many ways; the specific activity and thermal stability of the main enzyme components were improved and optimal mixtures of thermostable enzymes could be designed, leading to reduced costs for externally added enzymes.

Potentially, a further reduction of the hydrolysis costs could be obtained by ethanol-producing organisms with the ability to produce useful enzymes *in situ*, replacing some of the added enzymes. The ethanol production costs could be further decreased by improved fermentation yields and improved distillation techniques.

A special benefit was obtained by applying thermostable enzymes which could be recovered after the distillation at a fairly low temperature. This, together with our newly designed enzyme cocktails would also lead the way for advanced enzyme recovery and recycling techniques. Based on the pilot scale testing and reability report, the main sensitivity parameters in full scale plants are biomass cost, ethanol price and enzyme cost. Low severity pretreatment combined with low dose of thermostable enzymes allowed approx. 27 %

reduction enzyme costs and was more feasible than the base case.

What first drew you to research in the area of biofuels?

My background is in enzymology and industrial biotechnology, which are relevant technologies when searching for solutions to problems related to using renewable raw materials. The conversion of lignocelluloses raw materials into various products by using biotechnical methods has been a challenge since the 1970s.

The first attempts to convert lignocellulosic raw materials into sugars and ethanol failed due to inadequate knowledge and basic understanding of the underlying mechanisms, as well as a lack of applicable biotechnical methodologies. In Nordic countries lignocellulosic forest resources, due to their abundant availability, have been important for industry.

Presently, not only the energy sector but the entire bioeconomy area are looking for new opportunities and methods to develop energy-rich or value-added products from these raw materials. In all applications, biotechnical methods can play a role due to their sustainability and specificity.

What have been the advantages of participating in an EU project?

The main benefit is the possibility to bring together the best expertise in very specialised areas into one group. Thus, in our project, we had the best European expertise in pre-treatment techniques, basic and applied research, industrial production of enzymes, development and fermentation techniques of fungal and yeast strains, high-consistency hydrolysis and fermentation techniques, recovery techniques for the product, and all-over engineering know-how.

What are the next steps of the project, and next topics for your research?

Each partner will critically evaluate the results obtained and will pursue further



© HYPE project

Prof. Liisa Viikari

implementation, as well as develop the ideas and concepts the project has generated. The fascinating and important results obtained in the project on the recyclability of structurally improved enzymes deserve further basic and applied research in our groups. The commercialisation of second-generation ethanol will benefit from all the steps we've taken to advance and improve the conversion techniques.

1 'Nanocrystalline hetero-supermolecular materials for optoelectronic applications'.

Funded under the FP7 specific programme cooperation under the theme 'Energy'.
For further information:
<http://blogs.helsinki.fi/hype.project>

ENVIRONMENT AND SOCIETY



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Modelling land surface and atmosphere interactions

Strategies for mitigating climate change require an in-depth understanding of feedback loops found in processes affecting the Earth's atmosphere and surface. The JULIA project has developed computer simulations that help scientists better understand how these two components interact with each other.

State-of-the-art terrestrial biosphere models require a greater understanding of land-surface processes than previously available. The EU-funded JULIA¹ project helped close the gap between observational science and large-scale modelling of biosphere processes at a level of detail suitable for an Earth system model.

Two of the most important areas that needed to be addressed were plant-soil interactions and conductance from tree canopies. Both fields have a significant influence on land-surface fluxes, ecosystem productivity and long-term carbon sequestration.

Researchers also investigated the role of the nitrogen cycle in the climate system and its impact on the natural carbon cycle. In addition, they assessed the impact of nitrogen from human activities on terrestrial greenhouse gas fluxes. The studies showed that

greater effort is needed to mitigate climate change, since the carbon sequestration capacity of the terrestrial biosphere had previously been overestimated. Furthermore, nitrogen management is important for controlling changes to the climate system resulting from human activities.

Scientists used flux measurements, plant characteristics and the outcomes of ecosystem monitoring studies to create sophisticated terrestrial computer models of the biosphere. This work resulted in a series of publications on the nitrogen cycle, the modelling of plant-soil interaction and the effect of drought on tree canopies. Results were incorporated into a model system that is part of the international Global Carbon Project and provides data for the Intergovernmental Panel on Climate Change (IPCC) and its Fifth Assessment Report (AR5).

The JULIA project successfully developed a tool to better quantify interactions of the terrestrial biosphere and the climate system for use in Earth system models, thereby enabling more accurate predictions to be made for future climate conditions.

The project was coordinated by the Max-Planck-Institut für Biogeochemie in Germany.

1 'Joining ecophysiological understanding and global ecosystem modelling for improved simulation of land surface interactions with the atmosphere'.

Funded under the FP7 specific programme 'People' (Marie-Curie actions).
<http://cordis.europa.eu/marketplace> > search > offers > 9209

Protecting the origins of biodiversity

Evolutionary relationships among a group of arthropods from Gondwana, a supercontinent that existed between 510 and 180 million years ago, have been investigated by EU scientists using molecular sequencing technology. The results provided researchers with a clearer picture of the origins of biodiversity and why species arise in a particular environment.



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The Gondwana¹ project set out to explain current patterns of species' richness and why organisms originate in a specific area. In order to understand how present diversity emerged and responded to past climate-change events, it was essential to test a number of different hypotheses. The resulting data can enable scientists to

predict the future effects of climate change and how to best prioritise strategic conservation objectives and manage biodiversity.

Scientists generated and analysed data from every aspect of biodiversity research, focusing on those related to the different levels of organisation found in

evolutionary biology. Population-level studies investigated the effect of ecological and geographical factors in forming and maintaining distinct lineages and observed genetic divergence and the flow of genes from one population of the same species to another.

Studies at the phylogenetic level combined information from the fossil record with molecular sequence data to investigate the origin and diversification of different groups. This provided a framework for studying macro-evolutionary processes and compensated for gaps in the fossil record. In addition, researchers were able to characterise the diversification of species through time in a given region and to examine how past climate and geographical events can be related to shifts in species diversification.

Threat status alone should not be the only factor when assessing the importance of conserving different species. Molecular sequencing

in ecological niche modelling can also help scientists predict shifts in geographic range due to climate change. Therefore, scientists were able to use findings from the Gondwana project to provide a greater understanding of habitat loss, climate change and other drivers of biotic change.

Evolutionary studies such as Gondwana can help prioritise geographical areas for carrying out conservation activities. Knowledge of where unique evolutionary events or processes occurred can complement diversity information, thereby enabling scientists to preserve existing species as well as the processes that generate this diversity.

The project was coordinated by the Museum National d'Histoire Naturelle in France.

1 'Origin of biodiversity in Gondwanan Arthropods: from phylogeography to phylogenomic'.

Funded under the FP7 specific programme 'People' (Marie-Curie actions).
<http://cordis.europa.eu/marketplace>
 > search > offers > 9353

Humane treatment for farmed fish

Researchers in Finland and the United Kingdom suggest that the warming Arctic climate could turn existing shrubs into trees in the coming years. The finding, presented in the journal Nature Climate Change, reveals that patches of forest can emerge across the tundra, which in turn could speed up the planet's warming.

Most people are familiar with campaigns to prevent cruelty to domestic animals. Such campaigns target animals that are either used for the advancement of science or killed for the commercial use of furs and other body parts.

However, many organisations are also working hard to ensure animal welfare in the agriculture and aquaculture sectors. Issues here include those related to production, transportation, slaughter

and destruction due to disease control.

Fish have been largely ignored until recently as they tend to generate less empathy than furry mammals. In addition, the lack of scientific evidence on a fish's ability to perceive pain has done nothing to provide an impetus for industry to develop more humane aquaculture methods.

Several recent reviews suggest that fish have the necessary

chemical and physical make-up to perceive pain. Their physiological and behavioural responses make it very likely that they do have the capacity to suffer.

The EU supports stunning to render fish unconscious and insensitive as a vital part of any slaughter procedure. In this context, European scientists sought to develop humane stunning equipment for four selected farmed fish species (eel, tilapia, sea bass and turbot) important to the EU economy.

With funding of the Stunfishfirst¹ project, the consortium elected to use electrical stunning methods that can be applied to groups of fish swimming in water.

Scientists relied heavily on electroencephalogram (EEG) data to determine the condition of fish subjected to stunning. Behavioural data complemented the EEG data but were used with caution, since being able to swim in a coordinated way does not mean a



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fish is not in pain, nor does being motionless.

EEG data also enabled optimisation of conditions for an instantaneous stun without recovery during gutting and filleting. No effects on fish quality were observed with the procedure. In

addition, substantial power savings were achieved by using a pulsed square wave instead of a standard sinusoidal one. Slaughter rates satisfied desired goals of partner SMEs.

Commercialisation should help the EU achieve humane slaughter

for aquacultural species while enhancing the competitiveness of numerous European SMEs.

The project was coordinated by the Nederlands Instituut voor Visserijonderzoek (RIVO) BV in the Netherlands.

- 1 'Development of prototype equipment for humane slaughter of farmed fish in industry'.

Funded under the FP6 specific programme 'SME activities'.
<http://cordis.europa.eu/marketplace>
 > search > offers > 9373

On the tracks of mercury pollution

Mercury (Hg) pollution is a threat to people and wildlife everywhere. A European project has recently completed research into the fate of Hg in a range of environments, including power plants, lakes and sea water.



The HG-197 MEHG Assess¹ project has just completed research to trace Hg²⁺ in nature and experimental set-ups to find out what conditions favour the formation and degradation of the compound.

