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SPECIAL FEATURE

EUROPEAN WINE PRODUCERS STEP THEIR GAME UP



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**SKELETAL TISSUE
REGENERATION**

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SECURITY
**EUROPE'S RESILIENCE
TO THREATS GETS BETTER**

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EDITORIAL

by the editorial team

A CURE OF YOUTH FOR OLD WORLD WINES

With more than 167 million hectolitres (mhl) produced in 2015 out of a total of around 274 mhl, Europe is still the undisputed heavyweight of global wine production. Yet, its share is progressively shrinking — especially in the lowest price ranges — due to increased international competition. Consumption patterns are changing, with an annual decrease of 0.2% between 2011 and 2015. Stakeholders are calling for market reforms, and climate change is already challenging traditional production methods.

Part of the answer to such challenges lies in research and development, which has the potential to still shake things up by complementing EU producers' know-how. Higher crop yields, better plant resistance, shortened production processes, supporting technologies for everyday tasks or better wine quality are so many improvements they can bring.

**'Stakeholders are
calling for market
reforms, and climate
change is already
challenging traditional
production methods.'**

A look at the most recent EU-funded research achievements tells us much about what the scientific community and industry have left in the tank, and how vine growing will most likely look in a few years from now. This issue of the research*eu Results Magazine presents eight relevant projects of high potential value for the European wine industry, while at the same time reflecting on the challenges ahead.

The special feature is followed by highlights across nine themes of

research: health, society, energy, environment, aquatic resources, industry, information and communication technologies, security and fundamental research. The magazine closes with a list of upcoming events hosted by or involving EU-funded research projects.

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



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for carbon
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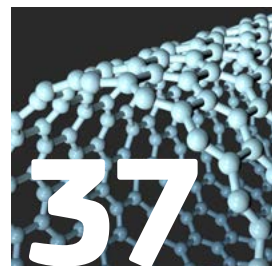
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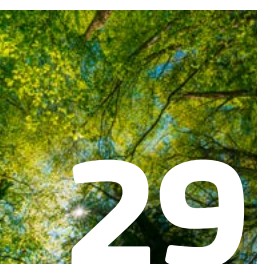


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SPECIAL FEATURE
EUROPEAN WINE
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INTERVIEW

AN AUTONOMOUS ROBOT TO PREDICT FUTURE YIELDS

A technology able to accurately predict future yields, without human intervention, would be a dream come true for vine growers across Europe. If all goes as planned, such technology should be available to them in less than two years.

In a market that's increasingly driven by quality, VINBOT (Autonomous cloud-computing vineyard robot to optimise yield management and wine quality) can provide European wine producers with a competitive edge.

As better forecasts also mean better decision-making, the autonomous robot and its network of sensors can estimate grape yield and relevant canopy features, generate maps, and share such information via the cloud.

André Barriguiha, CEO of Agri-Ciência and post-project dissemination/commercialisation leader of VINBOT, discusses the project's outcomes and plans for future work.

★ **What are the specific challenges that VINBOT aimed to respond to?**

André Barriguiha: VINBOT can run autonomously in the vineyard with no human intervention. It is equipped with a sensor system to allow navigation, localisation and data acquisition. It uses a single camera that collects shots from the canopy. Once it's done, it uses algorithms to identify the grapes and bunches and estimate future yields.

This is something that's currently not available on the market: There is no existing yield estimation device, so vine growers must resort to manual processes which are very time consuming and not very accurate. Thanks to VINBOT,

vine growers will have a new tool to make these estimates as early as possible.

★ **How come there was no such solution before VINBOT?**

Because it's very difficult to have a fully-autonomous robot that can both navigate inside the vineyard and estimate the yield. VINBOT is bringing just that: autonomous navigation thanks to an on-board GPS receiver and 2D rangefinder; an HMI to define a set of waypoints and the characteristics of the acquisition mission; vine measurement components; a cloud-based software that processes the robot's sensor data to extract relevant information and produce yield maps; and a web application for the end user to access these maps.

One of the major problems we faced was trying to identify the bunches in the vineyard, mainly when they are not visible to the camera (hidden by vegetation and/or other clusters).

This is a difficulty that we are still trying to overcome by the use of models based on the 3D canopy reconstruction obtained by the Range Finder. Our results showed that canopy features and yield can be estimated by the VINBOT platform with an acceptable accuracy. However, the underestimation of actual yield, caused mainly by cluster occlusion, deserves further research to improve the



© André Barriguiha

ANDRÉ BARRIGUIHA

algorithms' accuracy. We are confident that we can improve the accuracy by conducting further research, either on our computer vision algorithms or on the models to estimate the hidden clusters. We are aiming to put together a second project for that.

★ **What would you tell vine growers if you had to convince them of the benefits of using VINBOT?**

Manual error margins are huge, around 30%. So if they get a technology that helps them reduce this to 10%, it's a huge plus.

VINBOT can estimate their yield; yield maps autonomously and almost in real time; plan cluster thinning needs to prevent excessive production and consequent poor wine quality; as well as improve decision making regarding planning and organisation.

Finally, it can help plan for purchases and grape sales, decide on prices and management of wine stocks and on programming investments and develop marketing strategies.

★ **Do you already have an idea of what it would cost them to acquire the VINBOT technology?**

We don't think it makes sense for most vine growers to buy a VINBOT, because if it's only for yield estimation, then they would buy a device that will be in their garage practically all year. We rather intend to make VINBOT available through service providers, and probably wine producers managing large fields.

Also, VINBOT is not just the robot: it requires a server for post-image processing, so it would be easier and less expensive for vine growers to use a service provider.

Regarding commercial price, the final version of VINBOT would cost around EUR 30 000 including all components — however, as we fine-tune the technology, this price can drop.

★ **Speaking of which, VINBOT is cloud-enabled. Why was it important?**

Because of the large quantity of data to be processed, which makes it easier and cheaper to use the cloud. The algorithm to process the images is stored on a cloud-based

“Manual error margins are huge, around 30%. So if they get a technology that helps them reduce this to 10%, it's a huge plus.”

processor, so vine growers just need a login and a password to access their results.

★ **You also expect vine growers to be able to sell their wine at a higher market price thanks to VINBOT. How?**

It's not a direct benefit. If I use VINBOT, I can make better management decisions and indirectly increase wine quality: By optimising yield management and harvest logistics, quality and homogeneity of the fruit, canopy management, cluster thinning and differential harvesting I can plan more efficiently the production, marketing and wine distribution.

In theory, this enables wine growers to aim for a higher market price, but it might not always be realistic because of how highly competitive this market is. However, VINBOT can be relevant in decreasing overall production costs, thereby increasing profit margin.

★ **What can you tell about the main results from field tests?**

We are very happy with the overall robot platform behaviour. We have had a couple of issues with the traction of the wheels on tilled soil and the fact that the current system moves pretty much like a tank, but we are already thinking of implementing a new set of wheels that can turn independently of each other to resolve that issue.

The next challenge is mainly software and algorithms. We need a more compressive field validation not only focusing on data acquisition of images, but also to help us refine computer vision algorithms and modelling in data processing. This way we will know exactly what we need to do to achieve a less than 10-15% error margin regarding yield estimations.

★ **Supposing that you get further funding, when do you expect the technology to be commercialised?**

VINBOT is currently at level 7 of TRL (Technology Readiness Level). We are trying to get H2020 funding, and if we do get it and the upgrade/validation process goes as planned, it would be possible to see VINBOT on the market in under two to four years.

We also intend to put our technology to use beyond vineyards, for instance in raspberry greenhouses in Portugal which are interested in the image analysis-based yield estimation. We also have some contacts in the US and are planning to test VINBOT there. Finally, we intend to add more sensors, including environmental ones.

VINBOT

★ Coordinated by Ateknea in Spain.

★ Funded under FP7-SME.

★ <http://cordis.europa.eu/project/rcn/111459>

★ Project website:

<http://vinbot.eu/>



HOW GENETIC DIVERSITY CAN HELP VINE GROWERS FACE CLIMATE CHANGE

Maintaining the EU's competitive edge in the wine sector, in the face of climate change and increased competition, requires better and more diversified products. INNOVINE provides producers with much-needed knowledge, tools and genetic resources that will help them make the right choices.



The reputation of European wine mostly comes down to the selection of the best varieties, characterised by their taste and the terroir on which they are grown. But new challenges have emerged: if it is to compete in an increasingly globalised market affected by climate change and where consumer preferences are changing, the sector needs dedicated supporting tools.

“The most significant economic and environmental results were obtained by using new varieties.”

‘Recently we’ve been witnessing a rediversification pulled by producers developing organic or biodynamic vineyard strategies,’ says Dr Anne-Françoise Adam-Blondon, Research Director at INRA in France. ‘This requires new varieties whose resistance to disease reduces the need for pesticides, while also maintaining the typicality and value of the end-product. So far this could only be obtained with trial and error in long-term experimentation processes.’

With the INNOVINE (Combining innovation in vineyard management and genetic diversity for a sustainable European viticulture) project,

Dr Adam-Blondon and her team had two main objectives: providing stakeholders with tools that would help them better understand the impact of climate change and guide them in the related selection process, as well as developing a ‘portfolio’ of resistance genes to help them build new varieties faster and more efficiently.

‘The project aimed at combining short, medium and long-term approaches to conceive innovative viticulture systems, design and test novel agronomic practices and decision support systems and exploit the genetic diversity of grapevine, which all together will ensure progress towards sustainable viticulture,’ Prof. Adam-Blondon explains.

Among other things, the project developed two models able to simulate and predict the impact of vineyard practices and various abiotic stresses on grapevine physiology and berry composition under various climatic scenarios. Several non-destructive phenotyping tools were experimented and validated; different adaptive strategies were tested and fed into the project’s toolbox; as yet uncharacterised germplasm collections for resistance to diseases were screened; and current disease models were improved.

‘Overall, INNOVINE provides a set of diverse and complementary tools and knowledge that will be useful in

enabling a more environment-friendly control of diseases: level of resistance of tolerant varieties in field conditions, strategies to reduce the number of chemical treatments, as well as improved monitoring and DSS systems,’ says Prof. Adam-Blondon.

Benefits from the lab to the field

INNOVINE’s outcomes will be useful not only to growers, but also to scientists and technical advisors/service providers. Prof. Adam-Blondon expects growers to benefit from a significant decrease in pesticide use, making their farms more sustainable. Researchers, on the other hand, should benefit from the vast amount of knowledge generated by the project and tightened links between scientific communities.

‘The project has also enlightened two major topics on which extension services, technical advisors and service providers will have to focus their future work: the implementation of a better high throughput monitored viticulture and a diversification of the varieties that are used,’ says Prof. Adam-Blondon. ‘The most significant economic and environmental results were indeed obtained by using new varieties (resistant to diseases, better yielding in a given environment), but viticultural systems have to be improved in order to exploit this potential.’

In the near future, Prof. Adam-Blondon already intends to use some of the skills, knowledge and tools developed throughout the project to address the issue of wood diseases — which the community of grapevine growers identified as very important in a survey organised by INNOVINE.

INNOVINE

- ★ Coordinated by INRA in France.
- ★ Funded under FP7-KBBE.
- ★ <http://cordis.europa.eu/project/rcn/104501>
- ★ Project website: <http://www.innovine.eu/>

INTERVIEW

MICROWAVE TECHNOLOGY IMPROVES THE PROPERTIES OF GRAPE-DERIVED PRODUCTS

The WINESENSE project has successfully developed a novel extraction process for grape marc, resulting in higher polyphenol content. The consortium is already working on products for the cosmetics industry.

Beyond the fruit itself and the wine that results from its fermentation, grapes, and more particularly their polyphenolic content, hold much value for the food, pharmaceutical and cosmetics industry. The WINESENSE (Research on extraction and formulation intensification processes for natural actives of wine) project is hoping to tap into this potential through an improved extraction process based on Solvent Free Microwave Extraction, 'Microwave assisted extraction' (MAE), and emulsion-Template techniques combining high pressure and antisolvent effects.

Prof. Maria José Concero Alonso, coordinator of the project, discusses its results ahead of the final project conference taking place in June.

★ **What are the main shortcomings of current extraction processes?**

Prof. Maria José Concero Alonso: One of the main shortcomings of natural product extraction processes is the degradation of active components under high extraction temperatures and duration. The properties of natural products, for example their antioxidant capacity, natural colour, or flavour, are lost to a great extent.

★ **How is WINESENSE a solution to these problems?**

WINESENSE has developed a process intensification to reduce operation time. Our microwave technology allows for obtaining more selective extracts with operation times of a few minutes.

In addition, the process intensification technologies used in our formulation of the final product improve its quality.

Emulsion-template techniques combining pressure and antisolvent effects allow for achieving extract formulations of high quality. Formulation of non-water-soluble antioxidants in biopolymers has opened opportunities for the use of non-soluble polyphenols in food and cosmetic applications.

★ **How did you proceed to improve the extraction of polyphenols?**

The use of microwave technologies for the extraction of polyphenols from grape marc increases the contained amount of polyphenols, in particular anthocyanins and flavonoids. Anthocyanins are easily degradable polyphenols, and the reduction of extraction time to two minutes avoids its degradation.

Furthermore, the decrease in residence time reduces the concentration of sugars from the grape marc in the extract, so that post-treatment sugar fractioning steps are no longer necessary. Microwave extracts have an increased antioxidant capacity, mainly in easily degradable antioxidants.

★ **What would you say were the most important achievements of the project?**

The results of the project led to obtaining regional funding (Castilla y León Equipment Funding) to develop a continuous microwave technology able to extract polyphenols from agricultural sub-products.

The collaboration with Prof. Monzo Electrical Engineering Research Group from Cartagena University (Spain) has led to the development of a continuous microwave with an energy absorption efficiency of 98% and excellent heating homogeneity. The extremely high-energy efficiency allows for minimised consumption of microwave electrical power, which will in turn facilitate the commercialisation of microwave extract products.

★ **What kind of products do you foresee for commercialisation? With what benefits?**

I can give you two examples for the cosmetics industry. Quercetin booster (quercetin concentration 1800 ppm) encapsulated quercetin is enclosed in micronised liposomes made of natural lecithin. This formulation enhances penetration of the quercetin through the layers of your skin. Only natural compounds are used, and this formulation is produced by emulsion template technologies with pressurised water as an antisolvent. With this technology, we achieve a very efficient encapsulation, and it does not require expensive facilities. So, it could be used for small companies producing natural cosmetics.

Polyphenols extract formulates in food proteins are also undergoing epithelial cell *in vitro* studies at the premises of WINESENSE partner IBET in Portugal, to develop new natural cosmetics.



© Maria José Concero Alonso

MARIA JOSÉ CONCERO ALONSO



★ **What has been the feedback from industry so far?**

Our results will be presented during the WINESENSE School being organised by WINESENSE partner The Matarromera Company in Valbuena de Duero (Spain), on 21-22 June 2017. The event is open to both companies and researchers. Ribera de Duero is one of the best-known vineyards and wineries in Spain.

★ **When do you expect the first commercial products to enter the market?**

We are ready for it, now the ball is in the hands of industry!

WINESENSE

- ★ Coordinated by the University of Valladolid in Spain.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/110027>

THE ROLE OF ETHYLENE IN GRAPE RIPENING

Researchers have investigated the role of ethylene in grape ripening and taken steps towards understanding how different genes control this process.

Grapes are an important crop in Europe both as fresh produce and for winemaking, and the ripening process is key to producing good wine. The ripening process, the onset of which is called *véraison*, is a complex one, involving a number of different genes encompassing several metabolic routes.

The EU-funded project GRAPERIPE (The role of ethylene and of ERF gene regulators in the grapevine berry ripening) measured the endogenous ethylene gas in grapes of different cultivars and studied the function of one protein termed 'Ethylene responsive factor' (ERF) that switches grape-ripening genes on and off. Ethylene gas is a common ripening agent in many fruits, but the role of ethylene in *véraison* is not clear.

GRAPERIPE showed that in all cultivars tested, there is a peak in ethylene production about 10 days before grapes start to ripen, but the level is generally very low, though still likely playing a physiological role.

To gain more insight into climacteric and non-climacteric ripening, the researchers used melon, which is a perfect model for this type of study. They studied the variability in ripening behaviour and sugar accumulation in a collection of 175 melon accessions of different origin. The same samples were also investigated at the genetic level to compare the DNA sequence



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variability in 53 candidate genes involved in fruit ripening.

Another important result of GRAPERIPE has been the characterisation of transgenic grapevines with a high expression of an ERF encoding gene. The major finding was that this gene plays a key role in the morphology and structure of the leaf epicuticular waxes, besides other roles. This could make it of interest for future exploitation in terms of drought resistance as a result of reduced water transpiration, still to be tested.

GRAPERIPE findings will be useful for plant scientists studying fruit ripening, grapevine molecular biology and the role of ethylene, as well as for grapevine breeders and growers.

GRAPERIPE

- ★ Coordinated by the Edmund Mach Foundation in Italy.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/103718>

INTERVIEW

A WHEELED ROBOT TO MONITOR GRAPE GROWTH

Just like great wine needs time, great grapes require continuous attention and reliable assessment tools. Noting the absence of a convincing alternative to manual sampling and analysis, an EU-funded consortium has developed VineRobot, an 'Unmanned ground vehicle' (UGV) equipped with non-invasive sensor technology.



Today, assessing the readiness of vine grapes for harvesting requires growers to sample hundreds of berries, with their eyes as the only tool they can rely on.

With VINEROBOT's (VINEyardROBOT) technology, they can now look forward to the day when this tiresome work will be facilitated by a robot able to estimate future grape yield, monitor plant growth, as well as assess water status and berry composition, with all that information being made available on their smartphone or tablet.

Now with its second prototype, the VINEROBOT team has recently been granted a six-month project extension to complete its work. Dr Javier Tardaguila, coordinator of the project, discusses the benefits of this technology and his hopes for great success within the wine grower community.

★ What are the benefits of VINEROBOT's approach compared to alternatives?

Dr Javier Tardaguila: Recently, various remote sensing solutions from aerial platforms or satellites have been enhanced with simultaneous acquisition of spectral information in the visible and infrared ranges, allowing for the assessment of grapevine vigour and water status. But the small spatial resolution of multispectral devices, the discrete architecture of grapevine cultivation in rows rather than bulk crop, limited weather flexibility and the elevated cost of aerial monitoring, are major drawbacks which have forced small and medium-sized European vineyards to discard remote sensing altogether.

VINEROBOT is a promising alternative: It will provide reliable information using proximal sensors on-the-go in a non-invasive way, in different types of soils, and in a more cost-effective process that can be used across a wide range of vineyards.

★ What would you say are the most innovative aspects of VINEROBOT's UGV?

Rational decision-making in sustainable viticulture requires objective and continuous key parameter monitoring by means of advanced technologies and sensors in the field. But currently there are no commercial products that can simultaneously map key parameters such as agronomical, physiological and fruit composition on-the-go. Data sampling is being carried out manually, which implies high costs and low resolution, and is usually influenced by the interpretation of the person involved.

By designing, developing and deploying an agricultural robot in the shape of a UGV, and equipping this robot with several non-invasive sensing technologies to monitor the likes of grapevines' vegetative growth, nutritional status and grape composition, VINEROBOT aims to bridge this gap. Our goal is to optimise vineyard management, as well as improve grape composition and wine quality.

★ What tasks can this robot perform?

The VineRobot is equipped with non-invasive advanced sensors and artificial intelligence systems, to provide reliable, fast and objective information on the state of the vineyards to grape growers. Thanks to these technologies,

VineRobot will be able to work — that is, retrieving agronomical and physiological data from the grapevines — autonomously and safely over long periods of time under the uncertain environmental conditions typically found in vineyards.

