

# AG

ADJACENT GOVERNMENT | August 2015



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# Reinventing the City Building on Creativity

Creativity, innovation and a strong focus on social and cultural aspects of sustainability are at the very heart of developing the City of Varberg to become the Swedish West Coast's Creative Hot Spot by 2025.

In our vision for the future, the City of Varberg has unique opportunities. Our goal is clear, and we are acting on it. We are building a community converging around means of public transportation in a rapidly expanding region. The railroad, which has long created a barrier between the seaside and the city centre, will now be relocated into a tunnel underneath the city. To expand on this opportunity we are moving the harbour in order to further free up land for letting the city reclaim its position as a seaside town. In total, the project will result in more than 500,000m<sup>2</sup> of land for development of our future city front. For people living, working or visiting the city of Varberg, the change will dramatically increase the freedom to experience the coastline. Places of residency, places for eating and meeting, places to shop and work, etc. – comes as a bonus.

**Come to Varberg.** Share our vision.

Read more on pages 162 and 163.



The City of  
**Varberg**

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# Foreword

**Günther H. Oettinger**  
**Commissioner for Digital Economy and Society**  
**European Commission**

**T**here are few business sectors emerging as fast as the digital economy. Just a year ago almost no one had ever heard of the taxi company Uber, or the hotel substitute service Air B'n'B but now almost everyone knows about these 2 online services. Greater efficiency, the ability to adapt more quickly to the needs and wishes of consumers, and the absence of almost any additional costs when connecting to new customers are the decisive market advantages of this new model.

Digital services and digital technologies offer great opportunities. It is estimated that in Europe alone, this could contribute € 450 bn per year and create hundreds of thousands of new jobs. This is why digital technologies, and more precisely a "Digital Single Market", are one of the top priorities of this Commission. We believe that the potential of digital technologies is only fully unleashed, if there are no barriers and national silos which hinder the digital economy to flourish and citizens to use goods and services online beyond national borders. It's time to make the EU's single market fit for the digital age – tearing down regulatory walls and moving from 28 national markets to a single one.

To achieve this, the EU Commission has come up with its Digital Single Market Strategy – a paper describing ambitious legislative steps towards a connected digital single market. It includes 16 actions, most of them legislative proposals that will be proposed in the next 2 years. For example, we intend to simplify the rules for cross-border e-commerce and make parcel delivery more efficient and affordable as it is widely believed to be one of the main obstacles to shopping cross-border.

Secondly, we focus on high-quality infrastructure, which has to function smoothly across all of Europe. Because, without high speed broadband internet most of the new services will not fly. As a result we are willing to spend a share of the Commission's newly introduced €315 bn Investment Plan on schemes to extend broadband access. Thirdly, the Digital Single Market Strategy is also about creating the right conditions for a European digital economy and society. In this field, the Commission will for example propose an initiative on the free flow of data, as data gives huge potential for productivity and competitiveness across all economic sectors and a plan for integrated standardisation across sectors.

This strategy is only starting point. But if we make the right steps now, this will be a benefit for our future. ■





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# Introduction

**F**uture challenges are always at the forefront of people's minds, and although the future sounds far away, these challenges are closer than you might think.

There are a number of areas where these challenges are the most significant. This includes healthcare, the environment, the economy, and ICT. In this August edition of Adjacent Government, consideration is given to a number of these challenges that face Europe.

One of the major solutions lies in the field of digital technology, which has the ability to revolutionise the way in which these challenges are overcome. Opening the publication, Commissioner for the Digital Society, Gunther. H. Oettinger, outlines the great opportunities digital services and technologies could bring to Europe.

We also give consideration to the ageing population in this summer edition. With populations growing throughout Europe and people living longer, we consider if health services and care providers are prepared. With articles from Francesca Colombo, of the OECD and Professor Carol Jagger, of Newcastle University, we find out the opportunities that an ageing population could bring, as well as the challenges.

In a special focus, we discuss how heritage and culture plays a vital role in society-in particular the impact of museums for local communities. The focus includes stimulating articles from Dr. Jet Bussemaker, Minister for Culture in the Netherlands, The Heritage Lottery Fund and Museum Galleries Scotland.

Another challenge we face is climate change. Innovative technologies are key for overcoming this. In a speech, Commissioner for Energy, Miguel Arias Canete outlines the role of innovative and environmentally-friendly technologies while Daniel Johns, of the Committee for Climate Change explains why 2015 is an important year for climate change action.

Other topics that we give consideration to include: science and research; electric vehicles; economic development of towns and cities; the EU Urban Agenda; and, Lean Six Sigma training.

I hope you find the August edition full of interesting and thought provoking articles, and as always welcome any feedback you may have. ■





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# Innovative solutions for healthcare challenges

European Commissioner for Health and Food Safety, Vytenis Andriukaitis spoke at eHealth week in Riga about how digital applications are integral to tackling today's health challenges in Europe...

**W**hen I started as a practising medical doctor, we kept hand written health records and had face to face consultations. There was no other way. But this has been changing ever since. Digital applications and digital solutions are part of our daily lives – including in the area of healthcare.

It is now common for health records to be kept electronically. Patients' health information can be shared between health professionals in no time regardless of geographic location.

Remote consultations with a doctor over the Internet facilitate access to care, save resources and pave the way for telemedicine and tele healthcare services across and within borders.

eHealth products and services are contributing to prevention, health risk management, and thus to more sustainable healthcare. It also generates income and jobs, while offering high-level technology solutions to healthy people, patients and doctors.

eHealth also creates many possibilities for overcoming today's challenges in Europe's healthcare sector.

First, there is an increase in health risk factors such as alcohol, smoking, malnutrition which are badly managed, thus causing chronic diseases and premature deaths due to the lack of prevention.

Second, the number of people with chronic diseases is predicted to continue to rise which will put even more pressure on healthcare services. Already today, the costs of chronic diseases account for 70-80% of total healthcare costs in the EU.

Third, another challenge is Europe's ageing population.

The Europeans aged over 65 years already represent 17% of the total European population. This number will nearly double by 2060.

All of these challenges scream for innovative solutions – eHealth can offer them.

eHealth can empower people with risk factors and patients – we have to act in both cases.

**“With the establishment of the eHealth Network, Member State authorities can take the lead in Europe's activities on eHealth. I have no doubt that the eHealth Network will continue fulfilling its mission to the maximum.”**

There is huge potential in using eHealth tools to help prevent diseases and to promote good health.

New solutions such as mobile health apps can enable people to actively engage in their own health management for instance by tracking their fitness or by monitoring their health status. Apps can invite people to take part in screening programmes or inform about promotion campaigns.

These solutions are already becoming increasingly popular and the market for them is growing rapidly.

Of course, this requires a shift how we organise healthcare systems, to focus more on prevention and promotion, rather than on cure.

And, it poses regulatory and other challenges. It is not easy to find the right balance between quality, safety and confidentiality issues and maintaining sufficiently low barriers for innovation. Indeed, this is a dynamic





Vytenis Andriukaitis, Commissioner for Health and Food Safety

market where we need to support European SMEs and start-ups.

In this context, the European Innovation Partnership on Active and Healthy Ageing plays a defining role in pushing for innovative solutions from idea to market, and to deployment across Europe.

The Partnership is bringing new solutions to practice, helping millions of EU citizens to continue to lead healthy, active and independent lives as they grow older.

The Partnership is also contributing to the sustainability of our health and social care systems. It is creating new opportunities for businesses in eHealth and the broader silver economy.

It is the right momentum and scale-up such innovative

approaches to serve citizens in ever greater numbers.

To succeed we need to exploit and incorporate technological developments into our healthcare systems and improve their interoperability.

I am keen to ensure that the Commission is monitoring the functioning of health systems in the Member States including the implementation of eHealth applications. This will enable us to identify and – where appropriate – recommend actions.

I also believe that thanks to eHealth there is a scope to further integrate primary and secondary care in securing early diagnosis and timely treatment.

Health promotion through eHealth tools offers a cheaper solution to prevent or to manage chronic diseases.

Already, in many parts of Europe, diabetic patients are monitoring their blood sugar, transmitting the information electronically to their doctors. The care for their condition is ensured with less effort and at lower cost.

We at the Commission are convinced of the benefits of eHealth. We are already providing funding opportunities under Horizon 2020 to support research, innovation and cooperation. It also includes targeted measures to support innovative SMEs.

With the establishment of the eHealth Network, Member State authorities can take the lead in Europe’s activities on eHealth. I have no doubt that the eHealth Network will continue fulfilling its mission to the maximum.

**“New solutions such as mobile health apps can enable people to actively engage in their own health management for instance by tracking their fitness or by monitoring their health status. Apps can invite people to take part in screening programmes or inform about promotion campaigns.”**

It has already adopted the Patient Summary guidelines to provide continuity of care and patient safety across borders, and the Guidelines on ePrescription to facilitate the interoperability of electronic prescriptions between Member States.

This is a critical step forward – patients will benefit from an electronically processed prescription and get the medicine they need when travelling within the EU.

A new Joint Action on eHealth – funded by the EU Health Programme – will be launched to provide technical and scientific support to the eHealth Network.

Last but not least, the Commission has launched the new Digital Single Market Strategy.

This Strategy includes a set of key actions which will be taken at EU level in the coming years to complete the Digital Single Market.

Some of these actions, such as reinforcing trust and security in the handling of personal data; actions related to interoperability and standardisation; and supporting an inclusive eSociety, are of particular relevance for eHealth.

I am no techie but it is clear to me that we must seize the Digital Single market opportunities to fulfil a vision for healthcare in the 21st century – a vision of a single, universally accessible, sustainable and high quality, eHealth single market for the benefit of all European citizens and healthcare professionals.

By coming together and by sharing experiences in the Member States and at EU level, we will drive forward the case for eHealth. ■

This is a speech from eHealth week in May 2015, taken from European Commission website and republished with the permission of the Commission – [http://ec.europa.eu/commission/2014-2019/andriukaitis/announcements/speech-ehealth-week-riga-2015-0\\_en](http://ec.europa.eu/commission/2014-2019/andriukaitis/announcements/speech-ehealth-week-riga-2015-0_en).

.....  
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[http://ec.europa.eu/commission/2014-2019/andriukaitis\\_en](http://ec.europa.eu/commission/2014-2019/andriukaitis_en)



# Shepherding Physical Activity: Applying Practice to Purpose

I recognised the known determinants of free-living physical activity from a young age. I was a doer, then an academic expert and finally a public health advocate for physical activity. Here are a few important lessons from this process.

## **Lesson 1: Opportunity influences behaviour choice.**

My life is filled with opportunities for physical activity. I cycled everywhere as a child and I had physically active friends. My undergrad degree ensured I was knowledgeable about the benefits of exercise. We moved to a small house with a large yard so our children could embrace the Alberta outdoors and, as a family alpine skiing became part of our winter routine.

Our choice to participate in physical activity resulted in a supported environment and time constraints were not a significant barrier. The skiing in the mountains was accessible and we had the income to purchase equipment. This positive association between physical activity participation and education was influenced by individual preferences, knowledge and opportunities. None of it was just luck.

## **Lesson 2: Stay focused on the present.**

During my undergrad degree, B.Sc. in Human Performance with a Biochemistry focus, (1976) at the University of Victoria, BC., I was schooled in the rich historical past and filled with engaging

stories about important discoveries in anatomy, physiology, and medicine. I read about fascinating people and events that shaped the contemporary field of exercise and health physiology. For example, the ancient Greek physician Galen (131-201) wrote 87 detailed essays about improving health (proper nutrition), aerobic fitness (walking), and strengthening muscles (ropes climbing and weight training). From 776 B.C. to 393 A.D. the ancient Greek 'sport nutritionists' planned the training regimens and diets of Olympic competitors. These efforts and others, too numerous to mention, helped shape the origins of modern exercise physiology. Yet, I was not taught how to engage people in a healthy lifestyle. I thought they would just do it because there was so much information about it.

## **Lesson 3: All that is psychological is first physiological.**

My graduate program in 1984 investigated the process of overreaching in rowers, which from a sport science perspective would lead to improved performance despite the temporary underperformance and fatigue. I monitored acute and chronic changes to exercise stress through blood markers. My primary outcome, creatine kinase turned out to be a good measure of training stress. Interestingly, my questionnaire asking athletes to document their heart rate and mood state was a more promising method of predicting progressive fatigue. This revelation encouraged

me to study the overtraining syndrome (OTS); defined as a condition consistent with non-functional overreaching, but with a longer duration of performance reduction (greater than 2 months). OTS had severe symptomatology and maladapted physiology (psychological, neurological and immunological), and an additional stressor not explained by any other disease. I wonder how throughout my studies I had missed that the human body is the sum of its parts.

## **Lesson 4: The science of behaviour change.**

I pursued a doctor of Public Health degree (Dr. PH), at Loma Linda University (LLU) in the USA in 1992. I was required to complete two courses on the principles of behaviour change and initially I found this difficult to understand. My only strategy for motivating people was to say 'you can do it'. This was a hold over from working with national team athletes and yelling at them on the treadmill to keep running while measuring aerobic capacity. During my course I began to realise how important health promotion and behavioural change strategies were for engaging individuals to become more physically active. My thesis investigated the intention to exercise in patients with fibromyalgia and employed the Theory of Planned Behaviour. Understanding the antecedents that precede physical activity behaviour and the factors associated with intention to exercise



are critical for physical activity uptake. Now we must do the same for changing sedentary behaviour.

**Lesson 5: Knowledge sharing and the media.**

Armed with these behavioural change tools, I incorporated an ecological framework into my research. The NUDGE (Neighbourhood Urban Design Gets Exercise) and EcoEUFORIA (Economic Evaluation of using Urban Form to Increase Activity) were collaborative projects with colleagues in the Faculties of Environmental Design and Medicine. Intuitively, we knew that walkable neighbourhoods promoted healthier lifestyles and had higher levels of social cohesion, which our research demonstrated. The media loved it and used the title: ‘Slim in suburbia? Fat chance!’ which, fortunately was followed by “Suburb-Dwellers Shed Sloth Image in New Study”. For research to matter, it must be heard

and understood by people in a position to bring about change. We learned that multiple forms of knowledge sharing results in cooperation from the community and decision-makers alike.

**Lesson 6: Population health promotion.**

The definition of physical activity by Bouchard and colleagues (1990) is any body movement produced by the skeletal muscles resulting in an increase in energy expenditure. This purely physiological definition limits our ability to understand that the health of individuals is a combined result of their own health practices and the impact of the physical and social environments in which they live, work, and play. The most effective approach, leading to increases in physical activity behaviour must be a “combination of efforts at all levels – individual, interpersonal, organisational, community, and public policy.”

I also agree with the recreation industry which embraces being part of multi-sectoral partnerships to provide leadership in supporting their communities, but also to address the physical activity agenda.

**Summary**

Despite my lifetime fascination with physical activity for a healthy outcome, exercise and sport performance, I took for granted my role as a shepherd of physical activity. Perhaps I am not alone in this. Protecting, guiding, and watching over our families, friends, schools, workplaces and communities etc., to ensure that physical activity is part of our lives, is everyone’s role. The key is to identify the areas that are credible within our field and then determine how best to use our potential and position, to facilitate a movement of behaviour change.



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# Challenge of antibiotic resistance and the promise of metals as antimicrobials

The decrease in availability of effective antibiotics is the result of the confluence of two world-wide issues; the continual increase of antibiotic resistance and the absence of new antibiotics being developed. The first is a natural process of evolution, yet has been exacerbated by their over use. The second has been driven by the economics of the pharmaceutical industry where it is not profitable to support research and development in this area.

There is now conscious thought towards a multi-pronged approach involved in handling the challenge of 'super-bugs' and antibiotic resistance. A fundamental step required for continuous usage of antibiotics focuses on stewardship for use, and of the unnecessary use, of antibiotics. This will require accurate education for the public and healthcare professionals. These efforts should be combined with further funding directed towards discovery-based research. This will result in new defences against the superbugs resistant to our antibiotic regimen presently available.

Currently, active research in academia is exploring a wide range of alternatives to traditional organic molecule antibiotics including: bacteriophages (viruses against bacteria); isolated bacteriocins and other components of natural bacterial warfare; competitive therapies in which 'good' bacteria are added; amphipathic cationic peptides;

and metals, research to which our group has contributed to. In combination with recognising the need for an antibiotic post infection onset, suitable ideas have been directed at preventing the spread. One such concept is the use of antiseptic treatments such as engineering surfaces to inhibit biofilm formation, impregnating materials with antimicrobials, and use of nanotechnologies for targeted antimicrobial delivery.

Beyond developing new chemicals, a new structure of thinking is necessary. Rather than recognising a given bacterial species as a 'problem', we need to comprehend why such a bacterium proliferates well during infection. There has been relatively little focus in the area of understanding the relationships in a mixed species microbial ecosystem and the ramifications of an antibiotic on its efficacy and the microbial ecosystem balance. As we now appreciate the existence of the microbiome, the entire ecosystem of the animal must be considered for infectious treatments. For example a biofilm, which is composed of sessile bacteria attached to a surface, is found in a state surrounded by an extracellular matrix. It is this matrix, and additional changes in physiological state of the bacteria in the biofilm, that result in robust antimicrobial resistance.



Our group has been exploring metals as antimicrobial agents over the past decade in order to determine their efficacy at killing super-bugs and persister bacteria, and for the prevention or eradication of biofilms. Popular metals with antimicrobial activity include: silver, copper, zinc, and titanium. Essential metals such as zinc, calcium, nickel, copper and others have crucial roles in the biochemistry of living organisms. However in excess these metals are lethal, through various mechanisms, to all organisms. Other metals such as silver, mercury,

and tellurium, which are nonessential for life, demonstrate greater toxicity at lower concentrations than essential metals. The antimicrobial activity of both essential and non-essential metals has been exploited for several purposes, much longer than traditional microbe derived antibiotics.

**“There is now conscious thought towards a multi-pronged approach involved in handling the challenge of ‘super-bugs’ and antibiotic resistance.”**

Presently, metallic antimicrobial compounds are consumed for a variety of applications in agriculture and medicine and are widely accessible as commercial products. Copper is used as an antimicrobial and antifungal agent in addition to an animal feed additive. Copper can also be found in consumer products such as bedding, for the control dust mites and for the treatment of athlete’s foot by inclusion into socks. The EPA has already registered several copper-containing products as supplements to standard infection protocols in healthcare settings. Silver has certainly taken the stage seeing use as an antimicrobial topical agent in the treatment of burns. We also see silver impregnated into bandages, coated catheters and other medical devices as well as in bedding, towels, clothing, water filters, toothpaste, air purifiers, and homeopathic medicine. Additional examples include: zinc in toothpaste, shampoo and topical creams; tin in toothpaste; bismuth used to treat digestive issues and diarrhoea; and even mercury, which can be found as a preservative in eye drops.

Although metals are exceptionally effective antimicrobial agents, a fundamental concern is what happens to the metal after it has completed its role as an antimicrobial agent. As a result of metal persistence in the host (human or animal) or accumulation within the target bacteria, release into the environment upon death of the organism will eventually occur. When used in clothing or laundering, the washed out metals are transported through the drain and not cleared using current wastewater treatment processes. Furthermore, some water treatment facilities are now using copper and or silver. Such use leads to accumulation of metals in rivers and lakes. These examples, and others, might lead to ecological toxic disasters we now associate with industry drainage and mining.

The natural exposure of bacteria to metals is a process that has occurred for millennia and continues to occur. This exposure has driven the evolutionary capability of metal resistance in select micro-organisms to date. Some mechanisms include reduction in permeability or uptake, alteration of target sites, chemical modification, efflux of the metal ions, and detoxification – comparable to antibiotic resistance. The resistance of micro-organisms to metals might be regarded as of little importance due to their limited use in human and veterinary medicine to date, nonetheless their historical use in agriculture provides a reservoir of resistance.

The use of antimicrobials in both agriculture and medicine has contributed to the progression of microbial resistance. While we can continue to

replace “mature” antimicrobials with novel agents, such as metals, understanding the mechanisms, transmission and development of multidrug resistance must be given more acknowledgment than that provided by any political ‘5-year action plan’. Postponing the emergence of metals as antimicrobials may lessen the development of resistance, however, the commercial widespread access of antimicrobial metals to the public has formally prevented this action. We must re-evaluate the use of metals for non-medical purposes before the presence of multidrug resistance outgrows this potential alternative.



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# E-health: help or confusion?

With the development of online technologies, the internet has become one of the main sources of health-related information. Health information, which previously was almost exclusively available to health professionals is now made accessible to the general public. A national survey in the USA investigating behavior of internet use in the adult population (HINTS; Hesse et al., 2005), indicated that patients are first looking online for information, prior to talking with their physicians. And, then turn to their physicians for approval as to the quality of that information.

Internet has enormous potential to empower patients and help them make informed decisions with regard to their health. The use of the internet to locate health-related information might positively affect the patient-physician relationship, have a positive effect on individual demand for health care, help the patient to understand its treatment and increase their feelings of control over the disease.

There are however increasing concerns about the quality of information available, the ability of patients to identify sites providing quality information and their ability to interpret that information. When a patient and / or his / her relatives are overwhelmed with the quantity of information found on the internet, or when a patient is not able to interpret the relevance of the information found on the internet for his / her personal situation, then the use of internet for health-related

information can be detrimental. In those cases, the patient is unsure about who he/she should trust and which medical decisions are the best. This can be associated with emotional distress and feelings of confusion and can impact the patient's quality of life, as well as the relationship between patient and medical staff. The medical recommendations can be challenged and the medical staff can feel threatened by the patients' questions.

This is even more the case for fatal diseases such as cancer. One of the most frequently reported need by individuals suffering cancer is the need for information. Being well-informed on the disease, its treatment and course is associated with an increase in quality of life and self-efficacy in patients. These patients have better health-care outcomes when they are more informed about their disease, more involved with their treatment choices and more invested in their health care. Finally, information satisfaction is a predictor of quality of life in cancer patients. However, the need for information is among the less satisfactory needs of individuals suffering cancer. Not only the patients, but also their relatives have a strong need for information. Although close relatives often show more psychological distress and mental health problems than the individual suffering, little is known about their need for information.

Our research group, which is located at the Department of Psychology at the University Fribourg in Switzerland,

is currently conducting a survey on the need for health-related information and the satisfaction on the information found in individuals suffering cancer, their relatives and the medical staff involved in the treatment of patients, that is founded by the Stanley Thomas Johnson Foundation. This project called "Evaluation of the need and of the search of Internet information by cancer patients, by their close relatives and by medical staff" (in short RISC). Our first results confirmed that the majority of individuals suffering cancer, and their relatives have searched cancer-related information on internet, but report poor satisfaction with the information found. Additionally, even if the large majority of medical staff that participated in the survey is open to discuss information found on the internet with their patients, only a minority of them are able to suggest valuable internet sites to their patients. Another focus of our attention is therefore to analyse the sites consulted for the search for cancer-related information, or in general for health-related information and to evaluate their quality. There is so far no consensus on clear quality indicators for health information provided on the internet and we are developing on the basis of the search behaviour of our participants tailored quality criteria related to their needs. For this, we are working with the HumanTech Lab at the School of Engineering and Architecture at the University of Applied Sciences in Fribourg Switzerland, to create an interactive web-based interface to



analyse, on one side the searching behaviour of individual suffering cancer and on the other side provide them with quality sites related to their needs. We work with a large network of clinics and hospitals to obtain a representative view. Our website will also provide lists of trustful and valuable internet sites providing health-related information that physician can suggest to their patients, and to provide tools for patients and their relatives to improve their ability to search and find quality information on the internet. It will also help to identify whether the information is useful for them or not.

In the long-term, we hope to be able to extend our website for other chronic diseases, in order to improve the quality of health-related information and to enhance the transmission of health-related information on the internet, and therefore indirectly contribute to a better quality of life of

patients suffering chronic diseases. The association of psychological, medical and computer sciences is cutting-edge in this field and allow a modern and interdisciplinary perspective on these processes.

Our team is supervised by Professor Martin-Soelch, who is the Head of the Unit for Clinical and Health Psychology at the University Fribourg. Professor Soelch has a large experience in the investigation of mental disorders, as well as on psychosomatic problems and on the interaction between psychological and physical health. The unit of Clinical and Health Psychology has expertise on e-health and developed in association with the psychiatric institutions of the region an online program for relatives of individuals with mental disorders (programme RFSM-E-motion, <http://www.rfsm-e-motion.ch/index.php/fr/> ).

More information on the project RISC can be found at <https://www.facebook.com/etudeRISC/info> .

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# Chromatin and epigenetic changes the immune response

Histone modifications and chromatin remodelling are involved in regulating the immune response to different pathogens. A proper immune response is essential in combating viruses, bacteria and parasites that are harmful for us. We have several lines of defence; from the physical barrier of the skin to specific cells in the body. The innate system is an early response and is composed of several cell types; monocytes, macrophages and natural killer cells (NK cells). These cells react unspecifically to infectious viruses, bacteria or parasites and present these agents to the adaptive immune cells. T-cells and B-cells comprise the adaptive immune system and these cells recognise specific antigens of the infectious agents. These cells constitute the memory, developing specific memory cells that can quickly be stimulated upon a further infection. Several studies have now shown that a memory exists in the absence of T-cells and B-cells, trained immunity, but the mechanisms behind are not fully understood<sup>1</sup>.

Several recent studies have shown that both the innate and the adaptive immune system change the epigenetic landscape in response to infections. The development of immune cells in the bone marrow involves a large epigenetic reprogramming. Depending on signal, the different cells in the immune cells develops and acquire the specific gene profile for the cell



lineage<sup>2, 3, 4, 5, 6</sup>. High through-put transcriptome analyses, performed together with ChIP seq of histone modifications<sup>7, 8</sup> and analyses of the global DNA methylation profile<sup>9, 10, 11</sup>, has shown that the change in gene expression follows changes in the epigenetic landscape in the different cell lineages. In particular, cell type specific transcription factors and signalling pathway factors are regulated by histone modifications and DNA methylation.

The further response of different immune cells to infections also involves transcriptional and epigenetic responses<sup>12, 13</sup>. In response to viral infections, not only genes regulating the immune response, such as cytokines and signalling factors, are modulated, but also genes involved in DNA methylation and histone modification changed, maybe to adjust cells to the new epigenetic state. Similar changes also occur upon the induction of inflammation processes in response

to infection, but also to non-infections stimuli, such as nutrients, stress and exercise. Inflammation is the host early response induced by innate immune cells, creating fever, swelling and pain. When the response goes wrong, inflammation can be harmful. Genes involved in the inflammatory response is particularly regulated and is marked by epigenetic mechanisms<sup>14</sup>.

The immune system protects us upon infections, but can also be the cause of diseases. Allergy is caused by the immune system overreacting and autoimmune diseases, such as rheumatism and MS, is caused by the immune cells starting to attack our own tissues. Autoimmunity together with chronic inflammatory response have now been linked to many diseases and disorders, and may be the underlying cause for yet many more.

The immune response differs slightly depending on the pathogen involved. Many pathogens have evolved ways to elude or inhibit the full response of the host. The immune system has particular difficulty when combating pathogens with a life cycle in several stages. One such pathogen is the Plasmodium parasite, which is the cause for malaria. Studies towards specific antigens produced by the parasite has been investigating specific responses. The biology of the mosquito<sup>15, 16</sup> has also been studied and the immune response elicited to understand to many ways the plasmodium parasite affects its hosts. Malaria affects mainly children, those that survive are less susceptible as adults, but no real immunity is obtained. There are, however, differences in response between individuals as well as populations,

most likely caused by genetic factors. One ethnic group in Africa, the Fulani, which has been extensively studied because of the resistance to malaria. The immune response upon infection in the Fulani have been studied and compared with the response in various other neighbouring ethnic groups. These studies have mainly been SNP analyses, investigating variations in genes coding for factors in the immune response. One such example is the SNP study performed between them and the Dogon people in Mali that found genetic differences<sup>17</sup>. However, these studies have so far not been able to fully explain the differences in response between ethnic groups in the sub Saharan region. The relative resistance found in the Fulani group could therefore be explained by other factors. Interestingly, it was shown that miRNA also involved in the response to malaria and most likely other parasites<sup>18</sup>. Hence, we are interested in studying the underlying cause for the difference in immune response on another level; in epigenetic factors, such as differences in DNA methylation and histone modification profiles as well as in non-coding RNA levels. A further phenomenon of certain complex pathogens that needs to be explained is the lack of real immunity. Immune tolerance could be part of it, but not fully explain the lack of immunity. The memory of the innate immune system, trained immunity<sup>1</sup>, could be involved in the finding that adult people living in exposed areas are less susceptible to malaria, a protection that is lost when leaving these areas.

To understand the human immune response to complex pathogens, and

how host and the pathogen interacts, can then shed light to other responses causing a variety of diseases, such as stress-induced immune responses, autoimmunity and chronic inflammation.

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# Next generation global vaccines

Vaccination against infectious agents is the most cost effective approach in reducing morbidity and mortality in a population. While the innovative efforts of researchers in the past century have protected us against many of the worst diseases, it has been said that all of the easy vaccines have been made. We are now challenged to generate robust vaccines against some of the most intractable infectious diseases and to respond rapidly to the always open Pandora's box that is emerging pathogens.

## Location, location, location

Like real estate, next generation vaccines may well be all about location. Most infectious agents enter the body at a mucosal surface (e.g. the eyes, nose, lungs, vaginal, or rectal surfaces). Yet, most vaccines are not delivered at these mucosal barriers, but are instead injected into the skin or muscle. This may be a mistake, particularly when trying to protect against difficult diseases.

Combating the earliest events in an infection at the mucosal surface makes excellent strategic sense, since it is thought that only one or a few pathogens start most infections at mucosa. Neutralising these few pathogens or infected cells at the mucosal site of entry is numerically more achievable than combating billions of pathogens that arise later as they spread and overwhelm the body.

While standard injected vaccines can be protective, delivering a vaccine



inside the body is better at educating the immune system to repel internal pathogens and not as efficient at educating it to repel pathogens at their sites of entry in mucosa. Any easy to repel mucosal pathogen may be protected by an intramuscular vaccine, but challenging pathogens may not.

For example, if one wants to repel multi-drug resistant *Mycobacterium tuberculosis*, vaccinating the muscle may not be as effective as vaccinating where TB will set up camp in the lungs. Or, if protecting against the hospital-acquired *Clostridium difficile*, vaccinating the oral tract may be more effective than injecting vaccines into the arm. Sexually-transmitted diseases (STDs) like HIV-1 or emerging drug-resistant gonorrhoea or syphilis also infect at mucosal sites. One can consider vaccinating at their site of entry with a microbicide strategy with or without a contraceptive strategy. Alternately, one can harness the unique biology of the mucosal immune system to deliver vaccines to accessible sites (e.g. nasally, orally) to

elicit responses at sites that are less addressable, but that may be more relevant for protection (e.g. vagina or rectum).

## Needle-free Vaccines

The need to inject vaccines into the body requires the use of sterile syringes and needles. Ironically, these types of vaccines must breach the protective barrier of the skin to work. Breaching this barrier during a pandemic like Ebola virus may be ill-advised. The need to inject vaccines also poses a significant problem for global immunization particularly in regions where sterile syringes and needles are hard to obtain. Worse, if syringes and needles get re-used due to low availability, a well-intentioned vaccine effort may actually cause diseases rather than preventing them. Fortunately, needles can be avoided altogether with mucosal vaccines that are swallowed, administered under the tongue, or given intranasally. This may be a 'win-win' for next generation vaccines as this not only avoids syringes and needles, but also delivers vaccines where they need to be.

**Zero Waste Vaccines**

If we design the world’s best vaccine, we will probably want to vaccinate the more than 7 billion humans on the planet with it. If we only vaccinate them once with our vaccine and use syringes and needles, we will create 7 billion needles and 7 billion syringes. If we have to immunize everyone three times, then multiply the waste proportionately. If we deliver the same comprehensive panel of childhood vaccines that children in developed countries receive and deliver this panel to every child on the planet, multiply syringes and needle waste by orders of magnitude.

This is the biohazard equivalent of leaving landmines behind after a war for someone to step on. The billions of syringes and needles generated by vaccine efforts will end up in our burgeoning trash piles or worse yet on our streets. If we engage in wars on infectious diseases, we need to have comprehensive plans to not leave behind these biohazard landmines.

Given this, next generation vaccines should avoid the use of syringes and needles altogether. Oral or nasal vaccines already achieve this goal. If these needle-free vaccines are packaged in biodegradable vials or containers, they can truly be ‘zero waste’ vaccines.

**Adjuvants to Amplify Vaccines**

Many protein vaccines are relatively weak because they lack the ability to alert the immune system like a real infection. If one does not use a live-attenuated or gene-based vaccine to provide this alert, next-generation vaccines will also need to incorporate adjuvants that entrap and/or activate innate and adaptive immunity. Next-generation adjuvants will likely target

multiple immune cell targets for ‘dual licensing’ or ‘multiple-licensing’ to provide overlapping innate and adaptive immune cell activation to amplify responses to stealthy pathogen proteins.