Using the 197 Hg radiotracer, project scientists followed the path of Hg at the Reaktor Centre at the Institute Jozef Stefan in Slovenia. Monitoring Hg retention and the reduction capacity of Hg²⁺, the researchers evaluated tracer activity in the outgoing airflow as well as in bubbling water within the system.

A second phase of the project recorded the Hg²⁺ retention of gypsum used in a 'Flue gas desulphurisation' (FGD) plant. FGD plants are notorious for mercury emissions and are commonly installed at coal-fired power plants. Hg retention was also measured in an FGD system using a potassium manganate (VII) (KMnO₄) trap under different conditions of pH and reduction-oxidation (REDOX) control.

To study the behaviour of Hg in the natural environment, water samples from a lake, river and coastal lagoon as well as from sea and rain water were spiked with Hg²⁺, traced with 197 Hg and stored in different conditions. Losses of Hg²⁺ were evaluated for each of the solutions.

The HG-197 MEHG Assess project has fulfilled a rising need for the evaluation of mercury methylation in sea waters as opposed to in sediment, an area frequently researched. The improved methodology for assessing Hg formation and degradation will be a valuable tool for use in lakes and coastal ecosystems.

The project was coordinated by the Institut Jozef Stefan in Slovenia.

- 1 'Evaluation of Methyl-mercury production and decomposition by using Hg-197 radiotracer produced out of mercury enriched in Hg-196 isotope'.

Funded under the FP7 specific programme 'People' (Marie-Curie actions).
<http://cordis.europa.eu/marketplace>
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Methylmercury (MeHg), a powerful neurotoxin, is a frequent component of polluted water. Concern for the environmental and health effects have prompted studies on

both the methylation of Hg²⁺ ions in water and natural degradation (demethylation) of MeHg.

Grass ancestor reveals family history

Wild grasses have evolved into cereals over the last 10 thousand years as a result of farmers selecting beneficial traits. Although cereals now form the basis of human agriculture, the biology of wild grasses, which dominate many terrestrial ecosystems, is still not well understood.

The Natgrain¹ project used state-of-the-art technology to determine how genes control grain size. *Brachypodium distachyon* is a small wild grass species native to southern Europe, northern Africa and south-western Asia, and one that is close to major cereal crops including wheat, barley, oats and rice. The plant's short life cycle and ease of cultivation made it an ideal model for understanding the genetics behind biological processes in grasses and cereals.

Researchers characterised the stages of grain development at the morphological, cellular and molecular levels by using the reference strain Bd 21 grown under

controlled conditions. The aim was to study natural and induced variation in order to better understand grain development in *Brachypodium distachyon*.

Grain development was subsequently examined in mutant and non-mutant plants collected from different parts of Europe and the Middle East. Scientists mapped *Brachypodium distachyon* populations to facilitate the identification of genes that influence grain size and shape, while the identification of key sites enabled researchers to address the question of adaptation and the significance of variation in the number of chromosomes in the plants' cells.

Results demonstrated *Brachypodium distachyon*'s potential as a model species for understanding grain development in grasses. In addition, comparison with the widely used model plant species *Arabidopsis* proved *Brachypodium*'s use when analysing evolutionary differences between *monocotyledons* and *dicotyledons*, the two major groups that make up flowering plants.

Natgrain demonstrated that the ability of plants to change their DNA content through mixing across different species could be a major factor in the domestication of wild grasses. This process is often associated

with increased size, more rapid growth and increased tolerance of environmental stress.

The project successfully assessed natural variation in grain from *Brachypodium distachyon* and demonstrated how this variation was related to geographic origin and population structure. The results will provide scientists with greater understanding of plant populations and how plants respond to their environment.

The project was coordinated by the John Innes Centre in the United Kingdom.

1 'Grain development in *Brachypodium distachyon*'.

Funded under the FP7 specific programme 'People' (Marie-Curie actions).
<http://cordis.europa.eu/marketplace> >
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Willow research benefits livestock

Leaves from willow (Salix) trees can be used by farmers to feed livestock during summer droughts. However, the leaves contain tannins that may affect their nutritive value.



for tannins and provide the basis for a tree breeding programme that will benefit animal nutrition and health.

Tannins with different molecular structures were isolated from a range of willow species. Following purification, the compounds were tested for their ability to kill parasitical worms, using the larvae of *Haemonchus contortus* as a model.

Preliminary results indicated that polymer size and prodelphinidin content were the most important factors for combating worm infestation. Project partners showed that tannins differ between genetically diverse species of willow. In addition, different tannins have different properties for treating parasitic worms.

Tannin Structure QTL provided new targets for willow breeding and promoted alternative uses for the tree. These included sustainable shrub-based fodder systems that can cope with summer droughts and utilise local rather than imported feed resources. Supplementary feeding with shrub and tree leaves could help farmers better cope with climate change and extreme weather events.

The project was coordinated by the University of Reading in the United Kingdom.

Scientists from the EU-funded Tannin Structure QTL¹ project have analysed the tannin composition of a United Kingdom-based collection of willow tree species that comprised a unique genetic resource. Results from the willow collection at Rothamsted Research Centre

showed that tannin content and composition varied significantly between different willow species.

The researchers created a detailed branched diagram, known as a dendrogram, to show the different traits. The dendrogram can be used to identify genetic markers

- 1 'Linking tannins, biological activities and genetic maps in a unique willow germplasm collection'.

Funded under the FP7 specific programme 'People' (Marie-Curie actions).
<http://cordis.europa.eu/marketplace> > search > offers > 8938

Soil aids environment-friendly pest management

Rhizobacteria are root-colonising microbes that form symbiotic relationships with many plants. An EU-funded initiative investigated the use of rhizobacteria to induce systemic resistance in plants and apply it to integrated pest management, a technique that takes a holistic approach to pest control.

The RHIZO-Insect¹ project demonstrated that the presence of rhizobacteria has no effect on the preferences shown by plant-eating organisms. Studies also revealed that the presence of rhizobacteria does not affect the performance of specialist herbivores, which only feed on one species of plant. However, rhizobacteria were found to influence the behaviour of more generalist herbivores, which eat a variety of plants.

The composition of chemical compounds emitted by plants can also affect the behaviour of parasitoids which ultimately kill their hosts, thereby acting as an indirect form of defence for plants. Researchers

found that the colonisation of a plant's roots by rhizobacteria produced changes in the plant that interfered with the parasitoids' ability to recognise their aphid host.

Studies also revealed that compounds known as 'volatiles' in plants colonised by rhizobacteria were affected by the actions of herbivores, whereas plants without rhizobacteria were not. These results indicated that plant growth promoting rhizobacteria in the soil can affect the performance of insects on the plant's shoot.

Further investigations examined optimal exploitation in long-term pest control strategies that do not



rely on chemical pesticides but on a combination of biological pest-management practices. In the future this will prove significant for plant growth, encouraging rhizobacteria to become valuable components of a successful integrated pest-management strategy.

The project was coordinated by the Laboratory of Entomology of the Wageningen Universiteit in the Netherlands.

- 1 'Multidisciplinary approach to study effects of beneficial rhizobacteria on induced plant defences to aboveground herbivorous insects'.

Funded under the FP7 specific programme 'People' (Marie-Curie actions).
<http://cordis.europa.eu/marketplace> > search > offers > 8941

The wonders of soil micro-organisms

EU-funded research has done the spade work to show the enormous contribution of a new phylum of archaeon microbes, the Thaumarchaeota, to soil nitrification.



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Loss of ammonia from the soil through nitrification by soil organisms is proving extremely costly to both farmers and the environment. Once thought to be the sole domain of autotrophic bacteria, nitrification results in the loss of ammonia-based fertilisers and the production of a potent air pollutant and 'greenhouse gas' (GHG), nitrous oxide, which also causes ozone depletion.

Scientists have recently discovered another nitrifying culprit, autotrophic crenarchaea (recently renamed Thaumarchaeota which

literally means miracle or wonder in Greek). Although archaea have been cultivated from marine and thermal spring environments, none have so far been isolated from soil.

However, there is indirect genetic evidence from soil that archaeal ammonia oxidisers outweigh their bacterial counterparts in a wide range of soils. The Creneco¹ project aimed to assess the respective contributions of bacteria and thaumarchaea to soil ammonia oxidation. They also investigated whether autotrophic — as opposed to

heterotrophic — ammonia oxidation is a common feature of soil Thaumarchaeota.

Soil local to the University of Aberdeen was assessed for bacterial and archaeal communities using DNA-based fingerprinting, quantification of 16S 'ribosomal RNA' (rRNA) and 'archaeal genes' (amoA genes). Increases in rRNA and amoA genes during nitrification indicate that ammonia oxidation was mostly due to the soil archaea, since there was no evidence of a parallel growth in the bacterial community.

To assess the extent of autotrophic archaeal nitrification, Creneco scientists studied a key gene, hcd, in the autotrophic pathway unknown in heterotrophic lineages. Appropriate 'Polymerase chain reaction' (PCR) markers were developed and an abundance of hcd in two local soils (one acidic and one neutral) was assessed. Increases in gene abundance at the same time as nitrification provided evidence of archaeal nitrification. Use of ¹³C-labelled carbon dioxide also indicated that archaea were the dominant nitrifiers in the soils.

Creneco results mean that archaeal ammonia oxidation should be a significant part of current models of carbon and nitrogen cycling. The research and its follow up will have significance in many areas, including agriculture, health and global warming through nitrogen fertiliser loss, nitrate pollution of groundwater and GHG emission, respectively.