The first version of the VineRobot incorporates a fluorescence-based sensor to assess nitrogen content in leaves. The measurement is performed on-the-go and provides information about the heterogeneity and state of the vineyard.

The other sensor included in the VineRobot measures the anthocyanin content in grapes. This sensor is a fusion between a fluorescence sensor and a fine vision system: It gathers information about the composition of grape berries.

A second version of the VineRobot is already foreseen. It is expected to include two additional sensors: one for yield assessment and one to control vineyard water status.

★ What has been the sector's feedback so far?

Grape growers that have seen the VineRobot have shown a high level of interest, especially young grape growers (younger than 45 years of age), because they are often more open-minded regarding new technologies.

However, in the long term it is expected that older viticulturists will also consider using our robot, once they witness the good results brought in other vineyards.

★ What can they expect in terms of concrete benefits?

The VineRobot works alone, without the need for any human presence. Moreover, working speed can be adjusted depending on the size of the vineyard, so that the robot can obtain information about the whole vineyard easily and in a short period of time, whilst providing useful maps to vine growers.

These maps of wine parameters can help them with how to best treat the crop. For example, they can plan for a more precise mechanical harvesting or fertilisation, which will have a huge influence on the yield and the wine's quality.

★ When do you expect your solutions to be commercialised?

We are still developing and completing the VineRobot, improving its latest version. We don't really know when it will be ready, but we expect that the product could be commercialised next year.

VINEROBOT

- ★ Coordinated by the University of La Rioja in Spain.
- ★ Funded under FP7-ICT.
- ★ <http://cordis.europa.eu/project/rcn/111031>
- ★ Project website: <http://www.vinerobot.eu/>
- ★  <http://bit.ly/2mN96kv>



DR JAVIER TARDAGUILA

NEW WINE BOTTLING TECHNIQUES COULD BOOST THE SHELF-LIFE OF WINE

An EU-funded project has developed innovative new wine bottling technology that cuts the amount of oxygen in a bottle, reducing the need for sulphates.

From the Phoenicians to the Romans, winemaking may have been practiced for thousands of years across the globe, but the winemaking process is still evolving and undergoing refinement. Today, a group of winemaking experts in Italy are focusing on improving the bottling process, in a bid to reduce the amount of oxygen that can get mixed into the wine and quicken spoilage rates.

EU-funded project RICAMO (Innovative oxygen-free wine bottling process) has invented a new wine bottling machine using a totally unique method of introducing the wine into the bottle. 'A traditional bottling machine used across the industry can create a circulation of gas and liquid inside a wine bottle. This introduces oxygen and generates the



need to add unhealthy sulphates to a wine to lengthen its shelf-life,' explains Alberto Ruggin, RICAMO project coordinator.

During current processes, a filler straw goes into the neck of the wine bottle and inserts an inert gas. The wine is then injected onto the wall of the bottle. During this process oxygen can get mixed into the wine, so many wine-makers add extra sulphates to destroy the oxygen.

The wine bottling machine developed by RICAMO goes right down inside the bottle. It then injects a bubble of inert gas — like nitrogen or carbon dioxide — into the centre of the bottle. Wine is added into this bubble and the filler straw rises up as the liquid fills the bottle without touching the wine that is already inside the bottle. 'Our machine can introduce 10 times less oxygen than existing machines on the market and improve the quality of the wine as well as its shelf-life by about two to three years depending on the wine type,' says Ruggin.

RICAMO's technology is particularly suited to more natural wines including

organic and biodynamic wines which are becoming increasingly popular among more eco-conscious wine consumers. By eliminating more oxygen in the bottling process, fewer chemicals are needed to extend shelf-life enabling more and more wines without chemical additives to reach the market.

But it's not just about shelf-life. Ruggin claims RICAMO can improve the quality of the wine too. 'We have tested wines produced under exactly the same conditions — same grapes, same soil, same fermenting processes — it's only the bottling process that changes. Experts from across the wine industry have said that wine bottled using RICAMO technology tastes better — it has more freshness and an improved structure,' he says.

Although the project started just three years ago, RICAMO is hoping to start selling its machines to the wine sector by the end of 2017 or the beginning of 2018. Part of the EU funding received by the project will go towards offering the company's first six customers a discount price to help launch the new machine on the market.

"Experts from across the wine industry have said that wine bottled using RICAMO technology tastes better."

However, Ruggin does expect to meet some resistance to change from the more traditional Italian wine industry. Meanwhile, younger wine industries like those in the US and Australia have already shown an interest in the project's new technology.

RICAMO is also planning to target the beer industry, hoping to arouse the interest of microbreweries which could use the same bottling technique to improve the shelf-life and quality of beer. And, in the future, it could look towards other industries including olive oil.

RICAMO

- ★ Coordinated by Enter in Italy.
- ★ Funded under H2020-SMEINST-2.
- ★ <http://cordis.europa.eu/project/rcn/204575>
- ★ Project website: <http://www.ricamosystem.it/>

INTERVIEW

IMPROVED POLYPHENOL EXTRACTION THANKS TO ULTRASOUNDS

With ULTRAWINE, Spanish SME AGROVIN promises a piece of revolutionary ultrasound equipment for wineries, one that will accelerate the grape maceration process and reduce energy use drastically — all this whilst guaranteeing great wine colouration and quality.

Vine growers and wine amateurs know all about them: polyphenols are the most important flavour chemicals in red wine, and have been found in numerous epidemiological studies to help prevent vascular disease, cancer or diabetes. They give wine its much-appreciated colouration, and can even influence the aftertaste and body.

With the ULTRAWINE (Eco-innovative maceration system based on LFHP ULTRASound technology for WINEmaking) project, Ricardo Jurado and his team have created a technology that will help vineries produce a high-quality wine with high polyphenolic content, intense colour and great aroma, in less time and with less energy input than ever.

Their 'Low frequency high power' (LFHP) ultrasound equipment, which is designed for optimising the extraction of phenolic compounds from grape skins during the first stages of winemaking, promises the completion of the grape maceration process in six hours instead of four days, with 30 times less energy being consumed and the ability to process three times more grapes.

★ How did you achieve acceleration of the maceration process?

Ricardo Jurado: We used the cavitation phenomenon. Cavitation consists in the formation and sudden implosion of



RICARDO JURADO



gas bubbles in a liquid. Each bubble undergoes compression and rarefaction. This causes the bubbles to implode, in turn generating enormous pressure that destroys the cell wall and allows the phenolic compounds to migrate to the liquid medium.

Although different techniques, such as thermovinification, cryomaceration or flash détente have been developed with the same objective of enhancing the extraction of phenolic compounds, our device presents interesting advantages over all of them.

★ What are these advantages?

First, cavitation is a time saving process: Thanks to ULTRAWINE technology, extraction is completed within a few hours whilst maceration takes several days. Then, we use the cold extraction method, which means that there is no temperature increase during the treatment, and no production of 'hydroxymethylfurfural' (HMF).

Our device also presents significant energy advantages compared to alternatives since it requires neither refrigeration like cryomaceration (cold production is one of the most expensive processes of the food industry), nor heating like thermovinification or flash détente do. This, along with the fact that there are no waste products specific to ULTRAWINE technology, makes for an environment-friendly process.

Finally, we have more aromatic wines and faster clarifications thanks to the use of ultrasounds.

★ What about the quality of the end-product?

ULTRAWINE uses a technology that is totally respectful of grape variety, because it is a non-thermal treatment based on a physical process which avoids the appearance of undesirable organoleptic attributes. Besides, thanks to the increasing processing capacity of the winery, grapes can be processed at their perfect point of ripening.

★ What has been the feedback from potential customers so far?

The wineries having tested ULTRAWINE have confirmed the aforementioned advantages, along with the fact that installation and handling are easy, and that our device saves space thanks to its small dimensions.

In fact, winemakers have been acting as promoters of this great project: they were the ones calling for equipment

capable of improving the extraction of polyphenolic compounds in a short period of time with the least economic expense.

★ What did you achieve thanks to EU funding?

The SME INSTRUMENT has allowed AGROVIN to fully develop its ultrasound equipment. The funding has also been invested in dissemination activities, in the establishment of a commercialisation plan and in assuring the protection of the industrial property of the equipment and its working mechanisms worldwide.

★ How do you plan to further promote your equipment?

We believe in the technique's potential and, therefore, we are investing high economic and human resources in it. The commercialisation strategy includes different actions, notably training our commercial department, organising presentations of the technology at wineries, participating in important forums and fairs, ensuring media coverage, and remaining active on social media.

★ When do you expect the ULTRAWINE technology to be commercialised and what are your mid- to long-term objectives in terms of success?

Prior to its commercialisation, ULTRAWINE's technology must be authorised within the wine sector. The OIV (International Organisation of Wine and Vine) is the internationally-recognised organisation in charge of accepting new technologies, and will have to authorise the use of our technology in the sector before we can commercialise it. Currently, the technology is in phase 3 out of the 7 required by the OIV's procedure to obtain its legal status.

Once we obtain the OIV approval, AGROVIN's commercial efforts will be intensified. But we already expect to obtain a wide acceptance in wineries, considering the positive results already obtained.

ULTRAWINE

★ Coordinated by AGROVIN in Spain.

★ Funded under H2020-SMEINST-2.

★ <http://cordis.europa.eu/project/rcn/197152>

EXPERT NETWORK AIMS TO TACKLE VINEYARD DISEASES

A European network for sharing information and identifying promising solutions to tackle vineyard diseases could help boost Europe's wine industry. The network's effectiveness might also provide inspiration to other economic sectors facing similar challenges.

Whilst the EU remains a leading wine producer — accounting for 45 % of wine-growing areas, 65 % of production and 70 % of exports in global terms — it nonetheless faces a number of industry-threatening challenges. One of these challenges is vineyard diseases, which given their cross-border nature can only be effectively tackled through strong Member State cooperation.

'We have seen decreasing productivity within vineyards due to diseases such as grapevine trunk diseases, Flavescence Dorée, downy and powdery mildew and more,' explains WINETWORK (Network for the exchange and transfer of innovative knowledge between European wine-growing regions to increase the productivity and sustainability of the sector) project coordinator Eric Serrano, South West Manager of the French Institute for Vine and Wine. 'These diseases are very well-known in many vineyards and can have a major economic impact on the industry. In part due to the move towards reduced pesticide use, we have to develop new ideas for tackling diseases.'

Indeed, fungicides such as sodium arsenite or 8-hydroxyquinoline have been banned in Europe. With no highly effective treatments available, especially for Grapevine Trunk Diseases, new strategies are needed.

Spreading knowledge

Therefore the EU-funded project has focused on strengthening knowledge and dissemination structures at the European level. 'We wanted to focus on improving winegrowers' knowledge of diseases; put in place the means to better coordinate European research and highlight new ideas,' says Serrano. 'We want to see knowledge about tackling diseases reach a much wider audience than just those involved in this project. Winegrowers should also be able to share different kinds of knowledge, experiences and approaches.'

A key result is the project's Knowledge Reservoir on Flavescence Dorée and Grapevine Trunk Diseases. This online platform aims to play host to all

worldwide existing knowledge on these topics, and has been developed with both researchers and winegrowers in mind. 'Stakeholders — such as scientists, advisors or winegrowers — can contribute to this archive by uploading their videos, images and documents in a few simple steps,' says Serrano. 'With many winegrowers testing innovative and sustainable approaches to fight against diseases, it is vital that we capture and share these ideas between European countries.'

The project also developed 16 technical datasheets, five end-user flyers, four technical articles, five video seminars and six video clips to help spread information on tackling disease. The success of this dissemination has led to researchers picking up on several innovations, which are currently undergoing scientific trial. 'Partners are also studying the possibility of transferring some results to other agricultural sectors,' adds Serrano.

Facilitating a healthy industry

Another success of WINETWORK's methodology has been its effective use of facilitator agents. The project established a network of 10 — one for each wine region involved in the project — to update winegrowers and researchers with relevant

information and help to connect them with project participants elsewhere. 'This has been the key to our success because it enabled everyone involved in the project to be in permanent contact,' says Serrano. 'This has been the missing link between science and practice.'

These 10 facilitator agents worked with regional working groups and two scientific working groups, forming a network that enabled scientific results to be transformed into practical information and end user materials. This effective model for facilitating knowledge transfer is something that can be replicated in other projects and in other industrial fields.

WINETWORK

- ★ Coordinated by IFV in France.
- ★ Funded under H2020-ISIB.
- ★ <http://cordis.europa.eu/project/rcn/194794>
- ★ Project website: <http://www.winetwork.eu/>

"We wanted to focus on improving winegrowers' knowledge of diseases; put in place the means to better coordinate European research and highlight new ideas."



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HEALTH

SKELETAL TISSUE REGENERATION

Regenerative medicine is a growing field with numerous biomedical applications. To facilitate patient benefit, an international alliance set out to establish large-scale research projects for skeletal tissue repair.

Musculoskeletal degeneration and complications from injuries are eligible for treatment by regenerative approaches. These strategies aim to repair, restore or rejuvenate skeletal elements and associated tissues using stem cells and biocompatible scaffolds.

Ideally, scaffolds with integrated bioactive factors that support the differentiation of stem cells into tissue-specific cells should be able to respond to environmental cues. Moreover, scaffold biomaterials should facilitate the tissue-implant interface and could comprise titanium rods with bulk polymers and self-assembling short peptides.

The EU-funded SKELGEN (Establishment of a cross continent consortium for enhancing regenerative medicine in skeletal tissues) initiative brought together leading EU and New Zealand experts in the field of orthopaedic research. Through a multidisciplinary approach encompassing bioengineering and computational modelling, the consortium aimed to develop novel regenerative medical solutions for the human skeleton, including bones, cartilage and tendons/ligaments.

Skeletal tissue engineering

Researchers initially standardised protocols for the isolation, characterisation and expansion of skeletal stem cells from different sources. In addition, they developed several biomanufacturing platforms for the design and production of tissue-specific porous scaffolds. These were designed to deliver the supporting material and growth factors for the directed differentiation of skeletal stem cells into bioengineered bone, cartilage or ligament.

Researchers visualised construct topology, performed mechanical evaluation and immunogenicity testing, as well as *in vitro* evaluation of biomaterial scaffolds. Studies in various animal models validated the biocompatibility and potential clinical efficacy of the generated constructs.

The overall tissue engineering approach was assisted via computational modelling. The aim was to understand the mechanisms of cell and tissue regeneration as well as the cells-scaffold interaction in the three-dimensional setting. 'Computational modelling is a new research tool, which is very important for the integrated

understanding of stem cell behaviour, cell growth and nutrient requirements as well as gases modelling during the tissue regeneration process,' Dr Yang explains.

Clinical translation

The next step towards clinical translation of these candidate medical devices was mediated through contacts with orthopaedic surgeons and the industry. Importantly, partners believe that 'the engagement of research scientists with clinicians at the early stage of research and development towards clinical translation will have a huge social and economic impact for the community.'

Doctors and researchers at the University of Southampton in related research employed a construct made of bone and titanium in hip surgery. Patient-specific, the implant was designed and developed using computer-aided design and manufacturing technology. Doctors used bone stem cells to replace bone loss and encourage tissue regeneration behind and around the implant. This cutting-edge technology is expected to significantly improve patient outcome.

Overall, SKELGEN achieved its mission of establishing solid cross-continent collaborations through exchange of researchers between EU beneficiaries and NZ partners, annual progress meetings and workshops. Project achievements were communicated in international symposia and conferences as well as through publications. Collectively, these efforts have led to joint EU ITN grant applications by the consortium members.

Bypassing political and ethical concerns, SKELGEN partners envision that innovations in stem cell therapy can significantly advance the field of regenerative medicine. A rapidly rising ageing population necessitates such progress in regenerative interventions to improve the life of citizens and reduce healthcare costs.

SKELGEN

- ★ Coordinated by the University of Leeds in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/109152>

AN RNA-BASED TOOLBOX TO ADVANCE CELLULAR COMPUTING

Scientists from Germany, France and Austria have successfully programmed cellular networks and community behaviour of bacteria using newly engineered 'RNA based devices' (RNAdevs) — small molecular modules that regulate gene expression and function mainly based on ribonucleic acid sequences. The resulting toolbox opens the door to various applications in white biotechnology and medicine.

The parallelism between cells and computers is well-known. Cells have their own algorithms, and the field of cellular computing is dedicated to 'hacking' these algorithms for various purposes, notably in the field of biology. With the RIBONETS (Programming cellular networks and community behaviour with synthetic RNA-based devices) project, Prof. Ilka Axmann set out to use RNA to perform these hacks.

'RNA has three major advantages,' she points out. 'First, RNA turnover is fast, making it possible to perform efficient computing with RNA networks. Then, RNA folding and RNA-RNA interactions can be well predicted computationally, which means that a wide range of novel devices can be built. Finally, RNA production is energetically cheap, as the host cell is not affected by computing.'

With this in mind, RIBONETS consisted in developing a novel RNA-based toolbox for cellular computing — a prerequisite for new RNA designs in synthetic biology and life sciences. 'The usage of the RIBONETS toolbox enables the creation of RNA-based sensors and RNA-based devices with efficient regulation of engineered metabolic and signalling pathways,' Prof. Axmann explains.

RIBONETS's toolbox consists of entirely synthetic RNA switches acting negatively on the expression of a target gene of choice. A flexible nucleic acid sequence design tool, called RNABlueprint, was developed. It features a user-friendly interface, is open-source and can be found on GitHub.

Although the project was completed without a specific application in mind, Prof. Axmann highlights its tremendous potential: 'In the future, RNA-based diagnostics and bio-therapeutics will improve the human condition not only by means of technological applications but also with new therapeutic approaches. Synthetic RNAs and RNA aptamers — presumably in combination with assisting proteins like CRISPR-Cas9 — have an enormous potential

for targeting disease-related genes that so far have been considered impossible to treat. Recent advances in chemistry will allow for direct delivery of synthetic RNA into cells, thereby further increasing their potential for future applications in nucleic-acid therapeutics.'

In the case of biomolecular RNA sensors, Prof. Axmann believes that platforms could be provided to utilise RNA switches allowing for rapid detection of pathogens, similar to the Zika virus biosensor developed by Pardee and Green's paper 'Rapid, Low-Cost Detection of Zika Virus Using Programmable Biomolecular Components'. By linking isothermal RNA amplification to toehold switch RNA sensors, the team has been able to detect Zika virus sequences from the plasma of a viremic macaque and demonstrate their specificity against closely related Dengue virus sequences.

When such applications can be expected, however, is a different story. 'From the current status it is difficult to forecast precisely. We need to further improve the regulatory effects of our negatively-acting RNA regulators. Thanks to RIBONETS we are now at a point where all pipelines have been set up and a direct high-throughput screening is now within reach,' says Prof. Ilka

Axmann. Synthetic RNA switches and biosensors designed and implemented by RIBONETS could become available in four to five years.

In addition to its toolbox, RIBONETS' value also lies in the education and training of a new generation of RNA scientists, as well as the bridges having been built between RNA bioinformatics and RNA wet lab biologists. 'The workshops and symposia we organise are strengthening a lively, interacting RNA research community,' Prof. Axmann enthuses.

Now that the project is completed, the team is already looking forward to continuing their work in RNA research, and more specifically consolidating and exploiting RIBONETS' RNA toolbox.

RIBONETS

- ★ Coordinated by the University of Düsseldorf in Germany.
- ★ Funded under FP7-ICT.
- ★ <http://cordis.europa.eu/project/rcn/108666>
- ★ Project website: <http://www.ribonets.eu>



TIME TO REVISIT ANTIANGIOGENIC TREATMENT OF CANCER

Targeting tumour blood vessel network is a well-established anti-cancer strategy. However, European scientists showed that antiangiogenic treatments may prompt metastases and have continued research into this important area.