**Don’t Bring a Knife to a Gun Fight**

Most infections start with either one or a few pathogens and then take over the body by reproducing at exponential rates. For example, if a bacterial pathogen divides once every 30 minutes, this one bacteria can become 100,000,000,000,000 bacteria in 24 hours. Expecting a vaccine that cannot also amplify to repel this pathogen spread is likely unrealistic for our most difficult infectious diseases.

While recombinant protein vaccines like the hepatitis B and HPV vaccines can be potent, these are special cases. Instead, our most potent vaccines are actually live-attenuated vaccines like polio vaccine which are derived by damaging or mutating the cognate pathogen to protect against its wild-counterpart. Live-attenuated vaccines are robust because they amplify and also stimulate antibodies and cellular immune responses.

**Don’t Shoot Yourself in the Foot with Your Gun**

While live-attenuated vaccines like that for polio are potent, they can also cause the disease that they are supposed to prevent as demonstrated by the current vaccine-associated polio epidemic in Africa. Using the pathogen as a vaccine against itself may be ill-advised in next generation vaccines.

**Genes as Vaccine Bullets**

The genes of pathogens encode their proteins and these can then be targeted by vaccines. Rather than use



Michael A Barry PhD, Professor

the pathogen itself as a vaccine, we can extract their genes and use them as gene-based vaccines that have no risk of infection. Gene-based vaccines are now part of our next generation vaccine regimen. However, many are relatively weak in humans because they do not amplify their vaccine genes in the same way that the pathogen amplifies during an infection. Therefore, more robust next generation gene-based vaccines will likely harness the ability to replicate and amplify to provide better protection and to require that less vaccine be produced or used for immunization to achieve the same protection.



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# Inferior Vena Cava Ultrasound and Shortness of Breath

The role of ultrasound for Inferior Vena Cava measurement (IVC) in patients presenting with shortness of breath is often debated. Authors have disputed different modes and points of measurement and with varying probe placement.<sup>1-5</sup> Additionally, patient position, habitus, degree of respiratory distress, and the presence of mechanical ventilation can influence the size and collapsibility of the IVC. Common agreement may be found from a recent metanalysis suggesting a moderate level of evidence supporting the IVC diameter is low in hypovolemic patients as compared with euvolemic patients.<sup>6</sup>

The caval index calculates the percentage collapse of the IVC:  $\text{IVC expiratory diameter} - \text{IVC inspiratory diameter}$ , divided by the IVC expiratory diameter  $\times 100 = \text{caval index (\%)}$ . In the setting of shortness of breath, a caval index near 100% suggests complete collapse of the IVC and is indicative of volume depletion. The closer the number to 0% the more likely the patient has intravascular volume overload.<sup>7</sup> Additionally, cardiac tamponade from pericardial effusion should be considered with a non-collapsible IVC in patients who present with shortness of breath. The BRIPPED scan is a screening tool for patients with shortness of breath of unclear etiology. Among its components discussed below, the scan simplifies the caval index by qualitatively evaluating

the collapse of the IVC. Figure 1 demonstrates a collapsed IVC in a patient presenting to the Emergency Department with shortness of breath due to congestive heart failure. This patient is intravascularly depleted and required intravenous fluids. Figure 2 demonstrates a dilated IVC in a patient with shortness of breath due to congestive heart failure with intravascular volume overload. Additionally BRIPPED screens patients for pericardial effusion and other etiologies of shortness of breath.

**“A low frequency phased array or curvilinear probe is used to visualise the IVC long axis, and dynamic imaging is used to assess collapsibility as either complete or less than 40%.”**

The IVC is visualised in the long axis plane in patients who are semi-recumbent or supine. The IVC should be visualised as it enters the right atrium, to differentiate it from the aorta that runs parallel to the IVC. With the BRIPPED protocol, the sonographer may image the IVC, and obtain cardiac windows using the same lower frequency phased array probe to evaluate ejection fraction and pericardial effusion. The probe is placed below the xiphoid bone, and the probe marker rotated towards the patient's head. Alternatively, the probe may be placed anterior to the mid axillary



Virginia M Stewart

line, with the probe marker towards the head.

## **BRIPPED Protocol:**

The BRIPPED scan is an effective screening tool for shortness of breath that evaluates pulmonary B-lines, Right ventricle size and strain, Inferior Vena Cava (IVC) collapsibility, Pleural and Pericardial Effusion, Pneumothorax, Ejection Fraction of the left ventricle, and lower extremity Deep Venous Thrombosis.

**B-lines:** Sonographic pulmonary B-lines have been shown to correlate with congestive heart failure.<sup>8-11, 15, 16</sup> A high frequency linear probe is used to evaluate at minimum 2 mid clavicular apical lung windows.



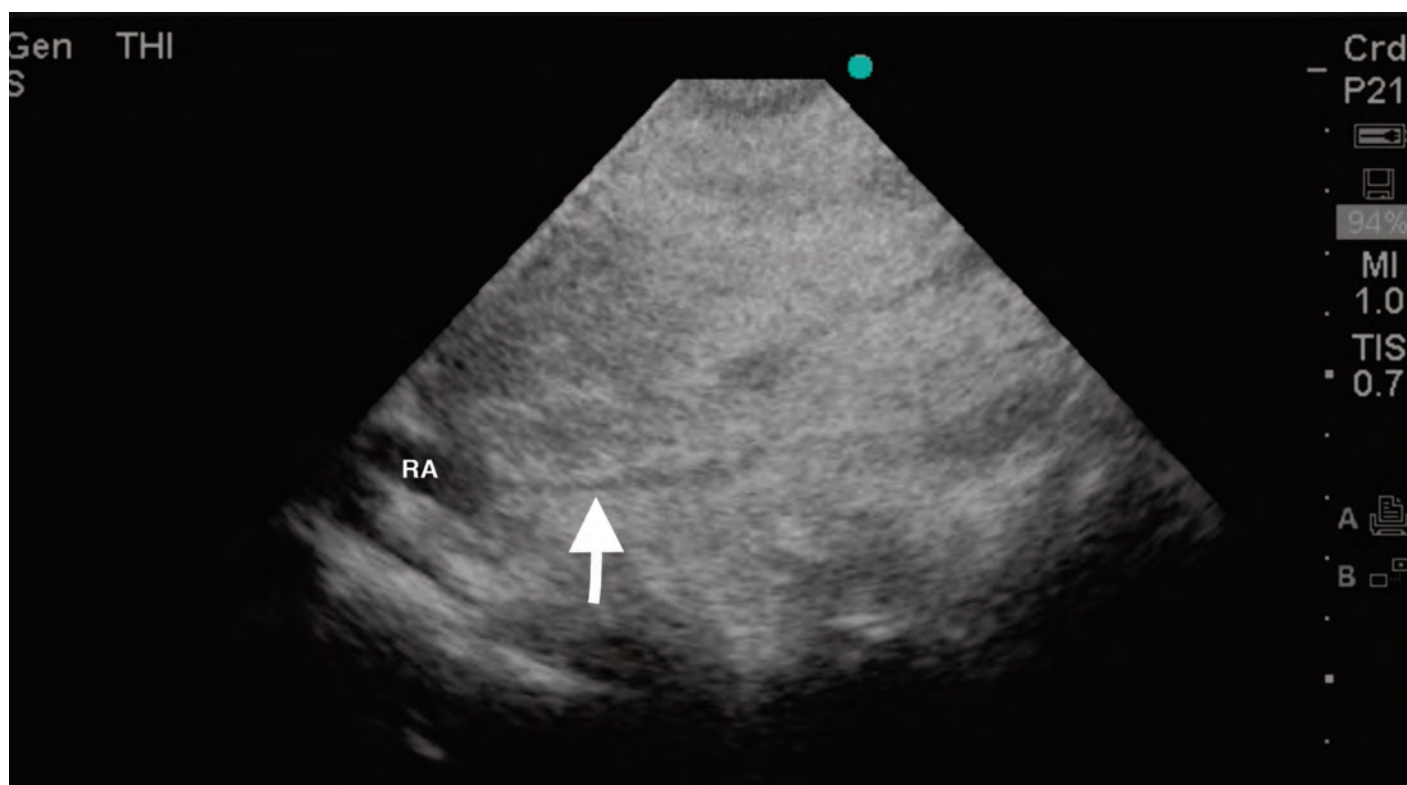


Fig 1: IVC (arrow) collapses with inspiration. RA = Right Atrium

**RV strain:** Right ventricular (RV) enlargement can be caused by a Pulmonary Embolus (PE), acute RV infarct, Congestive Heart Failure (CHF), pulmonary valve stenosis or pulmonary hypertension, and is a risk factor for early mortality in PE.<sup>17</sup> A low frequency phased array probe is used to evaluate RV strain in an apical 4 chamber view.

**IVC-size and collapsibility:** Using an IVC size cutoff of 2.0 cm has been shown to have a sensitivity of 73% and specificity of 85% for a Right Atrial Pressure (RAP) above or below 10 mmHg. The collapsibility during forced inspiration of less than 40% has even greater accuracy for elevated RAP (sensitivity 91%, specificity 94%, NPV

97%).<sup>18</sup> A low frequency phased array or curvilinear probe is used to visualise the IVC long axis, and dynamic imaging is used to assess collapsibility as either complete or less than 40%.

**Pneumothorax:** Bedside ultrasound is more accurate than supine chest x-ray with diagnostic ability approaching that of CT.<sup>19,20</sup> The same windows for B-lines are utilised for pneumothorax screening. Additionally any area of decreased breath sounds, or crepitus palpated along the chest wall is evaluated for pneumothorax with a high frequency linear probe.

**Pleural effusion:** EUS has been shown to have an accuracy similar to a CXR for evaluation of pleural

effusion.<sup>13,14</sup> A low frequency phased array or curvilinear probe is used to evaluate each mid axillary line at the costophrenic angle in the sitting patient.

**“The BRIPPED protocol can be performed in its entirety from a head to toe approach, switching between transducers, or completing the exam with one transducer then switching to the next.”**

**Pericardial effusion:** EUS has a sensitivity of 96% and specificity of 98% compared to formal echocardiography.<sup>21</sup> A low frequency phased array probe is used to evaluate pericardial effusion from an apical 4 chamber



Fig 2: Dilated IVC with minimal respiratory variation. RA = Right Atrium

view and a parasternal long axis view of the heart.

**“The BRIPPED scan is a screening tool for patients with shortness of breath of unclear etiology.”**

**EF:** The qualitative assessment of left ventricular ejection fraction by emergency physicians has been shown to correlate well with an assessment by a cardiologist.<sup>22-24</sup> The same low frequency probe and parasternal long axis used to evaluate pericardial effusion is used to evaluate ejection

fraction. Dynamic qualitative assessment of ejection fraction is classified as normal, depressed, or severely depressed.

**DVT in lower extremities:** Ultrasound was performed by emergency physicians using a two point compression venous ultrasound on patients with suspected lower extremity DVT. This approach had a 100% sensitivity and 99% specificity in diagnosing DVT, compared to a reference venous ultrasound in radiology.<sup>25</sup> A high frequency linear probe evaluates compressibility of the common femoral and popliteal

veins with dynamic scanning. If pretest probability is higher for DVT, then additional fields are included, starting below the inguinal ligament at the common femoral vein, and each segment of vessel is compressed every 2 cm to the trifurcation of the popliteal artery distally.

The BRIPPED protocol can be performed in its entirety from a head to toe approach, switching between transducers, or completing the exam with one transducer then switching to the next. An example of the latter would be to first use the low frequency

probe to evaluate the parasternal long axis and apical 4 chamber, noting the presence or absence of pericardial effusion, ejection fraction, and RV strain. Then the long axis of the IVC is evaluated for dynamic collapsibility. Moving laterally, the costophrenic angles are evaluated bilaterally for pleural effusion. The probe is switched to the high frequency probe to evaluate each lung apex is evaluated in the mid clavicular line for the presence of pneumothorax and B lines. Lastly, the dynamic 2 point DVT screening is performed with compression ultrasound. The BRIPPED protocol and other bedside ultrasound resources can be viewed here:

<http://www.anatomyguy.com/b-ripped-scan-for-evaluation-of-emergency-department-patients-with-shortness-of-breath/>

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# Therapies for weak muscles

It is estimated that ten percent of the costs of health care in Switzerland (or an equivalent of 500 billion Euros per annum in the EU) being associated with lost work is related to injury or dysfunction of the musculoskeletal system (Fig. 1). Surgical and subsequent rehabilitative interventions are important part of the therapy that re-establishes musculoskeletal function.

The Laboratory for Muscle Plasticity at Balgrist University Hospital aims to bring light into the underlying mechanisms in skeletal muscle with the goal of translating the findings into more effective clinical applications.

Skeletal muscle plays a major part in control of movement and posture and affects whole body metabolism through its effects on energy expenditure. Affections ranging from simple overuse injury to rupture of tendon and bones, or disease, lead to deconditioning of skeletal muscle as a result of inactivity and damage signals<sup>1</sup>. The consequent loss in muscle strength and fatigue resistance exerts a distinct negative impact on the quality of life and may render the affected individuals dependent. In these situations a surgical intervention and rehabilitation may be indicated, yet may come too late as irreversible changes may have resulted.

Focus on muscle plasticity: The laboratory for muscle plasticity investigates the mechanisms that underlie the conditioning of skeletal muscle structure and function during recovery

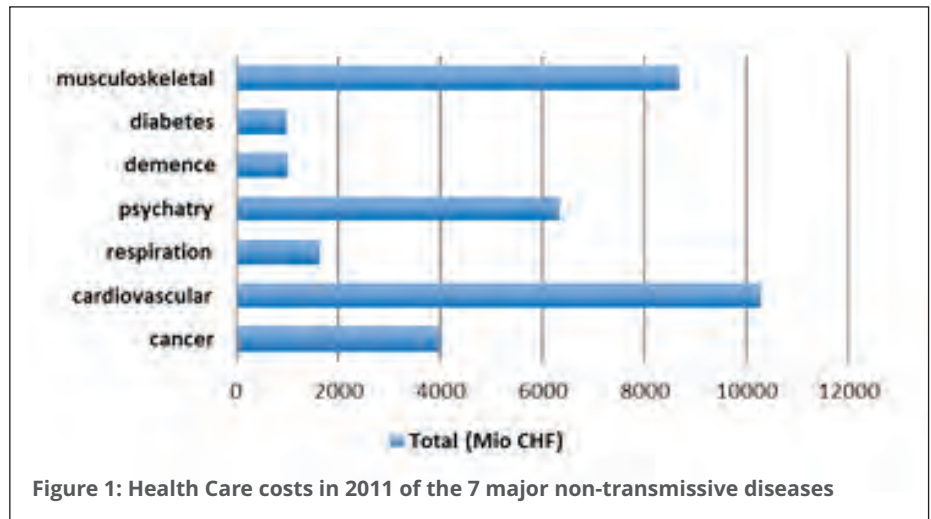


Figure 1: Health Care costs in 2011 of the 7 major non-transmissible diseases

from surgical interventions and rehabilitation. As shown through research on Sport Performance this process is driven by mechanical and metabolic stimuli. It is mediated through a gene response that instructs adjustments in muscle composition with the repeated impact of exercise during training. In consequence, force production and fatigue resistance of muscle may be improved or maintained.

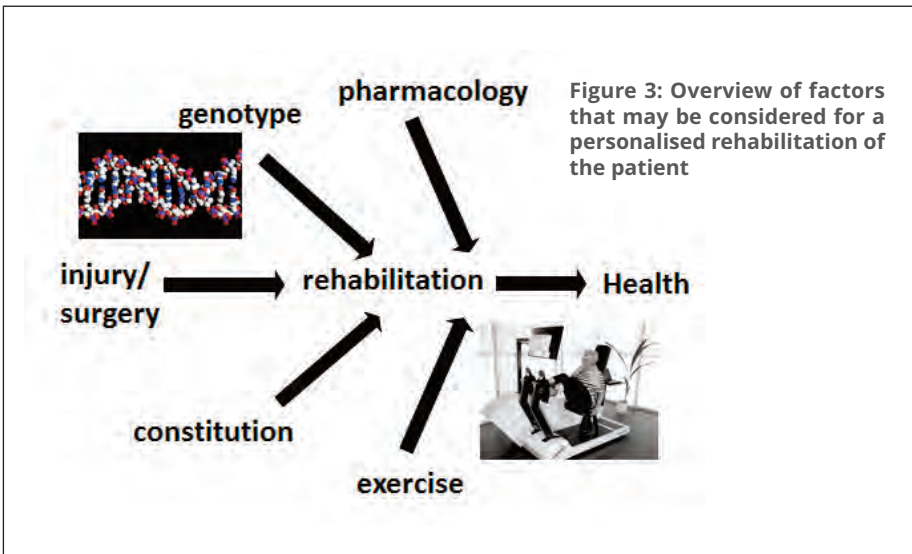
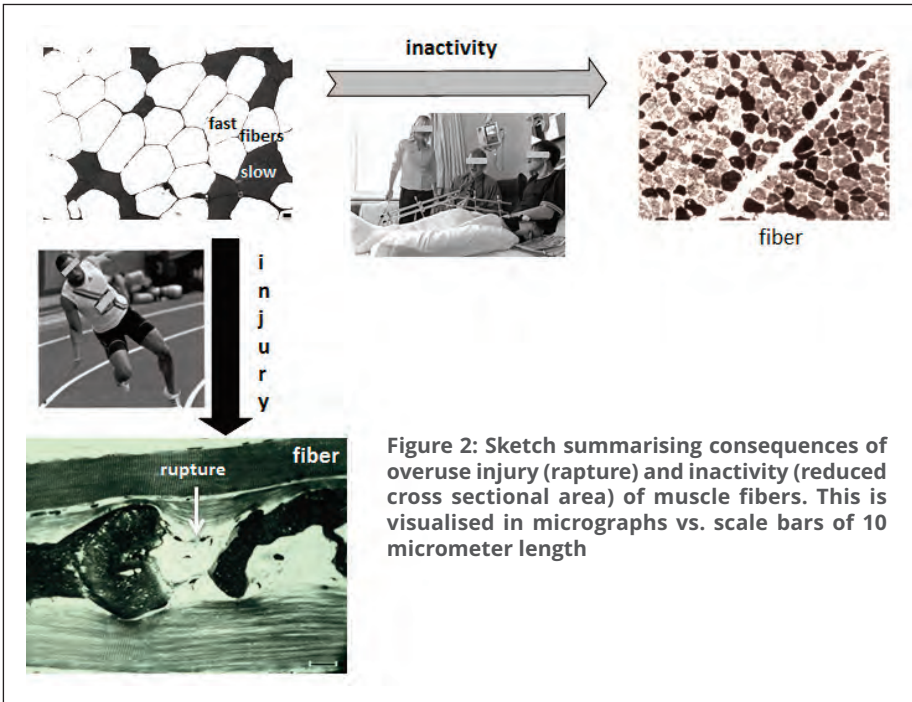
On the opposite muscle's functional capacity is reduced in the absence of a physiological stimulus by a reduction in the size of muscle fibers and their content in mitochondria (Fig. 2).

In fact, while the safety and effectiveness of physical factors for muscle conditioning are well established, the dose-effect relationship between exercise and muscle adaptation is often not fully respected in clinical practice. An example of this biological regulation is the important role of muscle contraction and loading in preserving muscle mass of the bedridden musculoskeletal patient after

surgery which otherwise loose muscle mass at a pronounce rate. Genetic factors (so called gene polymorphisms) importantly affect this adaptation<sup>2</sup>. This indicates that gene polymorphisms contribute to the inter-individual variability of the response to surgical interventions and rehabilitation.

**“The Laboratory for Muscle Plasticity at Balgrist University Hospital aims to bring light into the underlying mechanisms in skeletal muscle with the goal of translating the findings into more effective clinical applications.”**

Research projects: The emphasis of the research team lead by Prof. Martin Flück at Balgrist is put on major musculoskeletal affections that arise in the context of the Orthopedic Clinics at Balgrist Hospital. A special focus is put on resolving the contribution of gene polymorphisms to inter-individual differences in the healing of muscle with re-attachment of the ruptured rotator



cuff tendon, and the strengthening of skeletal muscle with rehabilitative exercise in patients.

The aim is to develop personalised forms of interventions that maximise muscle adaptation (Fig. 3). The latter approach is based on our previous work that points out the important exercise-intensity and exercise-type related influence of gene polymorphisms on the muscle response to the leisure type Sports activities<sup>3</sup>. This opens a venue to tailor the therapeutic

effective exercise intervention for patients which otherwise would demonstrate little plasticity to a generic exercise stimulus and for which pharmaceuticals alone do not work due to the importance of activity-induced muscle metabolism for muscle adaptations.

Patient-lead research: By the end of 2015 the laboratory will undertake a major step towards an expansion when it will move in brand new research facilities in what is to

become the Balgrist Campus (<http://www.balgristcampus.ch/en/>). A key ingredient of this research facility will an open-space landscape where research and development into musculoskeletal medicine is integrated under one roof between clinicians, biologist, engineers, and industry. The facility situates in the vicinity of the orthopedic hospital at Balgrist; thus providing a pipeline for a reality-driven approach that re-integrates questions from bedside to bench and returns to the patient. The laboratory for muscle plasticity is looking for potential partners that may want to exploit the research options presented in the future Campus in the frame of collaboration.

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# eHealth in health services and systems

**Dr Joan Dzenowagis from the eHealth Unit at the World Health Organization (WHO) outlines how eHealth is making an impact in countries worldwide...**

Ten years ago the World Health Organization's (WHO) governing body, the World Health Assembly, recognised that eHealth was transforming health services and systems around the world, and urged Member States to plan for appropriate eHealth services in their countries<sup>1</sup>. The digital economy was already a reality, and its continued growth over the past decade has further expanded the opportunities for health. On the broader development agenda eHealth is now seen as a driver, as well as a beneficiary of development, innovation and economic growth.

Today eHealth is making an impact in every country. From the local to the national level, information and communication technologies (ICT) in health, or eHealth, is changing how health care is delivered and how health systems are run. It supports critical functions by improving the ability to gather, analyse, manage and exchange information in all areas of health, from research on molecular genetics to large-scale humanitarian interventions. In health systems, ICTs are being used to improve the timeliness and accuracy of public health reporting and to facilitate disease monitoring and surveillance. They are fundamental in distance learning, and in enabling rapid response in emergencies. The strategic use of eHealth can support sector-wide planning as well as coordinating decentralised district health systems, and improving the ability to plan, budget and deliver services.

Since the first global survey on eHealth in 2005, WHO's Global Observatory for eHealth has documented the trends worldwide. Its adoption has continued to accelerate as stakeholders such as governments, industry, academia and others increasingly depend on it to conduct the daily business of health. More recently the rapid global uptake of mobile technologies has opened important opportunities in public health

and clinical practice to reach patients, health professionals and the public when and where needed. As health systems face stringent economic challenges, greater demands for efficiencies and higher expectations from citizens there is a need to provide more care and better care to more people, especially those most in need. The use of eHealth is now understood to be central to this effort.

However, there are social, economic and other barriers that affect a country's ability to take advantage of digital opportunities. To make eHealth a reality, countries must tackle a number of challenges at the national level. These include planning for and building infrastructure, deploying services and applications, developing a capable health workforce, ensuring a sound legal and regulatory environment and improving governance, standardisation and interoperability. The days of pilot projects are waning as governments move towards strategic, integrated planning and sustainable financing mechanisms to enable solid foundations for investment and change.

WHO has long recognised the need for a systematic, practical approach that aligns the many stakeholders in eHealth around a national vision and strategy. Towards that end, sustained commitment, investment and political will are as important as ever. Legal and ethical issues must be addressed to ensure that everyone benefits. Leadership and engagement are critical, as well as a long-term view to develop the potential of eHealth in regards to a country's economic context and needs. Health systems will need to develop new ways to test and adopt innovations that create value for patients and society, but which may not match the short time horizons for return on investment that now characterise our approaches. Beyond the technical challenges of implementing





eHealth at the national level, it will be critical in the coming years to ensure that cross-border, regional and international efforts in eHealth work in harmony, and that all governments build their capacity to engage in this area.

**“The adoption of eHealth has continued to accelerate as stakeholders such as governments, industry, academia and others increasingly depend on it to conduct the daily business of health.”**

WHO provides guidance to countries, to understand how ICT can support health goals and in defining a comprehensive strategy development process to go forward. Public policymakers often need a much better understanding of the main components of eHealth and how to plan for its adoption. The process of strategy development encourages the active participation of a wide range of stakeholders, public and private, towards achieving a shared goal of lasting progress in public and individual health.

The case for adopting information and communication technologies has been evident for over a decade. However, it has often taken a crisis in the health sector to move eHealth from the periphery to the centre of strategic health planning. Today, many countries are poised to take the next step: developing national eHealth strategies, building capacity, engaging in collaborations and striving to ensure public ownership, trust and confidence in eHealth for the years to come. ■

1 [http://apps.who.int/iris/bitstream/10665/20398/1/A58\\_2005\\_REC1-en.pdf?ua=1](http://apps.who.int/iris/bitstream/10665/20398/1/A58_2005_REC1-en.pdf?ua=1)

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# Your health on your mobile

**Renate Heinisch and Isabel Caño Aguilar, Members of the European Economic and Social Committee (EESC) highlight the importance of digital healthcare for Europe...**

**T**he general public and especially patients, healthcare professionals and the European Parliament have repeatedly stressed the need for comprehensive, accurate and up-to-date information on medicinal products. Improving the layout and content of medicine information on paper leaflets alone – as proposed in the Pharmacovigilance legislation – will not be sufficient to meet the expectations of patients and healthcare professionals. A fresh approach using modern digital options is needed.

## **Addressing digital health literacy and lifelong learning**

Health literacy needs to be addressed to allow all patients equal easy access to reliable information so they can better manage and participate in their own health care – something that could lead to greater patient adherence. Also, since people of all ages now use electronic health information, it is time to introduce electronic medicinal product information.

Empowerment needs to be supported by training and lifelong learning. Healthcare professionals need to get appropriate training, including in new technologies and digital options. Adult education centres could develop attractive courses that are tailored to the needs of users. In order to reach out to the target group they could team up with healthcare professionals (in particular doctors), local pharmacies and the local health and social affairs administrations. This is particularly important in rural areas, where people are more isolated. In particular, learning across the generations might help to exchange knowledge about contents and technical skills.

## **The EESC's proposal – a reliable digital information source**

Creating a single portal with up-to-date and targeted

information on medicinal products that is approved by medicines licensing agencies would deliver a trustworthy and easily accessible source of information, also meeting disability-access criteria. For people with learning difficulties the text could be accessible via "simplified language". Patients and healthcare professionals would thus be able to compare any information available elsewhere on the internet with this authorised information on medicinal products in the EU.

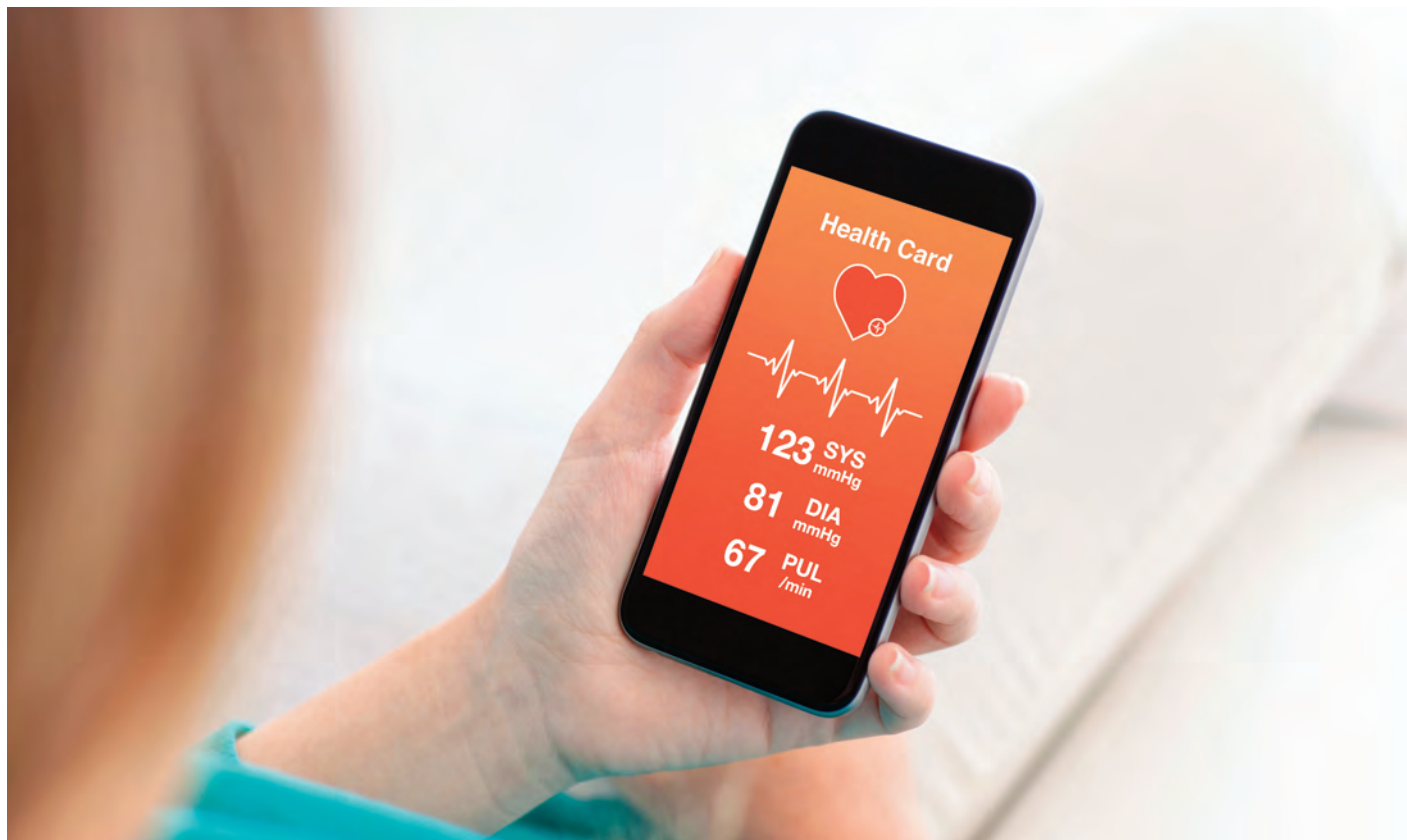
## **A stepwise approach**

In Italy, pharmacies are already required by law to print out updated packaging leaflets that the pharmaceutical industry has to make available via a database. Such printing – either by the pharmacist or by patients themselves (using ATM-like terminals) – is a further complementary option and could cater for those who do not use the internet.

## **Mobile health – Healthcare practices supported by mobile devices**

Innovations in eHealth and mobile health (mHealth) markets and practices are on the rise. We can see this all the time in hospitals, private practices and pharmacies and also on our mobile devices. There is no question that the applications are genuinely useful, but they also give rise to many questions and generate serious debate.

More and more people are using smartphones, tablets and other mobile devices and the new generations of digital users, familiar with cloud computing, social networks and mobile devices make extensive use of these technologies. Apps are beginning to play an effective role in managing chronic disease, promoting healthy lifestyles, empowering patients and enabling early detection.



Thought must be given to the type of apps which are desirable, such as strictly health-related apps to manage medical appointments, assist diagnosis, manage chronic illnesses and monitor pregnancy, or more general apps providing medical translation or related to wellbeing, nutrition or physical exercise. We should also consider issues such as quality, consumer safety, regulation, healthcare training, data protection and processing with the overall aim of establishing the EU as a leader in the sector.

**The EESC calls for an inclusive digital society**

The EESC advocates removing current regulatory, economic, structural and technological barriers that are detrimental to the European industry. The ultimate aim is to facilitate the establishment and growth of European businesses, especially small and medium-sized enterprises, which play a prominent role in the sector.

In its opinions, the EESC has called for an inclusive digital society providing online services in fields such as justice and healthcare. However, it is vital to guarantee access to these services to all citizens, as well as quality, security, interoperability and confidentiality. This means that priority must be given to improving

treatment and health and not to cutting health costs and jobs. The success of mHealth will depend on the participation of health professionals, patient organisations and the industry.

And one last point: before downloading an app, speak to your doctor! ■



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# Digital health – a European vision for better health and wellbeing

**Pēteris Zilgalvis and Elen Ohov from the Health and Well-Being Unit, DG CONNECT at the European Commission explain why digital matters for health and for the society...**

European health systems share common values of universality, access to good quality care, equity and solidarity. These values are currently being put to the test with increasing demographic and economic pressures.

With the European population ageing, we will see a greater demand for health and care services and a smaller working age population financing those services. According to the 2015 Ageing Report, the population aged above 65 will almost double from 87 million today to 152 million by 2060, accounting for 30% of the population. Longer lives are not lived without disability. Europeans are expected to live on average almost 20 years with an activity limitation. Chronic diseases account for 80% of the disease burden and consume 70% of total healthcare costs.

It is clear that innovations are needed to keep people active and healthy for longer and to maintain social and healthcare levels while coping with increasing pressures on public spending. We need to rethink the ways health and social care are delivered in order to make best use of existing resources and meet the changing needs of the ageing population.