The project was coordinated by the University Court of the University of Aberdeen in the United Kingdom.

1 'The role of mesophilic crenarchaea in soil nitrification'.

Funded under the FP7 specific programme 'People' (Marie-Curie actions).
<http://cordis.europa.eu/marketplace> >
 search > offers > 8934

Migrants boosting labour markets and transferring knowledge

Researchers have improved knowledge on migrant contributions to European labour markets. An EU-funded project has also advanced the significance of knowledge transfer as a result of migrant mobility.

Well-established communities of foreigners can be found in all major cities. Pre-industrial

cities and their labour markets are considered to have been quite open to foreigners, and

thus formed the crux of the circulation of women, men, wealth and knowledge between pre-industrial European countries. Previous research on migratory chains and professional concentration of ethnic groups has shown that immigrant communities were not secondary

actors on the labour market stage, but rather assumed important functions in their field of professional or commercial operations.

The Migrantworkeurolab¹ project traces the lines of a common working space, a



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European labour market where, in spite of cultural differences among its women and men, wealth and knowledge move along networks and contribute to local environments. In particular, project work focused on analysing the European labour market during the pre-industrial age in order to describe it as an area built up by the mobility of its workers and inhabitants, and as a location for knowledge transfer.

Research concentrated on the complexity of knowledge transfer dynamics, emphasising the role of migrant workers in creating a global interdependence between various regions in Europe. In this context, migrants covering long distances, but all the while maintaining contact with their places of origin, build bridges between different places in Europe and even beyond.

Other project work examined differences and similarities in the attitudes of European countries towards migrant workers and their inclusion in society. Of particular interest were the dynamics between the 16th and 17th centuries, during which migrants experienced differing receptions, contingent on place and time.

The project was coordinated by the Centre National de la

Recherche Scientifique (CNRS) in France.

- 1 'Migrant workers across European Labour markets. Mobility, citizenship and urban resources in the pre-industrial cities - XVIth-XVIIIth century'.

Funded under the FP7 specific programme 'People' (Marie-Curie actions).
<http://cordis.europa.eu/marketplace> > search > offers > 8940

Understanding turbulence: the key to weather prediction

After another anomalous summer, and with climate change still near the top of the political agenda, it seems that weather and climate forecasting have never been so topical. With the help of the ERC, Professor Sergej S. Zilitinkevich of the Finnish Meteorological Institute (FMI) is hoping to revise the way physics treats turbulence in the atmosphere and ocean — with important consequences for weather and climate modelling and prediction.

'Turbulence is the key to the atmospheric "machine",' says Prof. Zilitinkevich. 'We cannot understand weather systems if we do not understand the connections between their parts.' According to Prof. Zilitinkevich, for almost a century, turbulence has been understood in an oversimplified form, based on an assumption that it could be split into two parts: 'mean flow' (organised motion which can be analysed using classical

mechanics) and 'turbulence' (chaotic motion which must be analysed using statistical methods).

This approach works well for engineering applications, but in the field of geophysical turbulence — such as climate and weather — it faces increasing difficulties. In the atmosphere or ocean, the density of the medium changes with height. This leads to stratification, instability and phenomena such as

convection. The classical paradigm has not been able to deal with these phenomena satisfactorily.

'We are now seeing a scientific revolution in this field,' says Prof. Zilitinkevich. 'Atmospheric turbulence can now be seen as having three parts: regular flow, chaotic turbulence and self-organised structures.'

Self-organisation leads to long-lived structures, such as convective cells or rolls in the atmosphere or ocean. This new understanding means that both researchers and operational modellers need to account for these different types of movements and their role in energy and matter exchange in the atmosphere and ocean.

'Heat exchange between the upper-ocean and lower atmosphere is controlled by turbulence,' explains Prof. Zilitinkevich. 'Most thermal energy is in the ocean not the atmosphere, but we experience climate anthropocentrically as a characteristic of the near-surface part of the atmosphere, the atmospheric "planetary boundary layer" (PBL).'

His PBL-PMES¹ project aims to revise thoroughly the physics theories used to model PBLs. Not only will this lead to better understanding of heat exchange between land, sea and air, but researchers will also gain insight into phenomena like shallow stable atmospheric PBLs which trap smog and pollution in the air above cities.

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Prof. Zilitinkevich expects his research to lead to radical changes in scientific understanding of weather and climate and in the success of forecasting models. 'Within a decade, we should have incomparably better weather and climate predictions,' he says. 'Microclimates, such as local climate change due to land-use

change, will be modelled with greater accuracy.'

The new theoretical framework will then be implemented in modern weather-forecasting and air-pollution models. Until recently, one of the biggest limiting factors in weather prediction has been the spatial resolution of the models, restricted by the

power of supercomputers. But new improved physics means it is now the models that need to be revised. 'We are co-operating with a very good network of operational weather-modelling groups around Europe,' says Prof. Zilitinkevich. 'By the end of next year we hope to have some practical results from the Finnish Meteorological Institute — and we are also working with

MétéoFrance and the Danish Meteorological Institute.'

In addition, the project is working to validate its theories with astrophysicists, helping to explain convection in stars and the sun, as well as accretion disks around black holes.

'We are lucky in that we can now combine two hot new areas of research,' says Prof. Zilitinkevich, 'a new theory of turbulence and a new demand for turbulence applications in climate models.'

The project was coordinated by the Finnish Meteorological Institute in Finland.



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- 1 'Atmospheric planetary boundary layers: physics, modelling and role in Earth system'.

Funded by the European Research Centre (ERC) under the FP7 specific programme 'Ideas'.
<http://erc.europa.eu> > project and results
 > success stories

Recycling of optical fibre cables

The increasing use of 'optical fibre cables' (OFCs) requires novel methods for their disposal. To this end, a European initiative has studied new possibilities for the recycling of long fibres, including OFCs.

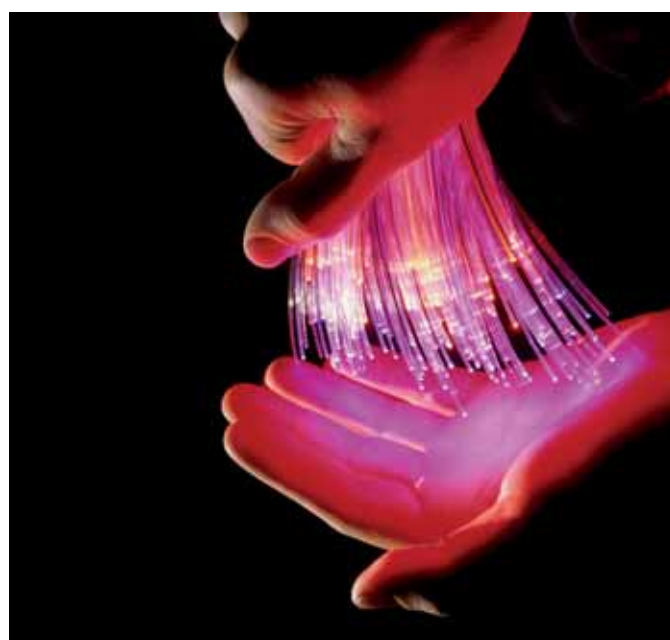
Pollution and global warming have become important topics over the past years, urging policy-makers and companies to look for new recycling techniques that would 'save the world' as we all know it. The recycling of 'optical fibre cables' (OFCs), for instance, is key to sustainability. Current methods are hampered by their complex composition, since they contain optical fibreglass, polyethylene, gels, aramid fibres and, for older cables, aluminium or steel.

To improve the recycling of OFCs, the EU-funded L-FIRE¹ project proposed to break down the components of the OFC, rather than cutting it into pieces. With this approach, partners planned

to recycle the different materials using a reverse processing technology.

Project scientists also worked towards a gel-liberation technique for eliminating gels by using specialised gel binders or chemical solvents. In order to ease the stripping process, methods for aramid removal and separation of metal-polymer sandwiched materials were also investigated.

The L-FIRE deliverables contributed to overcoming the ineffectiveness of OFC shredding and dumping, as well as reducing the costs of incineration. They open up encouraging prospects for OFC recycling. Implementation of this method is not only expected to



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have positive long-term environmental effects, but at the same time could strengthen the position of many companies in Europe.

The project was coordinated by Kema Nederland BV in the Netherlands.

- 1 'Long fibre recycling'.

Funded under the FP6 specific programme 'SME activities'.
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Bioremediation to alleviate surface water pollution

European research has investigated the possibility of using naturally occurring microbes to bio-decontaminate groundwater, a source of organic solvent pollutants in surface water.

Groundwater and surface waters are often characterised as separate resources, although they are interrelated. Surface water seeps through the soil and becomes groundwater. Conversely, groundwater can feed surface water sources.

The EU project Sedbarcah¹ aimed to investigate the possibility that the sediment between surface and groundwater may act as a supply of both biological and physico-chemical degradation agents. In particular, scientists focused on the biological source, a natural bio-barrier.

Harnessing the action of anaerobic microbes introduced into sediments by eutrophication, the project aimed to put the bacteria to good use. To do this, the researchers determined the role and genetic make-up of the microbial community living in the river bed by monitoring activity in sediments of the River Zenna in Belgium and the Belá river in the Czech Republic.

The project team concentrated specifically on a group of pollutants, the 'chlorinated hydrocarbons' (CAHs), one of which — perchlorethylene (PCE) — is a very common organic solvent used in dry cleaning

and industrial processes. Under anaerobic conditions, the CAHs can be completely oxidised to carbon dioxide (CO₂), water and chlorine by the microbes. Sedbarcah focused on dechlorinating bacteria in particular.