‘Renal cell carcinoma’ (RCC) is the main type of kidney cancer that has consistently increased in incidence. Metastatic RCC has a poor outcome due to resistance to standard chemotherapy and prominent vascularisation pattern. Moreover, RCC represents a paradigm for anti-angiogenic treatment but this often leads to the recurrence of metastases and even the development of new metastatic niches.

“VELYMPH work focused on sunitinib, a tyrosine kinase inhibitor of several VEGF receptors and a first line antiangiogenic drug administered in patients with RCC.”

Researchers with the EU-funded VELYMPH (Investigation of VEGF-C involvement in acquired metastatic properties of renal cell carcinoma following anti-angiogenesis treatments) project hypothesised that antiangiogenic ther-

apy might be triggering tumour cells to escape via the lymphatic system, causing metastases. They therefore set out to investigate the association between antiangiogenic treatment and ‘Vascular endothelial growth factor-C’ (VEGF-C), a growth factor for vascular and lymphatic endothelial cells.

Sunitinib — mechanism of action

VELYMPH work focused on sunitinib, a tyrosine kinase inhibitor of several VEGF receptors and a first line antiangiogenic drug administered in patients with RCC. The scientists used a mouse RCC model and showed that sunitinib induced stress that led to higher VEGF-C expression in treated tumours.

Strikingly, these high VEGF-C levels correlated with shorter survival and increased metastasis. Underlying mechanisms indicated a stimulation of VEGF-C gene transcription and an increase in the VEGF-C mRNA half-life. Ultimately this led to the development of lymphatic vessels that facilitated metastatic dissemination.

‘The receptors targeted by the current anti-angiogenic drugs are also expressed on tumour cells that finally adapt to the pressure of selection exerted by the treatments,’ Dr Pages explains. ‘Finally tumours relapse after treatment because of such genomic plasticity of tumour cells.’

‘The challenge was to prove that this mechanism operated in sunitinib-treated patients as well,’ Dr Pages continues. For this purpose, researchers collaborated with different hospitals to obtain samples from RCC patients treated with sunitinib in a neo-adjuvant setting. Analysis of these retrospective samples alongside primary cells from operated tumours indicated an increase in lymphatic vessel formation and lymph node invasion.

The next generation of antiangiogenic drugs

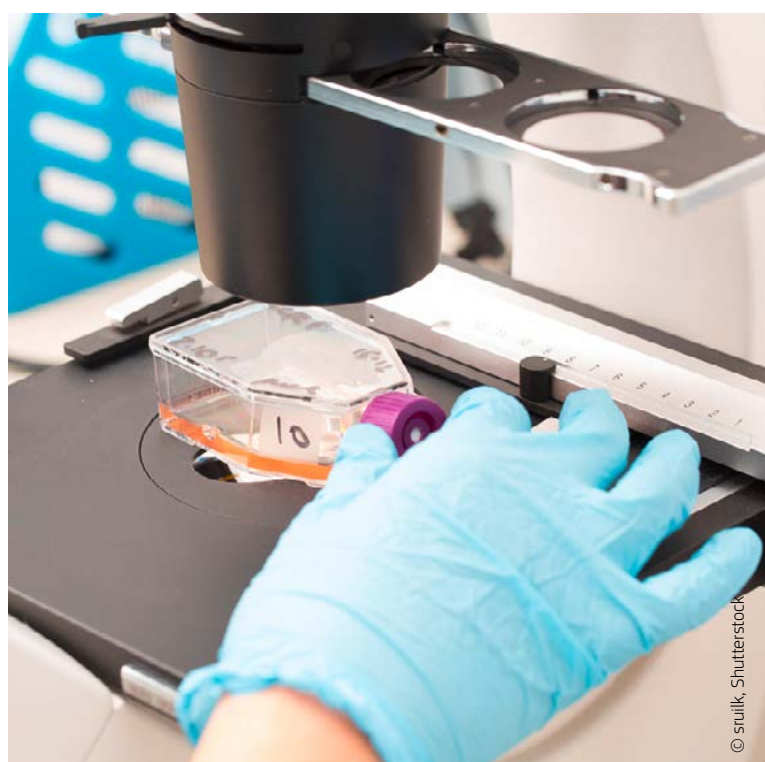
The VEGFC-dependent development of lymphatic vessels in RCC clearly demonstrated the capacity of cancer cells to

evade antiangiogenic treatment and emphasised the need for a new approach. VELYMPH data strongly suggest that a combination of antiangiogenic and anti-VEGFC treatments may improve the chances of long-term survival for patients with metastatic RCC. ‘It is important our results are communicated to inform clinicians that antiangiogenic treatment must not be used in a neo-adjuvant setting, note VELYMPH researchers.

Overall, the VELYMPH study demonstrated that although sunitinib and radiotherapy have revolutionised the care of RCC patients, their efficiency may be improved by targeting key molecules involved in the development of the lymphatic network. VEGF-C constitutes such a therapeutic target as well as a predictive marker of escape to antiangiogenic therapies. Improved treatment approaches for RCC and other cancers will lead to better clinical outcomes and reduced healthcare costs.

VELYMPH

- ★ Coordinated by LTM-CNRS in France.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/192276>



GETTING THE EU READY FOR THE NEXT PANDEMIC

For 18 months, the PANDEM project has been preparing recommendations to help the EU face a potential pandemic. Armed with its planning tool and other project outcomes, the team has identified research priorities and innovations needed to strengthen preparedness for pandemics.

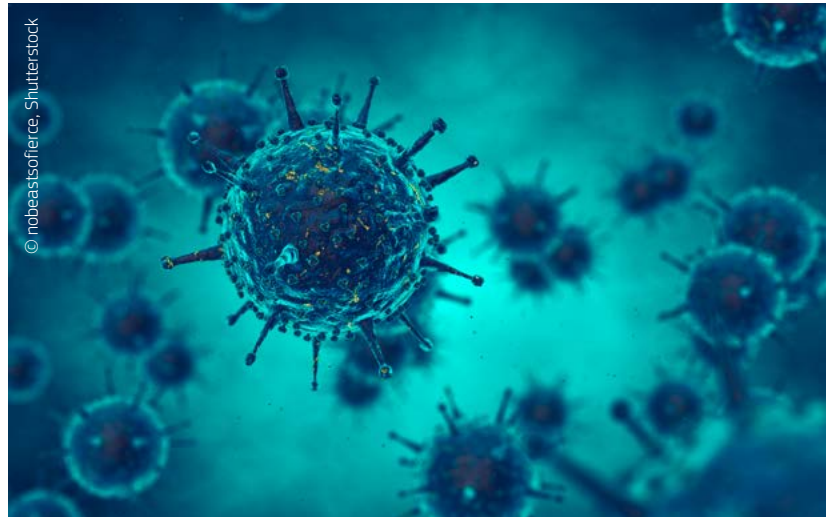
Whilst Europe is no stranger to pandemics, we could easily think that its darkest hours belong in history books — with the likes of the Plague that killed one third of Europe's population in the Middle Ages and the Spanish Flu that killed 40-50 million people in the early 20th Century — or overseas, with the well-known outbreaks of SARS, the Zika virus, Ebola and MERS-CoV.

The PANDEM (Pandemic Risk and Emergency Management) project, however, was initiated precisely because this threat is actually growing, even in Europe. Coordinated by the National University of Ireland, the EUR 1.3 million project notes the current convergence of risk factors driving disease emergence, along with the amplification and dissemination of pathogens with pandemic potential.

'The EU acknowledges that there is a growing health security threat posed by pandemics,' says Prof. Máire Connolly, coordinator of PANDEM. 'In Europe, the increasing numbers of airline passengers with larger travel hubs means that an emerging disease can arrive within hours in a European city. We also have a large population of over 750 million people, and densely populated cities.'

She continues: 'Add to this: the continuing circulation of influenza viruses among birds, pigs and humans; the threat of bio-terrorism; and the potential for an accidental release of dangerous pathogens if biosafety measures are not strictly implemented. Then put this in the context of antimicrobial resistance and we have a major threat to human health which could bring the management of infectious diseases back to the pre-antimicrobial era.'

In the face of this spine-chilling threat, PANDEM aimed to review best practices and identify the tools and systems needed to strengthen the EU's preparedness for pandemics and its capacity to face its health, socio-economic and security consequences at national, European and global level. Since the project started in September 2015, it has focused on identifying innovative solutions to build the capacity of EU Member States to collaborate on cross-border risk assessment, response and



recovery, within a multi-disciplinary, inter-sectoral network of experts.

'We have created a strong, multidisciplinary approach that has given us new insights,' Prof. Connolly explains. Together, experts in public health, microbiology, security, defence, information technology, communications and law notably created PandemCap, a planning tool for the visualisation and presentation of epidemiological data and simulation of the spread/containment of the pandemic depending on the implementation of control measures available to health professionals. 'The tool will allow planners to evaluate the cost of these measures and prioritise preparedness measures in order to maximise impact,' Prof. Connolly says.

All in all, PANDEM provides the European Commission with a number of recommendations on innovative solutions needed to strengthen pandemic preparedness. These recommendations were presented to a meeting of DG HOME's Community of Users on Safe, Secure and Resilient Societies in Brussels in March 2017.

Amongst the project recommendations is a model framework to ensure all EU Member States have legal underpinning for pandemic response measures such as quarantine and isolation, the equitable distribution of scarce resources such as vaccines and other medical countermeasures. 'Improved situational awareness using community

"We have created a strong, multidisciplinary approach that has given us new insights."

reporting of cases of an emerging disease and social media data will help ensure rapid detection and accurate monitoring of the impact of the next pandemic. This would also support citizen involvement in pandemic response by facilitating dialogue between public health institutions and EU citizens,' Prof. Connolly points out.

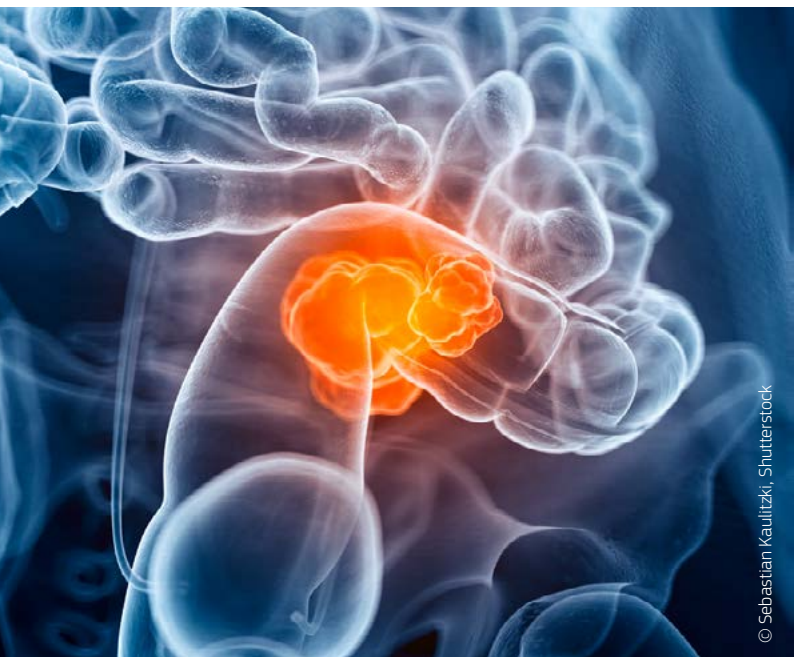
Whilst the team acknowledges that the timing and origin of the next pandemic is uncertain, they are confident that improved preparedness can minimise its impact on human lives and health, along with the resulting societal and economic disruptions. 'By applying innovations from the security, defence and crisis management sectors to improve the tools and systems used by the health sector, we can help to ensure that Europe and the wider world are better prepared to rapidly detect and mitigate the impact of the next pandemic,' Prof. Connolly concludes.

PANDEM

- ★ Coordinated by NUI Galway in Ireland.
- ★ Funded under H2020-DRS.
- ★ <http://cordis.europa.eu/project/rcn/197272>
- ★ Project website: <http://www.pandem.eu.com/>

THE POWER OF LONG NON-CODING RNAS

EU researchers are making major headway in determining what molecules cause cancer in the human intestine. The next step — formulation of personalised therapies for colorectal cancer.



“Researchers looked specifically at a class of newly identified genes, long non-coding RNAs (lncRNAs).”

Links to cancer

The ASCL2 gene is part of the system that controls the fate of stem cells in the intestine and, with WNTLINC1, forms a feedforward regulatory loop, which is dramatically amplified in colorectal cancer. WNTLINC3 researchers have also found that WNTLINC1-ASCL2 control is amplified in other forms of cancer and is involved with a tendency to develop the disease. ‘We are conducting experiments aimed at elucidating the WNTLINC1-ASCL2 contribution to non-intestinal carcinogenesis’ says Dr Hatzis.

Another two lncRNAs strongly implicated in cancer development are WNTLINC2 and WNTLINC3. Like WNTLINC1, they are necessary for the survival of colorectal cancer cells. Absence of the two lncRNAs causes changes in the fate of stem cells. Dr Hatzis talks about ongoing investigation, ‘We are currently carrying out experiments to decipher the mechanistic basis behind the dramatic phenotypes caused by the absence of WNTLINC2 and WNTLINC3 in colorectal cancer cells and studying their role in carcinogenesis in other tissues.’

Future of personalised lncRNA therapy in the clinic

Project researchers believe that some of the lncRNAs they have worked on could turn into promising targets for diagnosis and therapy in a personalised medicine setting. ‘WNTLINC1 for example is overexpressed in colorectal cancer and, through its actions on ASCL2, is putatively involved in cancer stem cell maintenance and expansion,’ explains Dr Hatzis. Moreover, WNTLINC1 in other tissues is expressed only in some patients and only in cancerous tissue. ‘This would make it an ideal candidate for personalised diagnostic and therapeutic applications.’

The potential of lncRNAs in personalised medicine is evident from the interest expressed by biotech companies. As for the time frame, Dr Hatzis is optimistic: ‘We could envisage that, given the right circumstances and sufficient interest from the biotech and pharmaceutical sector, some aspects of our work could have clinical applications within years rather than decades.’

The cells lining the adult intestine are continuously renewing themselves. A biochemical pathway, Wnt, lies at the heart of the crucial switch — when the cells stop dividing and differentiate to become a specialised cell. Mutations that cause faults in the molecular outcome of the pathway can cause colorectal cancer.

The WNTLINC3 (Identification and functional and mechanistic characterisation of Wnt-regulated long intergenic non-coding RNAs) project has identified novel Wnt target genes and explored how they are regulated by the pathway. ‘Understanding how the pathway regulates them and elucidating how these target genes impact intestinal physiology and disease is crucial in designing novel diagnostic tools and therapeutic approaches,’ explains Dr Pantelis Hatzis, project coordinator at the Biomedical Sciences Research Center Alexander Fleming.

Importance of lncRNAs in sickness and health

Researchers looked specifically at a class of newly identified genes, long non-coding RNAs (lncRNAs). Although thought to be highly important in cell health and disease, only a small number have been characterised, out of tens of thousands potentially out there. WNTLINC3 used cutting-edge technologies to address challenges such as the naturally low levels of lncRNAs in systems, sometimes lower than 10 molecules in one cell!

The researchers focused on ‘WNT-regulated long intergenic non-coding RNA 1’ (WNTLINC1), which is a direct positive target of the Wnt pathway and is necessary for the viability of colorectal cancer cells. To do so, WNTLINC1 molecules cause the formation of chromosome loop to come into contact with the regulatory regions of another gene close by, ASCL2.

WNTLINC3

- ★ Coordinated by BSRC Alexander Fleming in Greece.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/105436>

HERALDING A NEW ERA OF INCREASED LIFE EXPECTANCY AND GOOD HEALTH

A new study, drawing on the work of the EU-funded ERA project along with the further support of two others, finds more evidence that dietary restriction increases life-span, as well as delaying and protecting against age-related health problems.

Improving human health has been enormously helped by deciphering the human genome. Yet if we are to better understand physical processes, for example the onset of disease or the impact of ageing, we need to know more about how genes are actually organised and expressed, as well as their sequence. Problems with this control mechanism, referred to as our 'epigenome' have been implicated in common diseases such as diabetes and cancer. Our epigenome has also been linked to health declines related to ageing. With the ageing population ever-growing around the world, this is a challenge of increasing importance.

Yet there is strong evidence that epigenomic changes can be reversed. Investigating how this might be possible requires the production of reference maps for all relevant human cell types, accurate modelling, allied with efforts to track how epigenetic profiles, at both the individual and population level, are influenced by environmental factors.

Dietary restriction can protect and reprogramme

A recent study published in the *Genome Biology* journal focuses on work undertaken to understand one such environmental factor, namely that of diet. During ageing, it is known that reducing food intake can increase health and extend lifespan in a number of species, including rodents and rhesus monkeys. Indications are that Dietary Restriction (DR) can also improve metabolic and cardiovascular health in humans. But exactly how this happens is not yet well understood.

The study, drawing on the work of the EU-funded project ERA (Experimental Research into Ageing) (and supported by that of BLUEPRINT and EPIGENESYS — also EU-funded), found that mice lifespans could be increased by 30% when diets were reduced to 40% of their control group. To find an explanation, the researchers tracked the epigenetic impact of DR across the whole genome. They discovered that age-related changes to DNA methylation (a mechanism used by cells to control gene expression) across the genome, were substantially prevented

by DR. Additionally, DR also influenced the reprogramming of lipid metabolism genes resulting in protection against age-related increases of fat deposits in the liver and the development of hepatic insulin resistance, symptomatic of type 2 diabetes.

Professor Wolf Reik, Head of the Epigenetics programme at the Babraham Institute (part of the EPIGENESYS project consortium) is quoted as saying, 'This work significantly advances our understanding of epigenetic regulation of ageing and dietary restriction by connecting the epigenome more directly with lipid changes associated with healthy ageing. Future work may reveal if dietary restriction leaves a long-term epigenetic memory in the genome.'

Regenerative medicine

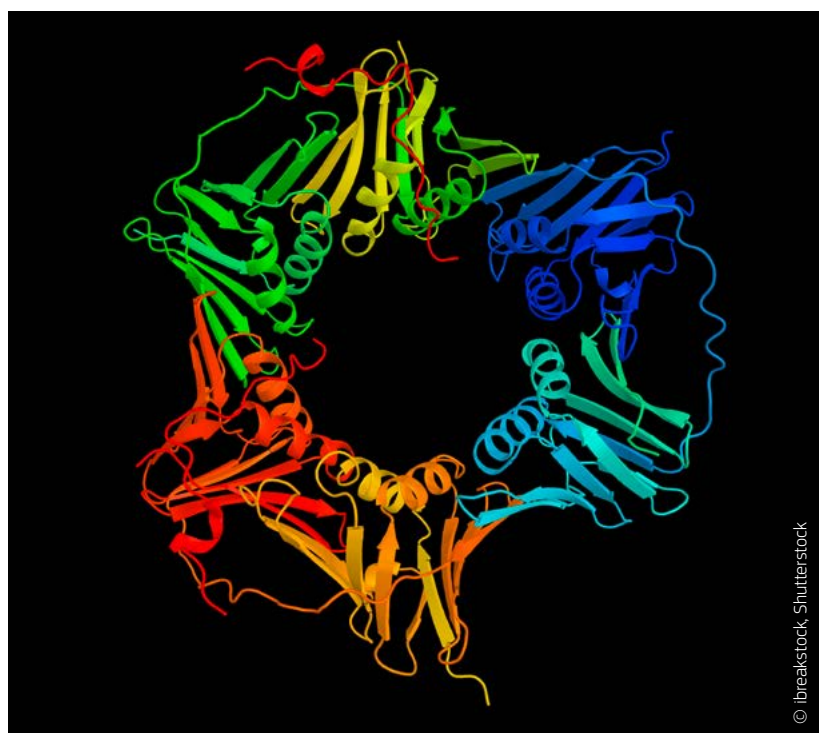
Looking to the future, the paper points out that recent research is adding to the stock of mounting evidence for 'particular components of nutrient-sensing pathways' that could prove valuable as pharmaceutical targets for drugs designed to prevent age-related disease.