Stimulating the market of products and services addressing the needs of elderly persons can create a massive pull-effect on existing or emerging markets, e.g. independent living and smart homes, health and wellbeing, autonomous vehicles, robotics, specialised medical devices and treatments. In many of these markets European economic operators have a strong potential for global leadership.

A European approach is needed however, to overcome differing market conditions and the lack of standards

in different sectors, and to avoid risks of fragmentation to emerging market opportunities, especially for SMEs.

## **Putting people in the driver's seat**

In the digital era with information becoming easily available, people are also becoming more aware about their own health. According to a recent Eurobarometer study 6 out of 10 Europeans go online when looking for health information. There is a greater demand for transparency and people want to be actively involved in making decisions about their own health. Putting people in the driving seat and giving them the power to decide about the use of their health data is a pre-requisite to empower people to be involved in their own health management.

New tools are becoming available which enable people to take a more active role in their own health management. Driven by the affordability of end-user devices, mobile health is an emerging and rapidly developing field. Mobile devices and applications are increasingly used for lifestyle and health monitoring, to support behavioural change and self-management of chronic conditions. It is estimated that around 100 000 mHealth apps are currently available across multiple platforms on the global market. Opening up to this vast amount of user-generated data is a challenge for health systems but could in long term lead to more personalised care, improved prevention and adherence to treatment, and thus more efficient use of resources.

Of course, effective data protection and citizens' privacy needs to be ensured. The EU is committed to the highest standards of protection of personal data and privacy. The new EU data protection legislation will increase trust in the digital services and the



Commission has committed in the Digital Single Market strategy to further reinforce trust and security, for example by tackling the cyber threats.

**Recognising the disruptive aspects of innovation**

ICT has huge potential to support the transformation in healthcare towards new models of care which enable better use of resources, more patient engagement, personalised services and better outcomes. Investment in independent living solutions and age-friendly homes can contribute to alleviating the escalating public spending dedicated to long-term care of the ageing population.

Whilst a significant number of good practices have surfaced that demonstrate real benefits of eHealth, for example, remote management of chronic diseases, most have only been applied at small scale and have not yet become an integral part of daily practice. The challenges and barriers are much the same for eHealth as they are for the whole Digital Single Market – regulatory fragmentation and legal uncertainty, lack of trust and insufficient security in the online environment, lack of interoperability, lack of awareness and digital skills.

Innovation relies on collaboration, daring to take risks and trying new approaches. It should be encouraged

by policy, legislative and technology assessment frameworks. We need to recognise the disruptive aspects of innovation and eHealth on healthcare and the healthcare industry, such as changing mind-sets in the ‘empowerment rebalance’ between patient and health professional. The increasing health awareness, new tools and wide availability of information is challenging the traditional roles and skill base of health professionals. Adapting education and training of health professionals to these changing needs is crucial to support the transformation. ■

The views expressed in the article are the sole responsibility of the author and in no way represent the view of the European Commission and its services.

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# Creating digital possibilities for healthcare

In an article, Federal Health Minister Hermann Gröhe, details the introduction of the electronic health card, the digital possibilities of telemedicine and the proposed e-health law...

On January 1, the electronic health card finally replaced the old insurance card. For now, it is like a sports car, which lurks in the garage on its use. We finally need information highways so that the electronic health card can show what it can do, as it is an important step towards the digital age of healthcare. It brings something forward, what we urgently need, but do not have much: networking! It is a paradox: Almost all surgeries and hospitals use digital data at a high level. But the transfer of this data is often still in the analogue age. Digitalisation must and will come. If we do not tackle it now, we will later run into problems after the development. Losing time now is a costly endeavour and harms everyone – in every respect.

Digital networking does not only mean faster communication and greater economic efficiency, for the most tech-savvy nerds or costs fixed manager, it's about tangible medical benefits. An example of the potential of the health card, which today lies idle but we finally want to open, with electronic, callable emergency data to the physician would provide important information in the future which is immediately available. This can save lives! We need more networking, but not just in emergencies. In Germany, unfortunately more people die by adverse drug reactions than on the road. A digital overview of the prescribed drugs can be a real step forward, especially for the elderly and people living alone.

We are just beginning to exploit the opportunities of the digital age in the health sector. However, I want more to happen quicker. For years, the electronic health card has been blocked and delayed by many sides. It makes no sense to stem the digitisation of healthcare. It is better to make this process constructively, and where necessary, also critically. I expect,



Hermann Gröhe, Federal Health Minister

doctors, hospitals, the entire self-government, and the industry to keep their promises and support the progress of the electronic health card with all their strength.

I do not understand that blockers appear on the scene again and try to stop the great progress into the digital age of health care with specious arguments. It is wrong, that it is not enough given privacy. The opposite is the case. The structure of the telematics infrastructure meets the highest safety standards: There is clear access rights, the access of doctors to data is logged, and health insurance companies are





obliged to provide information. Medical data is encrypted twice, the patient can also delete data – and unauthorised access leads to criminal prosecution. Above all, the relationship of trust between doctor and patient remains untouched. For me, the following applies: Effective data protection and health care in the digital age is of paramount importance.

Digital networking is a driver of medical progress. It is fascinating to see what is possible through telemedicine. For example, if someone has a stroke an expert is already available in the emergency room via video-conference for the treatment, and is placed directly above played computed tomography images of the patient within a few seconds. This ensures that the expert can help the patient quickly and efficiently along with the doctor. It overcomes telemedicine spatial barriers, especially for rural areas that will be in the future of the utmost importance.

Networking, telemedicine, new therapies and privacy protection – this is the digital revolution in the healthcare sector. Whoever denies this step out of selfishness, harms the interest of the public. This is

why the “e-health law” that we now bring, has a simple principle: Who blocks, pays. The central actors of self-government – in particular the accredited physicians’ associations and the central association of statutory health insurance – get periods to which they must achieve specified results. Cannot be sent, they have to take financial cuts in purchasing. Only then can we take pace. Nevertheless, it is not about what is technically feasible. But, it is important that we use all technical possibilities to ensure that the medical progress all patients really benefit. ■

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# Transnational leadership programme between Germany and Canada

Increasing Innovation through Leadership in public funded Expert-Organisations – Finding a road to resilience...

## Background

The many challenges in health care today create a special need for advanced effective leadership strategies (Stoller 307 -28; 876-78). Leadership development in healthcare includes principles of competency-based development, interdisciplinary, team learning and continuous assessment (Leatt and Porter 14-31). Progressive health systems that invest in leadership development for the entire senior management team will have the more significant return on investment in terms of organisational effectiveness (Leatt and Porter 14-31).

There have been a range of networks and programmes develop related to education involving specific aspects of healthcare such as technology assessment (Kristensen et al. 107-16) and interprofessional education (Liaskos et al. 543-547), as well medical practice (Williams, Blomkalns, and Gibler 203-09; Wilkerson and Irby 387-96; Schwartz and Pogge 187-92; Poorman and Mastorovich 142-43; Kristensen et al. 107-16). Additionally, a range of pedagogical strategies have been proposed (Wilkerson and Irby 387-96; Kumm and Fletcher 82-89; Jones and Sackett 204-08; Grossman 72-75; Copp 236-41; Burdick et al. 414-21). One of the most innovative to date has been the AFWI<sup>1</sup>, which is provided a contemporary approach to the translation and mobilisation of scientific knowledge into practice an the Transnational leadership Programme (TNLP) (Bomke 66-69).



## Method

Once established, the international relationship initiated a three-year programme implementation phase. This phase required identification of participants, definition of roles, curriculum outline, timelines, processes, objectives and goals. In situ across the programme a continuous reflective process was enacted for the purpose of feedback and goal correction at each step. The implementation process involved three international excursions and a summative symposia.

## Results

The programme was well accepted within the health service networks of both countries. Participants were able to use the programme to enhance

local projects designed to innovate and improve service delivery, which were component prerequisites and goals of their roles in the leadership programme. Furthermore, the international context was identified as a highly useful and novel learning space. While all aspects of the project were conducted in English, the fact that English was not the first language for half the group resulted in the simplification of concepts and principles that were to be communicated within and between groups and within and between the different professions of the participants.

Last but not least, the programme is the base of the ongoing prevention-initiative in the palatine region, called "Die Pfalz

macht sich/Dich stark – Wege zur Resilienz“ (The Palatinate region braces itself/you – building a road to resilience). Resilience is not only a matter of each individual it must be realized on all social levels (Bomke, Kendall-Taylor and Cawthorpe 2014; Bomke and Kendall-Taylor 2014). Enterprises, schools and communities should also promote mental health as a preventive measure and network their activities. So the group around the Pfalzlinkum uses a socio-ecological and multi-agency approach. Together with experts from medicine, health, work and social policy the initiative looking for ways to promote a sustainable change towards prevention in the health system in the Palatinate and are cooperating closely with international initiatives, such as the Centre for Early Child Development, Blackpool and the think tank Framework Institute, Washington, D.C. The vision is to build a resilient Palatinate until 2025 where mental health will be high on the citizens', enterprises' and politicians' agenda.

## Conclusions

- 1 The requirement to simplify language in the international context was directly related to the ability to simplify language and concepts in the communication of innovation within the responsible organisation.
- 2 The international context also highlighted leadership is a learning process related to both others and the self.
- 3 The international context provided an atmosphere that was directly related to the ability of participants to identify foci for innovation, strengths and weaknesses within their own organisations.

4 The long-term nature of the programme was a cornerstone of its success in relationship to participants' realising their organisational goals and objectives and to improve the social skills of the participants.

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<sup>1</sup> Alberta Family Wellness Initiative; <http://www.albertafamilywellness.org/>



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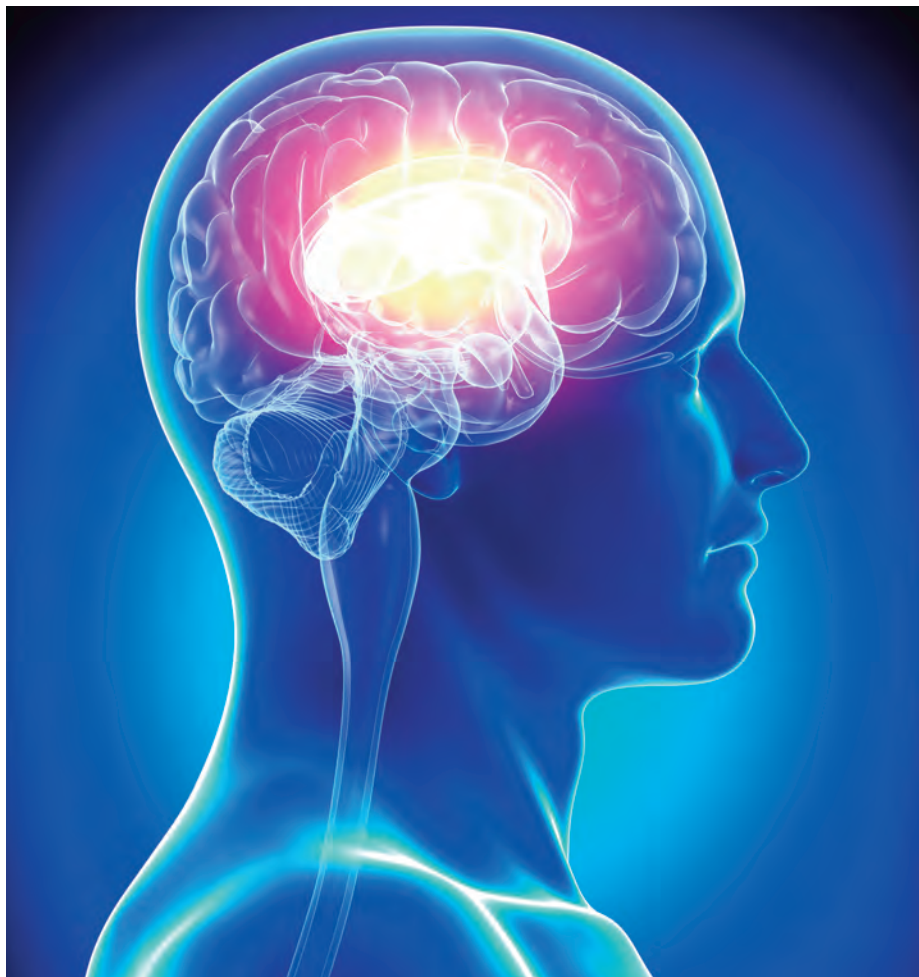
# What if antiepileptic medication does not help?

**E**pileptic seizures may be rare events and they cannot be predicted. It is especially the unpredictability of seizure occurrence that has psychological and social consequences. Patients suffering from frequent seizures have a feeling of loss of control associated with their reduced motor control. Anxiety and depression may be the result.

If you have been diagnosed as an epileptic, you will have to take antiepileptic medication in an effort to become seizure free. Anticonvulsion medication may accompany you for your whole life. If a single medication is not effective adding a second or even a third may be the only choice. But what if you are one of the 20-30% whose seizure activity cannot be controlled by drugs?

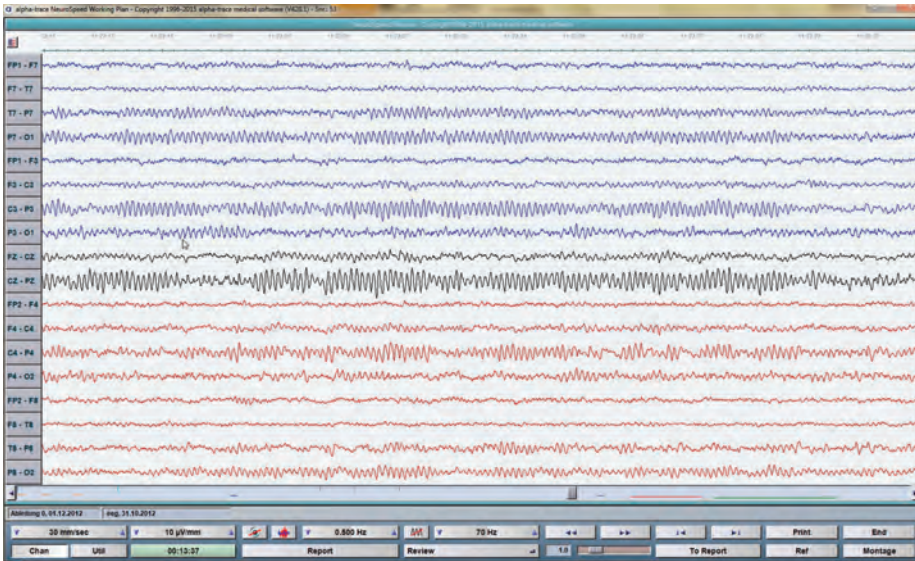
In an epileptic seizure abnormal and synchronized firing of neurons results in paroxysmal depolarization. Primary generalized seizures start in both hemispheres of the brain without focal localization and typically have tonic, tonic-clonic, myoclonic manifestations. Forms of partial seizures begin in one hemisphere and focal area of the brain and have no effect on consciousness. If you suffer from partial seizures there is hope that a neurosurgical intervention may help to get you seizure free.

The goal of epilepsy surgery is to identify the region in the brain from where seizure activity originates and remove it without causing any

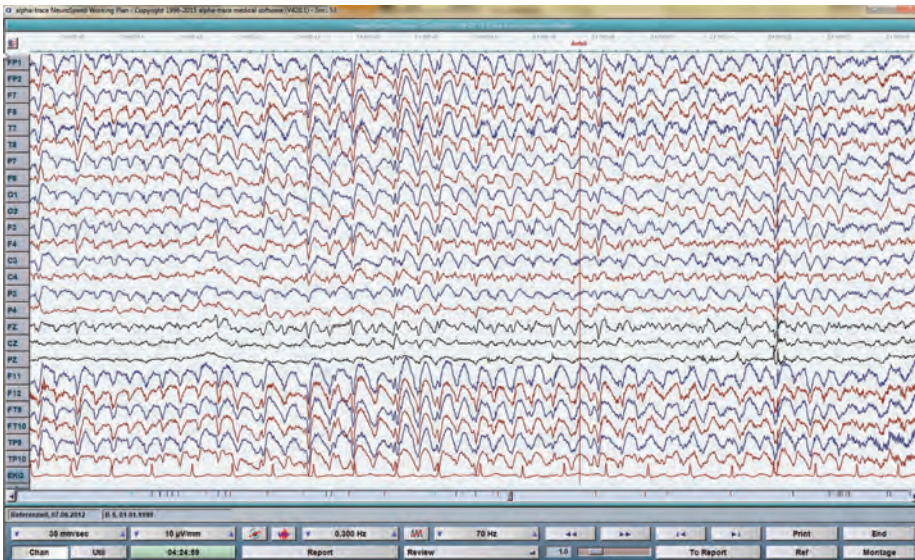


significant functional impairment. Before surgery can be accomplished a detailed presurgical evaluation is required. Most prominent is the question whether the seizures are focal or generalized. If focal are they of temporal origin? Is there a lesion associated with the seizures? Imaging technologies especially MRI are very useful to detect abnormalities of the brain. SPECT is also very helpful because the isotope injected at seizure onset is concentrated in the region of seizure onset available for imaging studies several hours after injection.

The most prominent intervention in presurgical evaluation is electroencephalography (EEG) recording with time-synchronized video monitoring. Video-EEG recordings may last for several days yielding hours of ictal (during seizures) and interictal (between seizures) data for analysis and detailed evaluation. Specifically EEG activity just preceding seizure onset is analyzed in detail to learn more about the focal onset and spreading of the paroxysmal depolarization to specific cortical areas. During this time of Video-EEG monitoring medication will be



**Normal ECG**



**Seizure**

gradually reduced to provoke seizure activity for detailed analysis. This means that patients will stay at specialized centers under full control for their safety. During the presurgical evaluation neuropsychological testing and psychosocial assessment will be performed prior to surgery. Once a primary epileptogenic region has been identified it may be necessary to probe further using some form of implanted electrodes. The risk of surgical intervention has to be counterbalanced by the hope of acquiring conclusive data from

epidural, subdural or intercerebral depth electrodes to localize seizure onset activity in a certain brain area prior identified by EEG recording using surface electrodes. Especially subdural metallic electrodes in forms of rectangular grids and strips are being used in presurgical evaluation. These electrodes are placed subdurally on the surface of the brain. Due to their proximity to the electrical generators within the brain and due to no EMG (muscle)-induced artifact activity the diagnostic quality of such recorded electrocortigrams is high.

However the placement of subdural grid electrodes requires craniotomy. Strip electrodes can be placed through burr holes over the lateral convexity or under the frontal or temporal lobes.

If presurgically obtained information consistently points to a single area of the brain for seizure onset then a surgical resection of this area may be indicated.

To ensure that resection of brain area will not cause a cognitive or neurologic deficit, centers using subdural recordings can use the electrodes to electrically stimulate the small region between neighbouring electrodes to gather cortical mapping.

With new fMRI technology it is possible to perform echoplanar imaging while the patient engages in a specific task such as fist clenching, verb generation, tongue movement, etc.).

If the surgical resection of the well identified brain area is successful the patient may benefit (60-70% of all cases) from a seizure-free life onwards after the intervention.



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## Promoting the prevention of HIV

**Dr Andrew Amato-Gauci from the European Centre for Disease Prevention and Control (ECDC) tells Editor Laura Evans which populations are most at risk from HIV, and what treatments are available for the infection...**

**H**IV still remains one of the most prevalent communicable disease throughout Europe. The World Health Organization (WHO) have stated that there were 80% more new HIV cases in 2013 compared to 2004. In 2012 UNAIDS and WHO estimated that 2.2 million people were living with HIV in the WHO European Region, including 1.3 million in Eastern Europe and Central Asia.

HIV is a virus which attacks the immune system and causes a lifelong severe illness with a long incubation period. The infection is spread by sexual contact with an infected person, by sharing needles or syringes (primarily for drug addiction), with someone who is infected, or through blood transfusions (something which is now very rare).

The European Centre for Disease Prevention and Control (ECDC) reported that during 2013, more than 29,000 people in the European Union tested positive for HIV, with many more remaining undiagnosed.

Approximately 80 people are diagnosed every day, with two - thirds diagnosed being men. Dr Andrew Amato-Gauci from the ECDC explains to Editor Laura Evans the impact of HIV throughout Europe and the populations they are most worried about.

“As part of our mandate at the ECDC we monitor reported diagnosis of HIV every year,” says Amato-Gauci.

“Based on this we have noted that HIV diagnoses have remained stable over the last decade. There has been a reduction in the number of heterosexual transmissions, but we are seeing a steady increase among men who have sex with men (MSM). The number of diagnoses in this group is growing fast.”

In Europe the ECDC reports that sex between men is still the predominant mode of HIV transmission. MSM are the only key population not to see a decline in new infections during the last decade. Compared to 2004, new diagnoses increased by 33%.<sup>1</sup>



Dr Amato-Gauci believes this is a major problem, caused, amongst other reasons, by changing attitudes of the population towards the threat of HIV, with many young men believing that they are not necessarily at risk.

“There is also an element of what we call ‘condom fatigue’, and against engaging in risk reduction. Especially young people don’t believe that it is going to happen to them, and don’t see HIV infection as a major problem,” he says.

One of the problems with people’s attitudes could be caused by the stigma that is still attached with having HIV. In Western Europe attitudes are changing and people’s views on gay relationships are not as negative as in other areas for example, Eastern Europe.

“You see the impact of stigma especially in countries where men who have sex with men do not have the same kind of liberties we see in the west.”

“There are studies showing that a very high proportion of these men in the East of Europe say that even their medical doctors or healthcare professionals do not know that they are gay, because of the stigma. Because of this, they shy away from getting tested,” Amato-Gauci explains. “HIV-related stigma has a very powerful negative impact on the epidemic.”

There is no cure for HIV, but there are treatments that can help people with the infection live long and healthy lives. This requires a lifelong course of combination therapy with at least 3 different drugs to suppress the virus, also known as antiretroviral therapy.

“The recent START study<sup>2</sup> provides convincing evidence that if you have HIV, no matter at what stage the infection is, you should take antiretroviral drugs,” says Amato-Gauci.

“Anti-retroviral drugs don’t cure or eliminate HIV, but it removes any trace of the free virus in the blood, leaving it dormant in your body. With constant treatment, the virus does not harm your immune system, and in most cases you are not infectious anymore.”

“There is also strong evidence to show that there are antiviral drugs you can take if you are the partner of someone with HIV that will protect you from catching the virus. This approach is called pre-exposure prophylaxis or PrEP, an HIV prevention strategy that includes antiretroviral therapy to prevent, or at least reduce the risk of HIV infection in adults who have not been infected with the virus, but are exposed to high risk of infection. This would make it safer to have a sexual relationship with someone who is infected with HIV. However, that is just one strategy of HIV prevention.”

As well as treatment, it is important to raise awareness about the importance of the various prevention measures. Making people aware of their own risks is key in order to prevent further infections.

“There needs to be awareness that HIV is still around, it hasn’t gone away and you should take care,” insists Amato-Gauci.

“Policy makers need to continue to raise further awareness and give prevention of HIV the right amount of resources. If you presume that it is no longer a problem and take your eye off the ball you get outbreaks. This happened for example a few years ago in Greece, and it’s happening at the moment in Romania.

“It’s vital to keep HIV on the health priority agenda,” added Dr Amato-Gauci. “We feel that it’s something that people have stopped talking about because they think it has gone away in Europe, but sadly it has not.” ■

1 <http://ecdc.europa.eu/en/healthtopics/aids/Pages/infographics.aspx>

2 <http://www.niaid.nih.gov/news/QA/Pages/STARTqa.aspx>

.....  
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# Ireland's health priorities for 2015

**Kate O'Flaherty, Director of the Health and Wellbeing Programme at the Department of Health – Ireland outlines the health priorities for 2015 and the Healthy Ireland Framework...**

Earlier this year, the Minister for Health Leo Varadkar set out 5 priority areas for his Department and a number of priority deliverables over the period 2015-2017. The Irish health and social care system is undergoing a significant reform programme, with a focus on modernising the health infrastructure including the development of a new national children's hospital; progressing universal healthcare with the introduction of GP services without fees to the under-6s and the over 70s; developing new strategies for maternity care and cancer, pursuing innovative funding models, and a range of reforms to improve patient outcomes and patient safety.

Driving the Healthy Ireland agenda is one of the 5 priority areas. This agenda is focussed on implementation of the government-led, multifaceted framework to improve the health and wellbeing of the population published in 2013. Drawing on international policy approaches such as World Health Organization (WHO) Europe's Health 2020, Healthy Ireland seeks to more effectively address the key lifestyle behaviour issues which result in ill health and chronic disease as well as the social and environmental determinants of health and wellbeing, through a 'whole of government' and 'whole of society' approach.

Under the Healthy Ireland agenda, a number of significant policies and strategies are being developed and are due for publication over the coming months. These include a first National Physical Activity Plan jointly developed with the Department of Tourism, Transport and Sport; a new Obesity Policy and Action Plan; a Sexual Health Strategy and a significant legislative agenda including public health legislation on alcohol and tobacco.

## **Healthy Ireland Framework and implementation**

The Framework's vision is an Ireland where everyone can enjoy physical and mental health and wellbeing to their full potential, where wellbeing is valued and supported at every level of society and is everyone's responsibility. It emphasises the international evidence that a whole-system approach, involving government and society, is required to effect sustainable improvements in health and wellbeing.

The Framework has 4 main goals:

- Increase the proportion of people who are healthy at all stages of life;
- Reduce health inequalities;
- Protect the public from threats to health and wellbeing;
- Create an environment where every individual and sector of society can play their part in achieving a healthy Ireland.

It sets out a range of action areas under themes which include partnerships and cross-sectoral working, empowering people and communities, reform of the health service to ensure a renewed focus on prevention, and building capacity around research, monitoring and evaluation.

The implementation of the framework is overseen by the Cabinet Committee on Social Policy and Public Sector Reform which is chaired by the Taoiseach (Prime Minister). A Cross-Sectoral Group comprising senior officials from other government departments, as well a range of national agencies relevant to health,



Minister for Health Leo Varadkar

research, environmental protection and local authorities supports the cross-sectoral implementation.

In addition, a Healthy Ireland Council, consisting of stakeholders from a wide range of sectors and chaired by businessman and former Irish rugby captain Keith Wood, has been established to champion the 'whole of society' engagement. It will also act as a platform to connect and mobilise communities, families and individuals into a national movement with one aim: to support everyone to enjoy the best possible health and wellbeing. The first meeting of the Council in June 2014 was addressed by WHO DG Dr Margaret Chan, who complimented the Framework, saying that it was "... a carefully orchestrated and united fight in a whole-of-government and whole-of-society approach. Engagement goes from the national level to the local, from the heights of academic research to the grass-roots voices of civil society organisations, who are extremely important, right down to communities and families which is where action will happen".

The Council has published an action plan for 2015, and established a number of subgroups to focus on key areas including communications and health inequalities. We are currently developing a communications strategy for the Council to support their role in engaging with their stakeholder networks and the wider public around the key deliverables such as the forthcoming National Physical Activity Plan.

### Health challenges in Ireland

Ireland's health challenges are not dissimilar from those of other countries across Europe. While our population is living longer, people are unfortunately not necessarily leading healthier lives. Ireland consistently records high rates of self-evaluated good health, but as set out in the Healthy Ireland framework, the picture in relation to chronic disease related to poor diet, smoking, alcohol misuse and physical inactivity presents a real clinical, social and financial challenge. For example, over 60% of Irish adults, and 25% of 3-year olds are overweight or obese, and the



prevalence of chronic conditions and accompanying lifestyle behaviours are strongly influenced by socio-economic status.

A new Healthy Ireland Survey which will report later in 2015 will give us an up-to-date picture of the health and wellbeing of the population for the first time since the last similar study in 2007.

### Meeting the Challenges

The Healthy Ireland Framework provides the context for addressing not only the lifestyle behaviour issues which adversely affect health and wellbeing, but also the social determinants and predictors of health and wellbeing. Many of these fall outside the health sector, e.g. housing, transportation, education, workplaces and environment along with an individual's socio-economic status.

In addition, the broad and complex nature of the Framework and the massive change agenda associated with its implementation requires that a critical focus remains on the wider enablers of implementation, such as stakeholder consultation, building a supportive culture, communication and leadership.

The initial phase of implementation (2013/14) focussed on:

- establishing the underpinning architecture and accountability structures and mechanisms;
- building the capacity of the new Programme set up in the Department to coordinate implementation, and embedding its work in the Department's overall responsibilities and work;
- establishing and supporting the Health Service Executive (HSE) capacity around health and wellbeing through a new Health and Wellbeing Division;
- identifying and building key strategic relationships and partnerships across a range of cross-sectoral partners.

The successful delivery of the priority projects set out for 2015, in addition to driving a number of cross-sectoral projects in partnership with other government departments and stakeholders, is the agenda over the next phase of implementation. These include ensuring close alignment with the new national policy framework for children and young people; integrating health and wellbeing into the educational agenda across primary, post-primary, higher and further education; embedding health and wellbeing into new structures and arrangements in local government; and, developing a national 'Healthy Workplaces' initiative across public and private sectors. In addition, the HSE recently published its implementation plan for Healthy Ireland in the Health Services for 2015-2017 which will be the main driver of that strand of implementation.

The implementation of Healthy Ireland, as well as the other significant reforms of our health system, is critical to the future health and wellbeing of our population, which in turn is central to our social and economic recovery and progress.

The enormity of the challenge is clear but by taking a collective and collaborative approach across government and society we aim to achieve the critical mass that can generate fundamental changes and make lasting positive impacts on Irish society. ■



.....  
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# Health and wellbeing on the agenda in Finland

**Adjacent Government highlights how Finland's new Government Programme will affect the promotion of health and wellbeing in the country...**

The Ministry of Social Affairs and Health of Finland is responsible for the preparation and implementation of the country's social welfare and healthcare policy. The Ministry aims to ensure that everyone has equal opportunity to lead a healthy and safe life, whether at home or in the workplace.

In May Finland's new Government Programme was announced, with health and wellbeing one of its key emphases. The government's overall goal for the Programme is that in 2025, Finland will be an advancing, caring and safe country. The 5 main objectives of the Programme are:

- Improving employment and competitiveness;
- Reforming knowledge and education;
- Promoting health and welfare;
- Facilitating the bio economy and clean solutions; and
- Reforming ways of working through digitalisation, experimentation and deregulation.

Speaking about the Programme in June, Prime Minister Juha Sipilä said: "Our strategy is based on a resolution, which we will seek to attain within the next 10 years. It is a vision which we have specified in the form of 5 separate objectives, from which we have derived our goals for the term of this government; we have defined key projects which will ensure these goals are met."<sup>1</sup>

As one of the key strategies for the new Programme, health and wellbeing plays a pivotal role in the government's overarching strategy for 2025. In a video interview, Taru Koivisto, Head of the Welfare and Health Promotion Group at the Ministry, detailed how the promotion of wellbeing and health is reflected in the new Programme.<sup>2</sup>

She said: "The promotion of wellbeing and health is one of the Government Programme's strategic priorities.

"The aim is that during the government term, the role of inter-sectoral health promotion and early support will be strengthened in decision-making services and working life, due to legislative changes and improved delivery".

"Differences in health and wellbeing will also have narrowed. In this respect, the Government Programme's objectives are very ambitious, but also very welcome", said Koivisto.

"In practice it means that, according to the Government Programme, the focus in social and health care services in relation to structural reform, will be placed on preventive services and ways of promoting wellbeing and health. The emphasis is on ways of supporting healthy lifestyles with the means of, for example, physical exercise and nourishment.

Koivisto went on to say, "The Government Programme consists of key projects with which to address these issues in a concrete manner. One of the key projects is to address child and family services with particular emphasis on preventative action and early support.

"The Government Programme as a whole includes a number of other measures which will have an indirect impact on people's wellbeing and health. However, what kind of effects these might be remains to be seen." ■

<sup>1</sup> <http://valtioneuvosto.fi/en/government-programme>

<sup>2</sup> [http://stm.fi/en/article/-/asset\\_publisher/miten-hyvinoinnin-ja-terveyden-edistaminen-nakyy-uudessa-hallitusohjelmassa](http://stm.fi/en/article/-/asset_publisher/miten-hyvinoinnin-ja-terveyden-edistaminen-nakyy-uudessa-hallitusohjelmassa)

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# Integration of Social and Health Care in the South Karelia, Finland

The South Karelia Social and Health Care District (Eksote) combines primary and secondary health care, elderly care and social care...

It was established in 2010 and works by delivering patient-oriented care to the approximately 133 000 citizens of South Karelia in South-Eastern Finland. Nine municipalities participate in the operations of Eksote and they enter into service contracts with Eksote based on the needs of those areas. Eksote employs approximately 4100 people and has a budget of 370 million euros.

## The South Karelia Social and Health Care District (Eksote)

Eksote provides health services, family and social welfare services, and services for senior citizens that promote the health, wellbeing, and ability of residents to function well in everyday life. Eksote's goal is to ensure equal access to social and health care services to all citizens in the region, across the boundaries of municipalities.

The services produced by Eksote include outpatient care, oral health-care, mental healthcare and substance abuse services, laboratory and imaging examination services, medicinal care, and rehabilitation centre, hospital services, family services, social services for adults, special services for the disabled, and flexible services for the elderly that can be adapted to the needs and age structure of the population.