The next step comprised enhancing pollutant-removal activities and sustaining these processes, as well as developing tools to investigate microbial degradation in situ. To increase the bioremediation potential of the community, the scientists investigated the effects of changing variables like nutrients and electron donors and receptors.

Surface water contamination by dissolved CAHs from degreasing activities in industry is a significant problem, occurring frequently at concentrations that are harmful

and carcinogenic. Sedbarcah has collected valuable data for bioremediation systems to decontaminate surface water systems.

The project was coordinated by the Vlaamse Instelling voor Technologisch Onderzoek in Belgium.

- 1 "Sediment bio-barriers for chlorinated aliphatic hydrocarbons in groundwater reaching surface water".

Funded under the FP6 specific programme 'Sustainable development, global change and ecosystems'.
<http://cordis.europa.eu/marketplace> >
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Ahead in the cloud

By providing computing resources as a service rather than a product, 'cloud computing' is revolutionising access to software, processing power and storage. Its development is being aided by ground-breaking research carried out in Europe.

Just a few years ago, if someone needed to store or process a large amount of data they would have to buy their own computers, servers, databases and other infrastructure. Now, thanks to cloud computing, they can instantly rent as much as they need for as long as they need it. With just an internet connection, they can access the resources they require — much as people draw on electricity from the power grid without having to worry about building their own power station.

According to some estimates, the global cloud computing market is currently worth around EUR 30 billion. By 2020, it is set to expand six-fold to almost EUR 200 billion. Businesses are turning to the cloud to lower costs by using online, on-demand cloud computing resources as and when they need them, thereby avoiding the need to set up

data centres and install other costly IT infrastructure. Governments and citizens are doing the same, increasingly using remotely hosted services, storage and processing tools to store, manage and use data.

'Users now require capabilities that are far richer than raw bits and basic storage,' says Dr Hillel Kolodner, from IBM in Haifa, Israel. Dr Kolodner is coordinating the Vision Cloud¹ project that aims to turn text, multimedia or software content stored in the cloud into smart objects that include rich semantic information describing what they are and how they should be handled, replicated or backed up.

In the meantime, researchers from Spain, France, Hungary, Italy and Romania are currently working together in the Mosaic² project to develop an easy-to-use brokering system

that will help users search for cloud services that best fit their needs, or use more than one cloud service simultaneously if no single service fits the bill.

While making the cloud smarter and easier to use will undoubtedly help, barriers to the development of cloud services still remain. IDC has undertaken a study, 'Quantitative estimates of the demand for cloud computing in Europe and the likely barriers to take-up', to identify these issues for the European Commission. According to the interim report, while user concerns do not stop uptake completely, worries about data location, legal jurisdiction, security and data protection do slow down its adoption by business.

With those concerns in mind, the EU is funding the Austrian-led Tclouds³ project, which aims to build trustworthy cloud >

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infrastructures. The TClouds project's work to push privacy through design technologies and legal guidance should help build a higher level of trust in public clouds.

And what if your needs go far beyond storage and data management, to processing and running software in the cloud? 'The new generation of applications we are seeing are all about interactivity — people need and want to access and work with them in real time, so any platform, any environment must also enable interactivity,' explains Dimosthenis Kyriazis, a senior researcher at the National Technical University of Athens. 'If the applications are interactive, the infrastructure that services them should facilitate that interaction.'

Dr Kyriazis is the technical coordinator of IRMOS⁴, a project that has brought real-time functionality to the cloud through an innovative service-oriented infrastructure. The team developed open source tools to enable anyone to build applications for real-time cloud computing. The project pays special attention to 'quality of service' (QoS) guarantees that are essential in a real-time working environment.

In the LinkedTV⁵ initiative, a team from eight European countries are building on the convergence of television and the internet, weaving content together to deliver a single, integrated and interactive experience. An online cloud of networked audio-visual content will be accessible regardless of place, device or source, and the experience will be

of 'TV', whether it is seen on a TV set, smartphone, tablet or personal computing device. For example, a library of documentary films and archives will put shared cultural knowledge and heritage at the fingertips of every connected citizen.

Meanwhile, researchers working in the Cloud4All⁶ initiative are using cloud computing in a pioneering way to boost accessibility to technology for people with disabilities, when and where they need it. Instead of individual products and services being adapted for a person with special needs, cloud-powered technology will automatically personalise the product or service for them, activating and augmenting any built-in accessibility features that the product or service has based on a profile of the user's requirements.

From the sheer range of these applications, it is clear that the cloud has a great deal of potential to be developed and exploited.

'Cloud computing will change our economy. It can bring significant productivity benefits to all, right through to the smallest companies, and also to individuals. It promises scalable, secure services for greater efficiency, greater flexibility, and lower cost,' Neelie Kroes, Vice-President of the European Commission responsible for the Digital Agenda, pointed out earlier this year.

EU research is both exploring potential cloud applications and breaking down the barriers to this development. The European Cloud

Partnership, announced by Commissioner Kroes in January and aimed at supporting cloud adoption in Europe, is expected to start producing results over the coming months, in the wake of initial funding of EUR 10 million from the European Commission. Meanwhile, the Commission is also putting the finishing touches to a European Cloud Strategy, following a thought-provoking Cloud Workshop held in June during the Digital Agenda Assembly in Brussels.

As Commissioner Kroes has noted: '2012 is the year when the cloud grows up. Let's be ready.'

- 1 'Virtualized Storage Services for the Future Internet', coordinated by IBM Israel Science and Technology.
- 2 'Open-Source API and Platform for Multiple Clouds', coordinated by the Seconda Università degli Studi di Napoli in Italy.
- 3 'Trustworthy Clouds? Privacy and Resilience for Internet-scale Critical Infrastructure', coordinated by Technikon Forschungs- und Planungsgesellschaft mbH.
- 4 'Interactive real-time multimedia applications on service oriented infrastructures', coordinated by Xyratex Technology Limited in the United Kingdom.
- 5 'Television Linked To The Web', coordinated by Fraunhofer-Gesellschaft zur Förderung der Angewandten Forschung E.V. in Germany.
- 6 'Cloud platforms Lead to Open and Universal access for people with Disabilities and for All', coordinated by Fundosa Technosite S.A. in Spain.

The projects have been supported either by the Sixth (FP6) or Seventh Framework Programme (FP7) for research. <http://cordis.europa.eu/marketplace> > search > offers > 9000

Low-cost, in-flight satellite communication system

EU-funded researchers have adapted cutting-edge technologies to produce a reliable and low-cost satellite communications system for aircraft. The system is designed to provide in-flight Internet services related to passenger web connectivity and safety.



Mobile communications have become routine. Not only do most people in the Western world own a cell phone, but in many cases Internet-related activities surpass those related to phone and message services.

Mobile communications are also used by aircraft for monitoring and guidance functions and, increasingly, passenger Internet services.

European researchers sought to develop technology for a low-cost, reliable, high-data-rate connection for in-flight connectivity with

funding for the 'Reliable, tuneable and inexpensive antennas by collective fabrication processes' Retina¹ project.

The system would be used for passenger web services and for 'Air traffic management' (ATM), the latter related both to flight parameters as well as to safety and security (online, real-time video streaming).

Retina scientists aimed at developing agile beam-steering in the Ka- or Ku-band of electromagnetic radiation used by most satellites for broadband satellite-based Internet services.

The technology was based on the 'Reflectarray' antenna, a

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revolutionary new-generation high-gain reflector antenna implementing arrays of elementary antennas. The Reflectarray antenna is also lightweight, low-cost and easy to fabricate.

Researchers explored phase-shifting technologies, including 'Radio-frequency

micro-electromechanical systems' (RF-MEMS) and ferro-electric capacitors, in order to shift up to Ka-band. Successful development of such technologies resulted in a demonstrated function of a partial Reflectarray antenna in the operational 'satellite communications' (SatCom) bandwidth.

Retina has laid the foundation for development of a full-scale Ku-band SatCom antenna using low-cost fabrication processes and enabling fast and reliable web-based in-flight services related to passengers and safety.

The project was coordinated by EADS in Germany.

- 1 'Reliable, tuneable and inexpensive antennas by collective fabrication processes'.

Funded under the FP6 specific programme 'Aeronautics and space'.
<http://cordis.europa.eu/marketplace> >
[search > offers > 9323](#)

Web-TV: a perfect match?

Do you surf the web in front of the TV, or tweet what you are watching? EU-funded researchers are creating technologies that combine web, social media and TV to enhance our experience and interactions across media.



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Research shows that consumers watch TV and use the web simultaneously for up to 3.5 hours daily, while 42% of UK adults discussed the programmes they were watching on social networks. Digital providers and broadcasters are always trying to improve entertainment, and combining social media, the

web and TV into a single user experience is an important step.

NoTube¹, a European-funded project, brought together the digital and broadcasting industries, along with experts in platform integration, with the aim of linking media so that consumers can watch

shows and interact with friends regardless of the devices they use.

The key to NoTube's approach is 'linked data', where information about a viewer — such as preferences, social networks, contacts and favourite shows — is stored 'in the cloud'. 'This

made it possible, for example, for broadcasters to create personalised news environments and online programme guides, showing users what they most want to see. Moreover, these work across devices and in multiple languages,' explains Dan Brickley, from VU University Amsterdam, >

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the Netherlands, one of the lead researchers in the project.