A future where chemistry can mimic the effects of dietary restriction to reduce age-related illness will require a greater understanding of the role that epigenomes play and more knowledge about the underlying biological processes. The International Human Epigenome Consortium (IHEC) was established to coordinate efforts to achieve just these aims.

The recently completed EU-funded project BLUEPRINT contributed to these efforts as it was set up to generate around 100 reference epigenomes to study (focusing on blood cell disease) and to create new targets for compounds and the development of smart technologies for better diagnostic tests. Likewise, EPIGENESYS contributed by providing a quantitative representation of epigenetic mechanisms to better enable predictive modelling.

ERA

- ★ Hosted by the Max Planck Society in Germany.
- ★ Funded under FP7-IDEAS-ERC.
- ★ <http://cordis.europa.eu/project/rcn/99209>





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SOCIETY

THE EFFECT OF SOCIO-ECONOMIC SEGREGATION ON EUROPEAN CITIES

EU-funded researchers, who studied the widening gap between the rich and the poor in 13 European cities, show how socio-economic segregation reduces a city's sustainability.

The widening gap between the rich and the poor is segregating Europe's cities. Middle-class residents are moving away from low income neighbourhoods, those without options are going where housing is cheap, and gentrification is pushing poor people out of desirable areas. The result can be disastrous for the social stability of urban regions — not to mention the negative impact it can have on residents.

Surprisingly, there is very little research on the mechanisms that create these 'neighbourhood effects'. To get a better understanding of the issue, the EU-funded NBHCHOICE (Neighbourhood choice, neighbourhood sorting, and neighbourhood effects) project, in coordination with the ERC-funded DEPRIVEDHOODS project, launched an interdisciplinary and international study on how 13 European cities changed between 2001 and 2011. By drawing on available data, researchers first made initial predictions for each city concerning segregation before later testing these

predictions in practice. They also linked the assessment to an in-depth analysis of the unique local situation and policy of each individual city.

'The link between social stratification and spatial segregation isn't straightforward and is mediated by many other factors,' says Project Coordinator Maarten van Ham. 'With this project, we developed a multifactor approach for understanding segregation that combined structural/formative factors with a context-sensitive analysis of segregation.'

Further and further away

The project found that, with some delay, socio-economic inequality causes people in different income classes to live farther and farther away from each other. The main causes of this segregation are globalisation, inequality, restructuring of the labour market and changes in the welfare and housing systems. 'This spatial segregation of the rich and the poor can become a breeding ground for misunderstanding and social unrest,'

says van Ham. 'Recent riots in Paris, London and Stockholm cannot be seen separately from the concentrations of poverty in these cities — and our study demonstrates that this is a growing problem.'

Researchers also noted that although social inequalities are increasingly found in urban spaces across Europe, the process differs for each city. 'The link between social inequalities and segregation is not straightforward as it is mediated by many factors, including the level of globalisation in a city, the intensity and nature of immigration and the local urban spatial and housing policies,' explains van Ham.

Strong cities for a strong Europe

According to van Ham, socio-economic segregation reduces a city's social sustainability. 'Those residents who have the means tend to leave predominantly low-income neighbourhoods, which accelerates the process of segregation, making neighbourhoods more susceptible to

social unrest and less attractive to new businesses,' he says.

To remedy this, what Europe needs is a strong urban agenda founded on a vision to invest in cities and neighbourhoods — a vision that must include investments in education and social mobility. 'A strong Europe needs attractive, inclusive and

competitive cities, which can be accomplished by investing in neighbourhoods and communities and by reducing inequality through education and social mobility,' concludes van Ham. 'This is not a matter of ability, but one of will as segregation is partly the result of political choices and thus the political system has

the ability to reverse this worrisome trend.'

NBHCCHOICE

- ★ Coordinated by Delft University of Technology in the Netherlands.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/104916>

UNEARTHING THE MIGRATIONS THAT CHARACTERISE THE POPULATION HISTORY OF EUROPE

The EU-funded NEMO-ADAP project challenges our knowledge about the replacement of Neanderthals by modern humans in Europe, also providing insights into climate change resilience.

Within paleo-anthropological research, the Neanderthal replacement and the Middle to Upper Palaeolithic transition are two of the most hotly debated topics. Consensus has not yet been reached as to their timing, scale or sequence. Additionally, most research has concentrated mainly on areas of western, southern, and central Europe.

To address some of these uncertainties and limitations, the EU funded NEMO-ADAP (Neanderthal and Modern Human Adaptations in Eastern Europe) project focused its attention on western Ukraine and Russia in the investigation of the Late Middle and Early Upper Palaeolithic. The project set out to answer fundamental questions about the behavioural and cultural adaptations which enabled modern humans to disperse into Europe; whether these adaptations were unique to modern humans and to look at the prevailing climatic conditions during that dispersal.

Generating newly excavated materials and datasets

NEMO-ADAP selected case study regions in Ukraine and Russia because as the project coordinator, Dr Philip R. Nigst, explains, 'They are characterised by long loess-palaeosol sequences with high palaeoclimatic resolution, providing a crucial climatic context in which Neanderthal and modern human occupations can be situated.' Additionally, remains relating to both species were also known to be present at the selected sites.

The project's approach was highly inter-disciplinary, including specialists from the realms of archaeology and anthropology as well as geology, climate studies, mineralogy, dating studies (incl. radiocarbon) and genetics, offering what Dr Nigst refers to as, 'a role-model for similar projects.' While prior interdisciplinary research had taken place, it was



limited to a few sites and crucially also applied a variety of methodologies, which as Dr Nigst summarises, 'resulted in datasets of variably comparable quality and resolution.'

The NEMO-ADAP team conducted surveys to find new sites through the occurrence of stone tools and bone fragments on the valley slopes. Once identified, a vertical section was created to study the succession of deposits and to collect samples for Neanderthal and modern human behaviour, age estimation and the reconstruction of past environmental and climatic change.

The team made a number of somewhat surprising discoveries. They found that the first appearance of modern humans and Upper Palaeolithic technologies in Eastern Europe was actually 2000 years earlier than previously thought. As Dr Nigst explains, 'This means that there was an extended time of overlap between Neanderthal and modern human populations within Eastern Europe.' Genetic and population analysis also indicate that Eastern Europe was likely colonised by what the team refer to as 'directional, rapid dispersals'.

The project also provided evidence for Neanderthal and modern human presence in Eastern Europe during the coldest and most arid climatic phases, whereas previously it had been assumed that both could only happen during the warmer climatic phases. This suggests resilience to climate change by both species, though they were unlikely to have used the same survival strategies.

A Europe long characterised by migration

By better understanding the dynamics of past population movements, dispersals and fusions, the study has implications for our appreciation of the formation of a European identity through its genetic and cultural heritage. As Dr Nigst elaborates, 'It highlights that this diversity is key for our survival and prosperity, something especially important in the light of increased migration to and within Europe.'

Additionally, the study sheds further light on our species' responses to climate change, alongside improved comparative knowledge about how another closely related species (Neanderthals) fared under similar circumstances. Knowledge that while specific in this instance to Europe has ramifications for diverse cultures around the globe.

Having generated plenty of new high-resolution data, the NEMO-ADAP project results will now be compared with Central Europe results from an earlier project, as well as with patterns of Neanderthal-Modern human replacement described by other research teams, in various parts of Europe and Western Asia.

NEMO-ADAP

- ★ Coordinated by the University of Cambridge in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/106254>
- ★ Project website: <http://www.arch.cam.ac.uk/research/projects/nemo-adap>

IDENTIFYING THE INGREDIENTS OF ECONOMIC GROWTH



What factors contribute towards sustainable economic growth? EU-funded researchers have identified several factors that are not typically included in measuring GDP, but are vital contributors nonetheless.

The EU-funded SPINTAN (Smart Public Intangibles) project looked at how economic growth is generated by considering what are known as intangibles. The project's pioneering results have received a great deal of attention from both policy makers and academics;

the aim now is to feed the findings into economic policies that benefit citizens through achieving jobs and growth.

The importance of intangibles

'Intangibles are things like informational assets such as software, public

“Our results clearly show the role played by intangibles especially those ‘Beyond GDP’ in advanced economies.”

databases and open data, as well as cultural assets, public and private R&D, investments that contribute to increased added value such as trademarks, improved internal corporate organisation and labour force training,’ explains Matilde Mas, SPINTAN project coordinator and professor of economic analysis at the University of Valencia in Spain. ‘Of these, only software and R&D are already included in GDP; the remaining assets are what we call “Beyond GDP”.’

There is growing acceptance that these ‘intangible’ factors are crucial to a country’s economic performance, and that certain policies contribute to enhancing the role of intangibles in the economy. For example, strengthening the rule of law and defence of property rights improves a country’s reputation, whilst training up a labour force leads to greater efficiencies and makes a country an attractive long term proposition to employers.

The objective of the SPINTAN project, which was completed in November 2016, was therefore to develop new metrics and methods for understanding

how these intangibles positively impact national economies, with a view to helping policy makers make better informed economic decisions in the future.

Understanding economic growth

The project had three strands — measurement and conceptual issues; construction of a set of database around public intangibles; and analytical research on various aspects of that performance. ‘The overall research purpose of the project was to identify and measure public sector intangible investment and capital services and to evaluate its role as a driver of firm-industry-country economic growth,’ explains Mas. ‘We hoped that this will provide new insights into how innovation policy agendas can be pursued, and about the key role of that public sector knowledge plays in economic growth.’

In particular, the project focused on improving citizen welfare through two channels: enhancing efficiency and highlighting the risk of increasing inequalities. On the efficiency side, the project called attention to the positive contributions of intangible assets to economic growth, and highlighted the link between tangible and intangible capital as well as between market and non-market sectors. The project also identified the existence of spillovers coming from intangibles in both market and non-market sectors.

‘Our results clearly show the role played by intangibles especially those “Beyond GDP” in advanced economies,’ says Mas. ‘We are now presenting the main results through high level presentations at the European Commission, the OECD and the Inter-American Development Bank, and through the media. We hope this will convince decision makers of their relevance.’

The potential of this project in supporting growth and jobs in Europe has just begun to be tapped. Mas is hopeful that further academic work will continue in order build on the project’s pioneering results. ‘For this reason a new consortium has been formed and a proposal has already been submitted to the H2020 programme,’ she says. ‘The intention is to expand on the analysis that we have already done and to include the results of two other EU-funded projects: EU KLEMS and WIOD in addition to SPINTAN and INTAN Invest, which already concentrate on intangibles.’

SPINTAN

- ★ Coordinated by Ivie in Spain.
- ★ Funded under FP7-SSH.
- ★ <http://cordis.europa.eu/project/rcn/111389>
- ★ Project website: <http://www.spintan.net/>
- ★  <http://bit.ly/2qe2xeV>

THE MURDER OF JOURNALISTS – A POTENT PRECURSOR OF WIDER POLITICAL REPRESSION

Researchers from the EU-funded RATE project have studied more than one thousand press corps deaths across the world between 2002 and 2013. The results paint a stark warning that the deaths of journalists signal a dangerous slide away from human rights adherence and are a potent sign of growing political repression.

An independent press is a cornerstone of democratic accountability, the rule of law and a benchmark for ensuring human rights protection. All too often repressive governments have ordered the targeting of journalists when their reporting offends them or contradicts their policies, not only silencing criticism but also halting the free-flow of information. In 2015 alone, over 70 journalists were killed, most reporting about political issues, in countries as diverse as Ukraine, Turkey and Kenya.

Analysing a violent trend

Published in the ‘Journal of Peace Research’, the RATE (Repression and the Escalation of Conflict) project team has collected and analysed data on the killings of over 1 300 journalists and media personnel from across the globe between 2002 and 2013 to better understand



whether a tangible link exists between violence against the press and wider political repression.

Their results highlight that amongst the most dangerous countries for journalists are Syria and Iraq, which throughout the period studied have experienced civil war and political chaos. Overall, 162 (Syria) and 287 (Iraq) journalists were targeted. However, journalists are not only attacked in countries experiencing civil war — roughly one third of all killings between 2002 and 2013 occurred in countries that were not embroiled in conflict. Between 2002 and 2003 alone, members of the press corps were killed in over 80 countries.

Journalists are a big target in Mexico, one of the most dangerous countries in the world for members of the press. Other countries that experienced significant violence against journalists include Brazil, the Philippines, Indonesia, Nepal and Egypt. Overall, many countries where journalists have perished aren't considered particularly brutal or repressive regimes.

"The researchers argue that the killing of journalists acts as a precursor for worsening state-sponsored political repression."

Political imprisonment, murder and execution are indeed extensive in these countries but have not expanded to the whole population.

A warning sign of worse to come

Against the backdrop of these alarming figures, the researchers argue that the killing of journalists acts as a precursor for worsening state-sponsored political repression — murdering even a single journalist generally signals instability and growing tension, followed by increasingly invasive and harsher government behaviour. This is highlighted by the fact that 'foreign' journalists are rarely targeted, with local — and consequently more vulnerable — reporters bearing the brunt of state repression. The research also reports that those responsible for the killing are often never identified and justice rarely served.

In particular, tracking repression against the press is particularly useful for a 'middling' group of countries that are neither solid liberal democracies with a long tradition of press freedom but can equally not be classed as countries that are renowned for their brutality and repression. As the researchers point out, a country such as Australia or Norway would not be expected to suddenly turn on its press, nor would a repressive country, such as Sudan or North Korea, be expected to suddenly begin allowing greater openness and press freedom.

Regardless of other factors, such as economic development and democratisation, violence against the press is a vital clue on whether these middling countries are beginning to backslide on their commitment to wider human rights protections. In essence, the researchers argue, a stronger economy is unlikely to make up for the risk presented when a journalist is murdered. Countries they highlight as falling within this category where repression of the press would be an important warning signal include Peru, Sierra Leone, Malaysia and Tanzania.

Taking appropriate action

However, it is not all doom and gloom — when journalists are attacked or murdered in this group of countries, the warning it sounds should encourage the international community to take immediate action. The research team argues that policy initiatives are likely to have the biggest impact on the moderately repressive countries, as achieving improvements in highly repressive countries is extremely challenging.

The RATE project, based at the University of Mannheim, Germany, is due to end in January 2019 and has received nearly EUR 1.5 million in EU funding.

RATE

- ★ Hosted by the University of Mannheim in Germany.
- ★ Funded under FP7-IDEAS-ERC.
- ★ <http://cordis.europa.eu/project/rcn/111262>
- ★ Project website: <http://www.sabinecarey.com/>

SCIENCE AND SOCIETY TAKE ON SOCIAL INNOVATION TOGETHER

The power of social innovation is increasingly being recognised for its importance in facing the challenges of European cities and urban environments. Dialogue with citizens and mutual learning contribute to inspiring policymakers with innovative ideas, bringing the scientific community much closer to society.

Building networks that foster mutual learning between society and the scientific community, with the support of policymakers, has many benefits for communities and individuals. One enterprising endeavour that worked fervently to achieve this aim was the EU-funded SEISMIC (Societal engagement in science, mutual learning in cities) project. Mobilising numerous urban actors to identify research and innovation priorities, the project focused on addressing real social needs through a new platform for dialogue and mutual learning.

Bridging the gap between the scientific community and society makes science more approachable and understandable in the public sphere,' says Paul Erian, Research Engineer from the Austrian Institute of Technology, who is coordinating the project. 'It involves the project in scientific processes and shows that science can achieve changes in our daily lives.' In this way, SEISMIC has helped clarify misconceptions and misunderstandings in science, showing how science can serve society

"The national networks created a powerful dialogue and mutual learning opportunities involving citizens and urban stakeholders to generate ideas that will benefit society."



and encourage inclusive processes that achieve better results.

To achieve this ambitious objective, the project created national networks in several European countries: Austria, Belgium, the Czech Republic, Germany, Hungary, Italy, the Netherlands, Sweden, Turkey and the United Kingdom. From NGOs and grassroots movements to social innovators, scientists and policymakers, SEISMIC brought together the relevant stakeholders in each country.

As a result, the national networks created a powerful dialogue and mutual learning opportunities involving citizens and urban stakeholders to generate ideas that will benefit society. 'The local workshops are designed in a low-threshold manner so that every interested stakeholder can join,' explains Mr Erian. 'The networks actively approach and recruit people to become part in a discussion on urban issues and city,' he adds. This effectively brings urban issues to the forefront and empowers society towards finding innovative solutions to address them.

A crucial part of the project has been the Mobilisation and Mutual Learning

Action Plan. 'The plan gives local stakeholders the ability to comment on issues and cooperate with research organisations,' says Mr Erian, 'in addition to providing direct input to EU urban research matters.' The plan connects people and ideas, as well as creates a deeper understanding of cities' challenges and how these are being tackled. 'Understanding what other Europeans are thinking about and giving people the opportunity to collectively think about urban life in Europe is one of the plan's key advantages,' Mr Erian comments.

In effect, the project has successfully empowered people to initiate projects and initiatives in their community. It has become a platform to collect local knowledge and identify research needs. The newly identified societal needs in urban areas have been taken up by JPI Urban Europe, an EU Member State initiative supporting research to improve European cities' sustainability, resilience and their liveability. From hotels run by migrants to enhanced involvement for women in governing cities, the new ideas that have emerged from the project continue to shape today's cities, notes Mr Erian.

The wide range of urban actors from civil society in the 10 participating countries were exposed to numerous social innovation good practices that foster a more inclusive, sustainable and liveable future for cities in Europe. Even though the project has ended, several of the most active participants in the SEISMIC national networks continue to contribute ideas and experiences via JPI Urban Europe's Stakeholder Involvement Platform (Agora). This ensures that the project's results continue to benefit society. Put simply, there is no doubt that social innovations are changing the world we live in to the better, thanks to projects like SEISMIC that have helped redefine the pivotal science-society connection.

SEISMIC

- ★ Coordinated by AIT in Austria.
- ★ Funded under FP7-SIS.
- ★ <http://cordis.europa.eu/project/rcn/185532>
- ★ Project website: <http://www.seismicproject.eu/>

ENERGY

BETTER GAS TURBINE ENGINE DESIGNS BOOST EFFICIENCY AND CUT NOISE

An EU-funded project has sought to smooth out technical problems with greener gas turbine engines using improved engine modelling.

Gas turbine engines — used for electricity generation and in domestic boilers for heating buildings — have become greener over recent years. This was made possible by mixing fuel with an excess of air before burning it, resulting in lower flame temperatures and reduced emission of pollutants.

However, this pollution-cutting technology is prone to ‘combustion instabilities’ which can lead to high noise levels and sometimes damage to engines.

Scientists working under the EU-funded TANGO (Thermoacoustic and Aeroacoustic Nonlinearities in Green combustors with Orifice structures) project have worked on ways to overcome these instabilities. ‘Within TANGO’s research we wanted to understand the thermoacoustic and aeroacoustic interactions in combustion systems like gas turbine engines and domestic boilers that play a key role in combustion instabilities,’ says Maria Heckl, TANGO project coordinator.

Combustion instabilities can trigger intense pressure vibrations within the engine. These can then cause excessive structural vibrations, fatigue of certain engine components and even catastrophic damage to combustor hardware. ‘There is an urgent need to understand the physical

processes that are responsible so that methods to predict and prevent these instabilities can be developed,’ Heckl says.