## Integration of the Social and Health Care

The main reasons for the large organ-

isational change, where Eksote was established, were solving claimed problems in economy, efficiency and service quality (e.g. equal access, continuity, client-orientation, and need-based service). The integration improved the balance and coordination between primary care, social services and hospitals, coordination in strategy, financing and investments by the owner municipalities, common use and recruit of staff and possibilities to meet the future challenges.

In figure 1 is presented evolution of the service system. In administrative framework concrete integrations were made in personnel systems, financial systems, decision making and management. Eksote has only one financial system; previously there were different systems in each municipality. New personnel system allows replacements of the personnel and salary harmonisation. In this stage Eksote achieved functional integration where social and health care services are optimised in South Karelia region. This allows better coordinated care processes to citizens. The aim is to build social and health care ecosystem where national entities are tightly integrated to proactively support the citizen's wellbeing.

The highest decision-making power in Eksote is Council. Municipal councils of the participating municipalities appoint members to the Council for the duration of their term in the office based on the population of the munic-

ipality. The administrative board manages Eksote's operations. The Managing Director is responsible for Eksote's operative management. He is supported by a committee of municipality managers, particularly in relation to planning of the financial operational conditions of the joint authority.

In information systems there is only one Electronic Social Care Record and Centralised placement assess-qualify-place (AQP) in Eksote. The common Electronic Health Record system is used in the health care centers and hospitals of all communities belonging to the organisation. The Electronic Health Record allows also for example developing mobile social and health care services and utilising a centralised placement model. Eksote's Electronic Health Record (EHR) solution contains the whole medical record of a patient. All information concerning primary or secondary care as well as dental health record can be found in the same place. A health care professional working anywhere in Eksote's region, including the Mobile Clinic, can utilise, when needed, information on the patient's whole care process e.g. the reasons for using health care services, any operations made and the time of being discharged from the hospital. A health care professional can also utilise the system for printing prescriptions and other useful forms. In addition the system allows collecting useful statistical information.



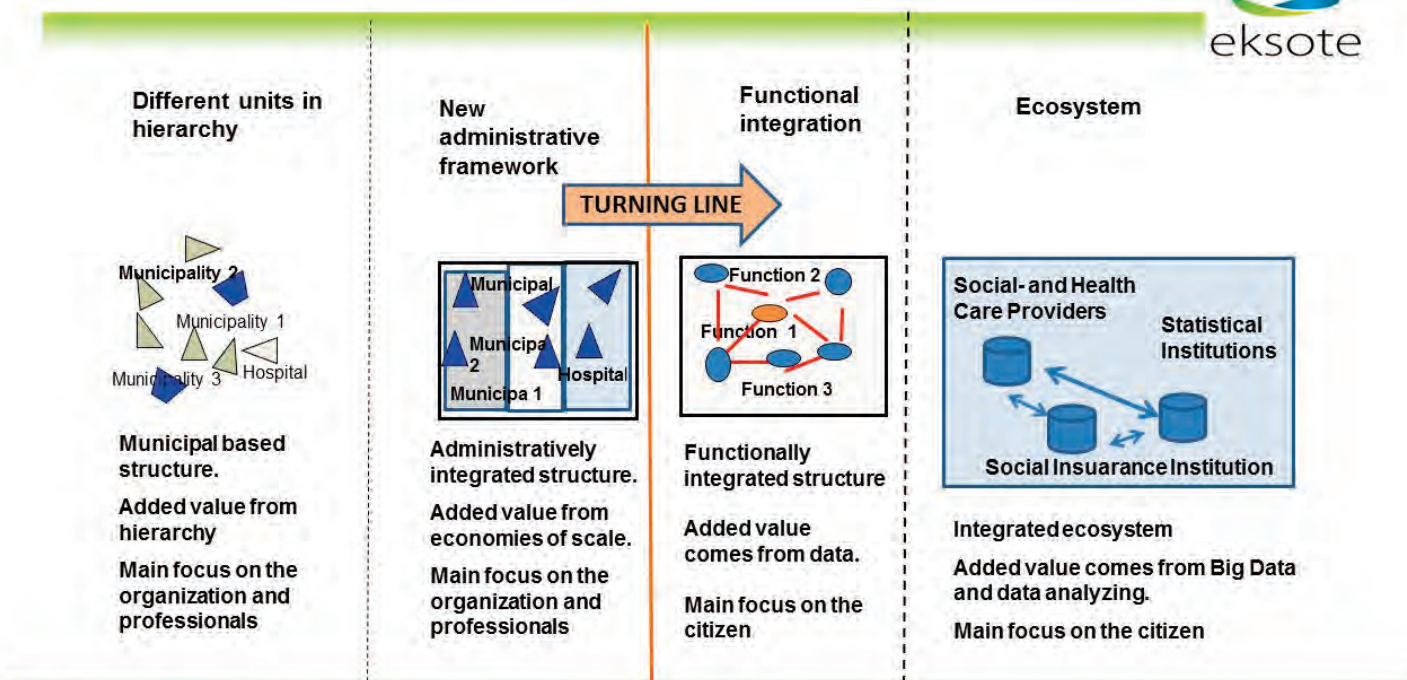


Figure 1: The evolution of the service system – from hierarchy to ecosystem

## Social and health care integration supported by development projects

### SmartCare

Promoting home care and independent living is one of the strategic objectives in Eksote. SmartCare project enable better co-operation of different elderly care professionals in Eksote. Staff will utilise the SmartCare infrastructure to support their care workflows. Staff will also be enabled to work collaboratively in the event that a service user's health and wellbeing deteriorates. At present, SmartCare services in South Karelia include video connection and GPS tracking. Informal carers such as relatives will be more tightly integrated into the care delivery cycle by involving them into elderly care paths. In near future also a third sector organisations providing services to elderly via videophone connection in South Karelia. New care processes supported by technology enable provide services to elderly people at home. In addition technology enable family members play more active role in elderly care.

### New kind of Moving Health Care Center Mallu – the Mobile Clinic

In South Karelia a large number of aging people are living in less-populated areas. It is often difficult to have transportation to centers where the social and health services are located. Eksote launched a Mobile Clinic to help in these difficulties. Since the beginning of year 2011 the Mobile Clinic has stopped at different appointed villages in South Karelia and provided to clients living in less-populated or rural areas services closer their home.

Currently the services consist of nurse's consultation, dental health care, remote doctor and blood samples. Citizens can get all nurse's services they need from the Mobile Clinic. The nurse can for example give health guidance, conduct small operations such as remove stitches and clear ears, give vaccinations, take blood samples for analysis and take care of the prescription traffic. Currently dental health care services provided in Mallu are oral hygienist's and dental assistant's services. The Mobile Clinic is

operated in a vehicle specialised for providing these health care services.

Professionals working in the Mobile Clinic have a secured access to Eksote's Electronic Health Record, Weblab and the Internet. The professional writes entries into the system during the consultation in the mobile unit in the same way the entries are written in any other health care unit within Eksote.



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# Reducing barriers for deafblindness

Ricard Lopez, President of the European Deafblind Network (EdbN) outlines points from the European Deafblind Indicators project and its conclusion...

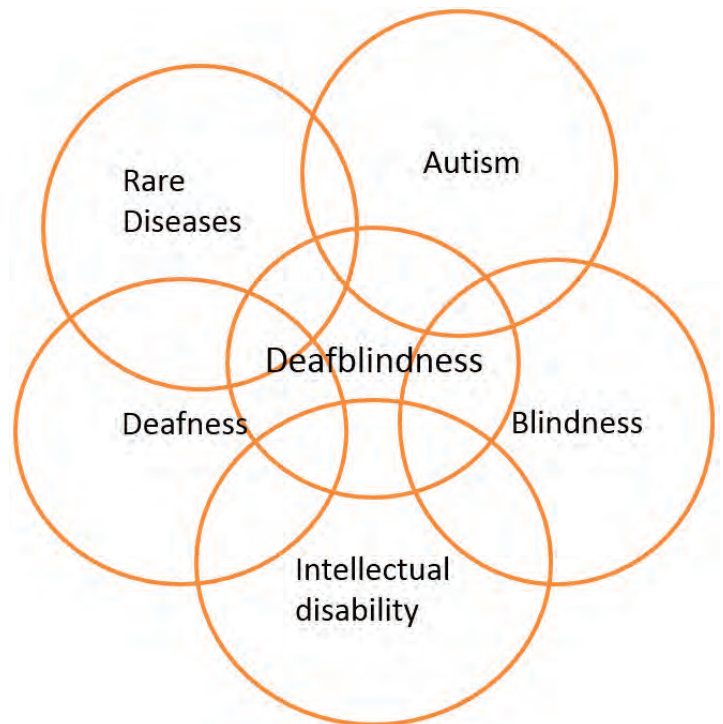
**M**ore people than ever are living with deafblindness. The European Deafblind Network's (EDbN) project, European Deafblind Indicators<sup>1</sup> was developed from 2012 to 2014. The project was granted by the European Commission under its Lifelong Learning Programme and was awarded with one star. The aim of the project was to set a common framework based on the UN Convention on the Rights of Persons with Disabilities UNCRPD, and to determine the situation of deafblindness across Europe. The most significant conclusion is that there is an emerging social group that demands a real social emergency.

First of all, deafblindness is a distinct disability with its own characteristics and necessities consisting of combined sight and hearing loss. It can be from birth (congenital) or acquired, total or partial. It is caused by many conditions, some of which are rare and complex<sup>2</sup>, becoming more common in line with the ageing demographic of Europe. More children are surviving prematurity and childhood illnesses, welcomed medical advancements for which the likelihood of presence of deafblindness actually increases.

Concerning the Project, organisations<sup>3</sup> from 27 different countries contributed to it. The following are some of the findings.

The situation of this group varies widely from one country to another. Few states collect official data on the number of deafblind people in their population. We can infer from this that the extent of deafblindness (and its needs) are invisible to those not working in this field. In conclusion:

The official recognition of deafblindness as a unique disability is required to ensure that the rights and lives of deafblind people are acknowledged.



Deafblindness is invisible in part because we tend to identify a disability with most known conditions: rare diseases, Autism, deafness, blindness, intellectual disability and others

National censuses, health professionals, schools and social services as well as Eurostat<sup>4</sup> should be mandated to collect data.

In the area of personal and family life, communication is a barrier for deafblind people therefore: training for communication methods and equipment is essential. The lack of statutory funding reduces opportunities.

In the choice and control area, deafblind people generally do not have rights in relation to support for living in a place of their choice. Legal rights do not mean practical rights and they may be unable to exercise their right to vote, so their needs may be ignored.



Some figures (EDbN 2014):	
Catalonia	38.000
Denmark	26.000
Germany	460.000
Netherlands	75.000
Spain	200.000
United Kingdom	280.473

To finish with, it is clear that the project has highlighted a number of key issues and commonalities relating to deafblind service provision and practice. Deafblind organisations have shown dedication to improving opportunities for deafblind people as long as there is better support from our government administrations to do so. ■

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EdbN. (2014). Mapping Opportunities for Deafblind People Across Europe. Barcelona: EdbN. Retrieved from [http://www.deafblindindicators.eu/images/PDF/1\\_1Final%20report%20-Mapping%20opportunities\\_0315.pdf](http://www.deafblindindicators.eu/images/PDF/1_1Final%20report%20-Mapping%20opportunities_0315.pdf)

1 EdbN [www.deafblindindicators.eu](http://www.deafblindindicators.eu)

2 Aetiology table [https://docs.google.com/viewer?url=http%3A%2F%2Fwww.deafblindindicators.eu%2Fimages%2FPDF%2F1\\_10Aetiology%2520table.pdf](https://docs.google.com/viewer?url=http%3A%2F%2Fwww.deafblindindicators.eu%2Fimages%2FPDF%2F1_10Aetiology%2520table.pdf)

3 Partners of the project [www.deafblindindicators.eu/index.php/aboutus](http://www.deafblindindicators.eu/index.php/aboutus)

4 Eurostat is the statistical office of the European Union. <http://ec.europa.eu/eurostat>

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The main conclusion on access to goods and services is that equal access is mainly an exception. Where accessible services exist, the emphasis is on physical accessibility rather than sensorial.

The education and lifelong learning determined the inconsistent educational options for deafblind children and adults across Europe. Dedicated deafblind educational programmes are not commonly available.

The work and employment conclusion is that support for deafblind people in the workplace is largely unavailable.

The income and poverty domain covers issues related to the financial situation of deafblind people as they spend a high proportion of their income on support and face negotiations with inflexible bureaucracy.



# Equality starts in early education

**Adjacent Government highlights the work being done by the European Agency for Special Needs and Inclusive Education to help remove education barriers for vulnerable and disabled people...**

In 2012 the European Commission reported that around 45 million EU citizens of working age have a disability, and 15 million children have special educational needs. According to a report by the Commission, special needs children and disabled adults are “still getting a raw deal.” The report states that children with special needs often leave school with few or no qualifications, before moving on to specialist training, which can, in some cases, impair rather than increase their job prospects.

The report calls on Member States to work harder to develop inclusive education systems, and to remove the barriers faced by vulnerable groups when it comes to participation and success in education, training and employment.

The report, “Education and Disability/Special Needs – policies and practices in education, training and employment for students with disabilities and special educational needs in the EU,”<sup>1</sup> highlights a wide variation between Member States as to how children with special needs are identified, as well as whether they are placed in mainstream or special schools.

It states that in Flanders (Belgium), 5.2% of pupils with special needs are in segregated special schools, while in Italy it is only 0.01%. The European Commission believes that more needs to be done to harmonise definitions and improve data gathering to help countries compare their approaches more effectively and learn from each other.

Speaking about the report, former Commissioner for Education, Androulla Vassiliou said, “We have to strengthen our efforts to provide adequately financed inclusive education policies if we want to improve the lives of children with special educational needs and disabled adults.

“It is time to deliver on the commitments which have been made. Inclusive education is not an optional extra; it is a basic necessity. We must put the most vulnerable at the heart of our actions to achieve a better life for all.”<sup>2</sup>

The European Agency for Special Needs and Inclusive Education is an independent organisation, supported by the European Commission. Acting as a platform for collaboration between Education Ministries in Member State countries, the Agency helps them to improve their educational policy and practice for learners with disabilities and special educational needs.

The Agency understands that there are differences in countries’ policies, practices and educational contexts. The following are strategic objectives:

- To promote quality in the field of special needs and inclusive education by maintaining a long-term framework for extended European collaboration;
- To facilitate effective exchange of knowledge and experience among, as well as within, member countries;
- To identify key factors that hinder or support progress and provide countries with information and guidance;
- To analyse and review policy developments in countries in order to support the development of sustainable and effective inclusive education systems.

In a recent blog the Director of the European Agency for Special Needs and Inclusive Education, Cor J W Meijer, said, “How can we be more effective in promoting equity and excellence for all children, including those

with special educational needs, and/or disabilities?" he said. "This is a question that keeps the Agency on its toes."<sup>3</sup>

The Agency believes that early intervention is the key in order to help improve the lives and opportunities for students and children with disabilities. Meijer explained in his blog, that studies show that early intervention can help young people with disabilities achieve what has previously been unthinkable.

"There is a wide policy consensus at EU and international levels (OECD, UNESCO) that a quality early childhood education and care (ECEC) experience is an essential foundation for successful lifelong learning, social integration, personal development and later employability," Meijer insisted.

"I strongly believe that early intervention is an effective strategy for children with any form of disability or disadvantage, in order to be enabled to participate in education and society.

"Numerous studies on specific interventions with samples of children show that young children with disabilities definitely improve with appropriate intervention," he said. "There have been cases of younger students with disabilities who, through early intervention, achieved skills such as reading and the ability to keep a job."

The Agency has launched a new 3 year project, which calls on member countries to follow the call to identify, analyse and subsequently promote the main characteristics of quality inclusive pre-primary education for all pupils.

The focus of the project will be on structures and processes at ECEC level in order to help develop a systematic approach to providing high quality education in mainstream early childhood education and care (ECEC) provision.

"The project will identify which children are regarded as being at risk of discrimination and exclusion in the

different countries, how these are identified, how their strengths and needs are assessed and the impact of such procedures, and how they are enabled to participate equally in quality ECEC," said Meijer.<sup>4</sup>

Through this project and previous ones, the Agency hopes to raise further awareness among European countries regarding the importance of the right education and support for children and young people with disabilities and special education needs. It hopes to help achieve some of the targets of the EU Strategies.

"The EU Strategy in 2009 set as one of its goals that at least 95% of children between the age of 4 and the age of compulsory primary education should participate in ECEC," Meijer explained.

"High quality early childhood education and care are seen as essential to the achievement of 2 other EU 2020 targets: reducing early school leaving to below 10%, and lifting at least 20 million people from poverty and social exclusion." ■

More information about the European Agency for Special Needs and Inclusive Information can be found here: [www.european-agency.org/](http://www.european-agency.org/)

<sup>1</sup> <http://www.nesetweb.eu/sites/default/files/NESE-disability-special-needs-report-2012.pdf>

<sup>2</sup> [http://europa.eu/rapid/press-release\\_IP-12-761\\_en.htm](http://europa.eu/rapid/press-release_IP-12-761_en.htm)

<sup>3</sup> <https://www.european-agency.org/news/directors-blog/inclusive-early-childhood-education>

<sup>4</sup> Ibid

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# Social Services for adults, Esbjerg DK

Municipalities in Denmark are required by law to give help to all citizens, who, because of reduced physical or mental level of functioning (disabilities) have a need for support in development and compensation for handicaps.

The target group resembles the population in regard to the desire to live a satisfying everyday life with family, friends, work, and recreational activities.

In order to create an overview of the span of the target groups' disabilities, Social Services has chosen to define handicaps based on how far citizens are from being able to master the challenges of everyday life.

Disabilities are assessed in relation to three dimensions:

- Physical
- Mental
- Social behavioral

Furthermore, each citizen's level of functioning is assessed in relation to seven dimensions, based on WHO's International Classification of Functioning:

- Practical aspects of domestic life
- Self Care
- Communication
- Mobility
- Community Life
- Social Life
- Health

## The Strategic Lines of Focus

The department has five target lines, which are given below:

1. Early and coordinated interventions

in relation to assessment of the citizen's resources and challenges followed by intervention through relevant actions.

2. Based on the citizen's level of functioning, individual support is given to develop the individual's competencies in order to allow them to live a life as close to normal as possible with regard to employment, education, recreational, and housing.
3. Everyday life is to be structured proactively and oriented towards learning, making it possible for the individual citizen to grow beyond current service frameworks and current level of functioning.
4. Through flexible interventions across formal structures, the citizen's needs are met optimally by using the fewest possible resources.
5. Development and experimentation with methods for involving civil society in Social Service provision.

The perspective of the human condition behind the target lines maintains that a citizen must be offered services with a minimal amount of invasion. This perspective puts its focus on what the individual can master independently.

Interventions are derived from the individual citizen's needs instead of from a more limiting target group-thinking, where the contents of the existing services define the interventions available for the individual citizen.

## Triangular Dialog for Assessment and Referral

Assessment and referral of the citizen plays a central role, as services are by referral only, with only a few exceptions.

The principle communication process in assessment and referral is called "The Triangle" between: Citizen, Case Worker, and Service Provider.

## Results- Based Management

Results-Based Management (RBS) is the focus for the future management of the department.

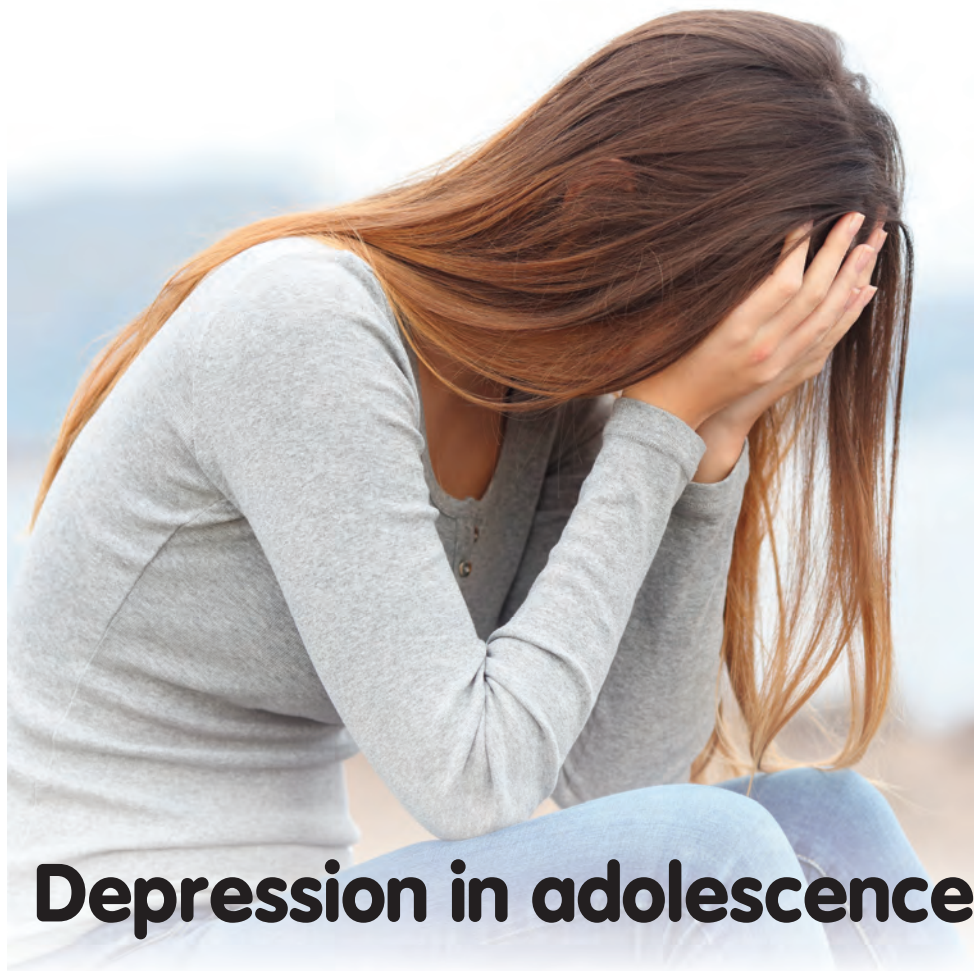
The essence of RBS is documenting results at an individual level, and out of this starting a process of learning and reflection, so the organization can direct resources towards interventions that work. This is done by registering the citizen's starting point (baseline) at referral, and at relevant points in time, to measure development.

These measurements of effect can be used both within the individual citizen's case, and more generally to improve management of services in Social Services.



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## Depression in adolescence

**Dr Rhys Bevan Jones, Clinical Research Fellow at the Institute of Psychological Medicine & Clinical Neurosciences, MRC Centre for Neuropsychiatric Genetics & Genomics at Cardiff University details how depression can affect adolescents...**

**D**epression is common in young people, with around 1 in 20 of those in adolescence affected. This leads not only to distress for the individual and their family and carers, but also social and educational impairments. Depression is also a major risk factor for self-harm and suicide, and there is an association with poor physical health, including increased rates of smoking and substance misuse, and obesity. There is a high recurrence rates in adulthood – young people who experience depression are more likely to experience an episode in adult life, compared to young people who do not. Adolescent depression is therefore a major clinical problem but there are treatments available.

Everyone's experience of depression is different. However, there are common symptoms listed in the diagnostic criteria, such as those of the International Classification of Diseases (ICD-10), published by the World Health Organisation (WHO). The criteria for a diagnosis of depression in young people are similar to those in adults, with the core symptoms being depressed mood most of the day and almost every

day, loss of interest or decreased energy. Irritability is also a core symptom in adolescence in the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), published by the American Psychiatric Association.

Other possible symptoms include: loss of confidence, unreasonable or excessive feelings of guilt, change in activity levels (agitated or 'slowed down'), concentration and sleeping difficulties, appetite loss/gain and a corresponding change in weight, and self-harm or suicidal thoughts/behaviour.

However, the diagnosis is more often missed in adolescents than in adults. This might be because the presentation can be different in young people, for example because of the presence of irritability and fluctuating symptoms. The primary presenting problem may not be specific to depression, for example physical symptoms such as pain (especially in younger adolescents), a decline in academic performance or social withdrawal. Many young people with depression have at least one other mental health difficulty, which can also complicate the assessment and management.

There is a range of risk factors for depression in adolescence – including individual, family and social issues. The strongest risk factors are a family history of depression and exposure to psychosocial stress, such as bullying. Offspring of parents with depression show 3-4 times increased rates of depression compared with offspring of non-depressed parents, although many children of depressed parents do not experience difficulties. Usually there is a complex interaction of the factors above, although there may not be an obvious reason.

The treatment of depression is targeted at the reduction of early and later adversities, modification of ways of thinking and feeling (such as cognitive behaviour therapy and other psychotherapies), and antidepressant medication in more severe episodes. Prevention strategies focus in particular on a combination of education and psychological approaches. There has also been increasing interest in resilience, which could be defined as better than expected functioning across psychosocial outcomes over time, in the context of a known risk factor (such as a family history of depression). Protective or resilience factors can inform prevention and management approaches.

There have been government calls for an emphasis on prevention and early intervention of depression, and centres such as the Child and Adolescent Psychiatry Section at Cardiff University have led studies in this area. For example over recent years, the ‘Early Prediction of Adolescent Depression’ (EPAD) study aimed to understand the links between parent and child depression. The study has also looked at protective and resilience factors in relation to adolescent depression. The translational aims of EPAD included increasing awareness, and improving assessment, prediction and monitoring of depression in children and adults.

Further to this study, a group within the department is developing an online multimedia package and accompanying ‘app’ to help young people with (or at high risk of) depression and their families. This is funded by the National Institute for Health Research (NIHR), and is consistent with the National Institute

for Health and Care Excellence (NICE) guidelines for ‘Depression in children and young people (Identification and management in primary, community and secondary care’), which were updated earlier in 2015. These stress the need for good information for the young person, family and carer and the use of psychosocial interventions which are evidence-based in the initial management.

Engaging young people in prevention and early intervention programmes is a major challenge for health and other services, as is improving the identification of depression and its management in this age group. ■

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Thapar et al (2012) Depression in adolescence. The Lancet.

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American Psychiatric Association (2013) Diagnostic and Statistical Manual of Diseases (DSM 5). APA

For more information please visit:  
Young minds – [www.youngminds.org.uk](http://www.youngminds.org.uk)

National Centre for Mental Health – [www.ncmh.info](http://www.ncmh.info)

Royal College of Psychiatrists – [www.rcpsych.ac.uk](http://www.rcpsych.ac.uk)

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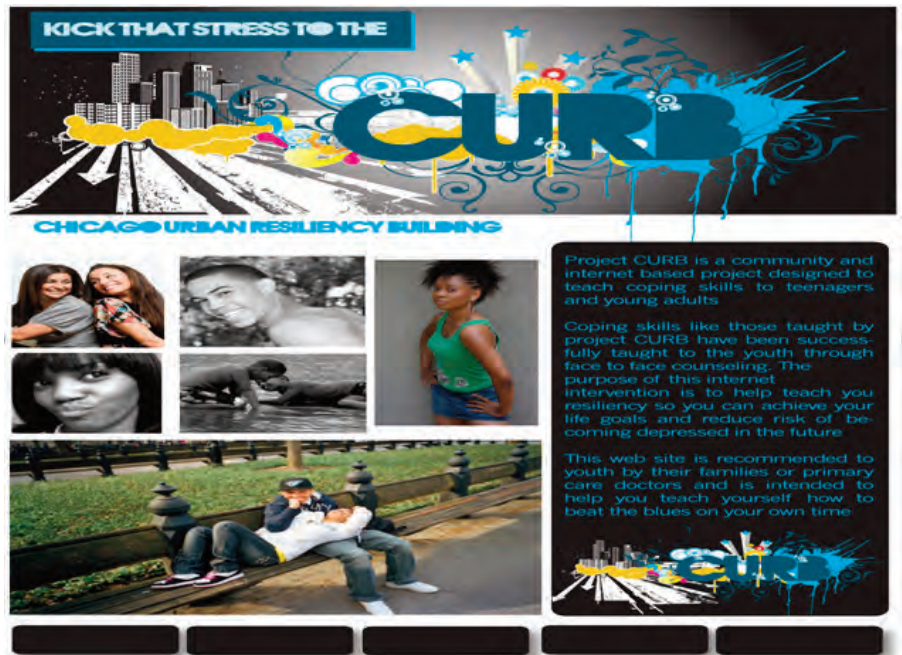
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[www.medicine.cf.ac.uk/psychological-medicine-neuroscience](http://www.medicine.cf.ac.uk/psychological-medicine-neuroscience)

# Addressing Population Health – One Teen at a Time

Answering the National Call for Better Mental Health Care...

In response to the call from the Institute of Medicine and as a key priority for the National Institute for Mental Health (NIMH) to prevent mental illness in adolescents, Benjamin Van Voorhees, MD, MPH and colleague Tracy Gladstone, PhD have developed a primary care/Internet based depression prevention intervention called CATCH-IT (Competent Adulthood Transition with Cognitive Behavioral Humanistic and Interpersonal Training). Currently CATCH-IT is in the third phase of randomised clinical trials, funded by the NIMH. With each phase they have refined their approach to addressing the pressing need for catching depression before it begins. They developed the primary care/Internet based depression prevention intervention (CATCH-IT) and are currently, in this phase comparing this intervention to a control intervention consisting of general health information (Health Education, HE). CATCH-IT is being fielded in a multi-site trial within six major primary care health (and over 30 primary care clinics) systems in Boston and Chicago. They have been able to demonstrate the feasibility of implementing this model in multiple health systems and have to date screened over 4,000 teens from primary care offices.

The design of this intervention, that targets adolescents with beginning signs of depression, works within the framework of the recently established United States’ Affordable Care Act.



The goal is to create a widely available public health strategy to reduce illness and death associated with depression, which is a lifelong illness. This strategy is intended to meet the NIMH call for developing “new and better interventions” for “diverse needs and circumstances” to “...preempt the occurrence of disease.” These interventions must:

- Have broad “reach” into at-risk populations;
- Work outside of traditional mental health systems;
- Use new technologies;
- Build on previous clinical trials;
- Reduce identified disorders/enhance functional outcomes;

- Include families; and
- Be personalised.

While such approaches widely desired, few if any have been successfully implemented at scale in diverse population within actual primary care sites and little is known about whether benefits of such interventions may be sustained or which aspects of these complex interventions are most associated with favorable outcomes.

### Innovation of the Trial Design

The innovation of this work lies in its novel approach to addressing population needs. Population based prevention of major, common mental disorders has not been previously attempted at scale within multiple, complex health systems and





Dr. Benjamin Van Voorhees

diverse populations. Face-to-face interventions have shown to be effective, however the CATCH-IT intervention represents a paradigm shift. The key innovations of this study include:

- It is the first of its kind, a public health adolescent depression prevention strategy (low cost, easily disseminated, acceptable and feasible primary care/Internet model),
- It combines a brief primary care-based motivational program with an Internet-based self-directed Cognitive Behavioral (CBT) and Interpersonal Psychotherapy (IPT) approach to address the key barrier of engagement/adherence;
- It targets both adolescent and parent vulnerability and protective factors in separate interventions, using an ecological model;

- It is personalised to the presence of parental depression and ethnicity/culture, key moderators in prior studies; and
- It uses media based learning strategies including music, videos, and stories to convey learning.

**“The goal is to create a widely available public health strategy to reduce illness and death associated with depression, which is a life-long illness.”**

**Relational Intensity Necessary to Address Barriers to Implementation**

Fielding a trial of this nature is not without its difficulties – but the study staff has adapted to both internal and external barriers presented by this trial. The internal barriers are identified as organisational and behavioral, and the external behaviors as political, economic, and regulatory complexities. These factors work against the implementation process and consequently affect the potential public health benefit to the proportion of adolescents at risk for major depression identified through screening in primary care.

During the initial run in phase of the clinical trial, the team examined the nature of how they confront barriers to implementation of the study. The themes reflect the considerable, and largely relational intensity of their work, rather than purely traditional practice education and implementation guidance to the primary care sites. This relational intensity was found to be necessary on the part of study staff

members to effectively implement the study. Critical factors of implementation have emerged around the need to deepen and broaden relational engagement with the practices so that they would create an environment in which screening could take place of adolescents. The team has considered the impact of the nature of the study – mental health – on the willingness of the practice sites to carry out the study. Because of the less discussed nature of mental illness in society in general, the team works to reflect back to the sites the recognition that the topic of mental illness may be difficult; but the effect of addressing it with teens before it is severe is a great service to individuals and the population at large.



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# A new approach to managing the NHS estate

**Kerry Bourne, Director of Property Consultancy at Essentia outlines how a new approach is needed to address healthcare property management...**

**W**e need to challenge the way in which the NHS deals with property. Healthcare property is not just an asset; when considered as part of a trust's investment strategy, it supports a 21st century approach to clinical care, as well as maximising efficiencies and reducing costs where possible.