With a vast array of devices and solutions marketed to viewers, it is difficult to achieve a consistent experience when linking online activity and viewing. The NoTube project looked at how this Web+TV combination could work from every angle, developing user interfaces along with underlying technology standards to support interoperability and data linking.

Systems using personal data must be secure and respect privacy, which is often a stumbling block for commercial solutions. 'People are often overcautious and misunderstand the risks involved, but they also need to understand how their supposedly anonymous online activities might inadvertently "fingerprint" them. It may take a few more high-profile privacy controversies, like the Netflix prize lawsuit or the AOL search logs case, before users adopt healthy privacy habits,' acknowledges Brickley.

Recognising that people use default settings and fail to guard personal data, the NoTube architecture builds in security to ensure linked data remains secure.

NoTube also found ways of linking people viewing TV. Led by BBC R&D, the team developed methods of giving programme recommendations based on social activity, and built technologies that make it easier for viewers to discuss and share TV information across their networks, whilst maintaining privacy. This led to the development of N-screen, a web application which can help small groups decide what to watch while using a second screen to interact with each other.

The NoTube partners were keen to extend other functional prototypes, such as the iFancy service that delivers personalised and contextualised advertising and TV. It uses a range of data, including time of day, device used and viewing preferences, to serve more engaging

(and therefore more successful) ads. The system also improves the delivery of audio-visual advertisements by adjusting volumes and automatically selecting the best positioning on the screen.

Another major result is the NoTube TV API which broadcasters can use to build new web-based applications and systems that make TV more interactive and 'do more'. 'The API opens up a lot of what we have developed in the project to broadcasters and media companies so they can build some of our functionality into their own platforms,' Brickley comments.

'We want the user to be back in the driving seat,' he says. 'NoTube can help people decide what to watch and share, record their preferences, find out more about a programme and have smarter conversations about TV programmes.'

Project partners are promoting results to the technical community; they hope that forward-thinking

companies will recognise the potential impact that cross-platform and open source solutions could have. 'Much of our research output and position papers are for a fairly small group of decision-makers in the TV industry and in standards organisations,' Brickley explains. 'But we have received excellent feedback and are involved in various discussions with the W3C standards community.'

The project was coordinated by the Vereniging voor Christelijk Hoger Onderwijs Wetenschappelijk Onderzoek en Patientenzorg in the Netherlands.

- 1 'Networks and ontologies for the transformation and unification of broadcasting and the internet'.

Funded under the FP7 specific programme 'Cooperation' under the theme 'Information and communication technologies' (ICT).
<http://cordis.europa.eu/marketplace> > search > offers > 9350

Enhancing virtual engineering

EU-funded researchers have developed a comprehensive virtual engineering platform for the aerospace sector. With integration of design, manufacturing and materials behaviour, the tool should significantly reduce associated time and expenses.

Software tools that help in the design of components have become quite common. Most are familiar with AutoCAD, the computerised drafting software that has replaced pencil and paper in many businesses.

Virtual design and manufacturing tools that take a product from conception through to manufacturing and have the ability to model material behaviour under various conditions are rare.

European researchers initiated the VERDI¹ project to develop just such tools for the aerospace sector. The goal was to facilitate the integration of robust manufacturing methods into the design phase, eliminating physical trials and long feedback times.

VERDI scientists developed the numerical algorithms for simulating eight different manufacturing processes, including metal deposition, welding, heat treatment, surface strain hardening and machining.

They integrated modelling of materials' behaviours to evaluate how materials held up to temperature ranges and changes as well as strains during these processes. The integrated VERDI virtual engineering tool was also able to predict component operating lifetimes.

Commercialisation of the VERDI platform has the potential to significantly reduce engine development time and cost while enhancing the reliability and lifetime of components.



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Project results provide a quantum leap in design and manufacturing of aerospace components that should contribute to global leadership of the European aerospace manufacturing industry.

The project was coordinated by Volvo Aero Corporation in Sweden.

- 1 Virtual engineering for robust manufacturing with design integration'.

Funded under the FP6 specific programme 'Aeronautics and space'.
<http://cordis.europa.eu/marketplace> > search > offers > 9319

A network to guide the future of computing

By around 2020, Moore's Law will start to reach its limits: the laws of physics will eventually pose a barrier to higher transistor density. How can computing systems, now facing a post-Moore era characterised by a data explosion, meet this ever-growing demand? This question is at the centre of the HiPEAC initiative.

HiPEAC¹ is a 'Network of excellence' from academia and industry that has been helping to steer European computing systems research since 2004. Currently in its third incarnation, supported over four years by EUR 3.8 million in funding from the European Commission, the project has become the most visible and far-reaching computing systems network in Europe.

'HiPEAC was set up with three main goals: to bring together academia and industry, to bring together hardware and software developers, and to create a real, visible computer systems community in Europe. On those fronts, and many others, we have undoubtedly succeeded,' claims Koen De Bosschere, professor of the computer systems lab at Ghent University in Belgium and coordinator of the HiPEAC network. 'We now have a portfolio of between 30 and 40 computer systems projects that we are working with.'

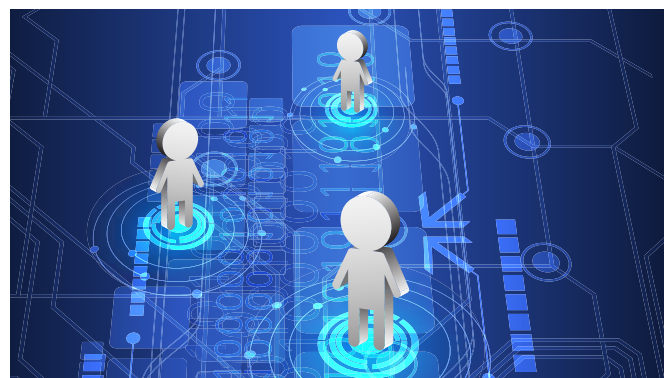
He points, for example, to the EuroCloud project, which began in 2010 with the support of EUR 3.3 million in funding from the European Commission. Coordinated by micro-processor designer ARM in the United Kingdom, the project is developing on-chip servers using multiple

ARM cores and integrating 3D DRAM with the aim of reducing energy consumption and costs at data centres by as much as 90%.

Meanwhile, the HiPEAC Roadmap, a new edition of which is due to be published this year, has become something of a guidebook for the future of computing systems research in Europe.

'We didn't really set out doing it with that aim in mind, but the Commission took notice of it, consulted with industry on it, found the challenges we had identified to be accurate and started to use it to focus research funding,' the HiPEAC coordinator explains. 'Since we produced the first edition in 2008, EU funding in the sector has almost tripled and the next call will propose around EUR 70 million.'

For the short and medium term, the latest edition of the HiPEAC report concludes that specialised computing devices is the most promising but difficult path for dramatically improving the performance of future computing systems. In this light, HiPEAC has identified seven concrete research objectives — from energy efficiency to system complexity and reliability — related to the design



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and exploitation of specialised heterogeneous systems. But in the longer term, the HiPEAC researchers say it will be critical to pursue research directions that break with classical systems, and their traditional hardware/software boundary, by investigating new devices and new computing paradigms, such as bio-inspired systems, stochastic computing and swarm computing.

'We can only go so far by following current trends and approaches, but in the long run we will nonetheless want and require more processing power that is more reliable, consumes less energy, produces less heat and can fit into smaller devices. More processing power means more applications and entirely new markets — just look at what's happened with smartphones and tablet computers over the last five years,' Prof. De Bosschere says. 'For industry, it means that today, instead of a person having just one desktop or laptop computer, they may have three or four devices.'

And, in the future, he sees ever-higher-performance devices doing

much more than is possible or even imaginable today: bio-inspired neural networks powering data-mining applications at 1% of the energy consumption of today's data centres, for example, or smartphones that can analyse a blood sample, sequence the DNA and detect a virus in a few minutes, rather than the days it currently takes using laboratory computer systems.

'The potential applications for computing technology in virtually every aspect of life are almost endless — we just need to make sure we have the processing power to run them,' he says.

The project was coordinated by the University of Gent in Belgium.

1 'High Performance and Embedded Architecture and Compilation'.

Funded under the FP7 specific programme 'Cooperation' under the theme 'Information and communication technologies' (ICT).
<http://cordis.europa.eu/marketplace> >
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Fisherman's atlas

The creation of a super web-based atlas for fish and their aquatic ecosystems will help improve the efficiency of fishing while promoting sustainability and environmental considerations.

The North Sea is known for its quality fishing, an industry supported by the Atlas of North Sea Fishes first published by the International Council for the Exploration of the Sea (ICES) in 1993. The recent EU-funded project ICES-Fishmap¹ aimed to

revise and digitise this valuable resource.

In light of changes in commercial species and rising interest in non-target species, the updated interactive web-based atlas incorporated data on fish

distributions and their projected evolution over the next three decades.

Available through the ICES website, the resource contains seasonal changes, species-specific information and references,

addressing topics such as biodiversity, ecosystem changes and exploitation. The atlas also allows users to plot fishing maps by age or length over specific time periods and access files on different species.

In addition, ICES-Fishmap made progress on enlarging the coverage area of the interactive atlas across the north-east >

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Atlantic shelf from the southern Iberian Peninsula to Iceland and Norway. This would eventually be extended into the Baltic and Mediterranean seas.

Such a valuable resource is highly useful for those interested in North Sea fisheries and

ecosystems, such as marine scientists, conservationists, fishery managers, ecologists, policy-makers and the public at large. It brings together information from over 1 million records and will have a positive impact on building a more sustainable fishing sector in Europe and beyond.