In a bid to advance this field, the project developed an early warning system capable of detecting the oscillations associated with combustion instabilities well before they reach dangerously high levels. The early warning system has now been patented and is marketed by TANGO partner IFTA under the name ‘IFTA PreCursor’.

In a second line of enquiry, the project aimed to avoid these instabilities specifically in domestic boilers, which typically have a heat exchanger in the combustion chamber. The researchers developed theoretical models, which not only demonstrate that a heat exchanger with carefully chosen properties can suppress instability, but which also serve as a tool to predict the optimal settings for that heat exchanger.

Heckl now expects Bekaert — one TANGO project partner — to use these models to create a new generation of instability-proof and quiet domestic boilers.

The project also advanced scientific knowledge on other aspects, for example how do micro-perforated plates interact with sound waves, and can they be used to reduce noise levels during a combustion instability?

In addition, the project also focussed on gender equality in science. Four out of the 15 fellows were female and all fellows were trained on gender awareness.

TANGO has published its results in many papers in scientific journals and at international conferences. The project expects its results to be taken up by scientists tackling specific research questions.

Even though the project has now ended, Heckl is aiming to keep the research going. 'TANGO was very successful and a joy to coordinate. I now hope to set up a similar project to

deepen our understanding of aeroacoustics and contribute to work reducing environmental noise. I will also continue my efforts to attract more women to engineering science,' she concludes.

TANGO

- ★ Coordinated by the University of Keele in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/105230>
- ★ Project website: <http://www.scm.keele.ac.uk/Tango/>

THE HYDROGEN STAMP OF APPROVAL

Creating a low-carbon certification system for hydrogen fuel is a step towards establishing a decarbonised European energy market. The EU-funded CERTIFHY project is taking that step with its new 'Guarantee of Origin' system.

Using hydrogen as fuel could have economic and environmental benefits, but currently over 95% of all hydrogen is generated from fossil fuels, in carbon dioxide-intensive processes. For hydrogen to be a climate-friendly alternative to fossil fuels, this needs to change and the recently completed CERTIFHY (Developing a European Framework for the generation of guarantees of origin for green hydrogen) project thinks its new framework might help do this. 'By defining green and low-carbon hydrogen, coming up with a detailed proposal for a Guarantee of Origin (GO) system and a roadmap for implementation, we hope to establish a market that can help decarbonising industry and transport in Europe,' says project coordinator Wouter Vanhoudt from Belgium-based energy consultants Hincio.

The CERTIFHY consortium led by Hincio, included technology, policy and regulatory experts but no industry, in order to avoid the interests of a particular sector dominating the scheme design process. But industry was closely involved through the affiliated partners including many multinational companies in manufacturing and energy production.

One of the first jobs of the consortium was to define hydrogen produced with low-carbon emissions, named Premium hydrogen. This was then divided into CERTIFHY Green Hydrogen and CERTIFHY Low Carbon Hydrogen, both having carbon emissions 60% lower than the current industry practices, but the former generated by renewable energy with the latter created by non-renewable energy. Both types provide a hydrogen fuel that responds to a different demand — be it greener products or the push to decarbonisation.

The consortium created a GO system which certifies the credentials of the hydrogen being traded as a fuel — either as Green Hydrogen or Low Carbon Hydrogen. It takes into account both renewable and greenhouse gas emissions, and as hydrogen is an energy carrier that can be made and transformed into electricity and (synthetic) natural gas, the scheme can be linked to certification schemes in other energy sectors. According to Vanhoudt this ultimately provides 'a transparent and credible system that empowers consumers by disclosing the environmental quality of hydrogen, with regards to origin and carbon intensity.'

Vanhoudt adds 'GOs allow the end-users to have the freedom to choose the carbon intensity and/or renewable content of the hydrogen they consume.' The hope is that this consumer-centred approach will become a driving force for Europe's energy transition and decarbonisation of industry and transport. The common understanding CERTIFHY is establishing with its GO system will boost demand and create a new market for Premium Hydrogen.

October 2016 saw the project's final meeting in Brussels where the consortium presented the project results and next steps to an audience consisting of leading industry, policy makers and industry associations. The system received strong support from amongst others, the European public-private partnership in fuel cell and hydrogen energy technologies. Bart Biebuyck, the executive director of the Fuel Cells and Hydrogen Joint Undertaking (FCH JU) stated 'CERTIFHY is a promising project with good support from the industry.'

With strong support there is a commitment to implementing the first EU-wide GO scheme for Premium Hydrogen. The consortium is building a supervisory board and developing a GO infrastructure. Its first validations will be pilot plants in Member States, where industry will produce green or low-carbon hydrogen using renewable electricity. The consortium will audit production batches to create GOs registered into a registry and then traded amongst market players.

CERTIFHY

- ★ Coordinated by Hincio in Belgium.
- ★ Funded under FP7-JTI.
- ★ <http://cordis.europa.eu/project/rcn/197066>
- ★ Project website: <http://www.certifhy.eu/>



INTELLIGENT UTILISATION OF GRID ASSETS

EU-funded researchers have introduced new concepts and technical solutions to extend control of electric distribution networks at all voltage levels while enhancing reliability of power supply and hosting capacity for renewable energy sources.



As electricity production becomes even more decentralised, the need to handle fluctuations intelligently grows continuously. Real-time data about load patterns is essential for utilities to see how their grid is performing and make necessary adjustments if, for example, any component is overloaded or the quality of supply does not meet customers' requirements.

Without detailed data, it is nearly impossible to locate problems and determine their cause. The EU-funded project IDE4L (Ideal grid for all) was launched with the aim of designing and demonstrating innovative concepts for distribution management in networks integrating 'Renewable energy resources' (RESs). A side goal was to improve the reliability of traditional distribution networks.

Smart grid architecture

'Distribution network automation includes the whole chain, starting from control centre information systems, substation automation and ending with home energy management systems,' explains Professor Sami Repo from the Tampere University of Technology in Finland, the project's scientific coordinator.

'The automation concept developed in IDE4L revolves around three points: firstly, hierarchical and decentralised control over distribution network automation based on international standards, secondly, virtualisation and aggregation of 'Distributed energy resources' (DERs), and lastly, large-scale utilisation of DERs in active network management,' he adds.

Commercial aggregators buy and sell energy. They work together with 'Distribution system operators' (DSOs) to meet technical constraints in their operation. On the other hand, aggregators can also provide flexibility services to DSOs as well as ancillary services to 'Transmission system operators' (TSOs).

Decentralised fault location isolation and supply restoration (FLISR)

'FLISR is part of the distribution automation infrastructure designed and developed within IDE4L. The basic elements are decentralised 'Intelligent electronic devices' (IEDs) that provide protection, logic selectivity and backup chronometric selectivity functionalities. IEDs control circuit breakers and switches,' notes Prof. Repo.

IEDs communicate horizontally with peers using the IEC 61850 standard. 'Generic object oriented substation event' (GOOSE) interlocking messages are used for the implementation of two-step logic and chronometric selectivity schemas, and for the integration of the control functions for DERs.

The FLISR solution can reduce the number of customers that experience power outages in the event of a fault and isolation of the affected area in mere seconds. The loss of load can thus be shorter than traditional schemes with logic selectivity where decisions are taken at the control centre.

In a real operating environment

Considerable work went into the design, development and testing of individual components of the architecture before testing subsets of the overall system in a real operating environment. Testing individual components was not enough. Partner laboratories tested several components together before bringing them to the field.

Tests were conducted in both simulated and prototype environments integrating architectures, algorithms and tools. Once the overall IDE4L architecture had been validated, technologies provided by partner development laboratories were applied in real demonstration scenarios.

'Three field demonstrations were carried out by three partner DSOs, Østkraft in Denmark, Unareti in Italy and Union Fenosa Distribution in Spain,' notes Prof. Repo. 'Real-time monitoring and control use cases provided valuable information on what is happening and how adverse interactions might be diminished in the low voltage grid.'

'IDE4L project has also proposed to utilise monitoring data to enhance network design and distribution planning by defining more accurate customer clusters and profiles. This will be of great importance in the future as customer behaviour changes dramatically with increased use of RESs and DERs,' he concludes.

IDE4L

- ★ Coordinated by the TTY Foundation in Finland.
- ★ Funded under FP7-ENERGY.
- ★ <http://cordis.europa.eu/project/rcn/109372>
- ★ Project website: <http://ide4l.eu/>

ENVIRONMENT

SEEING THE WOOD FOR THE TREES WITH ADVANCED SENSING TECHNOLOGY

With competition for the use of forest resources ever increasing, the EU-funded project DIABOLO sets out to track disturbances and degradation more effectively.

As part of what has been called the 'green infrastructure', Europe's forests are at the forefront of competing drives. They fulfil various functions including: the supply of raw materials for energy production, carbon sequestration to offset greenhouse gas emissions, provision of sanctuary for biodiversity conservation, and water protection, as well as offering recreation opportunities.

As demands for each use increase so EU policies, regulatory frameworks and reporting requirements strive to keep up. Indeed, forest management cuts across a range of sectors, each with their own data standards and processes, making effective resource management problematic.

The need for better forest health and vitality assessments, as well as to make information readily available to end-users, is recognised by the Green paper of the European Commission and in the new EU Forest Strategy. The EU-funded project DIABOLO (Distributed, integrated and harmonised forest information for bioeconomy outlooks) was set up to contribute to efforts to develop a sustainable European bioeconomy.

The state of play in data collection

Effectively monitoring the status of forests currently usually involves an assessment of 'disturbances' and 'degradation'. Disturbance typically refers to depletion of biomass or crown cover caused by one-time natural events, such as storms or fires. Whereas, degradation references human-induced impact, usually occurring over a longer time period, involving continuous or repeated events. The DIABOLO team have pointed out that previous efforts to monitor forests focused on the more straightforward mapping of deforestation and regeneration. 'Time series analysis' is now perhaps regarded as the approach to forestry information gathering and mapping which yields the best operational data. But it does come with its own challenges.

A recent review of the state of play by members of the DIABOLO project team, published by Current Forestry Reports, outlines some of the problems inherent in information gathering and processing. The team analysed mapping options for Europe's temperate forests and Africa's tropical evergreen forests. They found that tropical

forests are under more pressure than temperate forests, with only 24% of tropical forests in a mature and relatively undisturbed state.

The review however also highlights the fact that there is variance in the range of available data values, reflecting the challenges in making accurate forest degradation assessments. They caution that with a plethora of information gathering sources, the danger is for resultant data to be fragmented and partial, restricting its usability. They give the examples of varying nomenclature across assessments and the limitations of total area figures (for example being restricted to national level).

Towards data harmonisation for better management

DIABOLO's mission is to contribute to what the team have referred to as data 'harmonisation'. They point to advanced remote sensing technology such as the European Space Agency's Sentinel-2 polar orbiting satellite launched in 2016, as being able to facilitate the necessary standardisation. High resolution, optical data such as this can provide near real-time, geo-located and accurate information needed for decision-making.

In their paper the team also call for more focus on the classification of disturbance types (such as fire, storm, selective logging etc.) as well as more robust up-scalable mapping efforts. They also point to a need for longer term, regional and global disturbance observation capacity.

Referring specifically to tropical forest monitoring the authors reference another ongoing EU funded project, EOMonDis, which is aiming to offer operational Earth Observation (EO) services for better tropical forest management and reporting.

DIABOLO

- ★ Coordinated by the Natural Resources Institute in Finland
- ★ Funded under H2020-ISIB.
- ★ <http://cordis.europa.eu/project/rcn/193234>
- ★ Project website:
<http://diabolo-project.eu/>

WAS METHANE RESPONSIBLE FOR EARLY EARTH'S OXYGEN BOOM?

New research has cast new light on the Earth's early atmosphere, which was dominated by thick clouds of methane. These methane clouds forced hydrogen to leave the atmosphere, allowing today's oxygen-rich air to develop.

The research part-supported by the EU-funded OXYGEN (Quantifying the evolution of Earth's atmosphere with novel isotope systems and modelling) project, based at the University of St Andrews, UK, suggests that billions of years ago, Earth's atmosphere was filled with a methane-rich haze over a period of about a million years. This haze drove a large amount of hydrogen out of the atmosphere, clearing the way for massive amounts of oxygen to fill the air, resulting in an atmosphere much like the one that sustains life today. Before this methane-driven transformation, Earth's atmosphere was inhospitable, due to being filled with toxic gasses that drove wildly fluctuating surface temperatures.

The research was published in the journal 'Proceedings of the National Academy of Sciences', the international collaboration also included the University of Maryland, NASA's Jet Propulsion Laboratory, the University of Leeds and the Blue Marble Space Institute of Science. In their study, the research team propose a new contributing cause for the Great Oxidation Event, which occurred 2.4 billion years ago, when oxygen concentrations in the Earth's atmosphere increased more than 10 000 times.

'The transformation of Earth's air from a toxic mix to a more welcoming, oxygen-rich atmosphere happened in a geological instant,' commented James Farquhar, a professor of geology at the University of Maryland and a co-author of the study. 'With this study, we finally have the first complete picture of how methane haze made this happen.'

Specifically the researchers used detailed chemical records and sophisticated atmospheric models to reconstruct atmospheric chemistry during the time period immediately before the Great Oxidation Event. Their results suggest that ancient bacteria (the only life on Earth at the time) produced massive amounts of methane that reacted to fill the air with a thick haze. This current study is the first to show how rapidly these events began and how long they

lasted. For a modern comparison, such an atmosphere reflects the current atmospheric conditions found on Titan, Saturn's largest moon.

What made this research even more exciting was the discovery of anomalous patterns of sulphur isotopes in the geochemical records from this time. Sulphur isotopes are often used as a proxy to reconstruct ancient atmospheric conditions, but previous investigations into the time period has not revealed anything too unusual.

'High methane levels meant that more hydrogen, the main gas preventing the build up of oxygen, could escape into outer space, paving the way for global oxygenation,' said Aubrey Zerkle, a biogeochemist at the University of St Andrews and a co-author of the study. 'Our new dataset constitutes the highest resolution record of Archean atmospheric chemistry ever produced, and paints a dramatic picture of Earth surface conditions before the oxygenation of our planet.'

Overall, the methane haze lasted for about 1 million years and after enough hydrogen left the atmosphere, the right chemical conditions took over and the oxygen boom got underway, allowing for the evolution of multicellular life.

'Reconstructing the evolution of atmospheric chemistry has long been the focus

"The researchers used detailed chemical records and sophisticated atmospheric models to reconstruct atmospheric chemistry during the time period immediately before the Great Oxidation Event."

of geochemical research,' said Gareth Izon, lead author of the study, who contributed to the research while a postdoctoral researcher at St Andrews. 'Our new data show that the chemical composition of the atmosphere was dynamic and, at least in the prelude to the Great Oxidation Event, hypersensitive to biological regulation.'

The OXYGEN project will continue at St Andrews until May 2021 and received nearly EUR 1.8 million of EU funding.

OXYGEN

- ★ Hosted by the University Court of the University of St Andrews in the United Kingdom.
- ★ Funded under ERC-2015.
- ★ <http://cordis.europa.eu/project/rcn/199798>



HOW TO PROMOTE BIO-BASED PRODUCTS

Bio-based products, derived from renewable raw materials such as plants, contribute to a sustainable economy through reduced dependence on fossil fuels. An EU-funded initiative examined how markets can be opened up for bio-based products through standardisation, labelling and procurement.



Dialogue with consumers

Project partners also approached consumer groups to determine their needs and demands. This information was used to develop a database system that provided relevant information about bio-based products to public procurement officers.

'The work on social acceptance revealed both positive and negative perceptions about bio-based products, but there was some confusion over what the term actually means,' Ortwin Costenoble reports.

Users of the database can find information concerning the bio-based content of products, plus their sustainability, functionality and end-of-life aspects like biodegradability. These claims are substantiated by references to standards, technical sheets and labels.

The database will become the first port of call for those working in public procurement seeking reliable information about the range of bio-based products available on the European market. 'The database has resulted in important insights that have been fed in the new INNPROBIO project, which specifically deals with public procurement of innovative bio-based products,' says Ortwin Costenoble.

Bio-based products benefit everyone

Consortium members worked with European research institutes and companies to explore the possibility of developing an ecolabel. Applied to bio-based products the label can boost consumer confidence and increase market demand. This would enable all properties and applications to be clearly communicated to the users of bio-based products.

OPEN-BIO will thus help producers of bio-based products, wishing to increase their business by using standardised test results, to avoid misunderstanding and accusations of false claims. It will also aid those organisations involved in public procurement, thanks to the established database.

Society as whole will also benefit from the efforts of OPEN-BIO as its findings, especially those concerning biodegradability and recycling, will be used to support and prioritise new environmental policies within the EU. The resulting reduction in waste and pollution will protect the environment and help to mitigate the effects of a changing climate.

The EU has declared the bio-based products sector to be a priority area due to its high potential for future growth, job creation and its ability to address climate change by reducing greenhouse gas emissions like carbon dioxide.

The OPEN-BIO (Opening bio-based markets via standards, labelling and procurement) project aimed to provide tools to increase public acceptance of bio-based products by encouraging the development of standards, certification systems, ecological labelling and databases containing product information.

Standard tests developed

'The work carried out by OPEN-BIO was quite diverse,' says coordinator Ortwin Costenoble. 'A large part of the research was devoted to establishing and improving test methods for bio-based products; these concerned bio-based content, biodegradability under various conditions and improvement of functionality tests,' he explains.

Researchers built on an earlier project, which had begun developing standardised methods for testing the properties of bio-based products. OPEN-BIO moved these proposed standards forward and developed new ones, taking into consideration the ability to biodegrade in seawater, compostability and the possibility for conversion into biogas.

The team developed standardised methods to help manufacture and substantiate claims about bio-based content and related product properties. Several OPEN-BIO methods were submitted to the European Committee for Standardisation (CEN) and the International Organisation for Standardisation (ISO), with two being adopted already.

OPEN-BIO

- ★ Coordinated by NEN in the Netherlands.
- ★ Funded under FP7-KBBE.
- ★ <http://cordis.europa.eu/project/rcn/110950>
- ★ Project website:
<http://www.biobasedeconomy.eu/research/open-bio/>

GROUPS OF MONGOOSES BAND TOGETHER TO WAGE WAR ON EACH OTHER

War is not just a human activity. Costly group fights also break out between mongooses researchers have just found, with up to 30 animals on each side 'arranged in battle lines'.



Fights to the death, serious injury and the killing of litters are often the results of conflict between different groups of mongooses. While the interaction seems detrimental, researchers are uncovering the fact that there may be benefits. With support from the EU, the SOCODEV (Social development and life history evolution in cooperative mammals: an integrated approach) project is gaining insight into the dynamics of conflict among animals that are gregarious and their results are throwing up some surprises.

Professor Michael Cant of the University of Exeter, who leads the long-term study of banded mongooses in Uganda, says, 'Intergroup conflict can be very intense in social animals but has really only been studied in depth in humans and chimpanzees before now.'

He explains that the fighting is costly to both individuals and groups, 'Individuals are more likely to die and litters are less likely to survive to emergence if their group is involved in an aggressive encounter with a rival.' However, while young mongooses are vulnerable to attack during fights, the project also found that pregnant females are significantly less likely to abort their litter if their group was involved in a fight.

While these findings may seem counter-intuitive, researchers posit that the reason might be the need to preserve numbers in the face of a lethal attack. Unborn litters may be seen as particularly valuable during periods of conflict with rival groups. 'Pregnant females could be finding some way to maintain their pregnancy, perhaps to offset mortality from fighting and make their group bigger and more competitive in the future,' Professor Cant explains in the journal 'Animal Behaviour'.

A further benefit might be the opportunity to mate with individuals from another group. Mating takes place during the attacks and as mongooses rarely stray beyond their immediate circle, these events provide a chance to widen the gene pool.