Many NHS trusts have vast, sprawling estates with clinical services spread over a multitude of sites, sometimes coupled with outdated IT and an old-fashioned approach to working practices. This can lead to inefficiencies, especially with older estates not being 'fit for purpose'. Instead of trying to fit services to the space, trusts need to consider what size estate they actually need to operate and what buildings they need to be in. There are likely to be hidden revenue streams within NHS estates. Property and the estates strategy need to form part of the entire investment strategy; by taking a more holistic and integrated approach to how property is used, trusts will be able to develop efficient estates that are fully sustainable in the long term. This means addressing clinical need, financial position, IT and overall asset value as one strategy.

## **Rationalisation**

The last 5 years have seen a significant change for NHS estates. Confronted with an increasing need to boost performance and find significant savings, public sector bodies are waking up to how much they can achieve through property rationalisation.

This presents a particular opportunity for NHS trusts located in London, many of which own large portfolios of underused property. When Essentia helped Barts Health NHS Trust undertake a thorough review of its estate earlier this year, the Trust came to the conclusion that its estate needed to be leaner. A key decision was to dispose of The London Chest Hospital, based in an

old building which was outdated and no longer offered patients or staff suitable premises. However, the hospital was in a prime location for residential redevelopment and was successfully placed under offer in spring 2015, generating tens of millions of pounds for Barts to invest in new services and modern facilities. This also helps government housing targets.

## **A number of options**

Selling property is one route, but it's not the only option available. We need to do things differently and adopt a new approach if we are going to address issues around healthcare property in the long term. Flexibility is key. For example, a trust doesn't always need to own the freehold of the buildings it occupies; options such as a rental model, or partnership or sale with a long lease back can sometimes be more cost effective.

NHS trusts need to consider property in parallel with other factors, such as technology. Investment in good modern IT underpins a modern estate and ensures a more flexible and mobile workforce. Integration of technology and the estate will facilitate behaviour change, which will continue to change how we think about property. Property and desk sharing will become the norm, as will flexible working patterns and remote access for office and field staff.

An example of this is community healthcare workers, who spend the majority of their time delivering care outside the office. If they are able to remotely access documents, there is less need for them to be in the office, as communal hot desks and mobile technology could be used. Not only does this make better use of time, it also reduces the amount of desk space needed and saves on transport costs. This is exactly the approach that Essentia has taken in supporting various acute and mental health trusts, modernising





working practices that in turn enable more flexible and more efficient models of care.

It's not just IT that property experts should be working closely with. Estates management in the NHS would benefit greatly from a more holistic and integrated approach, treating property, healthcare planning and capital development as one, rather than as separate strands. This will prioritise clinical need and let property support it eliminating inefficiencies, duplication and/or gaps, and wasted opportunities.

**Crossing boundaries**

One area that has received much attention from clinicians and policy makers is the concept of integrating health and social care. The challenge here is often a lack of ownership across the local NHS estate. Ongoing changes can make it difficult to understand where different services and facilities fit into the local healthcare landscape. Add in trying to get a disparate set of stakeholders to agree a common way forward and you are left with challenges which many would find easier to avoid than embrace. These challenges can and are being overcome, leading to higher quality and more efficient healthcare. There is

no question that interest in blurring the boundaries between primary and community estate is growing rapidly. Smart land and flexible building usage goes hand-in-hand with this, just as clinical success goes hand-in-hand with sustainable estates management. It is early days but we are already seeing examples of this in a number of trusts and local authorities across the country, who are willing to take on the challenge of making this work.

In summary, healthcare property has the opportunity to play a significant role in enabling trusts to use the assets they already have to create efficiencies and deliver their clinical strategy without cutting services. With the right strategic planning, and by taking a fresh approach to estates property, the NHS can reduce costs and improve its financial position while creating a better environment and better services for patients. ■

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# Highlighting food borne viruses

**Ms. Messens Winy, Senior Officer for the European Food Safety Authority's Biological Hazards and Contaminants Unit, answers Adjacent Government's questions and sheds light on food borne viruses...**

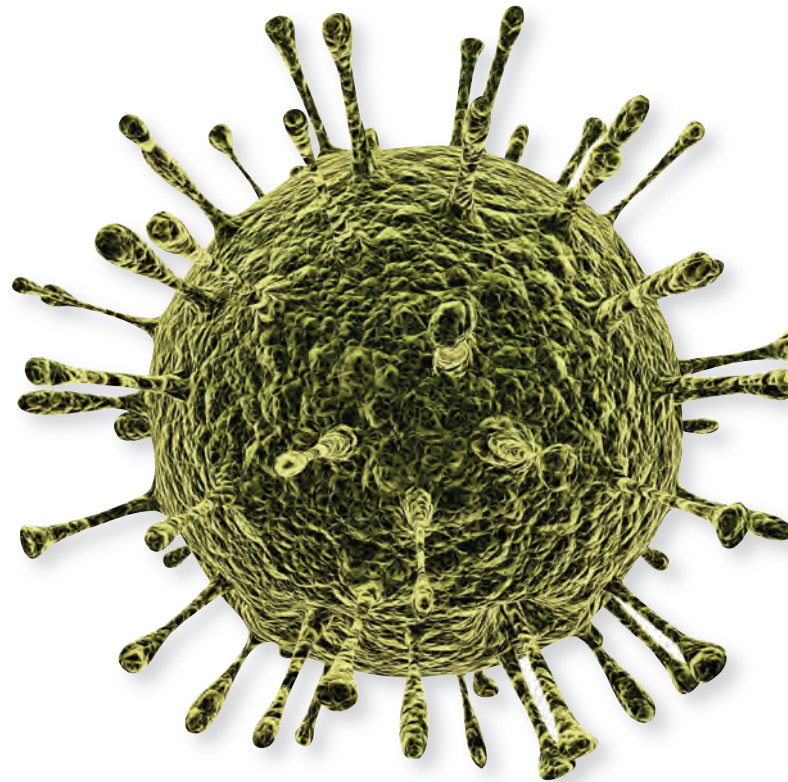
**F**ood-borne viruses are viruses present in food or drinking water that can cause zoonotic diseases when ingested. Thereby the food items merely act as vehicles for their transfer to humans. Unlike bacteria, viruses do not multiply or produce toxins in food. Consequently, viruses do not cause deterioration of the food and the organoleptic properties of the food are not affected due to the contamination by a virus. Food borne viruses may persist for extended periods of time as infectious particles in the environment, or in foods.

Viruses such as Noroviruses (NoV), hepatitis A virus (HAV), enteroviruses, astroviruses, adenoviruses, rotaviruses and hepatitis E virus (HEV) have all been implicated in food and/or water-borne outbreaks of illness. There is a potential for any enteric virus to cause illness when ingested through food, but in practice most reported incidents of viral foodborne illness in the EU are due to NoV and HAV.

## **How can they affect people?**

Noroviruses causes gastroenteritis – an inflammation of the digestive tract. Probably the best known presentation of a Norovirus infection is that of large outbreaks of vomiting and diarrhoea that lend the disease the initial description of “winter vomiting disease”. The illness typically is mild and self-limiting, but may be more severe and even fatal in elderly and immuno-compromised individuals. In the EU, the majority of Norovirus gastroenteritis cases results from direct person-to-person transmission. It has also been associated with consumption of contaminated leafy greens, berries, shellfish and drinking water.

The hepatitis A virus (HAV) usually causes flu-like symptoms, but can also lead to acute liver disease. In the EU, the major mode of transmission for HAV is person-to-person, mainly as a consequence of travelling to endemic regions, having risky sexual



Norovirus. The viruses are transmitted by fecally contaminated food or water, by person-to-person contact, and via aerosolisation of the virus and subsequent contamination of surfaces

practices, or consuming contaminated water or food. Foods of primary importance are those susceptible to be contaminated at the pre-harvest stage such as bivalve molluscs, particularly oysters, clams and mussels, salad crops, as lettuce, green onions and other greens, and soft fruits, such as berries.

## **How important is it for advice to be available to prevent contamination from these viruses?**

Food may be contaminated by virus during all stages of the food supply chain. Virus transmission can occur by consumption of food contaminated during the production process (primary production, or during further processing), or contaminated by infected food handlers. Effective control strategies for NoV and

HAV need to focus on prevention of contamination. Such prevention will have to occur primarily at the pre-harvest level for some products, at the harvest level (e.g. manual handling during picking fresh fruits and vegetables), and at the post-harvest phase for others (e.g. manual preparation of ready-to-eat foods). As an example, the main risk factors for the contamination of leafy greens with Norovirus at primary production are diverse and include among others the use of water for irrigation or pesticide treatment which has been contaminated by sewage.

At home, consumers are to be aware of the following advice: cooking food thoroughly; washing hands, surfaces and equipment frequently; separating raw and cooked food; using potable water and wash fruit and vegetables, especially if these are eaten raw.

**Have food borne viruses become a major problem? And, how are they affecting the EU population?**

In 2013, 941 food-borne outbreaks caused by viruses were reported in the EU, representing 18.1% of all outbreaks reported in the EU. Only 86 (9.1%) of these reported viral outbreaks had strong evidence. In these strong-evidence outbreaks, ‘Crustaceans, shellfish, molluscs and products thereof’ was the most commonly implicated food vehicle (40 % of outbreaks), followed by ‘Buffet meals’ (14.0% of outbreaks), ‘Fruit, berries and juices and other products thereof’ and ‘Mixed food’ (both 11.6%). Seventy-six outbreaks were caused by NoV, representing 88.4% of all the viral strong-evidence outbreaks.

At the EU-level it is unknown how much disease caused by NoV is foodborne. Studies in some countries suggest that this can be significant. The relative contribution of different sources (e.g. shellfish, fresh produce, food handling) to foodborne illness has not been determined. Current EU surveillance for foodborne NoV illness does not capture dispersed outbreaks very efficiently, and there is evidence of underreporting of foodborne NoV outbreaks. The background data from case reports of HAV is often insufficient to prove foodborne transmission, but occasional outbreaks have been documented. With the decreasing immunity to HAV in the EU population, the probability of outbreaks is increasing.

**How important are food standards and regulations to help reduce and prevent these viruses?**

CODEX Guidelines on the application of general principles of food hygiene to the control of viruses in food has been published. It contains 2 annexes: (i) control of HAV and NoV in bivalve molluscs and (ii) control of HAV and NoV in fresh produce. No specific microbiological criteria are set for viruses, as it is the case for bacteria. There are no specific requirements laid down in the legislation for the quality of water used in the food supply chain (in primary production), except for drinking water. EFSA’s panel on Biological Hazards (BIOHAZ panel) concluded that microbiological criteria for HAV and NoV would be useful for validation and verification of HACCP based processes and procedures, and can be used to communicate to food business operators what is an acceptable or unacceptable viral load.

**Is there enough being done in regards to EU policy to help prevent the problem?**

For live bivalve molluscs, as an example, production areas are currently classified in one of the 3 categories according to the levels of faecal indicators (*Escherichia coli*) in the mollusc flesh. In addition, a food safety criterium is set for *Escherichia coli* in live bivalve molluscs as an indicator of faecal contamination and for *Salmonella* in live and cooked bivalve molluscs. But, according to the BIOHAZ Panel, this does not ensure absence of viruses in bivalve molluscs.

**How does the EFSA give advice to help measure the control of food borne infections?**

EFSA gives scientific advice on foodborne diseases and supports decision-makers to draft policies and measures for the control of food-borne viral infections in the EU. In 2011, EFSA published a Scientific Opinion from the BIOHAZ Panel on an update on the present knowledge on the occurrence and control of foodborne viruses. Viruses are also considered in many other outputs. ■

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# Cancer research – 50 years and counting

Christopher P. Wild, Director at the International Agency for Research on Cancer (IARC) outlines how 50 years on, prevention still remains key to cancer research...

“Have you found a cure yet?” Which cancer researcher upon revealing their profession has not faced this question? One can respond confidently with examples of major improvements in survival: childhood leukaemia, testicular and breast cancers being notable. One can point to remarkable insights into the previously hidden biology of cancer, with drugs now tailored to exploit the molecular Achilles heel of an individual tumour. These triumphs of scientific creativity and endeavour merit the telling. Yet the disturbing, deeper truth is we cannot treat our way out of the cancer problem.

As people live longer and populations increase, the number of new cancers each year is projected to rise sharply. In 2035, just 20 years from now, there will be an estimated 10 million more people every year facing a cancer diagnosis. Increases are greatest in the developing countries where there is least capacity to treat and care for patients. The spread of risk factors linked to western patterns of individual behaviour and societal structure will exacerbate the problem. Even for the world’s richest countries the spiralling cost of cancer means improved treatment alone is an inadequate response. For the world’s poorest, the out-of-pocket expenses of treatment for one individual can be financially catastrophic for an extended family. The pain of cancer is far reaching. How did we end up here and what might be done better?

Fifty years ago, when the International Agency for Research on Cancer (IARC) was established, IARC scientists considered the striking global variations in cancer patterns and decided to study the causes of this heterogeneity as an avenue to prevention. Over the last 5 decades IARC played its part, with many others, in discovering human carcinogens. Tobacco remains the pre-eminent culprit. Chronic infections

account for 16% of all cancers, one in 4 in the most populous nation, China. Alcohol, radiation including excess sunlight, unhealthy diets, environmental contaminants and occupational exposures all contribute. Imbalances in calorie intake and expenditure are adding to the problem; many people are no longer moving enough to justify the amount they eat and drink.

**“The benefits of prevention can take many years to manifest. This is incompatible with the duration of a political mandate (at least in most democracies) but also with the immediacy of people’s personal experience, where what is sought is a cure.”**

Estimates vary but one can safely conjecture that some 40-50% of cancers could be prevented by translating this accumulated knowledge into interventions. Further inroads are made by detection of early-stage cancers or pre-cancerous conditions, combined with more effective treatment e.g. for cervical, breast, colorectal and oral cancers. Furthermore, prevention and early detection demonstrably work. Major declines in lung cancer following reduced tobacco consumption are remarkable as are the falls in cervical cancer following introduction of screening. Improved protection against work place carcinogens form part of the successes. Vaccination against hepatitis B virus and human papilloma viruses will in time yield their fruits. Many interventions have added value through reducing other illnesses of aging such as cardiovascular disease and diabetes.

Despite proof and promise, prevention is too often neglected. Commonly less than 5% of cancer research funding goes to prevention, a proportion dwarfed by the investment in basic science and clinical translational research. In addition, the science that is performed



too often remains at the stage of proof-of-principle, with a failure to implement. This under-investment in research and in implementation is costly and while the underlying drivers are complex, they merit exploration.

Part of the problem may be time. The benefits of prevention can take many years to manifest. This is incompatible with the duration of a political mandate (at least in most democracies) but also with the immediacy of people's personal experience, where what is sought is a cure. Economics is important, because while new therapeutics offer opportunities for private sector investment and growth, public health interventions are perceived as cost pressures. Complexity is a further element. Prevention requires a multi-sectoral cooperation across health, transport, environment, etc., to address the "causes of the causes". Responsibility has been too often placed solely on the shoulders of the individual whereas tobacco control has shown how appropriate legislation has been key to success.

Nevertheless, this is an exciting time for cancer prevention. Advances in cancer biology offer fresh impetus to studies of causes, early detection and prevention. Implementation research, close to policy,

can better indicate factors which help or hinder the translation of promising interventions into effective national programmes. Thorough analyses of the economic benefits of prevention may yet reduce the unpopularity of the Minister of Health among government colleagues. Prevention, applied at the population level, offers a sustainable approach contributing in turn to reduced inequalities in society.

From a global perspective the necessity of prevention is blindingly obvious. IARC enters its second 50 years with a renewed mandate to conduct cancer research for cancer prevention. As there is an undeniable responsibility to offer the very best in treatments for the patients of today, there is also an undeniable responsibility to prevent the suffering from cancer for the populations of tomorrow. Perhaps eventually, on revealing one's identity as a cancer researcher to a new generation, the question may just occasionally be: "Can you prevent it yet?" ■

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# The Anticancer Fund

**E**merging from the Swiss-based organisation Reliable Cancer Therapies, founded in 2009 by Belgian entrepreneur Luc Verelst, the Brussels-based Anticancer Fund (ACF) is a private not-for-profit foundation dedicated to expanding the range of treatment options available to patients. It is this central focus on patients which is the common theme that runs through the diverse activities of the ACF – both in terms of its approach to scientific and clinical research and also in its day-to-day work. While the ACF is a relatively small organisation, employing mainly scientists and medical staff, it has an international reach which extends well beyond the borders of Belgium. This manifests itself both in terms of supporting projects worldwide and in making available comprehensive scientific information to the public in multiple languages. These twin tracks of scientific and public engagement are apparent in the range of ACF projects and activities.

## Public Engagement

The most visible form of public engagement is in the provision of scientifically accurate information to the public via the ACF website ([www.anticancerfund.org](http://www.anticancerfund.org)). Here patients can find information on current cancer treatments, a gateway to search for clinical trials and information on non-mainstream treatments – including dietary and lifestyle interventions. Also of importance is information on some of the ‘alternative’ and complementary



therapies that cancer patients may come across.

The ACF takes seriously the task of ‘quack busting’, and has been active in exposing the activities of fraudsters who seek to exploit vulnerable cancer patients seeking ‘miracle cures’. For example there is a very active group of people in Europe selling a fake cure called GcMAF. The ACF has been active in informing the authorities about the fraudsters, publishing factual information about GcMAF, and ensuring retraction of a number of fraudulent scientific articles. The ACF is seeking recommendations at the European level on how we can act against fraudsters operating in different countries.

However, the ACFs engagement with the public goes beyond publishing

information and extends to direct support for individual patients seeking new options. Since 2010 over 500 patients, primarily from France, Belgium and the Netherlands have used this service.

Finally, there is another form of public engagement in which the ACF is becoming increasingly involved and that is public policy intervention – most notably this arises from the ACF research agenda.

## Scientific Research

The ACF believes that as a society we need to ensure that no treatment option is left untapped. To this end there are three major strands of research, focused primarily on non-mainstream treatments: drug repurposing, non-commercial immunotherapies



and non-pharmaceutical interventions. The objective is to bring these non-mainstream treatments into mainstream clinical practice.

The Repurposing Drugs in Oncology (ReDO) project is a collaboration with the US not-for-profit organisation Global Cures. The aim of the project is straightforward – to identify a range of existing non-cancer drugs which show strong evidence of anti-cancer activity and which have the potential for clinical use. There is a broad spectrum of drugs that the project has identified, many of them available as cheap generics, including antibiotics, anti-fungals and antiparasitics. Taking evidence from a variety of sources, the ReDO project has reviewed, summarised and published the results in peer-reviewed journals.

The ACF also aims to confirm this promising data in well-designed clinical trials. Examples include a pioneering trial of ketorolac in women undergoing breast cancer surgery, and the use of celecoxib and fluvastatin in paediatric optic nerve gliomas. The ultimate goal is to persuade other foundations, European and national governmental organisations to start mining this relatively unexplored field of affordable, non-toxic and potentially breakthrough opportunities that could benefit patients.

Another key area is non-pharmaceutical interventions, which covers nutritional, lifestyle and other non-drug approaches to cancer. While these interventions are gaining more and more public attention there are important issues to tackle in order to allow proper eval-

uation of these as additions to current standard of care treatments or, as claimed by some proponents, as alternatives to standard of care therapies. Quality of supplements and plant extracts need to be guaranteed, mind body interventions standardized and clinical trial guidelines adapted. In terms of non-pharmaceutical interventions the ACF supports a UK trial exploring dietary changes in advanced breast cancer; another is investigating mindfulness meditation in young adults during and after their cancer treatment.

Finally, the ACF is also active in the field of immunotherapy – with an emphasis on commercially neglected areas, such as non-patentable, cellular immunotherapy or combinations of the latest generation of highly expensive immunomodulating drugs with low-cost interventions.

The patient focus of ACF is also reflected in the support of clinical trials in patient populations with high unmet needs – particularly rare, refractory or metastatic cancers. For these indications repurposed drugs are the logical choice. An example is a multicentre trial in France with four repurposed drugs in advanced pre-treated osteosarcoma. This is a start but ideally this type of trial should be organised at a European level to minimise problems of slow patient accrual.

Another instance of the ACF commitment to public engagement is to look at the institutional and regulatory obstacles to these non-mainstream treatments. These treatments need to be compared to standard of care, but

this is not always a simple task. For example, trials using herbal extracts or nutraceuticals as a monotherapy are problematic due to current European clinical trial directives. There is also a lack of standardised extracts or GMP manufacturing of agents – and manufacturers are unwilling to invest to gain accreditation.

Trials in drug repurposing are easier to initiate, but there are obstacles to the adoption when positive results are reported. For example there have been a number of instances where repurposed drugs have shown evidence of efficacy but which have not then been licensed for cancer nor been adopted clinically. Changing practice is hard and the ACF believes it needs the involvement of regulators, insurers, clinicians, patients and other stakeholders to make it happen.

If we are to deliver on the potential benefits of these commercially neglected non-mainstream therapies, particularly in an era with globally rocketing health-system costs, these non-scientific barriers must also be overcome.



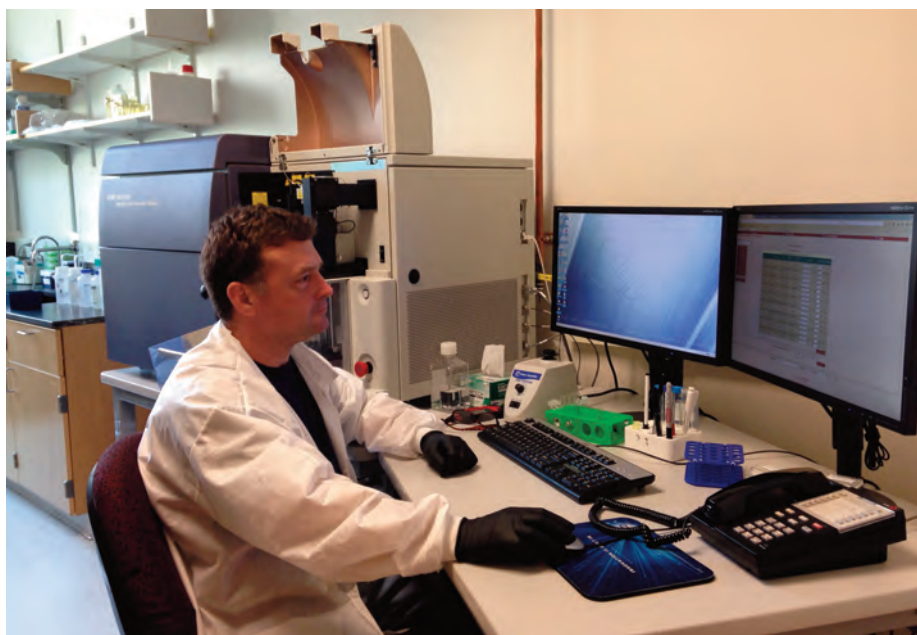
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# Vitamin D & Analogues in Cancer Prevention & Therapy Research

It is well-recognised that cancer is a major public health problem worldwide. In fact, it also constitutes an enormous economic burden on society. The increasing burden is anticipated because cancer will surpass heart diseases as the leading cause of death in the US in the next few years. This is also likely in other parts of the world as well, in part, due to the growth and aging of the population. Therefore, effective and low cost cancer prevention and therapeutic regimens are urgently needed.

Vitamin D was discovered almost a century ago as an antirachitic agent. Its role in maintaining healthy bones is well-established. There are two major forms of vitamin D, vitamin D<sub>2</sub> and vitamin D<sub>3</sub>. They are derived from two different, but closely related precursors, 7-dehydroergosterol (provitamin D<sub>2</sub>) and 7-dehydrocholesterol (provitamin D<sub>3</sub>) by the same photosynthetic mechanism. In humans, vitamin D<sub>3</sub> is the endogenous form and can be photosynthesised in the skin from provitamin D<sub>3</sub>, which is present in the epidermis of human skin, after sunlight exposure. However, vitamin D (D<sub>2</sub> or D<sub>3</sub>) itself is inert and must be activated before it can exert its biological effects on bone.

The activation of vitamin D involves two successive hydroxylation steps catalysed by cytochrome P450 enzymes. The first hydroxylation occurs in the liver at the carbon-25 of vitamin D



molecule, mainly by CYP2R1, to form 25-hydroxyvitamin D [25(OH)D], the major circulating form of vitamin D. The subsequent hydroxylation of 25(OH)D is carried out by 1 $\alpha$ -hydroxylase or CYP27B1 to produce 1 $\alpha$ , 25-dihydroxyvitamin D [1 $\alpha$ ,25(OH)<sub>2</sub>D], the active form of vitamin D. CYP24A1 is another one involved in vitamin D metabolism and actions. This enzyme is responsible for the degradation of 25(OH)D<sub>3</sub> and 1 $\alpha$ ,25(OH)<sub>2</sub>D<sub>3</sub> and, therefore, terminating the vitamin D actions.

The dependence of vitamin D synthesis on sunlight has led to the hypothesis that there might be a connection between vitamin D and cancer. It was reported in 1980 that there was an inverted association between latitude and colon cancer; people living closer to equator have less colon cancer

mortality rate than those living far from it. This connection was later extended to several other forms of cancer. The ecological evidence serves as a stimulator to further explore the mechanisms of this association at the cellular and molecular levels.

1 $\alpha$ ,25(OH)<sub>2</sub>D acts through its receptor called vitamin D receptor or VDR. Its binding to VDR can regulate a gene through the interaction of 1 $\alpha$ ,25(OH)<sub>2</sub>D/VDR complex with a VDR response element (VDRE). VDR has been identified by gene expression profiling approach not only in tissues involved in calcium, phosphate and bone metabolism, but in almost all cell types in our body, implying that vitamin D must play important roles beyond bone. Today, it is speculated that vitamin D may regulate more than 600 genes. Among the genes

affected are those closely linked to cancer biology, including genes regulating cell cycle, differentiation, apoptosis, angiogenesis, inflammation, and immune function. More recent studies using human cell cultures and animal models have provided unequivocal data supporting the vitamin D and cancer connection and, more importantly, the potential use of the active form of vitamin D,  $1\alpha,25(\text{OH})_2\text{D}$ , in cancer prevention and therapy.

**“The increasing burden is anticipated because cancer will surpass heart diseases as the leading cause of death in the US in the next few years.”**

In early clinical trials, unfortunately,  $1\alpha,25(\text{OH})_2\text{D}$ , was found to cause serious hypercalcemia and hypercalciurea in patients, and was not suitable for clinical practice. Aiming to eliminate the unwanted side effects and at the same time to enhance its anti-tumor activity, several thousands of vitamin D analogues have been synthesised. Knowing that the addition of  $2\alpha$ -(3-hydroxypropyl) group to C-2 of  $1\alpha,25(\text{OH})_2\text{D}_3$  molecule enhances VDR binding, and that the 19-nor analogues of  $1\alpha,25(\text{OH})_2\text{D}$ , such as 19-nor- $1\alpha,25(\text{OH})_2\text{D}_3$  and its sister compound, 19-nor- $1\alpha,25(\text{OH})_2\text{D}_2$  (also called Zemplar or Paricalcitol, which is an FDA-approved drug for treating secondary hyperparathyroidism), are non- or less-calcemic while maintaining the other potent cellular activities of  $1\alpha,25(\text{OH})_2\text{D}$ , Professor Kittaka rationalised that a vitamin D skeleton having a combined structure of “ $2\alpha$ -( $\omega$ -hydroxy)alkylated” and “19-nor” moieties could have enhanced biolog-

ical activities without inducing a significant hypercalcemic effect. One of the analogues synthesised, called MART-10 ( $2\alpha$ -(3-hydroxypropyl)- $1\alpha,25$ -dihydroxy-19-norvitamin  $\text{D}_3$ ), shows remarkably potent anti-tumor activity which is about 2-3 magnitudes more active than  $1\alpha,25(\text{OH})_2\text{D}$  in prostate, liver, pancreatic, breast, and head and neck cancer cells in cultures.

In a xenograft animal model inoculated with pancreatic cancer cells, MART-10 showed a 10-fold greater antitumor activity than  $1\alpha,25(\text{OH})_2\text{D}$  without raising serum calcium. The higher biological activities exhibited by MART-10 in vitro may be attributable to its tighter binding to VDR, more resistance to CYP24A1 degradation inside the cells, and lower binding to vitamin D binding protein in circulation, making it more bio-available inside the cells. The less dramatic effects in vivo may suggest that further modification may be necessary to make MART-10 more suitable as a drug. Based on the existent literatures, we have further synthesised two conjugates of MART-10, and showed that it was released upon the incubation of these two compounds with rat serum. We further demonstrated that these two compounds had similar antiproliferative activity as MART-10 in prostate cancer cell cultures.

Recent advances in vitamin D research by several laboratories, including the laboratory of Professor Sakaki, has demonstrated that  $1\alpha$ -hydroxylation of  $25(\text{OH})\text{D}$  molecule may not be a prerequisite step for the manifestation of vitamin D biological activity as long as there is a sufficient level of  $25(\text{OH})\text{D}$ . The finding suggests that

vitamin D analogs without  $1\alpha$ -hydroxyl group could be developed as drugs for cancer prevention and treatment.

In conclusion, ecological and biochemical evidence strongly suggests a potential use of non- or less-calcemic analogues of vitamin D for the prevention and treatment of cancer. By making a simple substitution at the A-ring of the  $1\alpha,25(\text{OH})_2\text{D}_3$  molecule, our team has obtained an ultra-potent vitamin D analogue, MART-10, as demonstrated in both in vitro and in vivo pre-clinical studies. Its further derivatisation has produced potentially more effective drugs for the prevention and treatment of different forms of cancer.



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# Stem Cells and immunity

## Stem cells, Chromosomal instability and Cancer

Life expectancy in the western world has been on the rise, leading to an upshift in median age that will continue in the next decades<sup>1</sup>. As a consequence of population ageing, the incidence of ageing-related ailments has escalated; not only degenerative diseases such as Parkinson or Alzheimer, but also the number of people affected by cancers has risen drastically. Notwithstanding its impact on society, the underlying mechanisms are still not completely understood, translating into relatively coarse and unspecific cancer treatments. Only in the last few years has the treatment of some forms of cancer evolved into a more guided approach, and years of investigation will still be needed to design intelligent treatments for a wide variety of cancers.

### Stem cell biology of cancer

Stem cells have a central role in most if not all ageing-related ailments. In most of the diseases studied, the depletion of stem cells and reduction of their proliferative capacity seems to be the main cause of tissue degeneration. In cancer, however, excess growth is the central underlying mechanism. The role of stem cells in tissue homeostasis depends on the equilibrium between differentiation and self-renewal. Whereas stem cell differentiation into more specialised cell types is the mechanism that produces the somatic tissues, self-renewal assures the maintenance of an undifferentiated cell population that maintains a

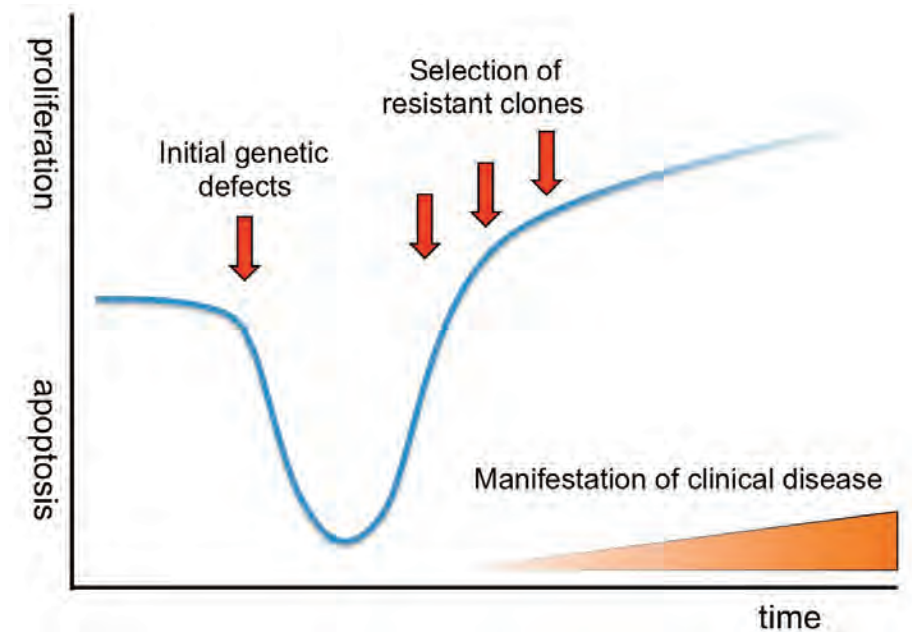


Figure 1: Stem cell depletion and cancer. Whereas the majority of ageing stem cells will enter senescence or apoptosis upon accumulation of genetic defects, a small proportion might survive and evolve into the rapidly dividing resistant population that causes cancer

proliferative capacity. In cancer, the equilibrium between differentiation and self-renewal is disturbed, provoking the accumulation of a population of poorly differentiated but highly proliferative cells.

The identification of a stem cell population at the heart of tumor growth<sup>2</sup> comprises yet another link between ageing and cancer; the role of stem cells in cancer is just as important as in degenerative diseases. Whereas stem cell depletion and their uncontrolled growth appear unrelated phenomena, they are in fact closely related; whereas a proportion of stem cells are lost during ageing, the

surviving stem cells have an increased chance of chromosome alterations.