The project was coordinated by the Centre Netherlands Institute for Fisheries Research in the Netherlands.

- 1 'Update and revision of the ICES Atlas of North Sea Fishes: a web-based application'.

Funded under the FP6 specific programme 'Research for policy support'.
<http://cordis.europa.eu/marketplace> >
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Handy technologies for dextrous robots

A team of EU-funded researchers has developed the world's first human-sized, five-fingered robotic hand that can learn to grasp and manipulate a range of delicate and oddly shaped objects just as humans do.

According to Bill Gates, a time is soon coming when there will be a robot in every home. It does seem like we are at the dawn of robotics with intelligent and cognitive systems popping up all over the place. The camera and infra-red sensor on new video game consoles hint at a future when we can control devices just by speaking or hand gestures. There are even vacuum cleaners that navigate around your house and clean it up while you are out at work. But one big problem that the robotics community has struggled to solve is that of manipulation.

As coordinator of the Dexmart¹ project, Prof Siciliano has led a collaborative team of robotics researchers which has built an anthropomorphic five-fingered robotic hand that can handle eggs, pick up and turn a credit

card around, or take a pen from another person.

'Using strings that are twisted by small, high-speed motors, we are able to exert high-tensile forces within a compact space,' says mechatronics researcher Chris May from the University of Saarland, Germany. The robotic hand is able to touch diverse objects, grasp and lift them and place them gently in a new position.

The twisted strings are made of a strong polymer and enable the prototype hand to lift a five kilogram load by 30 mm within a split second, making use of small electric motors that are located in the forearm rather than the joints, which helps to give the hand the correct dimensions. 'The vision of robots as personal assistants in the household, in the operating



© DEXMART project

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room as well as in industrial settings is becoming ever more realistic,' says researcher Gianluca Palli from the Bologna team.

This hand has a brain, too. 'One of the goals of robotics, especially for companion and helper robots in society, is their ability to behave autonomously,' says Prof. Siciliano. But what is the best way to endow robots with this cognitive power? The professor believes that robots, just like humans, need to learn through observation.

A team of researchers from Karlsruhe University, Germany, Second University of Naples, Italy and the UK technology firm OMG, used advanced image-processing technology to study the fine details of human hand movements. They stuck visual markers on a special sensorised glove worn on their hands and were asked to perform various manipulation tasks that were captured on video. The image-processing algorithms could track the movements on

each marker and use this data to create rules on how the robotic hand should handle and manipulate similar objects.

Trying to coordinate the movements of five fingers, each with four joints, is incredibly challenging. 'Research into human hand control and coordination has shown that we don't control each joint separately; our brain controls all the joints at the same time in a coordinated fashion. Neuroscientists have demonstrated that human hand positions and movements can actually be simplified to just three so-called "postural synergies". These three synergies can describe about 80% of all possible grasping actions and positions,' says researcher Fanny Ficuciello from the Naples team.

The Naples team developed a control system which would take input from the optoelectronic sensors on the hand (which measure the grasp pressure), work out the

synergies and actuate the finger movements. The grip precision that these three synergies can create is quite remarkable and permits extremely refined manipulations.

Several sensors have been developed to measure joint angles, tendon forces and tactile interactions with objects. Within the tactile sensor, advanced computational analysis of the captured light intensity inside a number of sensitive elements makes it possible to calculate the forces exerted on the object by the fingers and also whether the object is slipping out of the grasp. Professors Giuseppe De Maria and Ciro Natale, together with researcher Salvatore Pirozzi from Second University of Naples, who developed the sensor, have filed a European patent for the technology.

'The success of the Dexmart hand is based on the integration of all these novel technologies and concepts — the sensors, the actuators, the control and learning

mechanisms,' says Prof. Siciliano. 'Our demonstration hand has proven its capabilities and we are now receiving enquiries and interest from research groups from many countries. Despite all this new technology, the cost of one of these hands is significantly lower than anything you could currently buy, and which would have much less dexterity.'

The project was coordinated by the Centre Universita degli Studi di Napoli Federico II in Italy.

- 1 'Dexterous and autonomous dual-arm/hand robotic manipulation with smart sensory-motor skills: A bridge from natural to artificial cognition'.

Funded under the FP7 specific programme 'Cooperation' under the theme 'Information and communication technologies' (ICT).
<http://cordis.europa.eu/marketplace> > search > offers > 8917

A virtual platform for studying infectious diseases

The study of infectious diseases constitutes a multidisciplinary approach necessitating the integration of molecular biology, immunology and cell biology. An EU-funded initiative has brought this idea a step closer to reality by designing a European virtual institute for bacterial genomics.

The key objective of the EPG¹ project was to form a 'Network of excellence' (NoE) of leading European researchers in the field of infectious diseases caused by

bacterial pathogens. Among the project's initiatives was the stimulation of multidisciplinary collaborative research activities, the creation of a training facility and

the fostering of biotechnological applications.

EPG participants wished to structure and organise the overwhelming mass of genomic information that had become available for micro-organisms and their hosts. This 'tidying up' would enable scientists to study and decipher the cross-talks between pathogens and commensals, and their host cells and tissue targets.

The network's expertise integration was intended to promote discoveries leading to the development of innovative diagnostic tools, and the discovery of novel anti-infectious agents and their targets. High-level teaching was also organised by the project at both graduate and post-doctoral levels, and exchange

programmes were designed to facilitate international and multidisciplinary development.

The EPG NoE managed to establish an internationally competitive platform of knowledge, expertise and technology that will aid research into infectious diseases and provide innovations in the areas of diagnostics, and drug and vaccine development.

The project was coordinated by the Institut für Molekulare Infektionsbiologie of the Bayerische Julius-Maximilians-Universität Würzburg Germany.

- 1 'European virtual institute for functional genomics of bacterial pathogens'.

Funded under the FP6 specific programme 'Life sciences, genomics and biotechnology for health'.
<http://cordis.europa.eu/marketplace> > search > offers > 9270



INDUSTRIAL TECHNOLOGIES



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Metal-mediated polymerisation for smart materials

The organic monomer vinyl acetate (VAc) is the precursor to polyvinyl acetate, an important industrial polymer. Controlled polymerisation of VAc is set to produce an explosion in production of previously impossible-to-engineer compounds.

The advent of controlled radical polymerisation has led to the development of complex polymer architectures that were once impossible to produce. VAc is one of those: a very high-profile monomer or building block due to its application in coatings, textiles and the pharmaceutical industry.

One disadvantage of VAc is that the monomer can only undergo radical polymerisation and is nucleophilic. Complete success in gaining a wide variety of polymer materials has

so far been hindered by the resulting inability to control the radical polymerisation process.

The Metmed-CRP¹ project aimed to overcome this limitation. By tuning the strength of metal-carbon bonds in organometallic complexes, it sought to modulate and control the 'Organometallic radical polymerisation' (OMRP) process. Metals that do not form very strong metal-carbon bonds were required for a successful trial – iron (Fe) (II) and copper (Cu) (I) fit the bill. Fe-based catalysts seem

particularly attractive due to their low cost and toxicity as well as their use in other polymerisation processes.

Using Fe in the system, VAc polymerisation is controlled, albeit weakly. Additional control was achieved by the addition of phosphines to slow down the process. One further problem was higher molecular weights compared to the theoretical proportion. However, results showed relatively low polydispersity (range of size). Use of dimethylphenylphosphine

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in particular gave the smallest differential between the observed and calculated 'polydispersity index' (PDI).

Metmed-CRP scientists have also isolated a metal-capped short oligomer for future use. The team characterised the fragment using 'Nuclear magnetic resonance' (NMR) spectroscopy, 'Electron paramagnetic resonance' (EPR) and chemical derivatisation, and proved reversible radical release from the oligomer.

During the OMRP process, there has to be reversible release of the PVAc chains from the acetylacetonate (acac) 2Fe-PVAc species.

Being able to manipulate molecular weights and structures of derived polymers will help to realise the full industrial potential of VAc.

The project was coordinated by the Centre National de la Recherche Scientifique (CNRS) in France.

- 1 'Toward new polymeric materials by metal-mediated controlled radical polymerization'.

Funded under the FP7 specific programme 'People' (Marie-Curie actions).
<http://cordis.europa.eu/marketplace> > search > offers > 8961

Integrating multiple functions in aerospace structures

The aerospace sector is focused on reducing weight and volume of equipment while decreasing cost and providing added value. EU-funded researchers have developed multifunctional structures to do just that.

Conventionally, research has concentrated on individual structure mass reduction. However, design of elements that integrate numerous functions, so-called 'multifunctional structures' (MFSs) would provide benefits otherwise unattainable.

European researchers sought to combine electrical, thermal and structural functions in highly integrated MFSs with funding of the Mulfun¹ project.

Technologies required for MFS design included advanced

modelling and simulation tools as well as techniques for cost and weight reduction via modifications to current electronic housings. Scientists studied concepts for fibres with high thermal conductivity as well as flexible electronics.

The Mulfun consortium also evaluated 'electromagnetic interference' (EMI) and 'electromagnetic compatibility' (EMC) issues as well as shielding from radiation.

Four experimental circuits (breadboards) were developed,

demonstrating a mass savings of about 35 % in a phase-array antenna for transport applications and about 65 % for an electronic box. All four breadboards demonstrated good electrical, thermal and mechanical performance.