Broader application of new discoveries

While group fighting has been studied in pan troglodytes, namely chimpanzees, the lack of information on the causes and consequences of group aggression has set back understanding on what role intergroup conflict plays. SOCODEV aims to help address this information deficit.

There is great variation in the cooperative behaviour between individuals

of the same sex, age and status. While studies of lab animals indicate this could be due to early life influences on development, little is known about the function and mechanism of these developmental effects in wild mammals, or whether these effects are adaptive.

The project is using large-scale field experiments to measure developmental impacts on offspring growth, stress physiology, cooperation, health, cognition and other factors. Findings arising from the research could reveal truths about social evolution in other cooperative mammals and may even clarify aspects of human dynamics. As Professor Cant explains, 'Establishing the consequences of intergroup conflict in cooperative species can shed light on patterns of conflict and cooperation within groups and, in turn, facilitate our understanding of social evolution.'

SOCODEV

- ★ Hosted by the University of Exeter in the United Kingdom.
- ★ Funded under FP7-IDEAS-ERC.
- ★ <http://cordis.europa.eu/project/rcn/106436>

AQUATIC RESOURCES

NEW TECHNOLOGY AND MANAGEMENT TECHNIQUES COULD LIFT EUROPEAN AQUACULTURE INDUSTRY

Aquaculture is a booming industry, but growth in Europe is falling behind the rest of the world. One EU-funded project has developed new concepts and technology that could turn this around by triggering sustainable growth in European aquaculture.

Growth in European aquaculture is increasingly facing resistance from regulators and stakeholders. Now, EU scientists working for the IDREEM (Increasing Industrial Resource Efficiency in European Mariculture) project are hoping to solve this by introducing innovative sustainable techniques.

‘If we can move European aquaculture to more integrated-based production systems then we can help the industry to grow in an environmentally and socially sustainable way, while ensuring its economic competitiveness,’ says IDREEM Project Coordinator Adam Hughes.

One of the biggest problems the industry faces is waste. Aquaculture produces two main types of waste — small particulate waste and dissolved waste such as uneaten food or fish waste. Under current practices, waste is simply lost to the wider environment where it is absorbed into the ecosystem. ‘This can lead to the accumulation of organic matter underneath aquaculture production sites, as well as a potential overloading of nutrients in coastal waters,’ Hughes explains.

Using innovative new concepts, the project has created waste management strategies that convert waste streams into high value products. The Integrated Multitrophic Aquaculture (IMTA) system reduces net environmental emissions and increases

productivity and profitability for European aquaculture businesses.

The project found that growing different species together — such as queen scallops and salmon, or sea bream and oysters — cuts waste as queen scallops and oysters eat waste from the fish. ‘This increases the productivity at the site, and diversifies the aquaculture industry, both of which contribute to the economic sustainability of the industry,’ says Hughes.

IDREEM also developed advances in the design of farm layout, including making changes to anchoring grids which keep fish cages in place to make space for seaweed production. Meanwhile, modelling technology was developed to allow for a better prediction of the benefits of IMTA, maximising productivity and environmental benefits onsite.

IDREEM’s technology and strategies are currently in place at several sites across Europe, while the modelling technology is also available to the aquaculture industry via the project’s website. IDREEM has already produced products available on European markets including a condiment made from seaweed, and shellfish products such as queen scallops and mussels.

With this initial success now achieved, the project faces new challenges such as developing ways to certify products produced with the IMTA system. ‘Although our project showed that

across Europe there is willingness to pay extra for fish produced in an IMTA system, it is difficult for producers to secure this market premium without certification,' Hughes explains.

Appetite for seaweed grown in Europe was also a hurdle. Today, seaweed is a high value product imported into Europe in large quantities for uses like fine chemicals and gelling agents. There is a very limited market for European seaweed due to the current small-scale of production, but this is changing.

However, many IDREEM project partners are continuing to use the IMTA production system and some are looking at rolling it

out across many sites. Meanwhile, Hughes hopes that work can continue overcoming the challenges the project identified.

IDREEM

- ★ Coordinated by the Scottish Association for Marine Science in the United Kingdom.
- ★ Funded under FP7-ENVIRONMENT.
- ★ <http://cordis.europa.eu/project/rcn/104831>
- ★ Project website: <http://www.idreem.eu/>
- ★  <http://bit.ly/2rdfvGI>

BUILDING TRUST FOR BETTER WATER MANAGEMENT

An EU-funded project is helping people manage and treat water better in a region where water is scarce.

Water is a scarce resource in most countries around the Mediterranean and this is especially true for those on its Southern and Eastern shores. Water scarcity can lead to unfair access to water, lack of sanitation and associated health problems and even cause conflicts between communities. FP4BATIW (Fostering partnerships for the implementation of best available technologies for water treatment & management in the Mediterranean), a Spanish-led project which finished in September 2016, aims to make sure that water is managed and treated in the best way by building partnerships between academics and water treatment and technology businesses based on both sides of the Mediterranean.

'The big question is how to ensure the best possible water treatment policies are put into practice in Mediterranean Partner Countries by closing the gap between innovators and the water treatment industry,' says Professor Manuel Valiente, project coordinator and director of the separation techniques in chemistry research group at Spain's Autonomous University of Barcelona.

Matching supply and demand

FP4BATIW, involving 13 research centres and institutions from Egypt, Tunisia, Palestine, Jordan and Italy, has been striving to do this in various ways. The online Market Technology Platform has helped to match the demand and supply of expertise and technology. It allows researchers to publicise their ideas and companies to find solutions for their technology needs. Another, Water Kic, is serving as an online forum for the exchange of ideas and expertise.

Researchers and service providers have been encouraged to build useful working relationships face-to-face as every FP4BATIW workshop has included a brokerage session. At the last conference on water treatment strategies from a circular economy perspective, held in Barcelona in July 2016, 120 such meetings were held.

Innovative ideas, new techniques

The FP4BATIW prize has helped encourage researchers and entrepreneurs from Egypt, Jordan, Palestine and Tunisia to come up with innovative ideas for managing, treating and saving water. The authors of 10 promising proposals received coaching and advice from project partners for six months. The best three ideas were selected and their proponents were asked to present their ideas to an industry audience, including potential investors, at the final conference. These included new techniques from Jordan allowing planting in rocky areas or dry, eroded or degraded farmland areas and a surveillance and control system for water pipes from Tunisia which could significantly reduce leaks.

Training has been a key component of the project. This took the form of ongoing technical assistance to companies in Jordan and Tunisia to help them overcome water treatment problems in their production lines. One recent example was the work with a garment-making company near Sousse in Tunisia, who explored ways of recovering and reusing dye from waste water. Three cohorts of researchers and entrepreneurs from EU and Mediterranean countries updated their skills by working in partner institutions abroad via a series of travel bursaries.

Finally, the experience of working together for three years has not only given rise to dissertations, theses and publications in peer-reviewed journals. It has also helped to build trust between universities, municipalities and the private sector, thereby laying the foundations for new public-private partnerships in the water treatment sector. The final aim, according to Professor Valiente is 'a more sustainable management of water as a consequence of a better reuse of wastewater resources from a social, health and environmental point of view.'

FP4BATIW

- ★ Coordinated by the Autonomous University of Barcelona in Spain.
- ★ Funded under FP7-INCO.
- ★ <http://cordis.europa.eu/project/rcn/110366>
- ★  <http://bit.ly/17mbZ3a>



MAKING EARTH OBSERVATION DATA ACCESSIBLE TO AQUACULTURE

New online information services — based in part on data gleaned from Europe's satellite network — will enable aquaculture to make more informed business decisions. Both services have received glowing reviews from end users and are now ready to be fully rolled out.



Thanks to the EU-funded AQUA-USERS (AQUAculture USER driven operational Remote Sensing information services) project, Europe's aquaculture sector now has instant access to user-friendly data on issues such as water temperature, concentrations of chlorophyll and the presence of harmful algae blooms. This information, pulled from GMES satellite information and *in situ* observations, will help operators manage their farms in real time and aid commercial operations in finding optimal sites for production.

'Water quality is a critical factor for the success of fish farms and the culturing of other aquatic organisms,' explains AQUA-USERS project coordinator Dr Marnix Laanen from Water Insight in the Netherlands. 'It greatly affects the health and growth of species, and therefore has a huge influence on production costs.'

However, the uptake of Earth observation data has been constrained by several factors, including a mismatch between data and user requirements; difficulty in accessing information; and constraints

imposed by regulatory requirements. The AQUA-USERS project sought to address these points by developing a platform that delivers information specific to the needs of aquaculture.

Instant access to information

Two online services are now ready to be deployed. The first is a site selection service, which provides aquaculture producers with detailed information about a particular location. 'In a user survey, 94% of respondents found this service to be useful or very useful,' says Laanen's Water Insight colleague Kathrin Poser, who was also involved in the project. 'A follow-up commercial contract has already been agreed with the Danish Ministry of Environment and Food Production.'

The second service is a daily management service, intended to supply site managers with relevant and timely information to help them make informed decisions. A web portal and smartphone app have been developed to provide easy access. Indicators vital to aquaculture management, including

early warnings of harmful algae bloom (HAB) events, have been prioritised.

'Satellite monitoring is a valuable service used by salmon farmers to detect advance warning of harmful blooms,' explains Jamie Smith, Technical Executive of the Scottish Salmon Producers' Organisation (SSPO) and a key beneficiary of the project. 'The incorporation of this technology into a smartphone app is a real added bonus, as it means farmers can access information at all times of the day.'

In a final user survey, some 94% of respondents found the app to be very useful or useful to some extent, while 92% evaluated the HAB risk maps to be useful. A demo version of the AQUA-USERS portal is available online.

Marketing the results

Since the AQUA-USERS project was completed in October 2016, the focus has been on commercialising the results: both the AQUA-USERS Site Selection tool and the Daily Management tool.

'Within the consortium already some commercial activity has developed, mainly consultancy with regards to site selection and sales of the portable water quality scanner and HAB maps that are part of the daily management tools,' says Laanen. 'We are planning a generic, entry level subscription for both tools, and later we plan to tailor and add elements as required by clients.'

In addition the site selection and HAB detection tools will be refined in follow-up EU-funded projects, while a new generation of portable and fixed position water quality scanners will be developed. Project partners also intend to market their service to policy makers as well as industry. 'These services can also benefit regulators by providing relevant data for marine spatial planning,

zoning and licensing for aquaculture governance,' concludes Poser.

AQUA-USERS

- ★ Coordinated by Water Insight in the Netherlands.
- ★ Funded under FP7-SPACE.
- ★ <http://cordis.europa.eu/project/rcn/188852>
- ★ Project website: <http://www.aqua-users.eu/>

IMPROVING DESALINATION WITH NANOTECHNOLOGY

Desalination of seawater is now an important technology for supplying potable water, but it can be polluting and energy intensive. The EU-funded NAWADES project has used nanotechnology to solve some of the problems that have been holding this technology back.

Currently over 63 million cubic metres of water are desalinated in more than 14 000 plants globally each day. This is mainly achieved using reverse osmosis (RO), where a very dense polymer membrane allows only water molecules to pass through. But desalination using RO presents a number of environmental problems, so the NAWADES (Nanotechnological Application in Water DESalination) project has taken up the challenge to improve the process. The project has used nanotechnology to develop new solutions for the task.

According to the Intergovernmental Panel on Climate Change (IPCC) by the year 2050, around 60% of the world's population could experience severe water shortages, with 33% already under stress. Some countries are well on the way to covering their need by desalination; for example, Israel with over 40% and Saudi Arabia with 70% of water to its cities, coming from desalination – the process that turns salty sea-water into fresh potable water. Europe holds around 10% of the global desalination capacity, led by Spain, with more than 700 plants in place. Even in the UK, London has opened its first desalination plant. But the current technology has problems.

The waste stream generated by desalination using RO is one of these problems. Waste from the brine and added chemicals are usually discharged back into the sea. The overall process consumes considerable quantities of energy also. Optimal desalination using RO membranes is limited by the precipitation of bulk mineral salts, called surface scaling, and biological fouling by bacteria, both leading to shortened

membrane life. 'Continuous dosing of antiscaling agents, together with chlorination or dechlorination strategies are used to reduce scaling and fouling and the need for costly membrane replacement,' explains Christiane Chaumette of the Fraunhofer Institute for Interfacial Engineering and Biotechnology and NAWADES project coordinator.

The NAWADES project united a high-level European consortium in membrane production and application to carry out research on seawater desalination enhancement, starting at the very base: the membrane and including the complete process from seawater intake to effluent streams.

The consortium used technologies including plasma surface modification of the membrane and inbuilt UV-irradiation methods that enhance the removal of bio-fouling of the membrane. The new desalination device was designed to be self-cleaning using an additional curved casing with LED lights. This provides light to activate a titanium dioxide (TiO₂) catalyst in either polyvinylidene fluoride (PVDF) or aluminium oxide membranes. The project also investigated fouling and scaling monitoring using electrical impedance comparisons.

The LED and self-cleaning membranes were developed into demonstration prototypes and tested on-site in the pilot phase of NAWADES at the desalination plant of El Prat de Llobregat in Barcelona, Spain. Four different versions of the ultrafiltration membranes were tested during the demonstration in both dead end and cross flow settings and with and without LED-UV irradiation.

'Witnessing the transition from the NAWADES laboratory test through the demonstration and into a bouquet of market concepts has been a good experience. I am personally grateful that the industrial partners also permitted timely publication of several research results,' says Chaumette. The NAWADES partners have invested in two patent applications, one of them granted already. The partners have signed an exploitation agreement on NAWADES technology and continue development of specific technologies in bilateral and trilateral partnerships.

NAWADES

- ★ Coordinated by Fraunhofer in Germany.
- ★ Funded under FP7-ENVIRONMENT.
- ★ <http://cordis.europa.eu/project/rcn/105525>
- ★ <http://bit.ly/2qF9mHb>



INDUSTRY

HYBRIDISING SILICON DEVICES WITH CARBON NANOTUBES

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By using carbon nanotubes (CNT) in the development of hybrid silicon-based devices, EU-funded researchers have paved the way for the development of next generation CNT photonics.

Silicon has positioned itself as the material of choice for a range of photonic applications, including DataCom and sensing. As a result, today you can find numerous photonic devices capable of emitting, propagating, modulating and detecting light at the silicon chip-scale. Yet even with this advancement, there remains the challenge of integrating all the photonic building blocks onto the same circuit. This is because doing so requires integrating a range of different materials onto silicon. Although technically possible, the process is not cost-effective, thus limiting the use of silicon photonics for a broad range of applications.

The EU-funded CARTOON (CARbon nanoTube phOTONic devices on silicon) project overcame this challenge by developing a new strategy for hybridising silicon based devices that uses CNT as an integrated light source, modulator and detector in the near infrared wavelength range. 'We ultimately selected semiconducting single wall carbon nanotubes (s-SWNT) as it is a very versatile material that also offers very good electronic and optical properties,' says Project Coordinator Laurent Vivien.

According to Vivien, the advantages of s-SWNT are many. For example, it displays strong room temperature emission in the NIR wavelength range, as well as strong thermal photo-stability. By selecting a precise nanotube diameter and chirality, one can easily control emissions for wavelengths from 1 μ m to 1.6 μ m. They can be integrated to make diodes and field effect transistors, thus opening the possibility of using electrical pumping for luminescence and photo detectors. Furthermore, their electronic transitions, via predicted Stark and Kerr effects, can also be used to obtain modulation effects. 'For all these reasons, CNT is a very good candidate for solving the integration issues of silicon photonics, leading to a cost-effective and reliable photonics,' says Vivien.

Huge potential

Producing a range of important breakthroughs that have paved the way for the development of next generation CNT

photonics, the potential impact of the CARTOON project is huge. For example, it developed new strategies for achieving pure semiconducting carbon nanotubes for photonic applications. It also conducted the first successful demonstration of negative refractive nonlinear effect in CNT integrated in a silicon nitride waveguide, along with the first lasting effect based on the hybrid integration of CNT into silicon photonics devices. Furthermore, the project produced a hybrid, fully integrated silicon photonics platform for nanomaterials and optimised for nanotubes.

'The project introduced a new, unexpected concept for the use of CNT for silicon photonic applications,' says Vivien. 'It is a very promising material that could be used in developing all optoelectronic devices, and we're confident that CNT will facilitate the integration of photonics and electronics. In addition, as single CNT are quantum emitters, our strategy can also be used for driving silicon photonics in the realm of integrated quantum communication.'

Marketisation on the horizon

In 2015, a new company, ProNT GmbH, was founded by a CARTOON project researcher. Its aim is to commercialise the technology for the direct synthesis of semiconducting SWNTs using some of the approaches developed during the CARTOON project. If successful, this will provide industrial customers with s-SWNTs for integration into SWNT-based photonic and electronic devices, including sensors.

CARTOON project researchers also plan to build on their latest findings about optoelectronic devices with the launch of a new project. The focus of this new research will be on demonstrating a CNT-based silicon photonics circuit for use with next generation optical interconnects, quantum information and sensing.

CARTOON

- ★ Coordinated by the University of Paris-Sud in France.
- ★ Funded under FP7-ICT.
- ★ <http://cordis.europa.eu/project/rcn/110717>

FOREST-BASED COMPOSITES FOR HIGHER INDOOR AIR QUALITY

At the crossroads of indoor air quality and environmental concerns lies OSIRYS, a concept of forest-based composites for façades and interior partitions. Composed of biopolymers and natural fibres, the new material promises to reduce emissions of pollutants and actively eliminate other contaminants.

Indoor air quality and emissions from building materials are a major challenge that has been keeping scientists and industry busy for years. The excessive use of materials like plastics in constructions has only made things worse, contributing to the commonly named 'Sick building syndrome' (SBS) with its excessive impermeability; whilst coatings are infamous for the high amounts of 'Volatile organic compound' (VOC) emissions they cause.

OSIRYS (Forest based composites for façades and interior partitions to improve indoor air quality in new builds and restoration) resolves both issues with a single, holistic solution. Beyond developing individual materials, the project indeed consisted in combining these materials in different products and systems, including a multilayer façade, a curtain wall and interior partitions which can be placed together or as independent systems in new buildings or retrofitted ones.

'OSIRYS avoids the use of materials that generate particulates, VOC and formaldehyde,' says Dr Miriam Garcia, coordinator of the project. 'It also avoids the use of 100% plastic materials that are too non-permeable, and replaces them with biocomposites made of biopolymers and natural fibres that allow for moisture exchange.' Special attention has been paid to thermal efficiency and fire protection, whilst a photocatalytic coating has been developed to

eliminate the VOC and microorganisms generated by other materials.

According to Dr Garcia, OSIRYS' strength lies of course in its environmental and energy performance, and also in its appearance and the multiple manufacturing processes it can be processed with — from extrusion (fire-proof panels and wood foam panels) to pultrusion (profiles) and infusion (cladding panels). 'This provides endless design possibilities and demonstrates that new polymeric materials can both be used in construction and also provide various advantages. This provides new market opportunities to composite manufacturers,' she says.

The team is now focusing on the life cycle assessment of its solutions, although the use of natural materials is expected to translate into great sustainability performance. OSIRYS also complies with the mechanical, acoustic, thermal and fire requirements of the Technical Building Code, and has been successfully demonstrated at three demonstration sites: the KUBIK test building near Bilbao (Spain), a sports complex in Tartu (Estonia) and a seven-storey building in San Sebastián (Spain). Various stakeholders, from material manufacturers to construction companies, have already shown an interest in the project's technology.

The next steps? 'We now need some time to demonstrate the suitability of the new

products in real-life conditions,' Dr Garcia points out. 'The demo buildings in Tartu and San Sebastián offer a unique opportunity to demonstrate the behaviour of the new products over the coming years.'