### Chromosomal Instability (CIN)

A key difference between healthy, normal stem cells and tumor cells is the acquisition of genomic alterations by the latter. Most carcinomas present some form of genetic instability, either as an accumulation of intragenic mutations or as a large-scale alterations – translocations, deletions and numerical changes – termed chromosomal instability (CIN). Although the hypothesis that CIN itself can cause cancer has taken a long time before being accepted, CIN is frequently detected in tumors before intragenic

mutations and thus comprises a driving force in carcinogenesis<sup>3</sup>. Current theories suggest that CIN can induce cellular transformation through gene dosage or gene translocation; the genome fragments gained or lost in CIN frequently contain hundreds of genes, each of which can affect a pathway regulation step. The extra copies of many genes in CIN cause a gross imbalance in cellular regulation, which easily spills over into other pathways including cell cycle control<sup>4</sup>. Pathway interconnectedness thus appears to be the Achilles' heel of genomic stability in mammals.

### Stem cells, CIN, and cancer therapy

Because of their unique role in tissue renewal, stem cells have a combination of characteristics that renders them susceptible to genetic damage, transformation, and tumor initiation. Stem cells not only undergo rapid growth and division, but also seem to be tolerant for gene dosage effects that would induce apoptosis in other cell types. Notwithstanding their resistance, cancer stem cell theory clearly indicates that this population must be targeted to treat carcinomas efficiently.

Traditional anticancer therapy depends on tumor cell eradication by cytotoxic drugs, through the induction of additional chromosome defects that lead to apoptosis or necrosis. Although the efficacy of the classical cancer treatments has advanced tremendously, they still suffer from side effects, such as the shutdown of stem cells in skin, intestine, and immune system. Thus, a drawback of many

chemotherapeutics is the low capacity to distinguish between cancer cells and rapidly dividing non-cancer cells. In addition, most of the chemotherapeutic compounds favor selection of resistant and aggressive cancer cells.

The last decade has seen the development of new therapies, aimed at a more specific elimination of cancer cells while reducing toxic effects. One phenomenon in particular, oncogene addiction, might yield novel targets for anticancer therapies<sup>5</sup>. In oncogene addiction, the cancer's need for survival leads to activation of the corresponding signal pathways, to an extent where cells become completely dependent. Oncogene addiction has been characterised in only a few types of cancer so far, but preliminary results are promising. Oncogene addiction seems to increase with tumor progression, so targeting survival pathways might be the way to treat advanced cancer, where classical therapies loose efficiency. For example, the high level expression of HER that characterises the most aggressive forms of breast cancer is exploited for treatment with the neutralising antibody Herceptin®, improving the prognosis of HER-positive tumors. Novel targets in signaling pathways must be seen as an addition to classical therapies for now, but further characterisation of pathways might help to treat a wide range of cancers. Especially the targets that overlap with stemness and differentiation are interesting, for the possibility to attack cancer stem cells.

### Concluding remarks

The fundamental way in which cancer is treated is just recently being mod-

ernised. New therapies will hopefully be able to discriminate better between cancer cells and healthy stem cells, and be tolerated better by the patient than current treatment schedules. The combination of data from stem cell biology, tumor evolution, and genetic analysis of patient material has greatly improved our understanding of cancer biology. Still, continued efforts are needed to use this knowledge for the benefit of cancer patients.

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# A snapshot of breast cancer

Tom Stansfeld, Health Information Officer at Cancer Research UK gives an overview of breast cancer and how survival has improved...

**B**reast cancer is the most common cancer in the UK with more than 50,000 new cases diagnosed each year. Over the last 40 years breast cancer incidence rates have gone up by 72%.

But it's not all bad news – survival has also dramatically increased. In the mid 1970s just over half of women survived the disease beyond 5 years whereas now more than 8 in 10 women are alive 10 years after a diagnosis. Since the 1970s there have been advances across many different areas of breast cancer, from a better understanding of the causes through to earlier diagnosis and improved treatment options.

## Prevention

Some aspects of our lives can increase the risk of developing cancer. While nothing can guarantee a person won't develop cancer, there are many ways to stack the odds in your favour by making healthy lifestyle choices.

Certain things that affect a woman's risk of breast cancer are largely unavoidable, such as her age, when she had her first period, whether she has children and whether they were breastfed. But, making healthy lifestyle choices such as keeping a healthy weight, drinking less alcohol and being physically active, are more within her control, and could each help reduce the risk of developing breast cancer.

## Early Diagnosis

The earlier breast cancer is diagnosed the greater the chances of survival. If breast cancer is diagnosed when the disease is advanced – at stage 4 – survival is much lower than for those diagnosed at the earliest stages.

Cancer Research UK works to understand and encourage earlier diagnosis of breast cancer through

research and the International Cancer Benchmarking Programme (ICBP). It also supports public-facing campaigns such as the Public Health England (PHE) Be Clear on Cancer campaigns. The current campaign informs women over 70 that if they see any changes to their breasts, not just a lump, they should see their doctor straight away.

While the key to spotting cancer earlier is knowing your body and being able to spot unusual or lasting changes, regular and regimented breast self checks aren't advisable. Research has shown that women who regularly check their breasts aren't any less likely to die from breast cancer. But they are almost twice as likely to have a biopsy of a lump that turns out not to be cancer. Cancer Research UK advises women to get to know what their breasts are normally like, and tell a doctor about any unusual or persistent changes.

Men may also be diagnosed with breast cancer but the numbers are very small. 350, men are diagnosed with breast cancer in the UK each year and 75 die from the disease.

## Screening

Breast cancer screening (mammography) involves testing women with no noticeable signs or symptoms for the disease, with the aim of finding more cancers at an earlier stage. In the UK women between the ages of 50 and 70 are invited to take part in breast screening every 3 years. Women over 70 can still have screening but need to ask to take part. In England breast screening is being extended to include women aged 47 to 73. In the UK, breast cancer screening saves around 1,300 lives a year from the disease.

There is, however, also the potential for harm from breast screening. Women can suffer anxiety, and may





also be falsely reassured by a negative result and be less likely to report unusual breast changes. Because screening isn't perfect some women's breast cancers are missed (false negatives), while other women get a positive screening result and undergo further tests but turn out not to have cancer (false positives).

Screening also leads to over diagnosis of breast cancer, because doctors are unable to distinguish between cancers that will grow quickly and need to be treated and those that will grow slowly and would never have caused harm. This results in some women receiving unnecessary treatment. A review of breast screening in the UK found that around 4,000 breast cancers a year were over diagnosed – or around 3 women over diagnosed for every life saved.

When women receive an invitation to attend breast screening they will also receive information about the harms and benefits to help them make an informed choice about whether they want to take up the offer.

Breast cancer is often reported in the news, especially with high-profile celebrities like Angelina Jolie taking preventative action to avoid developing the disease.

In 2013, NICE provided updated clinical guidelines on supporting women with a familial history of breast cancer. These included the way in which patients are referred by their GPs to cancer experts, drugs to prevent the disease developing and criteria for more serious preventative surgery. More recently it was announced that NHS England would continue to routinely commission genetic screening for high risk genes for breast and ovarian cancer.

Breast cancer survival has improved over the past decades and many women are now treated successfully. This progress is down to world class research and developments in screening and prevention programmes. Cancer Research UK has played a key role in this progress and continues to be a world-leader in funding life saving research to help beat cancer sooner. ■

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# Enhancing breast cancer imaging

**D**r. Reznik's area of research is novel photoconductive materials and technologies for use in radiation medical imaging detectors. In combination with advanced detection schemes, these materials hold promise for improving the performance of imaging systems, i.e., providing superior image quality and reducing x-ray exposure to patients, for a whole variety of medical imaging applications including breast cancer imaging. Reznik's research vision is grounded in two underlying principles:

- Make every photon count, or taken to a limit, count every photon. For medical radiation detectors, we are limited by how much radiation we can use before damaging human tissue. In her approach to medical imaging detectors, Dr. Reznik is aiming to optimise detector design and use the radiation available to reduce overall radiation exposure to patient and medical personnel during diagnostic procedures.
- Miniaturisation. The second principle is the utilisation of highly integrated solid state detector components to miniaturise imaging systems. By keeping her developments compatible with modern electronics, Reznik aims to provide a ready and economically viable avenue to commercialise her concepts, while benefiting from the rapid development of these fields.

Both principles employed in Reznik's work is on solid-state technology for

organ-specific Positron Emission Tomography (PET), with a focus on the investigation of new and more effective ways to detect cancer. Currently, her primary focus is on breast cancer and developing breast-dedicated Positron Emission Mammography (PEM) imaging that is less painful and more accurate than conventional x-ray mammography, especially for women with dense breasts, and high-risk women who have to be screened at a substantially younger age than women at average risk.

Early detection remains the key to efficient and effective breast cancer treatment as it allows for detection and removal of pre-invasive lesions, preventing invasive cancers from developing. However, conventional anatomic breast imaging methods such as x-ray mammography have limitations for early-stage breast cancers. First, the sensitivity of mammography depends strongly on the density of the breast. For women with strong risk factors for breast cancer, mammography is too insensitive to detect very early-stage of the disease in time for intervention. Many women are forced to consider prophylactic mastectomy because they do not have confidence that the disease will be detected early enough for treatment. Secondly, the specificity of mammography suffers from its difficulty in distinguishing between benign and malignant masses. Dense glandular tissue, surgical scars, and fibrosis are frequently misinterpreted as

mammographic signs of malignancy and a large percentage of biopsies prompted by mammography reveal that cancer was not, in fact, present. However, large number of false positives causes unnecessary anxiety for anxiety, psychological stress and places a heavy burden on healthcare. In contrast to anatomical imaging techniques like x-ray mammography, the PEM technique is a functional (molecular) breast imaging modality that distinguishes cancerous cells from normal cells, by comparing biological processes and functional properties using a radiotracer. This allows for small masses to be detected with high specificity, irrespective of their density, and thus the technique can be more effective for detecting tumours in women with denser breast tissue.

**“In combination with advanced detection schemes, these materials hold promise for improving the performance of imaging systems, i.e., providing superior image quality and reducing x-ray exposure to patients, for a whole variety of medical imaging applications including breast cancer imaging.”**

To improve breast cancer imaging, Dr. Reznik and her team are developing a portable PEM scanner with improved resolution and sensitivity over commercially available PET imagers, that is achieved by highly sensitive and specific system design. In Reznik's

design, PEM uses small field-of-view gamma-photons detectors located in close proximity to the breast and oriented much closer together than in whole-body PET. In combination with advanced solid-state detector components these increase the collection efficiency and significantly improve detector sensitivity and spatial resolution. As a result pre-invasive tumors smaller than 2 mm in size can be detected at a fraction of a radiation dose used in whole-body PET scanners. In addition, use of PEM for screening of high risk population will allow for significant improvement in patients' compliance for frequent breast screening. Indeed, at the current stage of mammographic detector technology, extreme breast compression is applied. The associated pain and anxiety is so strong that large number of patients refuse mammography after their first experience. In contrast, PEM only requires breast immobilisation rather than compression, hence completely eliminating pain. This has a potential to significantly improve compliance and the effectiveness of cancer detection. Another advantage of Reznik's PEM is the device's portability, allowing for patients who live in remote locations or with limited mobility to access the same level of healthcare as available in centralised healthcare facilities. Moreover, the PEM scanner will cost significantly less than whole-body PET machines, further enhancing its potential impact on the overall health and well-being of cancer patients.

A clinical prototype of the device is near completion. Once this stage is complete, the researchers will embark

on large-scale clinical trials in partnership with academic research hospitals (including the Thunder Bay Regional Health Sciences Centre), in order to demonstrate the feasibility of the high-sensitivity, high-resolution PEM technology as an integral part of the surveillance protocol for women at high risk of breast cancer.

**“Early detection remains the key to efficient and effective breast cancer treatment as it allows to detect and to remove pre-invasive lesions so preventing invasive cancers from developing.”**

Dr. Reznik has well-established industrial collaborators, including, Philips Healthcare, and local spin-off company, XLV Diagnostics Inc. This methodology has paved the way to transfer the research from bench to bedside.

The overall vision is to provide a tool that is more accessible and painless, with the hope that more women would get screened, more cancers would be caught earlier, and more lives would be saved.

Key collaborators:

- Professor Safa O Kasap, University of Saskatchewan, Canada
- Professor John A Rowlands, University of Toronto and Sunnybrook Research Institute, Canada
- Professor Sergei Baranovski, Philipps-Universität, Germany
- Professor Gytis Juska, Vilnius University, Lithuania

Partners:

- Philips Healthcare  
Analogic, Canada
- Weinberg Medical Physics, LLC, USA
- XLV Diagnostics, Canada

Funding:

- Canadian Breast Cancer Foundation
- Natural Sciences and Engineering Research Council of Canada (NSERC)
- Canadian Institutes for Health Research (CIHR)
- Ontario Research Fund



**Thunder Bay Regional Research Institute**

In partnership with  
**Thunder Bay Regional Health Sciences Centre**  
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# Local government holds the key to cancer rehab success

**Katherine Selby of Action PR highlights how local community leisure centres play a key role in rehabilitation for cancer...**

**A** growing body of evidence <sup>1</sup> shows that physical activity is key in helping people with cancer cope with their treatment and boost their recovery. While this is excellent and positive news, the reality is that local authorities are now tasked to deliver exercise programmes to fulfil the potential recovery of those in their community with cancer. GPs, hospitals and charities all know that physical activity can help but few have the time or the skills to take responsibility for talking to people about this. Packing people off to the local gym isn't the answer, as individuals' needs must be addressed to take into consideration their personal circumstances, fitness levels and response to their treatment.

"We can't ignore the evidence that shows exercise is beneficial and safe for cancer patients," says Martin Ledwick, Head Information Nurse at Cancer Research UK. "Some studies show that exercise helps make patients feel better after their diagnosis, allowing them to cope more easily with the tiredness often related to treatment, and may even speed up recovery. In most instances, it is perfectly safe for cancer patients to exercise but they should discuss it with their doctor to get advice on the best kind of activity to suit their lifestyle and ability."

## **Perfect Partnership**

This bespoke care and professional insight into exercising with cancer has been achieved by partnering cancer care specialists' medical knowledge of the disease, with the expertise of exercise instructors who know how to develop programmes to meet certain protocols and desired outcomes.

Macmillan Cancer Support's ambition is to ensure everyone living with and beyond cancer is aware of the benefits of physical activity and they are able to

become and to stay active at a level that's right for them. Macmillan's evidence-based intervention model can be embedded into cancer care to provide a person-centred service with tailored support. This is for all people, from diagnosis, through treatment, after treatment and end of life.

This behaviour change service offers a minimum of 12 months' support by a trained cancer rehabilitation professional and provides access to a wide variety of physical activity opportunities in the community. This could include them getting back into sport programmes like no strings badminton, gardening, joining a walking group or doing more traditional gym based supervised programmes.

Locally the programmes are governed by a partnership of key decision makers including primary and secondary care, local decision makers including commissioners, public health and leisure services and service providers, supported by Macmillan. The service is robustly monitored nationally, proving its effectiveness against key outcomes.

## **Making local government feel better too**

Leisure centre programmes working in harmony with GPs, hospitals and medical staff can ease the burden on local councils and health services. Accessibility is another major benefit for people, with local leisure centres housed in the heart of communities and open all day. Furthermore, once people are feeling better, the transition to try other forms of exercise at the centre is straightforward and they will feel comfortable exercising independently in the familiar environment.

"We have found that apart from the physical benefits of exercising, the psychological benefit of following an



activity programme in a group or leisure centre, away from hospitals and medical staff, is huge,” explains Mark Collins, ESHT Macmillan Lead Cancer Nurse at East Sussex Healthcare NHS Trust which refers people to Hailsham Leisure Centre. “Exercising at a local leisure centre gives people a sense of normality that is welcome relief after the trauma of their illness and treatment.”

**Success story**

Local authority-run gyms, such as those managed by not-for-profit operator Freedom Leisure, are perfectly placed to run cancer rehab programmes. Its Hailsham Leisure Centre, operated on behalf of Wealden District Council, was the first site to implement the Cancer Rehab Exercise Course in the summer of 2013. The course was initially a pilot programme but its value was immediately clear. It now runs regularly with up to 15 people in each group. Freedom Leisure GP Referral Coordinator, Stephanie Wadlow, was trained by Macmillan and used this to devise a 10-week course comprising an exercise circuit followed by talk time in the centre’s café.

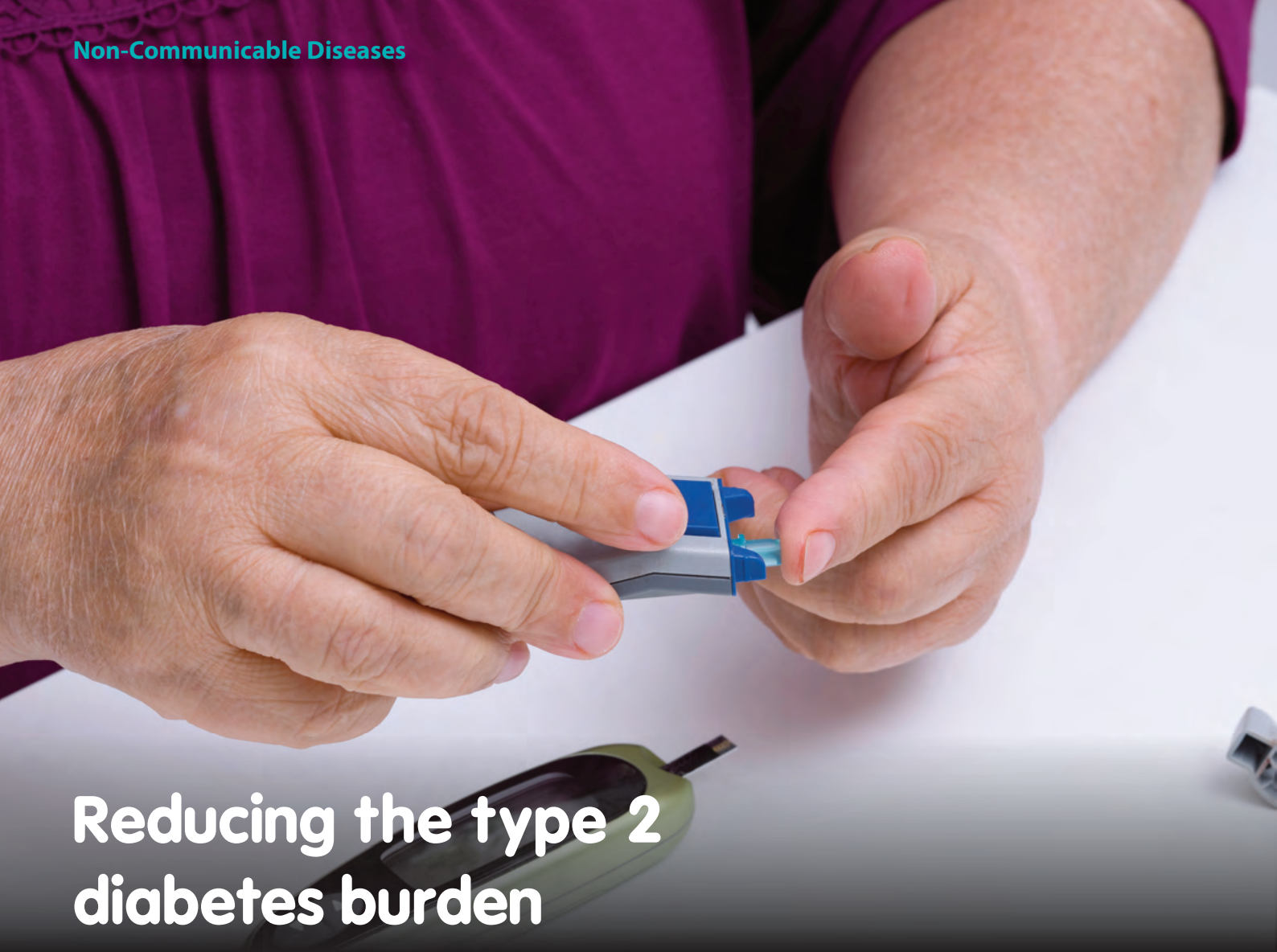
“Many people with cancer are quite weak and anxious initially so we train them very carefully to rebuild their muscular strength, endurance and confidence,” says Stephanie. “We understand it can be hard physically and emotionally to get back to exercise after cancer so our plan is broken down into manageable steps. Many people go on to exercise independently, having found the strength and confidence to do so.”

“Although Freedom Leisure runs this as a group, Stephanie works with each patient at their own level so they feel comfortable with exercise”, says Frances Jones, ESHT Macmillan Breast Care Clinical Nurse Specialist, Eastbourne District General Hospital. “I’ve seen first-hand some fantastic outcomes. Just last month I had a post-cancer patient who was really struggling: she felt incredibly tearful, was unable to face each day and taking antidepressants. After joining Stephanie’s sessions she felt more positive and happy and soon cast aside her antidepressants.”

It has taken a number of years to get to this stage but now local authorities can see the evidence and data that physical activity helps, they’re only too pleased for GPs and nurses to refer people to their local leisure centre. In fact, they are probably quite relieved to find such a rich resource to deliver this after-care for patients in their community. ■

1 [www.macmillan.org.uk/Documents/AboutUs/Commissioners/Physicalactivityevidencereview.pdf](http://www.macmillan.org.uk/Documents/AboutUs/Commissioners/Physicalactivityevidencereview.pdf)

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## Reducing the type 2 diabetes burden

**Professor Jonathan Valabhji, National Clinical Director for Diabetes and Obesity, NHS England, details the main impacts of type 2 diabetes and how the NHS National Diabetes Prevention Programme (NHS DPP) aims to limit these impacts...**

**D**iabetes is associated with in excess of around 22,000 deaths every year in England. Type 2 diabetes accounts for over 90% of all cases of diabetes. The health impact on the individual is stark – it is a leading cause of preventable sight loss in people of working age as well as being a major contributor to kidney failure, lower limb amputation, heart attack, and stroke. Financially, the cost of treating type 2 diabetes accounts for almost 9% of the annual NHS budget – £8.8bn a year.

There is a direct association between the growth in the number of people with type 2 diabetes and Britain's expanding waistline, as those who are overweight or obese are at higher risk of developing the condition. Currently two thirds of adults and one third of 11 year olds in England are overweight or obese and this

figure is increasing. We estimate that over 5 million people in England are currently at high risk of developing type 2 diabetes and worryingly, if current trends persist, one in 10 people could have type 2 diabetes by 2034, meaning that if nothing is done these devastating health and financial burdens will get a lot worse.

**“The programme will establish and implement simple and effective referral mechanisms so individuals identified to be at high risk of developing type 2 diabetes can be offered appropriate, evidence based interventions.”**

Studies suggest that a large number of cases of type 2 diabetes are related to modifiable lifestyle factors and



the risk of developing the condition can be significantly decreased by reducing weight, increasing physical activity and improving diet. The evidence shows such interventions can reduce the incidence of type 2 diabetes in those at high risk by 26% on average. This is why NHS England, Public Health England and Diabetes UK are establishing the first national at-scale diabetes prevention programme in the world, aiming to reduce the future incidence of type 2 diabetes.

The NHS Diabetes Prevention Programme (NHS DPP) is an evidence-based behaviour change programme focused on lowering weight, increasing physical activity and improving the diet of those individuals identified as being at high risk of developing type 2 diabetes. It is about supporting people to take control of their own health and reduce the risk of developing the condition. It's about prevention.

The programme will establish and implement simple and effective referral mechanisms so individuals identified to be at high risk of developing type 2 diabetes can be offered appropriate, evidence based interventions. It will also allow outcomes and follow up activity to be captured so that we can evaluate and improve the programme over time.

The NHS DPP will be available for adults identified as at risk. This will include people who have already been identified as at risk through previous blood tests and have existing results on practice registers and will also provide a referral option from the NHS Health Check programme, which invites adults between the ages of 40 and 74 for cardiovascular risk assessment, including an assessment for diabetes, every 5 years.

Public Health England has commissioned reviews of the available evidence from existing diabetes prevention programmes and from real-world translations of the evidence from the clinical trials. This will be published, following peer review, over the summer.

The evidence reviews have informed the development of the programme, ensuring it is driven by the best available and most current evidence.

**“Studies suggest that a large number of cases of type 2 diabetes are related to modifiable lifestyle factors and the risk of developing the condition can be significantly decreased by reducing weight, increasing physical activity and improving diet.”**

Alongside this we are currently working with 7 local areas, known as demonstrator sites, to learn practical lessons from delivery. These sites were selected to work with us to co-design the service model and support us in developing and implementing a national programme. In particular they will support us in examining local perspectives on the service model, including potential barriers and facilitators to implementation, and strategies for the recruitment and retention of at risk individuals and alignment with existing services. ■

For updates on the programme please visit: [www.england.nhs.uk/ndpp](http://www.england.nhs.uk/ndpp). You can also sign up to our regular e-bulletin by emailing: [diabetesprevention@phe.gov.uk](mailto:diabetesprevention@phe.gov.uk).

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# Reducing the impact of COPD

**Dr Richard Russell, Honorary Medical Advisor at the British Lung Foundation, outlines why chronic obstructive pulmonary disease (COPD) should be a priority for policy-makers and healthcare providers...**

Every year 30,000 people in the UK die as a result of chronic obstructive pulmonary disease (COPD) – it's the fifth leading cause of death in the country.<sup>1</sup> That means COPD, annually claims more lives than breast cancer, leukaemia and pancreatic cancer combined.<sup>2</sup> There are over a million diagnosed cases in the UK, although it is likely that the true total is up to 3 times higher, with many individuals undiagnosed and unaware of the degenerative disease progressing in their lungs.<sup>3</sup> In short, COPD is a significant burden on the health of the nation, and must be a significant priority for health service providers and policy-makers.

COPD is an umbrella term for progressive respiratory diseases that may be known by other names; such as emphysema and chronic bronchitis. The name COPD simply means a long-term condition in which the airways of the lungs become inflamed and the air sacs, within the lungs, damaged, making it harder to breathe in and out.

Up to 20% of COPD cases are linked to occupational exposure to pollution, dust and fumes.<sup>4</sup> It is also possible, though quite rare, to inherit a genetic condition that can lead to the development of COPD. However, smoking is the number one risk factor for developing COPD. Around 80% of all those affected by the disease are current or former smokers, and half of all cigarette smokers will develop some form of airflow obstruction.<sup>5</sup> Measures to prevent smoking uptake (such as increases in tobacco duty and the forthcoming legislation on standardised tobacco packaging) and encourage cessation need to be part of any health strategy looking to reduce the impact of COPD on the nation.

With up to two thirds of those affected by COPD remaining undiagnosed, millions of people could

be living unaware of the crucial lifestyle changes, treatment and support that could be used to slow the disease. Early and accurate diagnosis is absolutely crucial to limiting the speed and scope of damage done to the lungs. We have an urgent need for public awareness campaigns around early signs and symptoms. This will lead more people to see their GP in order to be examined and have the function of the lung measured. Symptoms to watch out for include persistent breathlessness, wheezing and a tight chest. A cough that won't go away is another warning sign, yet is all too often explained away as a 'smoker's cough'.

The breathing difficulties COPD causes can impact many aspects of day-to-day life, making doing the ordinary things most people take for granted a challenge. Just getting out of bed, getting dressed and walking downstairs can be taxing. Furthermore, people living with COPD may experience sudden frightening 'flare-ups' or exacerbations of their symptoms, which accelerate disease progression and speed up the loss of lung function. These exacerbations also mean COPD is the second most common cause of emergency hospital admission in the UK, costing the NHS over £800m every year.<sup>6</sup> While there is unfortunately no cure for COPD, its symptoms can be controlled and managed and disease progression can be slowed, reducing the impact on an individual's quality of life, as well as on health services.

The most crucial thing a person with COPD can do to protect their lungs from further damage is to stop smoking. In fact, quitting smoking in the disease's early stages has been shown to reduce the rate of decline of lung function by half.<sup>7</sup> While quitting can be difficult, those who use nicotine replacement therapy (NRT) and smoking cessation services are 4 times more likely to succeed in their attempts to quit.<sup>8</sup>



Smoking cessation services should be available for anyone who wants to quit, including all those affected by smoking-related illnesses.

**“However, smoking is the number one risk factor for developing COPD. Around 80% of all those affected by the disease are current or former smokers, and half of all cigarette smokers will develop some form of airflow obstruction.”**

Self-management is another important part of living with COPD and protecting lung health from deterioration. It is important to remain as active as possible and formal pulmonary rehabilitation – an 8 week exercise programme designed to improve muscle strength and lung fitness – should be offered to all those diagnosed with COPD. There is still inequality of the provision of pulmonary rehabilitation throughout the UK with some patients missing out from this essential effective therapy. It’s important to have an annual flu vaccination to prevent infection. In some cases treatments including oxygen therapy, inhalers and other medications may also be used to manage symptoms.

We already have the tools and knowledge to improve outcomes for people living with COPD, yet in order to put these into practice we must first find the missing millions living with the condition unaware. Only by improving diagnosis, focusing on smoking cessation support and ensuring everyone is receiving the correct health services and support, can we lessen the impact of COPD on the nation. ■

To find out more about COPD visit the [BLF website](#).

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- 7 Smoking cessation, decline in pulmonary function and total mortality: a 30 year follow up study among the Finnish cohorts of the Seven Countries Study, Pelkonen et al, Thorax 2001, 56:703-707 (September 2001).
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[www.twitter.com/lunguk](https://twitter.com/lunguk)



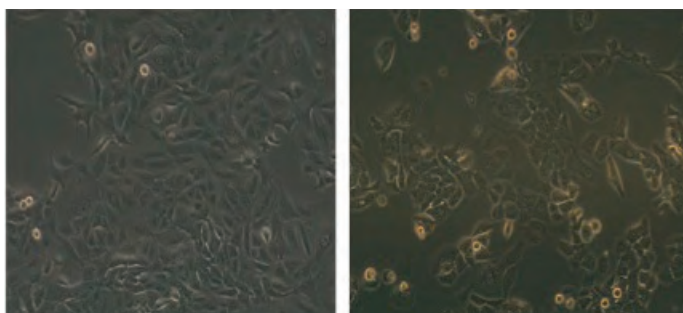
# Pulmonary disease research

The Mansour lab conducts *in vitro* and *in vivo* pulmonary research.

These research activities include designing, characterising, and optimising multifunctional polymeric phospholipid (lipopolymeric) self-assemblies for targeted pulmonary drug delivery, as multifunctional microparticles and nanoparticles. In particular, pulmonary research activities involve the targeted treatment and prevention of several pulmonary diseases.

## Pulmonary Diseases of Global Public Health Importance

- Asthma (various forms)
- Exercise-Induced Bronchospasm (EIB)
- Chronic Obstructive Pulmonary Disease (COPD)
- Pulmonary bacterial infections
- Pulmonary fungal infections
- Pulmonary viral infections
- Cystic Fibrosis (CF)
- Pulmonary Fibrosis (PF)
- Pulmonary Hypertension (PH)
- Lung Cancer (LC)
- Bronchiolitis Obliterans Syndrome (BOS) in Lung Transplantation
- Pneumonitis
- Lung Inflammation



Microscopy imaging of human pulmonary cells

- Respiratory Distress Syndrome (RDS)
- Lung injury

At The University of Arizona (UA), Professor Mansour has faculty appointments in the College of Pharmacy, the BIO5 Research Institute Arizona, the National Cancer Institute (NCI) Comprehensive Cancer Center, and the Institute of the Environment. Dr. Mansour has published over 70 peer-reviewed scientific papers in high impact scientific journals, 9 book chapters, and many conference abstracts. She has been an invited speaker at national and international conferences in the United States of America, Canada, and Europe. In addition, she is co-Editor of a nanomedicine drug delivery book published by CRC Press/Taylor & Francis.

She is an elected Fellow (Overseas Fellow) of the Royal Society of Medicine in London, United Kingdom and an elected member to prestigious honor societies including the Sigma Xi Scientific Research Honor Society, Rho Chi Pharmaceutical Honor Society, Golden Key International Honor Society, Phi Kappa Phi National Honor Society, and Phi Eta Sigma National Honor Society.

Professor Mansour is a member of the Royal Society of Medicine (RSM), The British Thoracic Society (BTS), British Society for Nanomedicine, Academy of Pharmaceutical Sciences of Great Britain (APSGB), The Aerosol Society (Great Britain), European Federation for Pharmaceutical Sciences (EUFPS), European Respiratory Society (ERS), International Pharmaceutical Federation (FIP) Board of Pharmaceutical Specialties, International Society for Aerosols in Medicine (ISAM), International Association of Colloid and Interface Scientists (IACIS), American Thoracic Society (ATS), the American Pharmacists Association (APhA), American Society for Nanomedicine (ASNM), American Association of Pharmaceutical Scientists (AAPS), Controlled Release Society (CRS), American Chemical Society (ACS), the Biochemical Society, and the Royal Society of Chemistry (RSC).