Mulfun made an important first step in the development of MFSs that should provide tremendous mass and cost savings for the aerospace and satellite sector while delivering comparable or better performance. Mulfun also identified important areas

for further research to optimise design concepts and take them from lab to market.

The project was coordinated by the Fundacion Inasmet in Spain.

- 1 'Multifunctional structures'.

Funded under the FP6 specific programme 'Aeronautics and space'.
<http://cordis.europa.eu/marketplace> > search > offers > 9427



INDUSTRIAL TECHNOLOGIES

Toward mass production of superconducting tapes

EU-funded researchers have investigated novel production methods for superconducting tapes that could lead to large-scale, low-cost manufacture and widespread market penetration.



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Superconductors are materials that exhibit nearly no resistance (infinite conductance) to the flow of electrical current when supercooled to temperatures near absolute zero. They are 'grown' on substrates in a process called epitaxy, referring to the ordered deposition of one

crystal layer on the surface of another.

Yttrium barium copper oxide (YBCO or $\text{YBa}_2\text{Cu}_3\text{O}_7$) was the first material to act as a superconductor at relatively high temperatures that are easier to achieve (hence the name

'high-temperature superconductor' or HTS). It has gained particular interest for its use in superconductor thin films and in YBCO-based tapes for long-length 'coated conductors' (CCs), which consist of a metal substrate over which a thick film of superconductor such as YBCO is deposited. Various deposition methods based on chemical solution processing have been applied in an effort to make low-cost, mass-production of nano-structured HTS materials possible.

European researchers sought to advance the current position by combining two different rapid-growth-rate chemical processing methods: 'Metal-organic decomposition' (MOD) and 'Hybrid liquid-phase epitaxy' (HLPE).

With EU-funding of the Hiperchem¹ project, they investigated the integrated processing. Their main objective was to develop nanostructured CCs with

better performance characteristics, faster growth rates and reduced costs compared to conventional methods.

Hiperchem concepts and their eventual exploitation should help foster the use of CC technology in numerous fields, including the electrical power sector.

The project was coordinated by the Department of Magnetic and Superconducting Materials of the Consejo Superior de Investigaciones Científicas in Spain.

- 1 'High-performance nanostructured coated conductors by chemical processing'.

Funded under the FP6 specific programme 'Nanotechnologies and nanosciences, knowledge-based multifunctional materials and new production processes and devices'.
<http://cordis.europa.eu/marketplace> > search > offers > 9329

Lead-free solutions for electronics industry

Lead-free soldering in production of flexible circuit boards is causing potential manufacturing problems linked to temperature. European research has investigated materials and methods to overcome this issue.



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Flexible circuit boards are a rapidly growing technology for electronic goods, including hand-held devices, smart cards, aerospace, engine controls and displays, and medical sensors. These circuits are manufactured using two base materials, polyimide and polyester, the latter being used in low-cost devices.

A limitation of both circuit board materials arises from temperature sensitivity: polyimide at about 177 °C and polyester around 74 °C. This calls into question whether the boards can tolerate the high-temperature soldering required when lead-free solder is used, which may impact their operation.

Given the significant use of flexible circuit boards in the manufacturing of electronic products, the Flexnolead¹ project aimed to develop new materials and processes. The prime objective was to ensure that flexible boards could withstand lead-free soldering temperatures.

Other important objectives, particularly for small and medium-sized enterprises (SMEs), included developing techniques for predictive assessment of lifetime. The scientists also gathered data on failure modes to enable model validation and to provide guidelines on the use and maintenance of devices incorporating flexible circuit boards.

Success of the Flexnolead project can be measured by the deliverables. The scientists gathered information as to how typical materials used behave in lead-free soldering

processes and on alternative materials, and provided methods for the production of flexible circuit parts. Details were also collected on the reliability of boards through physical testing and modelling.

The establishment of solutions for lead-free processing in flexible circuit boards promises to open up new opportunities in 'green' technology. This could very well be key to the production of next-generation electronic products.

The project was coordinated by TWI Limited in the United Kingdom.

- 1 'Flexible circuits processing, performance and reliability using lead-free soldering process'.

Funded under the FP6 specific programme 'SME activities'.
<http://cordis.europa.eu/marketplace> > search > offers > 9453

Improving plastics production

A European alliance between small and medium-sized enterprises (SMEs) and academia worked to develop a plastic extrusion method that is energy saving and cost effective. Partners are hopeful that industrial application of this technique will not only prove beneficial for Europe's economy, but will also be more environmentally friendly compared to current technology.



degradation of material can occur resulting in loss of mechanical properties.

Overcoming these obstacles and improving the output rates of plastic extrusion were the objectives of the EU-funded Flowfree¹ project. Previous work by project partners had shown that compressed carbon dioxide (CO₂) was capable of enhancing the production of solid extrudate with reduced viscosity, and at faster manufacturing rates and reduced temperature.

The next step was to demonstrate the commercial viability of the process by developing a prototype extruder that would allow the method to be adapted to industrial scale. Various prototype systems

were tested and parameters were optimised. After scaling up they were installed at four industrial locations to enable testing of the process within a production environment.

The Flowfree patented technology offers enhanced solid extrusion rates, with the associated benefits of reduced melt viscosity. Its commercial exploitation will relaunch the plastics industry in Europe by significantly improving its global competitiveness.

The project was coordinated by Rapra Technology Ltd in the United Kingdom.

- 1 'Development of a high output processing method for the extrusion of solid thermoplastic sheet and profile'.

Funded under the FP6 specific programme 'SME activities'.
<http://cordis.europa.eu/marketplace> >
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Plastic parts and products are manufactured through extrusion and co-extrusion processes that involve the melting of plastic beads into a continuous

profile. The viscous nature of polymer, however, slows down the manufacturing rate at normal processing temperatures. If the temperature is increased,

Textile production comes clean

The amounts of resources, dyes and chemicals that go into producing textiles can be reduced considerably using cleaner and more economical strategies based on advanced-sensor technology.

In general, laundry processes such as washing, dyeing and rinsing are considered very cost intensive and waste large amounts of water. This implies a strong need for a more advanced method to calibrate and streamline the process.

The EU-funded project Washcontrol¹ aimed to overcome

this limitation through the use of advanced-sensor technology. It was hoped the system developed would reduce water consumption by up to 30 % by using water-recycling membrane technology. With this in mind, the team developed sensors and identified control parameters for rinsing and washing, in addition to analysing

washing processes and identifying alternatives to less harmful chemicals. Consequently, it developed and tested a multi-detector system and control software under actual industrial conditions.

Washcontrol investigated the most appropriate membrane recycling methods and the effect of alternative chemicals, including overall tests of the wastewater that is treated through these filters. It found that permeate from selected nanofiltration or reverse-osmosis membrane treatment was the most suitable for rinsing and dyeing without affecting colour fastness. In parallel, the project successfully tested and achieved water-recycling improvements, perfecting the associated software

to yield more cost-effective recycling during the dyeing process.

In effect, the project articulated a method for cleaner, more ecological textile production that is very cost efficient. Once the prototype hits the market, it will help the competitiveness of the sector in the EU and give a much needed push to the European textile industry.

The project was coordinated by the Institut fuer Textilchemie und Chemiefasern in Germany.

- 1 'Development of an online-sensor-based wash-control system and water recycling for use in textile dyeing houses and laundries'.

Funded under the FP6 specific programme 'SME activities'.
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INDUSTRIAL TECHNOLOGIES

Advances in mathematical group theories

New findings and proved theorems in group theory, graph theory and related disciplines have opened the topic to much more research and interpretation in the field of mathematics.

Modern mathematics principles rely heavily on group theory, where symmetries of arbitrary mathematical objects form groups that have a bearing on several areas of the discipline. One particular group of interest is the infinite or residually finite group where the intersection of sub-groups of finite index is trivial (e.g. finitely generated linear groups or arithmetic groups).

The EU-funded project Resfingroup¹ investigated the asymptotic behaviour of invariants on the sub-group lattice related to residually finite groups.

To achieve its goals, Resfingroup examined topics such as group theory, graph theory, elements of topology, dynamics and probability

theory. It probed links among asymptotic invariants of covering towers, algebraic invariants of residually finite groups and dynamical properties and invariants of profinite actions. In addition, it focused on how unimodular random graphs behave like vertex transitive ones.

In-depth research related to these topics revealed many important findings and results. For example, it proved that for a higher rank simple real Lie group, the quotient manifolds converge to the Lie group. This result affects various applications, such as the growth of Betti numbers and counting multiplicities of unitary representations.

Moreover, the research team developed a rigidity theorem on

expander Cayley diagrams and proved a strong version of Kesten's theorem on spectral radius. It also experimented with the chromatic polynomial of finite graphs that revealed enlightening information on uniform probability. These results have certainly opened new areas of interest in mathematics, particularly since they connect specific areas of the discipline in novel ways.

The project was coordinated by the Alfred Renyi Institute of Mathematics of the Hungarian Academy of Science in Hungary.

1 'Invariants of residually finite groups: graphs, groups and dynamics'.

Funded under the FP7 specific programme 'People' (Marie-Curie actions).
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Microwave radiation for resin polymerisation

A successful new method of resin cross-linking using microwave radiation boasts higher efficiency while reducing waste and environmental pollution. Advances in this area are expected to increase industrial competitiveness.

Resin polymerisation, also known as curing, is performed using heat, ultraviolet (UV) radiation or electron beam radiation. The thermal process, most commonly

used, takes place in metal forms and is most suited for mass production. However, for large parts like ship bodies, thermal curing takes too long as it is necessary

to fill the form with resin, thus increasing energy consumption.