With the project now completed, the consortium intends to focus on optimising each industrial process in order to successfully bring their products to market.

'We expect individual components to be commercialised within the next one to two years, whilst the complete systems (multilayer façade or curtain wall) could take longer,' Dr Garcia concludes.

OSIRYS

- ★ Coordinated by Tecnia in Spain.
- ★ Funded under FP7-NMP.
- ★ <http://cordis.europa.eu/project/rcn/108625>
- ★ Project website: <http://osirysproject.eu/>
- ★ <http://bit.ly/2pOxQKd>



BIO-PRODUCTS FROM LEGUME WASTE

Turning waste from legume processing into a useful source of material and energy is the aim of an innovative EU-funded project which has recently ended.

The LEGUVAL (Valorisation of legumes co-products and by-products for package application and energy production from biomass) project team, led by Spanish engineering company IRIS, was spurred into action by the three million tonnes of legume waste European companies produce every year. This mountain of waste — the residues from processing peas, beans and lentils — is generally given away for use as animal feed.

'Our starting point was: is there some way we can monetise that waste?' says Edurne Gaston Estanga, LEGUVAL project coordinator and project manager at IRIS. 'Can we offer something to industry which can allow this to be used?'

After studying current practice in the legume processing sector and analysing the needs of the plastic industry, LEGUVAL set out to explore what can be done. First the team developed a

method for extracting proteins from pea waste, producing a green powder with a degree of purity of almost 80%.

They experimented with using the proteins to produce a new kind of biodegradable coating. 'The idea was to combine this coating with plastic to have a multilayer system with the right qualities to be suitable for food packaging,' says Dr Gaston Estanga. The results were encouraging — producing coating film material with barrier properties which performed 7–10 times better than conventional PET. As well as protecting food efficiently, this would provide a more sustainable alternative to fuel-based plastics.

Biodegradable plant pots

The LEGUVAL team used the protein to develop new biodegradable plastic materials. Slovenian organisations Tehnoloski

Center POLI-EKO and Bokri used their normal processes and equipment to produce items such as semi-soft plastic trays for fruit packaging or thermoformed trays for catering with a dry processing technique. Biodegradable plant pots for use in agriculture were the most successful — ‘when you put these pots into the soil, you can leave it in the earth and over time it will completely biodegrade,’ says Dr Gaston Estanga. Using standard extrusion and injection moulding technology was important to demonstrate product feasibility.

The next step was to extract the fibre in the lab and mix it with different additives to produce new bio-composites with up to 40% fibre content. The LEGUVAL team tried producing catering equipment such as spoons and trays, as well as lightweight automotive parts, although in the latter case the plastic was not strong enough.

The final fraction of the biomass was evaluated as a source of biogas in both batch and continuous modes. Testing the leftover waste as a source of bioenergy was a way of completing the cycle and achieving maximum valorisation. ‘Even this fraction, which people would say is useless, can be used,’ says Dr Gaston Estanga.

Money for nothing

Plastic converters at demonstration events in Italy, Spain and Slovenia have shown interest in the results. ‘We are offering

them a solution with improved properties as there is a lot of demand from the public for producers to go bio,’ says Dr Gaston Estanga. Other beneficiaries could be legume processors who could earn money from something that is currently discarded, consumers concerned about their environmental footprint and end users in sectors such as agriculture.

The missing link, which could slow down take-up, is the lack of processed materials. ‘There is interest from Italian companies, but currently no one is producing the protein on a commercial scale,’ concludes Dr Gaston Estanga.

“Plastic converters at demonstration events in Italy, Spain and Slovenia have shown interest in the results.”

LEGUVAL

- ★ Coordinated by IRIS in Spain.
- ★ Funded under FP7-SME.
- ★ <http://cordis.europa.eu/project/rcn/111096>
- ★ Project website: <http://leguval.eu/>
- ★  <http://bit.ly/2qf0KEc>

RECYCLING SILICON DUST TO REDUCE SOLAR PANEL WASTE

EU-funded scientists have found a way to recycle waste from silicon wafer production, making solar panels more resource-friendly

Silicon wafers — ultrathin semi-conductors used in the manufacture of solar panels — are produced by slicing large silicon blocks. But the process is wasteful, with as much as 50% of the valuable original material lost as fine silicon powder during the industrial sawing process.

EU-funded researchers under the SIKELOR (Silicon kerf loss recycling) project have been looking at ways to recycle the silicon dust and so reduce waste in an industry already under pressure from cheap producers outside Europe.

‘The thickness of the silicon wafer is in the order of around 10 to 20 microns and the thickness of the sawing wire is almost the same. That means about half of the material remains as sawing loss,’ says project coordinator Dr Sven Eckert, a physicist at the Helmholtz Centre Dresden-Rossendorf.

The main goal of the team, made up of both academics and industry researchers, was to develop a single process to compact and melt the expensive silicon waste and separate the impurities so that it can be reused in solar panel manufacture. ‘Impurities reduce the efficiency of solar panels. You want very

clean materials at the end of the recycling process,’ Dr Eckert says.

Compacting and melting

The team first developed a process for compacting the fine powder into pellets. But this ‘is not so straightforward’, Dr Eckert notes, as the tiny particles present a risk of dangerous explosions, and are not so easy to compact. Project partner GARBO, Italy, which specialises in purifying recycled silicon has expertise in producing such pellets safely.

However, carbon particles in the dust produce small solid particles of silicon carbide as a waste product during the melting process that need to be removed, while keeping the oxidation rate on the surface of the silicon powder as low as possible to prevent the formation of silicon dioxide.

The project consortium used inductive heating to melt the pellets and remove the impurities. The applied high-frequency magnetic field brings the electrical conducting melt into motion, effectively ‘stirring’ the mixture, which reduces the oxygen content in the melt. ‘The melting is good for de-oxidisation but if there is silicon carbide in the melt then a suitably tuned high frequency magnetic field is needed for purification,’ Dr Eckert says. The silicon carbide impurities are expelled and deposited onto the sides of the crucible during this stage, where they can be removed.



Silicon block loss reduced

Silicon is relatively efficient in converting energy from sunlight into electricity in photovoltaic cells. The most energy used is in the silicon production itself and a large amount of this is lost as sawdust, Dr Eckert notes. Under this process developed by the project scientists, that loss is reduced from around 50% of the silicon block, to just 5-10% overall — a considerable saving that will improve the competitiveness of Europe’s photovoltaic industry.

A demonstrator has been built at the University of Padua in Italy to run experiments to show the reliability of the technology, prior to beginning work on scaling up the process for industrial use.

SIKELOR

- ★ Coordinated by HZDR in Germany.
- ★ Funded under FP7-ENVIRONMENT.
- ★ <http://cordis.europa.eu/project/rcn/110318>
- ★ Project website: <https://www.sikelor.eu/>

MODELLING ENERGY EFFICIENCY FOR THE NEXT GENERATION OF MICROCHIPS

As the internet's carbon footprint grows, scientists have developed multiscale energy-use simulations to help design more efficient components.

EU-funded scientists have carried out simulations from the nanoscale to device level to determine energy consumption of microchips and Light Emitting Diodes, or LEDs, to pave the way for a more energy-efficient future generation of electronic devices and lighting.

As internet data traffic grows exponentially every year, it sucks in more energy for communications whether via smart phones, tablets or PCs, with current energy usage estimated at 5% to 10% of all electricity used globally.

Every query on an internet search engine like Google accesses a huge data centre of networked computers. The interconnections and the transistors in the microchips already consume so much energy that managing heat levels created by the components has become a major design issue for industry.

'The internet is already beginning to make unsustainable global energy demands, which will only get worse with the development of the Internet of Things,' says Professor Eoin O'Reilly, project coordinator for the DEEPEN (From Atom-to-Device Explicit simulation Environment for Photonics and Electronics Nanostructure) project. 'If energy efficiency does not improve, you can extrapolate that within, say, 15 years, it will be 50% of all energy use and this begins to look unsustainable,' he adds.

The project team have been simulating energy consumption in microchip components and LEDs to model energy efficiency. However, as components shrink to the nanoscale — sometime to just 50-100 atoms wide — simulations that traditionally assume bulk or average properties for the semiconductor materials cannot provide an accurate model of energy use.

The DEEPEN partners involving researchers, software developers, experts in simulation and its application to device design, as well as manufacturing industry partners such as Osram in Germany, one of the world's largest LED producers, conducted simulations at both the device and the atomistic level, developing a 'library' of material properties and their changes at the different scales.

'Nanoscale behaviour becomes more important as devices shrink in scale,' says Prof O'Reilly, of the Tyndall National Institute in Cork, Ireland. 'At the smallest scale you can describe electronic properties very accurately but it is very expensive in terms of time and computing memory.'

So, DEEPEN experts worked together over three years to devise multiscale simulations using different computer software codes for various problems and then linked the codes together.

For LEDs 'our simulations found that local atomic effects are really important to understand the light emission characteristics of green and blue LEDs. These local atomic effects have been ignored up till now in trying to model (energy efficiency) of devices,' Prof O'Reilly says.

With transistors — the semiconductor devices within microchips which transfer electronic signals using electrical power — traditional energy efficiency modelling treated the devices as having average properties. 'But in our project, for the first time, we were able to link the very sophisticated description of the atomic properties of the active region with the higher-level treatment of the rest of the device,' he says.

The linked models, drawn up with input from other projects in the European Multiscale Modelling Cluster to create new standards and processes for such coding, will be used to improve device capability design.

'We are now in a much better position to provide accurate design guidelines to the semiconductor industry and support its ongoing research efforts in energy-efficient nanoelectronic devices,' Prof O'Reilly concludes.

DEEPEN

- ★ Coordinated by University College Cork in Ireland.
- ★ Funded under FP7-NMP.
- ★ <http://cordis.europa.eu/project/rcn/110555>
- ★ Project website:
<http://www.nmp-deepen.eu/>

ARM-BASED SERVERS FOR FUTURE DATA CENTRES

Could ARM-based micro-servers improve the energy efficiency of data centres across the world and put Europe at the forefront of this highly competitive sector? Confident with this potential, the EUROSERVER project is leading the way with novel ARM-based server architecture.

Centrepiece of our smartphones, ARM processors are increasingly being considered for exploitation beyond mobile. The world's biggest manufacturers are using them for next-generation laptops, whilst engineers making a start on exascale computing have been charmed by their energy-efficiency performance.

EUROSERVER is also betting on this potential, but this time for building the data centres of the future whilst providing Europe with a competitive edge.

'The ARM solution is undoubtedly the most promising for Europe. Back when we began working on this project, the advancement of ARM processor capabilities were already igniting the interest of a number of ARM technology licensees targeting server solutions, in particular for micro-server-based markets. Even though it was acquired by SoftBank, ARM is still headquartered in Europe and the IP is European,' says Isabelle Dor, R&D engineer at the French Alternative Energies and Atomic Energy Commission and coordinator of the EUROSERVER (Green Computing Node for European micro-servers) project.

Despite this potential, no ARM-based server chips were being built by European companies. 'The past few years have been rather turbulent for ARM-based devices aimed at the server market, Dor says. 'Many have come

and gone, with others either currently up for sale, not-prioritised, or acquired.'

Quickly, EUROSERVER positioned itself as the first and only European processor for micro-servers, bringing notable improvements in energy efficiency, cost-effectiveness and software resource efficiency.

The project's solution, which revolves around silicon nanotechnology, data centre system architecture and software innovations, is designed for scalability. Its basic building block, a micro-server board, is suitable for use in high-density cloud and data centre deployments as well as for embedded applications such as transportation, or telecom infrastructure.

The project's main innovations include a scalable memory scheme dubbed UNIMEM, a transparent main-memory compression technology to maximise the density and bandwidth of external memory, a new hypervisor technology called MicroVisor, as well as advanced software features to optimise resource sharing and communication within the system.

'Our architecture has an innovative structure comprising interconnected compute "coherent island" nodes, to get an optimal balance between data locality and transfer efficiency,' Dor explains. 'The compute SoC internal structure was organised around several independent silicon-modules known as "chipelets", each implementing one of the islands. The coupling between these chipelets was

realised by high-speed serial links with process native memory addressing.'

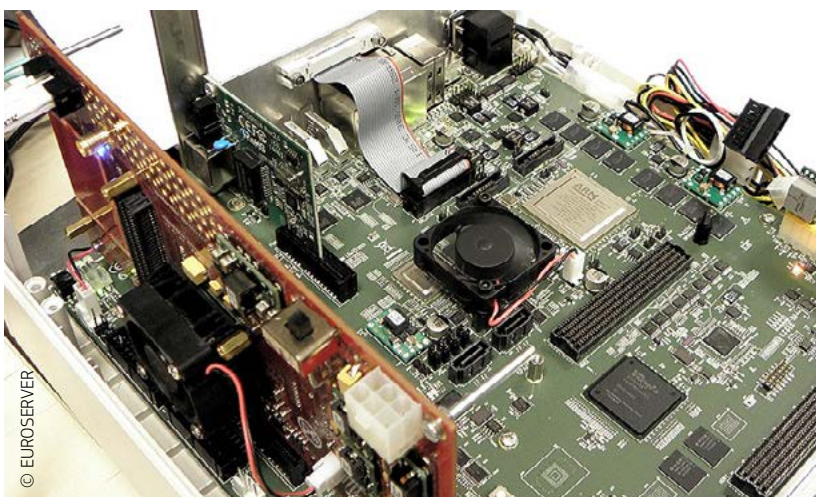
All in all, 10 patents were registered or submitted for registration. The MicroVisor technology is being used in new commercial offerings. ONAPP, one of the project partners, is working with leading researchers in topics related to potential market areas.

The project has also led to the development of two spin-off companies; KALEAO in Cambridge, UK with labs in Crete and Italy, and ZeroPoint Technologies in Chalmers, Sweden.

'KALEAO has introduced a unique new generation of web-scale, true-converged server appliance enabling low energy consumption and significant computing capabilities. ZeroPoint, on the other hand, commercialises the project's memory compression innovations under the MaxiMem™ product family. The company plans to have its first products, which can triple memory capacity and effective memory bandwidth, commercialised by the summer of 2017,' Dor says. Web services, e-commerce, and other common enterprise IT services are foreseen.

The KMAX platform, a server integrating OnApp's MicroVisor solution, is available preinstalled in the Kaleao KMAX Appliance Edition.

Overall, EUROSERVER provides a European foundation and ecosystem for a scalable, low-power and low-cost approach for computing. Several subsequent H2020 projects in the field of HPC core technologies are already aligned with the EUROSERVER concept, and will keep developing the fundamental concepts that EUROSERVER proposes over the years to come.



EUROSERVER

- ★ Coordinated by the Alternative Energies and Atomic Energy Commission in France.
- ★ Funded under FP7-ICT.
- ★ <http://cordis.europa.eu/project/rcn/191814>
- ★ Project website: <http://www.euroserver-project.eu/>
- ★ <http://bit.ly/2qmVqAO>

THE KEY TO A SECURED CLOUD FOR BUSINESSES

Cloud storage may have been available for a while, but successful attacks on major providers have made companies wary of the consequences of entrusting it with their most sensitive data. Thanks to a secure framework developed under the PRACTICE project, these companies won't have to rely on cloud providers anymore to keep their data whole and confidential.

PRACTICE (Privacy-Preserving Computation in the Cloud) is really about hiding data from other users and cloud providers, and securing computation between servers and between untrusting parties. This means that businesses can now benefit from the economies of scale brought by cloud computing while sleeping soundly.

'Our technologies let data owners encrypt the data themselves and provide it to a service or analyst without the key to access it,' says Dr Klaus-Michael Koch, coordinator of the project for Austrian company Technikon. 'Most importantly, these technologies do not have to decrypt data to process it, which enables end-to-end security for data on the cloud. Insider or outsider attacks become completely useless, as the cloud server is incapable of seeing the data, but can transform it into new encrypted results using PRACTICE tech.'

The PRACTICE framework is named SPEAR, which stands for Secure Platform for Enterprise Applications and Services. It makes use of advanced cryptographic technologies while supporting users in selecting the best possible approach and mechanisms to address their specific needs.

'One of our final deliverables consists of a large set of general guidelines, including examples of how to integrate different secure computation tools into developed applications as well as how to deploy them in the cloud. Moreover, we demonstrated a semi-automated service for setting up these technologies on the public cloud with no special skills required. We expect our industrial partners to roll out these services in the coming years, whilst platforms from our partners Cybernetica and Partisia are already on the market,' says Dr Koch.

Thanks to PRACTICE achievements, Cybernetica is offering a general platform for analysing tax fraud, medical records, genomes or building cloud platforms. The company already works with several customers in the fintech, biotech and government sectors both in Europe and other countries. Partisia, on the other hand, demonstrated an impressive and confidential benchmarking application with several Danish banks, a consultancy house and other financial organisations. Both companies are also planning cloud-deployed services for general use.

Adapting the PRACTICE framework to concrete use cases was probably the most important part of the consortium's work, as Dr Koch and his partners always aimed at a providing market-ready and turnkey solutions. They notably provide solutions for aeroengine fleet management, auctions, privacy-preserving personal genome analyses and studies, location sharing with nearby contacts, key management, mobile data sharing and secure statistics.

As Dr Koch points out, there is indeed no unique model or tool which can cover all different application scenarios. 'In some cases, use of a particular tool for implementing some



"We expect our industrial partners to roll out these services in the coming years, whilst platforms from our partners Cybernetica and Partisia are already on the market."

scenarios is possible but not expedient. Factors such as performance, number of participants, presence or absence of colluding parties, etc. determine whether the use of a tool to implement a use case scenario is suitable or not,' he says.

Whilst the project has been completed since the end of October 2016, project partners are now focusing on dissemination and roll-out of new services.

PRACTICE

- ★ Coordinated by Technikon in Austria.
- ★ Funded under FP7-ICT.
- ★ <http://cordis.europa.eu/project/rcn/111030>
- ★ Project website: <https://practice-project.eu/>

SECURITY

EUROPE'S RESILIENCE TO THREATS GETS BETTER

Alongside benefits, globalisation has also increased the reach of threats, both accidental and malicious. Europe must now be more ready than ever to combat threats of a chemical, biological, radiological, nuclear or explosives (CBRNE) nature.

Several improbable hazard-related disasters on a mass population scale are becoming increasingly possible, particularly those involving CBRNE materials. Successful CBRNE resilience requires a global system-of-systems approach where all countries can collaborate to overcome threats.

In addition, the possible proliferation of the knowledge on the use of chemicals as warfare agents to terrorist organisations also poses a threat. 'Although CBRNE incidents in the "civil security" environment were considered "low probability", global conflicts and the use of chemical weapons have also strengthened the case for developing CBRNE resilience,' the project coordinator points out.

The EU-funded EDEN (End-user driven demo for CBRNE) project sought to overcome this challenge with a 'toolbox of toolboxes' and was unique by not presenting ONE solution (as it might be understood from the term 'toolbox of toolboxes', but rather presented a wide array of solutions. With the CBRNE market being fragmented, 'one size cannot fit all'. There is a need to provide a range of solutions for the different users to choose. Having a 'resilient response' means you have a team that is well trained, has the right tools and is confident in their use.

This is exactly what the 'EDEN legacy' is all about. 'It provides end users with available comparable solutions and expertise with over 270 tools in the EDEN

catalogue. These range from basic tools through to systems, toolboxes, i.e. collections of tools, human expertise and knowledge, standard operating procedures and a new CBRNE training framework,' explains the project coordinator.

This couldn't have come at a better time also in the EU civil sector. The capabilities of the EDEN solution extend to radiological, chemical, biological, explosive and terrorist threats. 'EDEN has tools dealing with detection, decontamination, personal protective equipment, medical care, imaging and transfer of data, command and control and other pivotal aspects to cover needs of end users in the preparedness, response and recovery,' the project coordinator assures.