Her pulmonary research expertise is sought out as an expert member of the NIH U.S. Pediatric Formulations Initiative (PFI) New Drug Delivery Systems & Aerosol Working Groups and is an expert member of study sections at the US National Institutes of Health (NIH). In addition, she is an

expert reviewer for the Austrian Science Fund, the Indo-US Science & Technology, the German-Israeli Foundation (GIF) for Scientific Research and Development, the Deutscher Akademischer Austauschdienst Dienst (DAAD) German International Academic Exchange Service, the Catalent Applied Drug Delivery Institute, and the Cochrane Airways Group of the National Health Service (NHS) National Institute for Health Research in Britain.

Professor Mansour has trained Postdoctoral Scholars, Visiting Scholars/Professors, graduate students, physician-scientist (MD/PhD) fellows, pharmacy student researchers and undergraduate student research fellows. Her pulmonary research program has produced Senior Research Scientists currently employed at major pharmaceutical companies in the USA. Her pulmonary research program has produced a number of Assistant Professors currently employed at universities in the Republic of S. Korea and in the USA.

A Selection of Highly Recommended Publications on Pulmonary Disease Research:

Meenach, S.A., Anderson, K.W., Hilt, J.Z., McGarry, R.C., and Mansour, H.M. High-Performing Dry Powder Inhalers of Paclitaxel DPPC/DPPG Lung Surfactant-Mimic Multifunctional Particles in Lung Cancer: Physicochemical Characterisation, *In Vitro* Aerosol Dispersion, and Cellular Studies. *AAPS PharmSciTech* (2014) 15 (6) December: 1574-1587. [\[link\]](#) [\[link\]](#)

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# Importance of sickle cell genetic screening in Ireland

**Lora Ruth Wogu, CEO and Founder of Sickle Cell and Thalassaemia Ireland, outlines what sickle cell disease and thalassaemia are and why screening in Ireland is fundamental...**

**S**ickle cell anaemia and thalassaemia disease are 2 of the major genetic blood disorders that affect the red blood cells. Sickle cell disease is a disorder that affects the red blood cells which contain a special protein called haemoglobin. The haemoglobin is a protein in the blood that carries oxygen from the lungs to all parts of the body. For people who have sickle cell anaemia/ sickle cell disease, the red blood cells do not live up to the normal 120 days, they lose oxygen and form multiple sickle shapes which stick together, causing blockage in the blood vessels. This in turn causes severe excruciating pain to the person known as sickle cell crisis.

Thalassaemia disease is a genetic blood disorder in which the body makes an abnormal form of haemoglobin (protein in the blood). This results in excessive destruction of red blood cells, which leads to severe anaemia.

A blood test for haemoglobin S or sickle haemoglobin can tell you if your haemoglobin is normal, if you have sickle cell disease (SCD) or sickle cell trait (carrier status) or if you have another type of abnormal haemoglobin. (i.e. thalassaemia).

Getting screened to know a person's sickle cell or thalassaemia status is extremely important at child-bearing age because sickle cell disease, sickle cell trait and thalassaemia can be passed down to children through their parents' genes.

It is of great importance to know if you have sickle cell trait because you could have a baby with Sickle cell disease if your partner also has sickle cell disease, sickle cell trait or another abnormal haemoglobin gene (like haemoglobin C or Beta-thalassaemia).

It is vital that all new-borns should be screened for sickle cell anaemia/disease or sickle cell trait. If left undetected and untreated, sickle cell Disease can lead to severe health problems and even death, early in childhood. It is of great importance to Screen for sickle cell anaemia and Thalassaemia at birth.

**“As per 2009 statistics, (by Dr Corrina McMahon, consultant haematologist and lead specialist for sickle cell and thalassaemia in Ireland). There are currently over 400 children and 100 adults suffering from sickle cell disease in Ireland.”**

## **Inheritance of sickle cell disease or sickle cell trait**

If both parents have sickle cell trait, there is a 50% (or 1 in 2) chance that any child of theirs also will have sickle cell trait, if the child inherits the sickle cell gene from one of the parents. Such children will not have symptoms of sickle cell disease, but they can pass sickle cell trait on to their children.

If both parents have sickle cell trait, there is a 25% (or 1 in 4) chance that any child of theirs will have sickle cell disease. There is also 25% (or 1 in 4) chance that the child will not have sickle cell disease or sickle cell trait.

If one parent has sickle cell trait, there is a 50% (or 1 in 2) chance that any child of this parent will have sickle cell trait and an equal 50% chance that the child will not have sickle cell trait.

## **Sickle Cell Disease in Ireland**

Due to the influx of Migrants from all over the world into Ireland in the last 2 decades, the lack of awareness





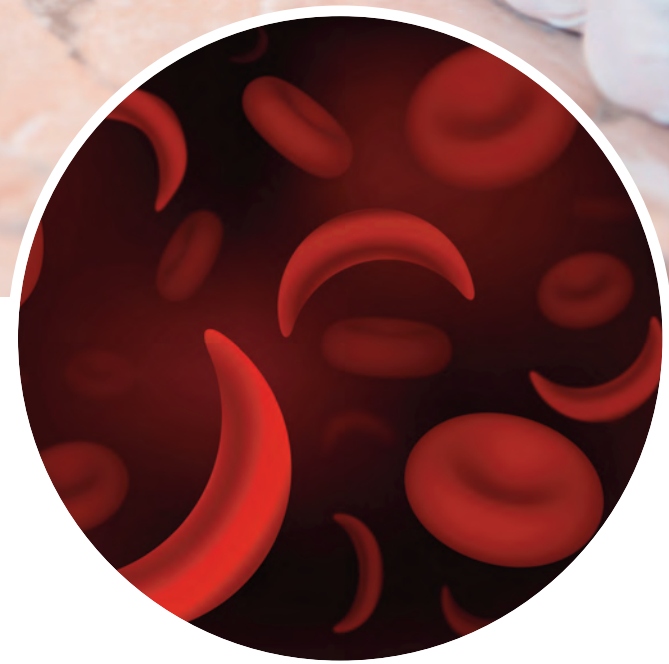
for sickle cell disease and thalassaemia, the rise in cases of sickle cell disease is bound to increase dramatically.

As per 2009 statistics, (by Dr Corrina McMahon, consultant haematologist and lead specialist for sickle cell and thalassaemia in Ireland).

There are currently over 400 children and 100 adults suffering from sickle cell disease in Ireland.

Sickle cell is still considered relatively new in Ireland and there is a huge deficit in knowledge among the healthcare professional on its management, treatment and related complications. There is no proper genetic screening protocol in place, and this fact is the front runner of SCTI'S campaign, "Be Aware, Know Your Gene Status" in partnership with Dr McMahon from Our Lady's Children Hospital Crumlin.

We have been holding talks in several immigrant accommodation centres, encouraging people to get tested and know their Geno-type; we take part in the yearly Flora women's mini marathon, health fairs and



educational workshops relating to sickle cell and thalassaemia diseases. Awareness is vital to fighting the growth of sickle cell and thalassaemia cases and New-born screening will very much help in the fight and detection of sickle cell cases. ■

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# Raising awareness of skin cancer

**Dr. Myrto-Georgia Trakatelli, Dermatologist and Chair of the Media & PR Committee at the European Academy of Dermatology and Venereology (EADV) highlights the growing problem of skin cancer...**

**T**he skin is the largest organ of the body; it's our contact with the rest of the world. We can see it, we can touch it and we can feel with it. Any change to it can be accessed directly by a simple visual examination. Unfortunately most of the times we look but we do not see, or we see too late.

Skin cancer is the most commonly occurring cancer in Europe. On average, about 1 in 6 Europeans will get diagnosed with a skin cancer during their lifetime.

The 3 most common types of skin cancer are the very common basal cell carcinoma (about 85% of skin cancer cases or 70-165 new patients per 100,000 persons), and the less common types: squamous cell carcinoma (about 5% of all skin cancer cases or 4-50 new patients per 100,000 persons) and cutaneous malignant melanoma (about 5% of all skin cancer cases or 10-24 new patients per 100,000 persons). The latter is by far the most aggressive type especially when it is detected belatedly and it accounts for the majority of skin-cancer related deaths.

The frequency of these cancers is increasing rapidly all over Europe - by several percentage points each year. This is due not only to population growth and ageing, but also to a real increase in risk factors.

Since many cancer registries do not routinely collect and/or report information on the annual number of new patients with basal cell carcinomas and squamous cell carcinomas, little is known about the exact magnitude of the problem in Europe. Moreover, many patients with basal cell carcinomas tend to develop several of these tumours in their lifetime, but, generally, at most one of these tumours is reported by the cancer registry. This results in an under-counting of numbers of basal cell carcinoma patients by about

30% of the reported numbers, implying that we are only seeing the tip of the iceberg.

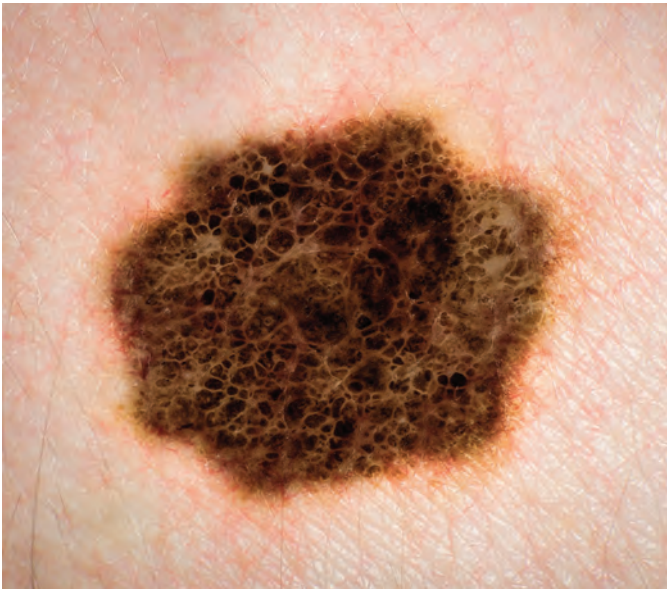
The real magnitude of the skin cancer problem is even larger than estimated at present and this has large implications for the costs and organisation of our healthcare systems.

This makes the need for raising public awareness extremely important. Skin cancer can be prevented through primary prevention - i.e. explaining to the public how to avoid these cancers - and also through secondary prevention favoring early diagnosis.

The most obvious reason for cutaneous cancer occurrence is over-exposure to ultraviolet radiation either from the sun or from tanning beds. In 2009, the International Agency for Research on Cancer classified the whole ultraviolet spectrum and indoor tanning devices as carcinogenic to humans (group 1) together with substances such as asbestos, arsenic, tobacco and plutonium. The rationale for classifying UV and sunbeds as group 1 carcinogens was based on convincing evidence both from basic and epidemiological research.

We live in a time where having tanned skin has become a lifestyle choice and this has contributed to the increase of skin cancer cases. Messages explaining the importance of avoiding excessive UV exposure should start in childhood during schooling and continue in adulthood by stressing the importance of the damage that can be inflicted to the skin from wanting to tan at any price.

Some good news is that skin cancers and precursors to skin cancer are relatively easy to treat if detected early enough. Here we come back to the concept of



looking and actually seeing. People should be taught what they should look for so that they can see it and have it removed as soon as possible. Public campaigns such as Euromelanoma have been running for more than a decade in numerous European countries trying to raise awareness on the one hand and provide information on primary and secondary prevention on the other.

Skin cancer awareness campaigns have also been organised in the European Parliament for the last 4 years by the European Academy of Dermatology and Venereology (EADV) together with key opinion leaders such as the European Cancer Leagues (ECL), Euromelanoma and World Health Organization (WHO) aiming to inform on the various forms of skin cancer giving emphasis each time to a different politically important aspect of these malignancies. Members of European Parliament from various countries and parties have endorsed these campaigns, recognising the importance of these aspects and even addressing relevant questions about them to the EU commission.

The danger of UV exposure in outdoor workers was the main theme of the policy debate on the Skin Cancer Awareness Day 2015 that was hosted by Dr. Charles Tannock MEP, Vice President of the MEPs

Against Cancer group of the European Parliament, an informal, all-party group of MEPs committed to policy action on cancer. The debate took place at the WHO Office at the European Union, in co-operation with EADV and ECL.

There is growing scientific evidence linking sun exposure in outdoor workers to the increasing incidence of skin cancer in this group. Outdoor workers appear to be at a 43% higher risk of basal cell carcinoma, and at a 77% higher risk of squamous cell carcinoma. This poses new challenges not only for the individuals concerned but also to employers, national health systems and social insurances. It has been calculated that in Europe more than 20 million workers are UV exposed. Against this background, examples of recently enacted laws to protect outdoor workers at Member State level were discussed and the need for more targeted policy action at European level on decreasing the burden of occupational skin cancer was stressed.

Though there are definitely things that are progressing in the area of skin cancer in Europe, we should take the next step and go more than “skin deep” and to the “heart of the problem” by raising awareness, supporting research and registration, and implementing relevant legislation to protect the citizens. As dermatologists we are committed in this course and we are there to support our patients. ■

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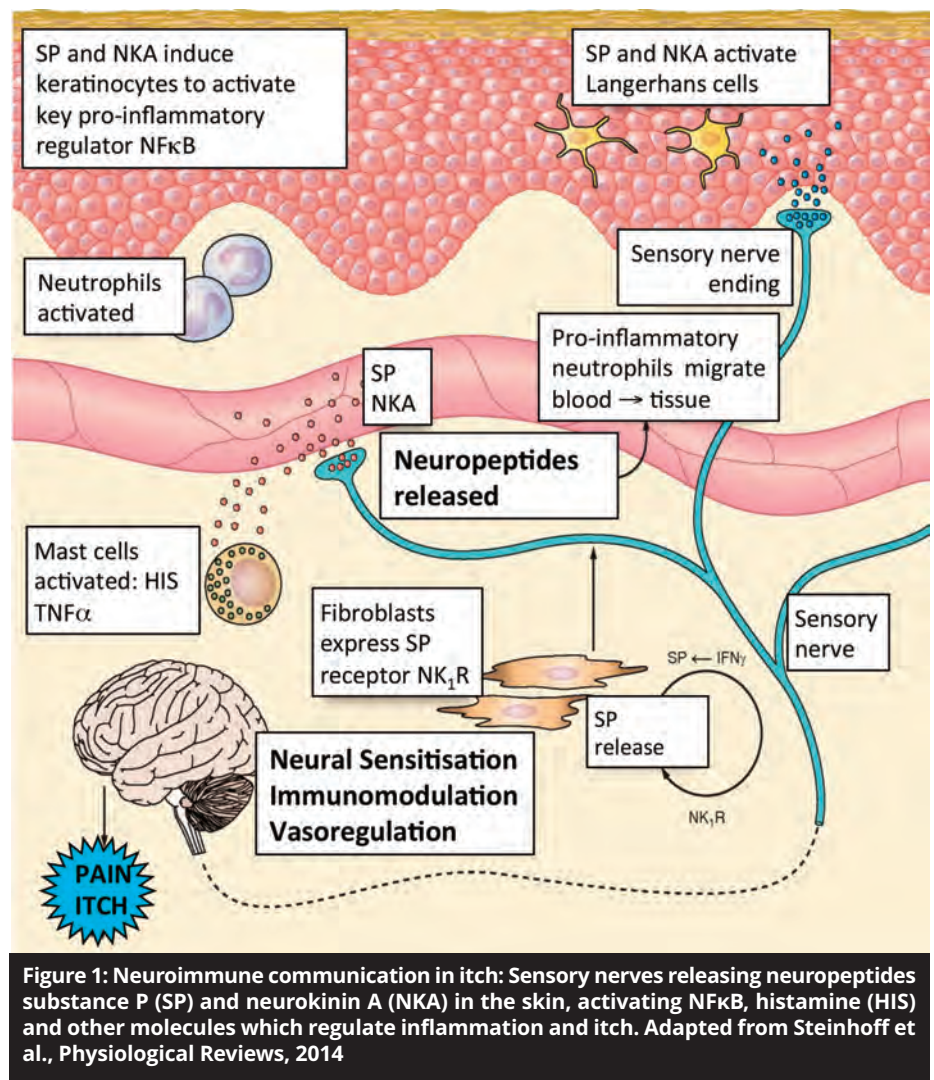
# Systems medicine approaches in dermatology

Although a small field in medicine, dermatological diseases are very frequent and span a wide range of illnesses such as allergies, inflammation (e.g. atopic dermatitis, psoriasis), autoimmune diseases or malignancies (e.g. melanoma). Thus, translational dermatological research is an important, innovative field for future basic and clinical research for many diseases in which treatment is still an unmet medical need.

## Skin conditions under investigation

The major areas of dermatology under investigation at the Charles Institute are atopic dermatitis, rosacea, itch and other inflammatory skin conditions (Director: Professor Martin Steinhoff, Professor Frank Powell), cell signalling (Professor Cormac Taylor), wound healing and epidermolysis bullosa (Dr Wenxin Wang) and melanoma genetics (Dr Simon Furney). These areas are explored using a wide range of innovative techniques: disease models, 3D skin models, proteomics, genomics, metabolomics, cell signalling, immunology, systems biology, and state-of-the-art imaging.

Itch serves as a self-protective system under normal conditions, but chronic itch can have a debilitating impact on quality of life. Chronic itch can be caused by skin conditions such as atopic dermatitis (eczema) and contact dermatitis, or after zoster (shingles), by systemic disorders or certain medications. Terminally ill cancer patients, for example, often experience such severe itch in response to morphine



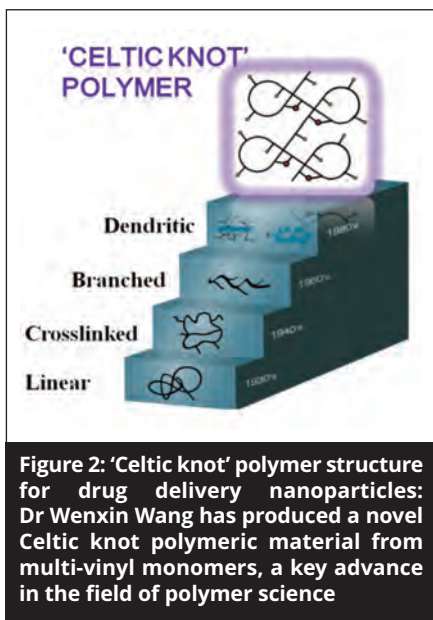
**Figure 1: Neuroimmune communication in itch: Sensory nerves releasing neuropeptides substance P (SP) and neurokinin A (NKA) in the skin, activating NFκB, histamine (HIS) and other molecules which regulate inflammation and itch. Adapted from Steinhoff et al., *Physiological Reviews*, 2014**

that many choose to live in pain rather than take the medication. Steinhoff's laboratory is discovering more about the mechanisms of itch (Fig. 1). A large part of their work focuses on endothelin-1, and they have shown that it is possible to turn the dial up or down on the level of itch by targeting this pathway.

Epidermolysis bullosa is a family of genetic skin diseases characterised by skin fragility, resulting in blisters, chronic wounds, scarring and skin

cancer. In an effort to find a cure to this devastating disease, the Wang team has developed a non-viral, polymer-based vector carrying normal collagen type VII expression to cells in which it is missing. Unlike most genetic therapies, this is designed to be applied directly to the skin.

Wang's laboratory designs and builds polymers with a variety of defined shapes illustrated in Fig. 2 which can be specifically tailored to suit the application. This distinctive combina-



tion of chemical and biological expertise offers promising prospects for application to many areas of bioscience, including drug delivery, immunology and the development of vaccines, biodetection and biosensor, antimicrobials and antiviral agents.

Another target group of patients in Wang's sights is people with diabetes. Over time, diabetes can damage the nerves and circulation of the lower limbs, and if wounds form they can be very hard to heal and in severe cases the person may need an amputation. The Wang group has been looking at the specific needs of diabetic wounds and has developed a tailored biomaterial that could be used in dressings to carry therapeutic agents such as stem cells and growth factors.

Rosacea is a chronic inflammatory skin disorder with symptoms of dry, sensitive facial skin that commonly affects middle-aged people, with a

particularly high incidence among people of Celtic extraction. As an example of modern translational research, Steinhoff's recent findings gave new insights into the pathophysiology of rosacea, which is so far incompletely understood. Using a combination of transcriptomics and immunohistochemistry, his group elucidated for the first time the complex pathways of genes involved in this condition (Journal of Investigative Dermatology 2015). Another approach led by Prof. Frank Powell focuses on deciphering the role of the Demodex mite, a microscopic organism associated with the inflammatory lesions which affect rosacea patients.

**Translational research**

At the UCD Charles Institute of Dermatology, the vision is to establish a centre of excellence for translational dermatology research in Ireland, working with colleagues in dermatology clinics at UCD's affiliated hospitals. The goal is to understand the pathophysiology of skin diseases in a translational fashion. The outstanding infrastructure with patient care clinics, clinical trial units, and a new €20m research centre for over 70 scientists provides a unique opportunity to comprehensively study the pathophysiology of various skin diseases, develop new treatments and perform innovative clinical trials for patients with treatment-resistant skin diseases.

**Funding**

Avon; Bayer; Bristol Myers-Squibb; Chugai; City of Dublin Skin and Cancer Hospital Charity; DEBRA International;

Galderma; German Research Foundation; Leo Foundation; L'Oreal; Maruho; National Institutes of Health (NIH); Pfizer; Salix; Science Foundation Ireland; Tigercat; Toray; Vertex.

**Director biography**

Professor Martin Steinhoff is a clinical dermatologist as well as a basic scientist with 20 years' experience in translational dermatological research. He is a trained dermatologist, allergist and phlebologist with specific interests in neuroimmunology, inflammatory skin diseases and systems medicine. After his appointment as associate professor in Germany (2005-2008), he worked at the University of California, San Francisco, as full professor (2009-2013) with NIH-funded research. Steinhoff began his position as professorial chair of dermatology and director of the UCD Charles Institute of Dermatology in January 2014.



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# ACHIEVING THE IMPOSSIBLE: 310 DAYS PRESSURE ULCER FREE

## The prevailing pressure ulcer crisis

Globally, **pressure ulcers affect 15.3% of patients**, across a variety of care settings<sup>1,2,3,4,5</sup>. 20-25% of beds are occupied each day by patients with pressure ulcers<sup>6</sup> 60-80% of these are hospital acquired<sup>6</sup>. The cost to treat an individual ulcer ranges from £1,064-£1,551<sup>7</sup>. **Pressure ulcers cost the NHS an estimated £1.4bn-£2.1bn** annually (4% of total expenditure)<sup>7</sup>.

Mölnlycke Health Care through research and product development have introduced a solution proven to help reduce the risk and occurrence of avoidable pressure ulcers. Prof. Nick Santamaria's RCT shows a **76% fall in incidence of hospital acquired pressure ulcers when using dressing in prevention**<sup>8</sup>. Our dressing Mepilex® Border Sacrum has been demonstrated to impact four extrinsic factors that can contribute to developing pressure ulcers; these being to redistribute shear, redistribute pressure, reduce friction, and to maintain an optimal microclimate<sup>9,10,11</sup>.



University College London Hospital, Critical Care Unit have demonstrated a significant decrease in pressure ulcer incidence and prevalence.

The unit is a 35 bedded multi-specialty facility which accepts level 2-3 critically ill patients. The unit receives elective and emergency surgical admissions and emergency admissions via the wards and the accident & emergency department. The workforce comprises 200 whole-time equivalent nurses & nursing assistants, and a multi-disciplinary team of approximately 50.

Given the risk factors that most Critical Care Unit (CCU) patients present with, a rapid and immediate assessment of patient risk is required in order to ensure that these potential or actual risks are alleviated as far as possible.

After discussion amongst members of the multidisciplinary team at UCLH, it was agreed that given the need to reduce the number of pressure ulcers on their unit (19.9 acquired PUs per 1,000 in 2011)<sup>12</sup>, and various local and national quality drivers, they would explore a 'whole team' approach to pressure ulcer prevention, including the prophylactic use of dressings on sacrum and heels.

There were a number of outcomes that they wanted to achieve:

- **Eliminate all pressure ulcers on UCLH Critical Care Unit**
- **Embed a culture of candor and harm free care within the Multi-Disciplinary Team**
- **Embrace Quality Improvement methodology**
- **Improve and support teamwork and communication**
- **Improve the patient experience and outcomes**

UCLH set about achieving their outcomes by developing an all encompassing intervention protocol that demonstrated a shift in culture from cure to prevention. The nurses use their clinical judgment on a minute by minute basis to assess the level of risk. They discuss their mistakes, celebrate their successes and have introduced Bay Safety Huddles which encourage staff to question the needs and individual risks to each patient. The final piece to their intervention protocol was the prophylactic use of dressings.

A Mepilex® Border Sacrum Dressing is applied to all level 3 patients, high risk patients or anyone that is of concern. The dressing is peeled back once per shift and the sacrum inspected by two nurses, and the dressing changed as required.

These changes in practice helped pressure ulcer incidence in their critical care unit to decrease from 19.9 per 1,000 patient population to 0.84 per 1,000 patient population in 2014<sup>13</sup>. Incredibly, they went **310 days pressure ulcer free!**



Watch this short video below, to hear from Elaine Thorpe, Critical Care Matron, University College London Hospital



Mölnlycke Health Care is a global provider of healthcare solutions. We have two complementary areas of focus, Wound Care and Surgical Solutions, both which work in parallel to benefit patients and healthcare professionals alike. Mölnlycke Health Care has a history of developing innovative wound care dressings for nearly 70 years. Over that period our aim has been to improve the quality of life for millions of people.

We offer support to the health care sector in a variety of different ways; to name a few we aim to provide our customers with clinical education and resources, most



Figure 1. Mepilex® Border Sacrum

of our solutions come complete with a wide range of evidence, both clinical and value justification and we aim to support in controlling costs and meet financial objectives. We work with NHS Establishments individually and help them meet the challenges that they are facing so that the quality of care that a patient receives remains best in class.

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- <sup>13</sup> University College Hospital London, Pressure Ulcer Incidence, 2014

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## Clinical research in ophthalmology

**Cecília Martinho, Daniel Fernandes and José Cunha-Vaz of the European Network of Clinical Research in Ophthalmology explain the importance of clinical research for eye care...**

**O**phthalmology is, presently, the second market after oncology with more investment in new drugs. Many ophthalmic drugs and solutions are being developed to respond to ophthalmic patient needs.

There is a clear need for clinical research and development of new drugs, solutions and treatments to improve eye care. Investigator-Driven Clinical Trials (IDCTs) are, usually, performed at a national level but not multinational as investigators need to assume responsibilities of the sponsor. EVICR.net coordinates clinical research in ophthalmology at European level and providing all the necessary support for IDCTs.

The EVICR.net – European Vision Institute Clinical Research Network is a network of European ophthalmological clinical research sites dedicated to perform clinical research in ophthalmology with the highest standards of quality, following the European and

international directives for clinical research according to harmonised Standard Operating Procedures (SOPs). Its aim is to strengthen the capacity of the European Union to explore the determinants of ophthalmic diseases and to develop and optimise the use of diagnostic, prevention and treatment strategies in ophthalmology.

At present, EVICR.net has 97 clinical research centres members from 19 European countries. EVICR.net coordinating centre is located at AIBILI in Coimbra, Portugal.

EVICR.net is a platform for clinical research in ophthalmology and a useful Industry resource in the process of developing new drugs and medical devices in ophthalmology. Its main objective is to facilitate multinational IDCTs across the European Union. EVICR.net promotes all aspects of clinical research in ophthalmology following ICH GCP guidelines; coordi-

nates training activities for its members; promotes quality, transparency and optimal use of clinical research data and informs patients and citizens of the challenges and opportunities raised by clinical research community in ophthalmology.

Regarding its organisation, the Steering Committee is responsible for the activities of the EVICR.net and the coordinating centre, AIBILI, is the contact point for the members and industry when performing ophthalmological clinical research in Europe.

The Network has 5 expert committees that have a fundamental role in the scientific evaluation of EVICR.net studies and activities, covering the following main areas of research: age-related macular degeneration and retinal dystrophies; diabetic retinopathy and retinal vascular diseases; glaucoma; anterior segment; and reading centres. The Network has also 2 transversal sections that work together with the expert committees, when applicable: medical devices and rare diseases.

The EVICR.net coordinating centre assumes the coordination and management of IDCTs in ophthalmology across Europe through the Network. EVICR.net members have the opportunity to submit abstracts for IDCTs to the coordinating centre in order to be evaluated by a specific expert committee. If approved they will have access to support for coordination and implementation of the IDCT. EVICR.net members are invited to participate in IDCTs developed by the Network or in industry-sponsored studies.

The number of multinational IDCTs within the EVICR.net has been growing steadily in the last years. In 2014 EVICR.net had 12 ongoing multinational clinical research studies of which 3 are funded by the EU research programmes. These studies are in the following areas: 3 in age-related macular degeneration and retinal dystrophies, 6 in diabetic retinopathy and retinal vascular diseases, 2 in glaucoma and 1 in the anterior segment. Advantages of multinational clinical research coordinated by EVICR.net include: larger sample size and shorter recruitment periods and in full compliance with ICH-GCP guidelines which is guaranteed by the support of the coordinating centre.

EVICR.net has developed a Quality System for its members compliant with ICH-GCP guidelines with 9 Organisational SOPs. All EVICR.net clinical site members agree to adopt or adapt these SOPs in their centres which will be checked before they are certified as sites of excellence. The implementation of this system will give a common standard way of working when performing multinational clinical research. EVICR.net has also developed 31 technical SOPs for performing specific ophthalmic examinations or evaluations that can be used within the network for clinical research. These SOPs are also made available to our members.

In parallel, EVICR.net has developed 22 organisational SOPs for the reading centres so they can work as a network of reading centres in order to be able to have the capacity to respond to the industry needs for grading ophthalmological images in a standardise way with the most novel equipment. EVICR.net with its coordinating centre at AIBILI provides the supporting services needed to develop and implement IDCTs compliant with ICH-GCP guidelines at a multinational level which investigators alone are not able to do on their own. This way EVICR.net contributes to the development and improvement of diagnostic, prevention and treatment strategies for better patient care. ■



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# TEARS: Future begins today

Founded in 2007 by Dr. Tatiana Suárez, PhD, Bioftalmik is a Spanish privately owned biotech company focused on the discovery, validation of specific biomarkers in the ophthalmology field and in their implementation into *in vitro* diagnostic medical devices. Bioftalmik is specifically oriented to the study of the main ocular surfaces diseases affecting the population in a large extend such as Dry Eye and Ocular Allergy, among others. In the last eight years, Bioftalmik has positioned itself, through its high impact scientific publications and patents as an internationally recognised main force in the tear protein biomarker research field.

## What is a biomarker?

According to the FDA (U.S. Drug and Food Administration), a biomarker is defined as an anatomic, physiological, biochemical, or molecular parameter associated with the presence and severity of specific disease states. A biomarker may be detectable and measurable by a variety of methods, including physical examination, laboratory assays, and medical imaging. A good biomarker should fulfil parameters such as: reproducibility, high specificity and sensitivity, and applicability in different populations.

## What is tear film?

The tear is a complex fluid secretion containing proteins, peptides, mucins, lipids, carbohydrates, hormones, neurotransmitters, electrolytes, etc.



that is critical in maintaining the physiological function of the ocular surface. The function of tear fluid includes:

- Smoothing the cornea surface for light to pass undistorted into the eye;
- To wet and protect the delicate eye surface;
- To inhibit the infection by mechanical flushing and the antimicrobial action;
- To provide the cornea with necessary nutrients.

## Why analyse tear film?

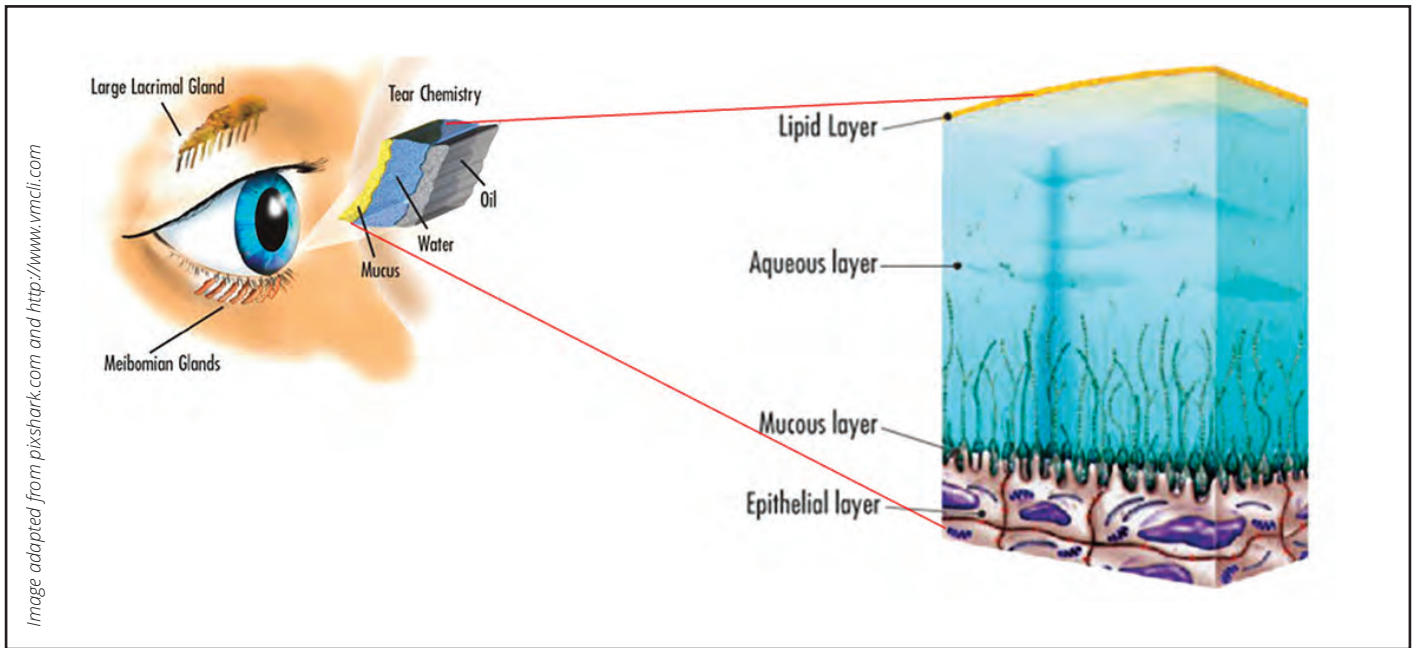
Despite its reduced volume, tear film is an interesting non-invasive sample to analyse, due to its diverse molecule composition and thus, is a

relevant source of biomarkers (ex: up to 1543 proteins have been reported by Zhou L *et al.* 2012), and the easy sample collection through non-invasive approaches makes it suitable for diagnostic and prognostic purposes.