The EU-funded CODE¹ project proposed to separate the filling and polymerisation reactions by modifying the resin-infusion process and using microwave radiation to polymerise the resins. By doing so, the curing time was reduced from days to hours.

A specialised agent was developed to enhance microwave-energy absorption by the resin, without changing its other properties. By measuring the temperature of the resin, partners were able to homogeneously heat it up and ensure its efficient cross-linking, reaching a polymerisation efficiency of nearly 100%.

The CODE-developed resin-curing method offered obvious improvements in working conditions, in terms of processing temperature in the production plant and

significant reductions of emissions. The structures produced by this improved method were more lightweight since they contained higher levels of fibres.

Partners are convinced this new polymerisation technique holds great potential in industrial applications as it combines lower processing costs and environmental benefits.

The project was coordinated by the Fraunhofer-Gesellschaft zur Förderung der Angewandten Forschung E.V. in Germany.

1 'Curing polyester resins on demand'.

Funded under the FP6 specific programme 'Nanotechnologies and nanosciences, knowledge-based multifunctional materials and new production processes and devices'.
<http://cordis.europa.eu/marketplace> > search > offers > 9456



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Protective coatings for lightweight metallic components

Funding provided by the EU has enabled scientists to develop thin-film protective coatings for one of the most promising yet underutilised materials demanded by the aerospace and other industries.



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Lowering the weight of metallic components while enhancing their physical, chemical and mechanical properties could bring tremendous benefits to industries such as the automotive and aerospace sectors.

Such characteristics lead to reductions in energy consumption and an increased lifetime for components in the face of environmental pressures and overall wear and fatigue.

Aluminium and titanium are two metals with low densities, which mean a lower weight per volume. They are also corrosion-resistant and capable of withstanding relatively high temperatures.

Titanium aluminide (TiAl) is an alloy produced by the combination of these two. Among the

three major compounds it forms, gamma TiAl has received the most attention, in particular from the aerospace industry.

However, despite its exciting potential and progress made in processing and engineering, widespread use has been limited in part by insufficient performance under severe environmental conditions and temperatures exceeding 800 °C, as well by its brittleness or limited ductility.

European researchers initiated the Innovat1al¹ project to develop protective coatings for gamma TiAl materials and to meet growing market demand.

Four different types of ultra-performance nano-scale-structured thin films were developed: nano-scale multilayers,

nanocomposites, intermetallic coatings, and 'Thermal barrier coatings' (TBCs).

In addition to developing new coatings, the Innovat1al consortium utilised a novel process for applying the coatings, namely 'High-power impulse magnetron sputtering (HIPIMS), a method for the 'Physical vapour deposition' (PVD) of thin films.

HIPIMS has the advantage of producing higher-density films with increased toughness, particularly important in increasing the attractiveness of gamma TiAl.

Innovat1al coatings demonstrated enhanced performance for the long-term protection of gamma TiAl components. Commercialisation has

the potential to help gamma TiAl meet the growing demand from the aerospace, automotive and energy sectors for lightweight, high-performance materials subjected to elevated temperatures and extended dwell times.

The project was coordinated by the Deutsches Zentrum für Luft und Raumfahrt e.V. of the Institut of Materials Research in Germany.

1 'Innovative processes and materials to synthesise knowledge-based ultra-performance nanostructured PVD thin films on gamma titanium aluminides'.

Funded under the FP6 specific programme 'Nanotechnologies and nanosciences, knowledge-based multifunctional materials and new production processes and devices'. <http://cordis.europa.eu/marketplace> > search > offers > 9318

EVENTS

Fourth European Multidisciplinary Meeting on Urological Cancers

The Fourth European Multidisciplinary Meeting on Urological Cancers will take place from 16 to 18 November 2012 in Barcelona, Spain. It will focus on 'critical appraisal and consensus on new treatment approaches in urological cancers'.

Co-organised by the European Association of Urology (EAU), the European Society for Medical Oncology (ESMO) and the European Society for Radiotherapy and Oncology (ESTRO), the meeting aims to deliver an in-depth review of the latest multi-modal management strategies for prostate, bladder and renal cancers. Sessions will include the most up-to-date information on research outcomes in Europe and overseas, the assessment of current treatment standards, and discussion on the future of medical therapies.

For further information, please visit:

<http://emucbarcelona2012.org/>

Fifth International Conference of Education Research and Innovation

The International Association of Technology, Education and Development will organize its Fifth International Conference of Education Research and Innovation from 19 to 21 November 2012 in Madrid, Spain.

Educational research consists in the evaluation of different aspects of education including, but not limited to, student learning, teaching methods, teacher training, and classroom dynamics. The conference will shed light on various aspects of educational research. It is intended to be a forum for researchers, practitioners, and students who are interested in all educational fields and disciplines.

For further information, please visit:

<http://www.iated.org/iceri2012/announcement>

'Cloud and security — threat or opportunity?' conference

The Direction Générale de l'Armement's conference 'Cloud and security - threat or opportunity?' will be held from 20 to 22 November 2012 in Rennes, France.

The advent of cloud computing generates new challenges for existing information technology operations and associated risk-management models. In this context, the conference will focus on the safety of cloud computing models. Discussion topics will include the sharing of applications, services or infrastructure across multiple domains, the impact of new business eco-systems and economic frameworks on traditional governance approaches, and the decoupling of application delivery from client device management.

For further information, please visit:

<http://www.cesar-conference.org>

'Earth observation and cryosphere science'

The European Space Agency will host an event on 'Earth observation and cryosphere science' from 13 to 16 November 2012 in Frascati, Italy.

The wide variety of satellite remote sensing techniques used in cryosphere research, as well as the increasing observational capacity provided by current and future optical, radar, laser altimetry, interferometry and gravimetry observations, provides a major opportunity to advance our knowledge about one of the most rapidly changing parts of the Earth's global climate system. This conference will provide a forum for scientists to present new research results and focus on and discuss future challenges on earth observation technology for cryosphere science.

For further information, please visit:

<http://congrexprojects.com/12c20>

Fifth Spain-Latin America Forum on Marine Resources and Aquaculture

The Fifth Spain-Latin America Forum on Marine Resources and Aquaculture will be held from 26 to 29 November 2012 in Cádiz, Spain.

Aquatic systems, seas and oceans occupy two-thirds of the Earth's surface and have a leading role in supplying food and consumables. According to the United Nations, 52 % of marine stocks are overexploited. The situation is particularly critical in Spain and Latin America, where increasing birth rates are leading to rising consumption of fish for a healthy diet. The forum will be an opportunity to discuss the diagnosis and relevance of focused strategies for fisheries and aquaculture in Spain and Latin America.

For further information, please visit:

<http://www.juntadeandalucia.es/agriculturaypesca/ifapa/firma2012/texto/41f107aa-d885-11e0-a65c-c5d9efb4b7b6>

'European gender summit - quality research and innovation through equality'

The 'European gender summit - quality research and innovation through equality' will take place from 29 to 30 November 2012 in Brussels, Belgium.

Extensive research has demonstrated that the quality of research and development is improved when gender is considered as a critical success factor. Organised by the European Science Foundation, the summit will be a forum for stakeholders to jointly examine how gender issues will impact the implementation of the upcoming Horizon 2020, European Research Area and Innovation Union.

For further information, please visit:
<http://www.gender-summit.eu/>

Sixth International Meeting on Molecular Electronics

The sixth International Meeting on Molecular Electronics will take place from 3 to 7 December 2012 in Grenoble, France.

Historically, molecules have never played a prominent role in electronic devices. However, over the past few years, an increasing number of synthetic and quantum chemists, physicists, engineers and other researchers have become more and more interested in their untapped potential. This event will address recent progress in molecular, organic and 'hybrid' inorganic/organic (opto)electronics, covering topics such as organic electronics, carbon nanotubes and nanowires and biomimetic devices.

For further information, please visit:
<http://www.electmol.com/>

Second World Congress on Fertility and Antioxidants

The Second World Congress on Fertility and Antioxidants will take place from 6 to 7 December 2012 in Paris, France. It will focus on 'strategies to overcome male and female infertility'.

Infertility has many causes involving either the female, the male, or both partners' reproductive systems. From a medical point of view, infertility is believed to be caused by several factors including ovulation failure, tubal damage, endometriosis, low sperm quality, and/or exposure to environmental contaminants. The conference will discuss some of the latest advances in oxidative stress effects and impacts on infertility. It will look at how this stress can be controlled and modulated to limited infertility and degenerative diseases, and in particular how it can help in the prevention and treatment of many chronic diseases.

For further information, please visit:
<http://www.fertility-site.com/>

'Towards a sustainable bio-based society: aligning scientific, cultural and societal agendas for bio-innovation society'

From 6 to 7 December 2012, Amsterdam in the Netherlands will host a conference entitled 'Towards a sustainable bio-based society: aligning scientific, cultural and societal agendas for bio-innovation society'.

Probably one of today's biggest challenges, the creation of a sustainable bio-based economy is often referred to as a 'second' Industrial Revolution and a 'greening' of industry, entailing a plethora of both promises and concerns. Organised by the European Science Foundation, the conference will bring together experts from academia, industry and politics with an interest in life sciences, social sciences and humanities. Together they will deliberate on a common agenda for research, a debate which will serve as a kick-off event for the ESF Conference Series devoted to this topic.

For further information, please visit:
<http://www.echallenges.org/e2012/default.asp>

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