EDEN has also demonstrated that current EU food regulation does not enforce the food companies and operators to comply with any procedure to prevent and to detect deliberate contamination.

A panel of end users evaluated EDEN's tools, ascertaining enhanced CBRNE resilience from threat assessment to recovery through three pivotal themes: food defence, multi-chemical and radiological. This involved demonstrations in food processing plants, industrial and hospital response environments, and a large-scale radiological test demo. Over 300 end-users and observers have been involved in the 15 EDEN demonstrations and over 100 tools/systems have been evaluated.

Stakeholders can now benefit from a common framework that enables access to the

latest products and services, as well as to secure real-time exchange networks. The project has also promoted the establishment of food defence standards that should be implemented at EU level.

Project results are already being exploited, and a number of tools are being further developed in complementary EU-funded projects. An example of this is a new light detection and ranging technology real-time evaluation of surface microbial contamination to evaluate surface cleanliness before, during and after decontamination which is being further developed in another DG HOME project.

EDEN has significantly advanced CBRNE capabilities, many of which offer commercial exploitation opportunities. The new online EDEN CBRNE training framework was developed with the aim of launching a new European standard.

Law enforcement authorities, food producers, researchers and policymakers will be in a better position to identify the sector's vulnerabilities and define prevention and mitigation strategies.

EDEN

- ★ Coordinated by BAE Systems in the United Kingdom.
- ★ Funded under FP7-SECURITY.
- ★ <http://cordis.europa.eu/project/rcn/110015>
- ★ Project website: <http://www.eden-security-fp7.eu/>

EMERGENCY KITS TO HELP OVERCOME DISASTER

Responding to large-scale disasters has become easier with the development of new, innovative kits for humanitarian organisations to use to aid recovery. The concept has the potential to save many lives.

Within the EU-backed S(P)EEDKITS (Rapid deployable kits as seeds for self-recovery) project, novel emergency kits were developed for use during emergency response and humanitarian aid work. The kit contains special equipment which is either used by humanitarian workers or given to the affected population. The project focused on kits that can be easily shipped and rapidly deployed within the first hours of an emergency, hence the focus on SPEED. At the same time, the kits needed to contain materials and provide solutions that would be useful beyond the actual emergency situation. This means that the kits needed to be able to form the SEED for long-term recovery, potentially via local adaptation/upgrading.

The project covered the domains of shelter (providing semi-temporary housing), water (drilling kits), sanitation (easy to deploy toilets for emergency situations), energy infrastructure, medical infrastructure (containerised operation theatre) and deployment support (high-tech tracking capabilities in real time). Emphasis was also put on smart packaging of the kits and on compiling self-explanatory manuals that ensure neutrality in terms of gender and culture.

Within each of these domains, the partners worked on ideas and conceptualisation, then early prototypes and eventually field demonstration. The guiding principle was that the kits should be high tech in design (by incorporating the latest technologies and materials), but simple, robust and easy to use. This resulted in several innovative kits being field-tested, e.g. a Hospitainer (a containerised operation theatre) which was deployed in Syria and Sudan, and also in the Philippines in the wake of Typhoon Haiyan. Elsewhere, novel shelter solutions were demonstrated in a small rural settlement in Senegal, while in Ethiopia and Madagascar field drilling tests were successfully conducted.

Eight of the developed kits are now available as commercial products, including a multipurpose shelter unit, a jetting kit for water drilling, raised toilets, a mobile de-sludging device for emptying latrines, a water tower kit and containerised medical infrastructure. The commercialisation has been made possible through project partners and collaboration with external companies. The customers for these novel kits are humanitarian organisations such as Médecins Sans Frontières, Oxfam,

UNFPA (United Nations Population Fund) and national Red Cross Societies.

S(P)EEDKITS was partially funded by the EU FP7 programme and was coordinated by Centexbel, the Belgian textile centre. It was implemented by a consortium of 15 partners with diverse expertise from six European countries, and also included, apart from research and industry partners, several humanitarian organisations including Médecins Sans Frontières, The Netherlands Red Cross and the Shelter Research Unit of the International Federation of the Red Cross and Red Crescent Societies. A video showing a field demonstration in Senegal can be viewed on YouTube.

S(P)EEDKITS

- ★ Coordinated by Centexbel in Belgium.
- ★ Funded under FP7-SECURITY.
- ★ <http://cordis.europa.eu/project/rcn/103078>
- ★ Project website: <http://www.speedkits.eu/>

“Eight of the developed kits are now available as commercial products.”

ROBOTIC TOOLS PROVIDE BETTER ASSISTANCE TO CRISIS INTERVENTION TEAMS

Local authorities and emergency services often face the challenge of effectively managing catastrophes such as earthquakes and tsunamis. The EU has funded new tools and crisis management solutions for saving human lives and speeding up the search and rescue process.

‘Search and rescue’ (SAR) operations are extremely hazardous and complex tasks which often lead to the loss of life for both the rescuers and the victims. Current unmanned SAR vehicles designed to assist operators and responders face difficulties in locating human survivors and reaching incident sites.

The EU-funded ICARUS (Integrated components for assisted rescue and unmanned search operations) project aimed to provide a comprehensive and integrated set of unmanned SAR tools to support human personnel in the field.

Through several demonstrations, project partners have successfully developed and tested unmanned solutions for detecting, locating and rescuing humans. These air, ground and sea robots are designed primarily to gather data as the first explorers at a scene. All ICARUS tools are capable of navigating independently or together, and can follow complex instructions from a base station.


The robots connect wirelessly to a base station and to each other through a cognitive wireless network of mobile communication nodes that adapts to

different terrain. Equipped with various sensors, the robots can also detect if any humans are present. At the base station, the data is processed and combined with geographical information, thus improving decision-making and enhancing the situational awareness of the operators.

ICARUS researchers also addressed the difficulty that unmanned SAR tools face in finding their way to end users. They bridged the gap between the research community and end users by developing a toolbox of integrated components for unmanned SAR.

The ICARUS project has introduced technologies to give SAR personnel the option of deploying robots to survey an area and gather important data without risking their own lives. With the incidence of natural disasters on the rise, the project has ultimately reduced the direct human and economic impact of their aftermath.

ICARUS

- ★ Coordinated by the Royal Military Academy in Belgium.
- ★ Funded under FP7-SECURITY.
- ★ <http://cordis.europa.eu/project/rcn/102326>
- ★ Project website: <http://www.fp7-icarus.eu/>
- ★  <http://bit.ly/1xLkBBE>



FUNDAMENTAL RESEARCH

QUANTUM LEAP FORWARD IN UNDERSTANDING BIOLOGICAL PROCESSES

EU-funded researchers have successfully applied quantum physics in order to better understand some fundamental biological processes. This ground breaking work could eventually help industry to develop more efficient light harvesting technologies and artificial odour sensors.

The PAPETS (Phonon-Assisted Processes for Energy Transfer and Sensing) project focused on two key biological processes: photosynthesis (the process by which green plants use sunlight to synthesise nutrients from carbon dioxide and water) and olfaction (the capacity to recognise and distinguish different odours). Understanding how photosynthesis works at the most fundamental level could result in the design of much more efficient solar cells, while better artificial odour sensing technologies could be used to detect impurities or pollution in the food, water, cosmetics or pharmaceuticals industries.

Lessons from nature

'Unlike seeing, hearing or touching, the sense of smell is difficult to reproduce artificially with high efficacy,' explains PAPETS project coordinator Dr Yasser Omar, from the Instituto de Telecomunicações in Portugal. 'We were able to prove that the internal vibrations of a molecule are a signature of its odour, and we believe that this could involve the tunnelling of electrons.'

These findings, achieved through rigorous scientific experiments and study of the behaviour of *Drosophila* flies, were then demonstrated at various scientific exhibits, helping to communicate complex science to a wide audience. 'Our exhibits provided a guided and interactive explanation of the likelihood that our sense of smell uses vibrations of odorants in order to distinguish fragrances,' explains Omar.

'We let visitors smell fragrances with the same structure but enriched with different levels of hydrogen isotopes. These compounds have a similar shape but vibrate at different frequencies. Those who were able to differentiate the isotopes were therefore able to smell molecules which have a very similar shape but vibrate differently — in effect they smelled vibrations!'

Another project breakthrough involved the study of a vibronic mechanism that explains how energy is transported in photosynthetic complexes. This was found to play an essential role in charge separation process in organic photovoltaics, and the results of this were published in the journal 'Nature Communications' in December 2016. 'This suggests the possibility that the vibronic coupling concept — developed from

the study of photosynthesis — could be exploited to improve solar cells,' says Omar.

The project also examined how photosynthetic organisms use delicately built antennas to harvest energy from sunlight. After capturing the light, its energy is rapidly transferred within the antenna, which retains functionality despite operating in a fluctuating environment. The project team was able to accurately record this process in action for the first time. These unique insights could eventually be applied in the design of man-made solar antennas.

Applying quantum physics

These breakthroughs were made possible through the application of quantum physics, and in particular, the principle of 'superposition'. This stipulates that a particle can be described as being in two different states simultaneously. Superposition — though rather mindboggling to the non-expert — is based on solid science.

'Superposition contributes to more efficient energy transport,' says Omar. 'An exciton, a quantum quasi-particle carrying energy, can be transferred faster along the photosynthetic complex due to the fact that it can travel through different paths simultaneously. What's surprising and exciting is that these quantum effects have been observed in biological complexes, which are large, wet and noisy systems. Superposition is fragile and we would expect it to be destroyed by the environment.'

The PAPETS project, which was completed in November 2016, has helped to further advance the understanding of the role of quantum effects in biological processes, namely in photosynthesis, and the further insights gained have important practical applications. The frontier between biology and quantum physics remains an area rich in undiscovered scientific value.

PAPETS

- ★ Coordinated by Inatel in Portugal.
- ★ Funded under FP7-ICT.
- ★ <http://cordis.europa.eu/project/rcn/108664>
- ★ Project website:
<http://www.papets.eu/>

BIOREACTOR FOR HUMAN STEM CELL CULTURE

Currently, 'stem cell' (SC) production requires labour-intensive methods that lack reproducibility. However, an EU consortium has developed novel bioreactors for human SC production and differentiation with therapeutic applications in mind.

Stem cell-based technology is very important for future therapy and has already shown efficacy in clinical trials. To tackle life-threatening diseases via cell therapy, new methods to increase the manufacturing capability of SCs under controlled conditions are urgently needed.

The EU-funded HESUB (High efficient, single-use-bioreactor simulating mammalian tissue conditions for expression and proliferation) project developed disposable bioreactors for SC production. The three-year project involved five industrial partners from four European countries.

HESUB designed and successfully developed two versions of the perfused 'Single-use-bioreactor' (SUB) for human SC culture. The reactors are equipped with 'electrospun nanofibre' (ENF) scaffold made from biocompatible and biodegradable polymer. Single-use sensors measure pH and dissolved oxygen concentration and detect metabolites, glucose, lactate and ammonia.

The ENF scaffold chemistry and architecture were optimised for culture in the perfused

bioreactor. Researchers then tested five biodegradable polymers for ENF preparation. The two versions of bioreactors differ in volume. The 5 ml stainless steel mini-bioreactors are highly reproducible systems that can easily be used in parallel. The 50 ml bioreactor, called SUB-SC, is a single-use-bioreactor for cell production on a larger scale.

Experiments in mini-bioreactors successfully demonstrated the proliferation and differentiation of human myogenic precursor SCs. In addition, the project tested the differentiation of 'human embryonic SCs' (hESCs) into neural cells and hepatic cells. Proliferation of pluripotent hESCs clearly demonstrated the bioreactor's potential.

The processes developed in the mini-bioreactors were applied to the SUB-SC bioreactor for expansion of myogenic precursors. An open platform for monitoring and controlling the SUB-SC bioreactor enables its integration into any instrumentation and control system.

HESUB demonstrated proof-of-concept for SUB-SC utility in cell therapy with the successful production of human myogenic SC precursors. In addition, HESUB enabled the production of tailored organoid grafts using ENF and cultured SCs. Development of a commercially available SUB-SC would facilitate the development of cell therapy applications with benefits for all.

HESUB

- ★ Coordinated by the Royal Institute of Technology in Sweden.
- ★ Funded under FP7-HEALTH.
- ★ <http://cordis.europa.eu/project/rcn/108560>



QUANTUM PHYSICISTS BRING SCHRÖDINGER'S CAT TO LIFE (AND DEATH)

A real cat can't be both alive and dead at the same time, Austrian physicist Erwin Schrödinger said. But quantum physics rewrites the rules, a fact now demonstrated by a team of researchers funded by the EU.

Schrödinger's famous feline thought experiment showed how tricky it is to apply quantum theory to real life. But photons behave differently to cats. Superposition means photons can be all things — in all states and places — at once. They don't even obey the rules of cause and effect, where events follow each other in a certain causal order.

Now, EU-funded physicists at the University of Vienna have found a new way to 'watch' this indefinite causal order, likening their experiment to a runner, Alice, simultaneously winning and losing a race. Philip Walther and his team working on the EQUAM (Emulators of Quantum Frustrated Magnetism) project believe that scrambling causal order will allow them to make leaps forward in computing and communications.

Can I get a (causal) witness?

The problem with superposition is that once you try to 'see' or measure it, it ceases to exist. Where a quantum particle used to

"The causal witness confirmed that the photons had passed through both quantum operations in two orders at the same time."

be all things at once, it assumes a definite state. In short, if you open Schrödinger's box, you collapse the experiment. So scientists trying to prove a lack of causal order have had to infer it from the success of an algorithm, rather than directly measure it. But the EQUAM team has found a third way.

By using a theoretical mathematical concept known as a 'causal witness' — designed by Časlav Brukner's group at the Austrian Academy

of Sciences — Philip Walther and his team were able to show, for the first time, that a quantum process was not causally ordered.

A meaningful step forward

In their experiment, the scientists used an optical device to split a beam of light in two, and set about scrambling the order of the different paths it took. So as not to disturb the fragile process, they set up another quantum system to 'raise a flag' when the light passed by. The causal witness measured this additional quantum system, while keeping the superposition intact.

The causal witness confirmed that the photons had passed through both quantum operations in two orders at the same time. In other words, they were able to 'see' Alice both win and lose the race, and measure the degree to which the two situations were superimposed. 'Our experimental demonstration is a meaningful step forward in this area, since it demonstrates how to extract information inside these processes without disturbing their quantum nature,' said Giulia Rubino, the lead author of the study.

There are already a large number of studies about the role of causal relations, but the EQUAM project team has brought the theory to the laboratory. The group's next goal is to create superpositions of more complex processes to gain further insight into causal relations.

EQUAM

- ★ Coordinated by the University of Salerno in Italy.
- ★ Funded under FP7-ICT.
- ★ <http://cordis.europa.eu/project/rcn/108662>
- ★ Project website: <http://www.project-equam.eu/>

EVENTS

JULY
03

Chania, GREECE

CONFERENCE

AGRISPIN FINAL CONFERENCE

The EU-funded AGRISPIN project will be holding its final conference in Chania, Greece on 3 July, 2017.

For the last two and a half years the AGRISPIN (Space for Innovations in Agriculture) project has brought together 15 partners from 12 countries to foster best practices and support for innovation in European agriculture.

The final conference will give partners the opportunity to share their results on: the innovation process; the role of advisor and support services; tools and methods for stimulating innovation, and the Cross Visit method as a way of reflecting on and improving the innovation process.

The event will be held in connection with the 23rd European Seminar on Extension and Education (ESEE) which will run from 4 to 7 July.

The final agenda will be available in the week preceding the event.

For further information, please visit:

<http://www.conferencemanager.dk/agrispin-endconference/agrispin-end-conference.html>

JULY
09►15

Fiuggi, ITALY

SUMMER SCHOOL

ACACES SUMMER SCHOOL

The EU-funded HIPEAC project will be hosting the ACACES Summer School, in Fiuggi, Italy, from 9 to 15 July 2017.

The ACACES Summer School is organised by the HIPEAC Network of Excellence. ACACES 2017 is the thirteenth edition of the Summer School.

The ACACES Summer School is a one week summer school for computer architects and tool builders working in the field of high performance computer architecture and compilation for computing systems. The school will disseminate advanced scientific knowledge and promote international contacts among scientists from academia and industry.

The broad scope of this Summer School will range from low level technological issues to advanced compilation techniques. In the design of modern computer systems one has to be knowledgeable about architecture as well as about the quality of the code, and how to improve it. This summer school offers the ideal mix of both worlds – both at the entry level and at the most advanced level.

For further information, please visit:

<http://acaces.hipeac.net/2017/>

JULY
17►20

Girona, SPAIN

WORKSHOP

WORKSHOP ON MODELLING FOR FRESHWATER RELATED ECOSYSTEM SERVICES

The GLOBAQUA project will be organising a workshop on Modelling for freshwater related ecosystem services, at the Catalan Institute for Water Research (ICRA) in Girona, Spain, from 17 to 20 July 2017.

The workshop targets researchers and water managers interested in the modelling of freshwater-related ecosystem services in coupled socio-environmental systems. It will provide an introduction to basic principles, and participants will be able to co-develop their own case-study modelling exercise with the help of lecturers.

The morning sessions will be dedicated to theory; whereas the afternoons will be focused on the implementation of the learned concepts into individual case-studies. Deadline for registration is May 30th 2017.

For further information, please visit:

http://www.globaqua-project.eu/en/event_registration/new/&pid=49

EVENTS

For more forthcoming events:

<http://cordis.europa.eu/events>

AUG.
20►26

Brest, FRANCE

SUMMER SCHOOL

GEOTRACES SUMMER SCHOOL

The EU-funded GEOTRACES ARCTIC project, which forms part of the GEOTRACES international community, which will be holding its first Summer school in Brest, France, from 20 to 26 August, 2017.

The summer school will bring together over 60 students and 20 world-leading international scientists and aims to teach the skills and knowledge necessary for a good understanding of the biogeochemical cycles of trace metals. It will allow PhD students and early career researchers to see how their work fits within the international community of GEOTRACES.

General lectures will be given by international experts in the field of the GEOTRACES program and practical workshops in the laboratory will be ran throughout the week.

For further information, please visit:

<https://geotraceschool.sciencesconf.org/resource/page/id/3>

European market for climate services through innovative EU research

Climate change remains one of the world's most pressing challenges and the European Commission is committed to a 'forward-looking climate policy' that will see a reduction of fossil fuel emissions by 80 to 95 % by 2050 — and their complete phase-out by 2100 — and significant adaptation efforts to society and the economy to make this happen.

Climate services will be a significant component in the creation of effective adaptation strategies solutions. Whilst a relatively new and specialised sector, today's pressing challenge for climate services is to analyse and disseminate information on the full range of likely impacts of climate change (under different scenarios) and provide effective responses and bolstering the resilience of vulnerable communities.

The use of the best available climate data and knowledge is essential to create effective tools, products and services that will spark innovation on adaption, mitigation and disaster risk reduction. This will allow for better and more informed decision-making, enable a more robust approach to risk management, foster the development of a market for climate services, create jobs, and make a positive contribution to Europe's future and sustainable economic growth.

In May 2017, Cordis published a new Results Pack that showcases four EU-funded projects that are making big and exciting advances in developing Europe's climate services market. Each project is contributing to the advancing of our scientific understanding on climate change and the role that we humans are playing in this process.

Please see the following link for more information:

http://cordis.europa.eu/article/id/400203-a-european-market-for-climate-services-through-innovative-eu-research_en.html



About CORDIS Results Packs

CORDIS Results Packs are a new set of products grouping EU-funded project results per topic and target audience. The aim is to disseminate information about new studies, scientific findings and technologies to the relevant target audience, in order to facilitate their exploitation across Europe.

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