Advantageously, tear film may reflect altered states, not only for specific eye disorders, such as dry eye, ocular allergy, keratoconus, or contact lens incompatibilities between others. But, also for other non-ophthalmological diseases, such as cancer, multiple sclerosis or diabetes.

## Interest of biomarkers in Ocular Surface Diseases management

Ocular Surface Diseases (OSD) are mainly chronic and age related conditions. Considering the ever increasing over 50's European popula-



tion, it has become a major health challenge in recent years. OSDs are estimated to affect approximately 15-30% of the general elderly population; but 30-40% approximately of patients have no proper diagnosis. Thus, there are millions of patients suffering from OSD (according to 2014 Dry Eye Report, 26.8 million people suffer dry eye in Western Europe), with high costs associated with their management. Therefore health systems (public and private) require the incorporation of innovative diagnostic and monitoring tools to help clinicians in making diagnosis, therapeutical and surgical decisions, or even to predict the response or possible adverse effects of pharmaceutical compounds.

**Challenge of translation of biomarkers in clinical practice**

Despite relevant efforts done by many groups around the world, investigating diagnosis based on biomarkers; the translation of the basic and applied research to the real clinical practice (bedside) is not an easy task. Certainly, only few verified biomarkers have reached clinical application status into

medical devices ready to use and point of care (PoC).

In the case of ophthalmology and tears it may become even more complicated due to several reasons such as:

- The small size of a tear sample to analyse (just few microliters, 1-5 µl);
- The Ocular Surface Diseases are mostly complex processes, and thus only one biomarker is not enough to perform a correct diagnosis;
- The Ocular Surface Diseases implicate deregulation of proteins (up or down concentration), instead of switch on-off, therefore quantitative devices able to detect and quantify those variations are needed to provide doctors with useful tools for assisting in making diagnosis, therapeutically and surgical decisions;
- The final diagnostic/monitoring device should be accessible to all doctors and patients. It must be sensitive and specific enough but at a reasonable cost.

Bioftalmik has worked under all those premises, setting up an internal and external multidisciplinary team. The company is involved in the final step of technical validation of a novel point of care (PoC) system, able to measure protein biomarkers in a single microliter of tear sample. Furthermore, under the leadership of its partner Horus Pharma, the Nice based (France) pharmaceutical company leader in innovative preservative free solutions for ocular surface therapies, Bioftalmik has been granted with a promising phase I SME grant and currently is preparing Phase II proposal for the clinical validation of its Tears PoC device.



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# Adapting to an ageing population

Francesca Colombo, Head of the Health Division at the OECD speaks to Editor Laura Evans, and sheds light on an ageing population...

Throughout Europe and even worldwide, the population is living longer. Between the years 1970 and 2013 the world's elderly population life expectancy has expanded by 10 years. In 1970 life expectancy for OECD countries was 70 years, this grew to 80.5 years in 2013.

As people live longer, challenges may arise due to ill health and health systems that struggle to cope with the cost pressure arising from the introduction of new medical technology and the need to adapt health services to the needs of a growing elderly population.

Francesca Colombo, Head of the Health Division at the OECD, tells Editor, Laura Evans more about the ageing population and the challenges it could bring in the future.

"As we are living longer and fertility rates have dropped, so the share of the population that is old is growing –" explains Colombo.

Although an ageing population is often pictured as being a problem, ageing should be seen as a positive. The fact that people are living longer – enjoying healthier lives for many and being able to remain active and productive until later in life is surely a good thing – Colombo agrees.

"An ageing population is an opportunity, something we should never forget; we need to take ageing as something to celebrate," she says.

"In many cases, as they age people live in good health and have opportunities to live a more active life. However, this is not the case for all; we're not always living in good health as we get older.



"People aged over 75 are very likely to have 2 or even 3 chronic conditions and inequalities in life expectancy across different societal groups – for example those with higher or lower education attainments – remain large".

Encouraging healthier lifestyles early in life helps prevent the development of chronic diseases, and other disabilities. Throughout Europe, there are some excellent health services, however, it is vital that they do not become over stretched to help deal with the ageing population.

Colombo explains: "Health systems must adapt to changing patterns of morbidity and disease burden.

"Health systems across the OECD are still too much hospital focused and struggle to innovate approaches to care for an ageing population. The way health systems have developed is more oriented towards the treatment of disease and dealing with acute episodes of care, rather than focussing on preventing ill health, managing chronic care needs and encouraging continuity of care.



“GPs and primary providers should play a more central role, working alongside community health and social care services” she adds.

Besides medical care, countries differ significantly in the way social care for our elderly population is organised. Poorer countries may not have developed a formal, publicly financed care system yet. In many countries, the family still continues to play a key role in taking care of dependent elderly people.

“There are huge difference across countries in government spending on long-term care for the elderly, reflecting differences in fiscal capacity, the traditional role of the family, and models of organising public support for elderly care” Colombo explains. “But even in countries with the most comprehensive formal care systems, the family continues to play a key role. Whether providing help with daily living activities, or support with organising some of the tasks elderly people are unable to do themselves. This means that family carers do need help too, to ensure that they continue to play this role without themselves becoming ill or having to quit their job.

Looking into the future, innovations in healthcare can play a fundamental role helping older people live more independent lives and through the development of new treatments for chronic diseases. Colombo explains however that services have not always been developed having the elderly in mind.

“Despite much talk about the silver economy, the way products and services are delivered in the economy does not always have older people in mind,” she says.

“New technology and innovations might not be accessible to older people. Take for example the internet, which is used for simple tasks such as banking and paying bills. In recent years, ICT and web-based technology have been a critical part of product and service innovation. Of course, future generations may be more accustomed to using digital technologies.

“But today, it is clear that older people use the internet much less than younger cohorts. In some countries like Italy, Mexico and Turkey, fewer than 20% of older people have access to the internet. Information

technologies must be available and user-friendly for all population groups.”

An ageing society also has an impact on the economy. Services are needed to support people living longer and to address their health needs, which means that there is a growing demand for care workers that will look after the over 75s. At the moment, however, care workers usually are paid little, but as the demand for more care services goes up, due to the rising number of an elderly population, could this change? What is the impact of an ageing society on the economy?

“When you think about an ageing society and the economy,” says Colombo. “The simple way to describe this is to consider both the production and the consumption side. In terms of the production, this has to do with how an older society – and older people working in society – contribute to the economic output. The employment rates of older people have increased in the past decade, particularly in the mature western economies. But there are still countries where the number of older people in employment is still low, moreover unemployed people over 55 are more likely to be long-term unemployed than younger people. More can be done therefore to help older workers upgrade their skills and encourage firms to keep them.

“The other side of it is the consumption, which we have already discussed;” she says “Caring jobs are becoming more in demand. There is a need to encourage innovation as a way to improve productivity in caring, but also health services have to adapt to an ageing society – for example, there is a need for greater services that encourage autonomy including facilitating in-home monitoring and remote contact with care providers. There is certainly still a gap between the needs of the elderly and the way care services are organised and produced. Making the needs of old people central to the development of services and products will help.” ■

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# The Challenges of Pharmacogenomics and Personalised Medicine in an Aged Population

Over 60% of the major problems of health in developed countries are represented by cardiovascular disorders (25-30%), cancer (20-25%), and brain disorders (10-15%). Of particular importance for their cost and chronic disability are mental disorders, which affect 1-2% of the population, and neurodegenerative disorders and dementia, with a progressive age-related prevalence (1-2% at 60 yrs, 20-35% over 80 years of age). In the U.S.A., death rates for the leading causes of death are heart disease (200.2 x 100,000), cancer (180.7 x 100,000), and stroke (43.6 x 100,000). Dementia is the fifth leading cause of death in people older than 65 years of age, representing 71,600 deaths/year. Alzheimer's disease affects approximately 5.4 million individuals in the United States and is estimated to affect up to 16 million by 2050. Disability caused by senility and dementia affects 9.2 x 1,000 in the population aged 65-74 years, 33.5 x 1,000 in those within the 75-84 range, and 83.4 x 1,000 in the population over 85 years of age. In countries with low and middle income, dementia makes the largest contribution to disability, with a median population-attributable prevalence fraction of 25.1%, followed by stroke (11.4%), limb impairment (10.5%), arthritis (9.9%), depression (8.3%), eyesight problems (6.8%), and gastrointestinal impairments (6.5%).

Across six European economies (France, Germany, Italy, Spain, Sweden and the UK), total costs from cardiovascular disease are estimated at



€102.1 billion in 2014, with a direct healthcare cost of €81.1 billion and an indirect cost (premature mortality >1 million cases) of €19.6 billion. The cost of cancer in the 27 countries of the EU is over €130 billion (health care cost >€100 per citizen), with >1.3 million deaths. The cost of brain disorders in the EU is over €800 billion (direct health care cost 35-39%; direct non-medical cost 20-25%, indirect cost 38-45%). The economic impact of dementia in Europe was estimated to be €160 billion (€22,000 per demented patient per year), of which 56% were costs of informal care.

The worldwide scientific investment in the leading causes of death is enormous, with 2.5 million references to cancer since 1818 in the international literature; 1.6 million references to cardiovascular disorders since 1927; and 1.01 million to central nervous system disorders since 1893. However, not always there is a positive correlation between the scientific production and the introduction of novel findings

into the clinical practice. In the case of diagnostic procedures or new drugs, there might be an interval of more than 10-15 years from discovery to clinical application, with the consequent increase in productive costs and in the final cost of the products.

Specifically, brain disorders, in general, and age-related neurodegenerative disorders, in particular, pose several challenges to our society and the scientific community: (i) they represent an epidemiological problem, and a socio-economic, psychological and family burden; (ii) most of them have an obscure/complex pathogenesis; (iii) their diagnosis is not easy and lacks specific biomarkers; and (iv) their treatment is difficult and inefficient. In terms of economic burden, approximately 10-20% of direct costs are associated with pharmacological treatment, with a gradual increase in parallel with the severity of the disease.

Most of these complex disorders are highly heritable (>50%). They result

from the interaction of polygenic defects distributed across the human genome with diverse environmental factors and epigenetic phenomena. For the past 3 decades, with the advent of revolutionary concepts derived from data obtained from the novel disciplines of genomics, transcriptomics, proteomics and metabolomics, new insights into the pathogenesis of different medical conditions have helped us to lay down the groundwork for future genomic medicine. The scientific community begins to accept that the findings related to the human genome might help us understand who we are, where we come from and where we go. In healthcare terms, genomic medicine is helping us to better understand the pathogenic mechanisms responsible for the emergence of diseases and their causes (etiology) (less than 10% of the causes of human disease are currently known); it serves to find new biomarkers that allow us to establish an early diagnosis or even identify the risk of a particular disease many years before its clinical onset. Probably, the most important impact of genomic medicine on the clinical practice at the present time is the possibility of customise treatment based on the pharmacogenetic profile of each patient, so that the physician can prescribe the right drug to the individual patient in the precise dose minimising side effects. Genomic medicine may also serve to distinguish endogenous and exogenous factors that can positively or negatively affect our health; and it also serves to identify epigenetic changes that influence health and/or disease and that may modify our response to drugs or other modalities of therapeutic intervention.

The drug treatment of complex disorders has made remarkable strides, but improvement in terms of clinical

outcome, however, has fallen short of expectations, with up to one third of the patients continuing to experience clinical relapse or unacceptable medication-related side-effects in spite of efforts to identify optimal treatment regimes with one or more drugs. Potential reasons to explain this historical setback might be that: (i) the molecular pathology of most complex disorders is still poorly understood; (ii) drug targets are inappropriate, not fitting into the real etiology of the disease; (iii) most treatments are symptomatic, but not anti-pathogenic; (iv) the genetic component of most complex disorders is poorly defined; and (v) the understanding of genome-drug interactions is very limited.

The optimisation of therapeutics requires the establishment of new postulates regarding (i) the costs of medicines, (ii) the assessment of protocols for multifactorial treatment in chronic disorders, (iii) the implementation of novel therapeutics addressing causative factors, and (iv) the setting-up of pharmacogenomic strategies for drug development. Personalised therapeutics based on individual genomic profiles implies the characterisation of 5 types of gene clusters: (i) genes associated with disease pathogenesis; (ii) genes associated with the mechanism of action of drugs; (iii) genes associated with drug metabolism (phase I and II reactions); (iv) genes associated with drug transporters; and (v) pleiotropic genes involved in multifaceted cascades and metabolic reactions.

With regard to the future of pharmacogenomics as a practical discipline to efficiently optimise therapeutics, several issues should be addressed: (i) the education of physicians in medical genomics and pharmacogenomics is

fundamental (less than 2% of the members of the medical community are familiar with genomic science); (ii) genomic screening of gene clusters involved in pharmacogenomic outcomes must become a clinical routine (without genetic testing there is no pharmacogenetics); (iii) each patient must be a carrier of a pharmacogenetic card indicating what kind of drugs he/she can take and which medications he/she should avoid; (iv) Regulatory Agencies should request pharmacogenetic data from the pharmaceutical industry when applying for drug approval; (v) pharmacogenetic data must be incorporated into the patient information leaflet and the pharmaceutical vade mecum; and (vi) new guidelines for daily praxis, such as that of the first World Guide for Drug Use and Pharmacogenomics, will facilitate the understanding of the relationship between drugs and genes (and vice versa) to make drug prescription a real personalised procedure.



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# Striving towards a better understanding of delirium management

**D**elirium is an acute disorder affecting the brain. Little is known about the actual biologic processes that lead to delirium although multiple hypotheses have been proposed. Delirium is a ubiquitous disorder seen in all patient populations, and can accompany other illnesses or stressful situations. Prevalence rates range from 10% to greater than 70% in some settings (such as the intensive care setting or pre-terminal conditions). It is common in surgical and medical settings (10%-60% prevalence rates), in the nursing home population and emergency room settings. It therefore affects the management of diverse conditions and populations. Older individuals and those with underlying dementia are at increased risk for developing delirium.

The concept of delirium, or acute brain dysfunction in response to being ill, has been recognised since the time of Hippocrates (“acute confusional state” or “encephalopathy” referring to similar entities). Core features of delirium include altered awareness of the environment (or an inability to attend to the environment) and a global cognitive disorder, which develop over a short period of time. Classically, it was believed that delirium would reverse with treatment of the associated illness or stressor. However, with current medical and surgical practices, and the increased longevity of individuals (often with significant co-morbidity), delirium appears to have a different course. Whereas the acute illness may have been treated adequately, delirium symptoms may



still persist. Recent studies suggest persistent delirium symptoms are common (reported in 30-70% of delirious individuals), and are associated with worse health outcomes.

When delirium accompanies an illness it portends a worse outcome compared to someone who is ill with the same illness, without accompanying delirium. People who develop delirium have an increased chance of dying (mortality rates reported between 14-37% after one year), going to a nursing home or having worse functional recovery. This is independent of other concurrent illnesses or co-morbidities that co-exist. Delirium also prolongs length of hospital stay and is associated with significant cost (conservative American cost estimates exceeding 140 billion US dollars annually in 2005).

Given that delirium is very common, can be associated with any illness(es)

and is associated with increasing morbidity and cost, understanding why delirium occurs and how to manage it are important health priorities. Much remains unknown about delirium. There have been promising results from delirium prevention studies. Delirium may be preventable in about one third of cases using non-pharmacologic delirium prevention strategies. These include careful attention to hydration status, mobilising hospitalised individuals, adequate provision of sensory aids (such as glasses), avoiding certain drugs if possible, re-engaging the brain while hospitalised, and limiting restraint or catheter use when possible. Drug therapy for delirium prevention is also an area of research, with some studies suggesting targeted sedation, or the use of novel anesthetic agents may help in some circumstances. More research however is needed to establish approaches to prevent delirium and its sequelae.

There are fewer studies to guide clinicians on the appropriate management of the actively delirious patient, and approaches to management remain largely empiric. While delirium may resolve in some circumstances, with treatment of the underlying acute illness or stressor, in other cases delirium symptoms can persist leading to poor health outcomes. Understanding why delirium sometimes persists and is associated with poor outcomes is crucial in trying to prevent the debilitating consequences of delirium.

A recent study has attempted to understand some of the factors associated with poor recovery after an episode of delirium. In this study, seniors at least 70 years of age or older, admitted to general medical in-patient wards were actively screened for delirium. To be included in the study, patients had to be admitted for an acute medical issue and could not be pre-terminal or admitted to the ICU or surgical units. Investigators looked at predictors of persistent delirium symptoms to derive and test a model that would predict poor recovery after delirium. Poor recovery was defined as any one of death, long-term care institutionalisation or decreased ability to do activities of daily living (such as dressing, grooming or bathing) compared to the pre-delirious state, 3 months after an episode of delirium (or at hospital discharge).

Poor recovery was seen in 69% of delirious individuals. Approximately 50% of delirious individuals who were discharged home after their hospital-

isation were found to have poor recovery when contacted 3 months later. Baseline factors associated with poor recovery included older age, poor baseline ability to do activities of daily living, increasing severity of delirium symptoms at presentation, and certain medical situations (low oxygen levels and poor kidney function). However even individuals without these predictors had a high (50%) risk of poor recovery. These results highlight the often irreversible and devastating effects of delirium on ultimate health status.

**“Given that delirium is very common, can be associated with any illness(es) and is associated with increasing morbidity and cost, understanding why delirium occurs and how to manage it are important health priorities.”**

Caring for the delirious population in hospital was complicated by refusal of care or treatment in greater than 50% of the population. Care was also complicated by restraint use, sitter or security service use in 9%-31% of delirious individuals. These findings highlight the practical difficulties in managing delirious individuals. Events occurring during the hospitalisation that were associated with worse recovery included the occurrence of a fall, pressure ulcers, poor oral intake and swallowing difficulties. Individuals with poor recovery also had additional diagnoses made in hospital (compared to delirious individuals who had better recovery). Poor recovery was also

associated with repeat admissions or visits to hospital and falls after discharge. Repeat visits to the emergency department were common occurring in approximately 40% of individuals discharged back to the community.

These findings would suggest that delirium is a complex disorder, which can be difficult to manage; multiple factors may impact recovery. Delirious individuals are at high risk for re-hospitalisations. Further studies should assess interventions to improve recovery after delirium. Interventions may include paying special attention to hydration and oxygen levels, as well as nutrition and mobility. Close follow-up after discharge may also enable improved management of at risk delirious individuals. More research is required to improve outcomes after delirium.



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# The impact of ageing globally

Adjacent Government highlights the impact of an ageing population as detailed by the World Health Organization (WHO)...

According to the World Health Organization (WHO), between now and 2050, the number of people over the age of 60 throughout the world is expected to rise, from 11% in 2000 to 22%. The proportion of over 60s will increase from 605 million to 2 billion over the same period. Due to this rise in numbers, the ageing population is quite a concern, as it can have a detrimental impact on our health systems.<sup>1</sup>

The risk of chronic diseases rises over the age of 75, with an estimated 25-30% of people aged 85 or older having some degree of cognitive decline, such as dementia. A rise in the number of people that can no longer look after themselves will have a major impact on social care services and the economy. In November 2014, Dr John Beard, Director of the Departments of Ageing and Life Course at WHO warned that, "Deep and fundamental reforms of health and social care systems will be required."<sup>2</sup>

Worldwide life expectancy will continue to rise, and by 2020 for the first time in history, the number of people aged over 60 will outnumber children aged under 5. Eighty per cent of these older people will be living in low-income and middle-income countries, WHO predicts. The long-term challenges of illness and reduced wellbeing will not only affect the patient, but also their family, health systems and the economy. With forecasts predicted to accelerate, latest estimates indicate that the number of people with dementia is anticipated to rise further, from 44 million in 2014 to 135 million in 2050.

Dr Ties Boerma, Director of the Department of Health Statistics and Informatics at WHO said, "We must be careful that these reforms do not reinforce the inequalities that drive much of the poor health and functional limitation we see in older age.

"While some interventions will be universally applicable, it will be important that countries monitor the health and functioning of their ageing populations to understand health trends and design programmes that meet the specific needs identified."

**"The risk of chronic diseases rises over the age of 75, with an estimated 25-30% of people aged 85 or older having some degree of cognitive decline, such as dementia."**

Dr Boerma added: "Cross-national surveys such as the WHO study on Global Ageing and Adult Health (SAGE), the Gallup World Poll, and other longitudinal cohorts' studies of ageing in Brazil, China, India and South Korea, are beginning to redress the balance and provide the evidence for policy, but much more remains to be done."

WHO believes that strategies are needed to help prevent and better manage chronic conditions that blight ageing populations. "Collectively, we need to look beyond the costs commonly associated with ageing to think about the benefits that an older, healthier, happier and more productive older population can bring to society as a whole," added Dr Chatterji, also from the Department of Health Statistics and Information Systems at WHO. ■

1 <http://www.who.int/ageing/about/facts/en/>

2 <http://www.who.int/mediacentre/news/releases/2014/lancet-ageing-series/en/>

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## Managing an ageing population

**Professor Carol Jagger from the Institute of Health and Society at Newcastle University speaks to Editor Laura Evans about why the population is living longer...**

In the UK there are around 11.4 million people aged 65 or over. Over a third of the total population in the UK is 50 years plus – 23.2 million, and 14.9 million aged 60 and over. This means there are now more people in the UK aged 60 and over than there are under 18. By 2030, the number of people aged 60 or over is expected to pass the 20 million mark. The proportion of people aged 65 plus will rise from 17.7% to 23.5% in 2034. <sup>1</sup>

With the population living longer and elderly people outnumbering young people, the question is why? How can health systems in the UK manage such a large ageing population? Professor Carol Jagger from the Institute of Health and Society at Newcastle University explains why to Editor Laura Evans...

### **What are the main challenges of an ageing population?**

The main challenges will be in containing the spend on health and social care and pensions in the face of the rising numbers of older people. The key is to try to ensure that older people stay healthier for longer because if they do, they will make less demands on the NHS and social services and will be productive, in terms of both paid and voluntary work.

### **Do we have sufficient plans in place at the moment for the ageing population of the future?**

In 2010 a Lords report 'Ready for Ageing' concluded that we were not at all ready. This is now being followed up by the Foresight 'Future of an ageing population' project, which is compiling the evidence of the best ways to

improve the health and quality of life of older people. Hopefully this will provide older people with the information they need because at present I feel they have little information to be able to plan. This country also has huge inequalities in health and it is obvious that health messages are not getting through. We have to find out why people are not or cannot take up healthy behaviours, because changing their behaviour is the only way we will reduce those inequalities.

### **Are healthcare systems we have in place at the moment enough to support an ageing population – now and in the future?**

Ideally if we keep people healthier longer, they won't need to spend as much time in residential care or in hospitals. The biggest problem is that the very old – those over 85 – are the fastest growing section of the population, and as we get into very old age we tend to have multiple diseases. The problem is the NHS isn't set up to handle that.

One of the most feared diseases is dementia and because its prevalence increases strongly with age, we are seeing many more people with the condition. Inevitably this also means that there are older people admitted to hospital who have dementia as well as other conditions. We haven't really seen those patients in the past and, of course, they require much more care. It's about training of the NHS workforce to be able to deal appropriately with people with dementia and making hospitals more dementia friendly. This is starting to happen but it is a huge task.

### **Is there enough research and innovation being done to prepare more and offer support for the coming ageing population?**

There is a lot of research and innovation being done, however, I'm not sure that it's being translated into action. By that I mean that there are many local community initiatives, but there doesn't appear to be a mechanism by which successful ones can be diffused out to wider areas.

This has become most obvious in a European project that I am involved with called Innovage. One of the tasks within Innovage is to create a database of successful social innovations that have the capacity to increase healthy life expectancy and that could be

scaled up wider than their own area. So far we have identified over 60 but the vast majority are in small regions within a country and certainly haven't crossed national boundaries. A further issue is that because of the way they have been developed, formal evaluation was often not part of the process, so we don't have any robust measure of effectiveness. Once a system is in place then it becomes much more difficult to evaluate properly. I can see that this is also an issue within the UK with devolution of power down to local authorities. Though they know their own populations, unless there is a mechanism for them to learn from each other about good practice and what works, there will be a lot of unnecessary duplication of effort.

### **Is the onus then on the local authority to ensure that area and community has the right support available?**

Yes, but there needs to be some co-ordination at a higher level also. For instance one of the social innovations we have identified in Innovage was preventive home visits for older adults, which reduced functional decline. This was initially piloted and evaluated in one region in Denmark but is now being delivered on a national level.

The government here tried this in the 1990s by compelling GPs through their contract to visit and assess their over 75s annually. However, this was instigated on the basis of little evidence and it was very difficult to properly evaluate after. In addition GPs were never told how to do it – whether this should be a home visit – or what they should assess and with which tools. If this had been rolled out properly we would now have immensely valuable data on, amongst other things, physical and mental functioning of this age group over time in order to be able to project service need – data that we don't have in routine GP databases.

### **What kind of impact will an ageing population have on the economy and do you think there is enough funding available?**

Older people provide a huge amount to the economy. Many continue to work either paid or in a voluntary capacity, including caring for grandchildren, so that younger family members can work, or providing informal care for elderly parents. With the growth in





the population aged 85 and over, the latter might be particularly problematic as their carers are around the age of 60 and are the people expected to work longer. This means employers are going to have to start thinking about more flexible working patterns. The Newcastle University Institute for Ageing has recently addressed this by issuing a paper identifying the current challenges that might inhibit older people from working longer and recommending solutions to address the issues.<sup>2</sup>

**“There is a lot of research and innovation being done, however, I’m not sure that it’s being translated into action. By that I mean that there are many local community initiatives, but there doesn’t appear to be a mechanism by which successful ones can be diffused out to wider areas.”**

Presently the funding crisis is because we are not spending the money at the right point and intervening early enough. Ideally we need to provide lower level help and advice when older people are beginning to

have a problem, with say mobility, rather than waiting until they can no longer get around. This would keep people at home longer and reduce the costs of residential care. I personally don’t see the ageing population as a big problem but as a huge encouragement that we have managed to extend life expectancy as much as we have. Now we have to ensure that the majority of those years are healthy ones by educating people and providing the right information at the right time so that they keep as healthy and active as possible and for as long as possible. ■

1 [http://www.ageuk.org.uk/Documents/EN-GB/Factsheets/Later\\_Life\\_UK\\_factsheet.pdf?dtrk=true](http://www.ageuk.org.uk/Documents/EN-GB/Factsheets/Later_Life_UK_factsheet.pdf?dtrk=true)

2 <http://www.ncl.ac.uk/ageing/about/news/ageingworkforce.htm>

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# Main strategies in active and healthy ageing in Europe

The importance of identifying the users groups and their profiling

**A**ctive and Healthy Ageing (AHA) is a main direction in the HORIZON2020. One of the basic tasks is to face the challenge of turning existing research efforts to reality for healthy and chronic diseased elderly people across Europe. Existing flexible ICT solutions could assist elderly users in organising, carrying out and completing daily tasks and functions having been part of their life for years and provide essential stability and adjustment factors for continuing to be and feel independent. Thus, within AHA we will need to develop all-around, personalised, multi-faceted existing ICT solutions and services addressing diverse daily activities (shopping, eating, physical activity, commuting, mental stimulation, communication, social interaction, etc.) to elderly users taking largely into account cognitive impairments and their carers living in their own home or in care centres.

## Current practices

As aforementioned, ICT solutions are existing applications and services which will be improved and most solutions are considered to be at technology readiness level 7 and above. Several solutions are already commercial or open source products and available for use and others were developed within the framework of European projects and are prototypes.

It is expected that we start from a relative mature level 5 (levels: 1-9) for the

majority of tools and we anticipate to reach a TRL of 7 more for around 75% of tools within the next 7 years.

It is clear that the needs and requirements for the addressed user groups at an early stage of developing chronic diseases or changing states in their organism functioning are essential and are a cornerstone within an extended and flexible evaluation framework.

For example in the case of cognitive impairment, the main user groups are:

### 1. Mild Cognitive Impairment (MCI)

people are usually elderly who have lost cognitive functioning on at least one aspect, with no sign of dementia, and who still function in daily activities. People with MCI are estimated to account for 20% of the elderly over 65. ICT solutions as interventions might have more potential for people with mild cognitive impairment, as these are still in the early stages of forgetting and are still active, eager, and can learn new functionalities.

**2. Early stages of Dementia**, people have been diagnosed with dementia but they are still maintaining some aspects of their daily functions (early signs of dementia are apparent) and users have been diagnosed by specialists (i.e. neurologist, neuropsychologist) and might be under medication. The improvement in daily functioning is usually rather limited compared to

the deteriorating effects of the disease. Since early and moderate dementia users can still carry out certain activities with assistance.

### 3. Cognitive impairment as a co-morbid condition

users with other conditions and diseases with cognitive impairment as a co-condition is a common situation among the elderly. Increased medical co-morbidity is evident in elderly. High rates of medical co-morbidity are evident in elderly living at large urban areas due to low socio-economic status (SES) and poorer access to health services.

**4. Caregivers**, either formal (i.e. healthcare, social, etc.), or informal (i.e. family members and friends) that need to be empowered with knowledge and tools to support the elderly in their everyday life activities. Informal caregivers often struggle combining work and caring for their relatives, resulting in strains on their own health and coping mechanisms.

In addition, there are many **stakeholders** with an interest in, but not a direct involvement in day-to-day care provision. Some main stakeholders, are described briefly below:

**Regulatory authorities on local, national or international level**, regulating a wide range of aspects from device safety and essential performance, via legal, ethical and privacy related issues. This group

includes an Ethics Control Board with external expertise and representatives from all the pilot sites for ensuring applicable regulations are respected.

**User interest organisations** work to serve the interest of their members. This group involves care centres and organisations for elderly people and dementia centres with experience in working with and for users with cognitive decline.

**Standardisation bodies** are organisations that define how AAL care systems should work in a consistent manner (i.e. members of Continua Alliance). Furthermore, another important standardisation body is INFOTERM, aiming to promote and support standardisation actions in the AHA area.

**Public bodies, insurance companies and care organisations** are important as they define care standards offered and the reimbursement levels provided. We need to interface these stakeholders primarily via on-site care centers, outpatient clinics, hospitals, organisations, dementia research centers and their networks.

It is in the domain of consumers' study that the move away from the 'medicalisation' has been more radical with the introduction of the concept of **resilience** in opposition to that of frailty. The concept of resilience can be defined and measured along two dimensions: a) capacity to function in terms activities of daily life or of disability-free status; and b) Socio-Economic Status (SES), where we include not only more tangible dimensions (income, education attainment) but also social support and networks.

Using these two dimensions we can determine the taxonomy. We identify four archetypes (so in qualitative and ideographic fashion) that have different needs, should be the target of different interventions, and possibly of more granular monitoring indicators. For the sake of simplicity we describe the four segments considering the extreme (low/high) and neglecting the nuanced and intermediate situations.

**Dependent.** These are individuals with low SES and with poor health severely hampering the capacity to function. They may also suffer from isolation and lack of social support, which means little or no access even to informal care. They need public support for immediate care.

**Assisted.** These are individuals with good SES yet suffering from health related limitations. Since they can afford it, they are likely to seek quality of life improvements and can afford to buy care and other support, or can rely on social support and networks. They can potentially demand and pay for assisted living and other aides to independent life. They may be the target of some of the services that can be brought to market and can afford to pay for them.

**At risk.** These are individuals with low SES but holding onto normal life due to their good health status enabling resilience at least in one dimension. They are at risk in the sense that lack of SES resources may bring them easily in the condition of the dependent elderly, when and if, a health problem emerges and limits their functioning capacities. They may be the target of pre-empting public policies such as for instance health

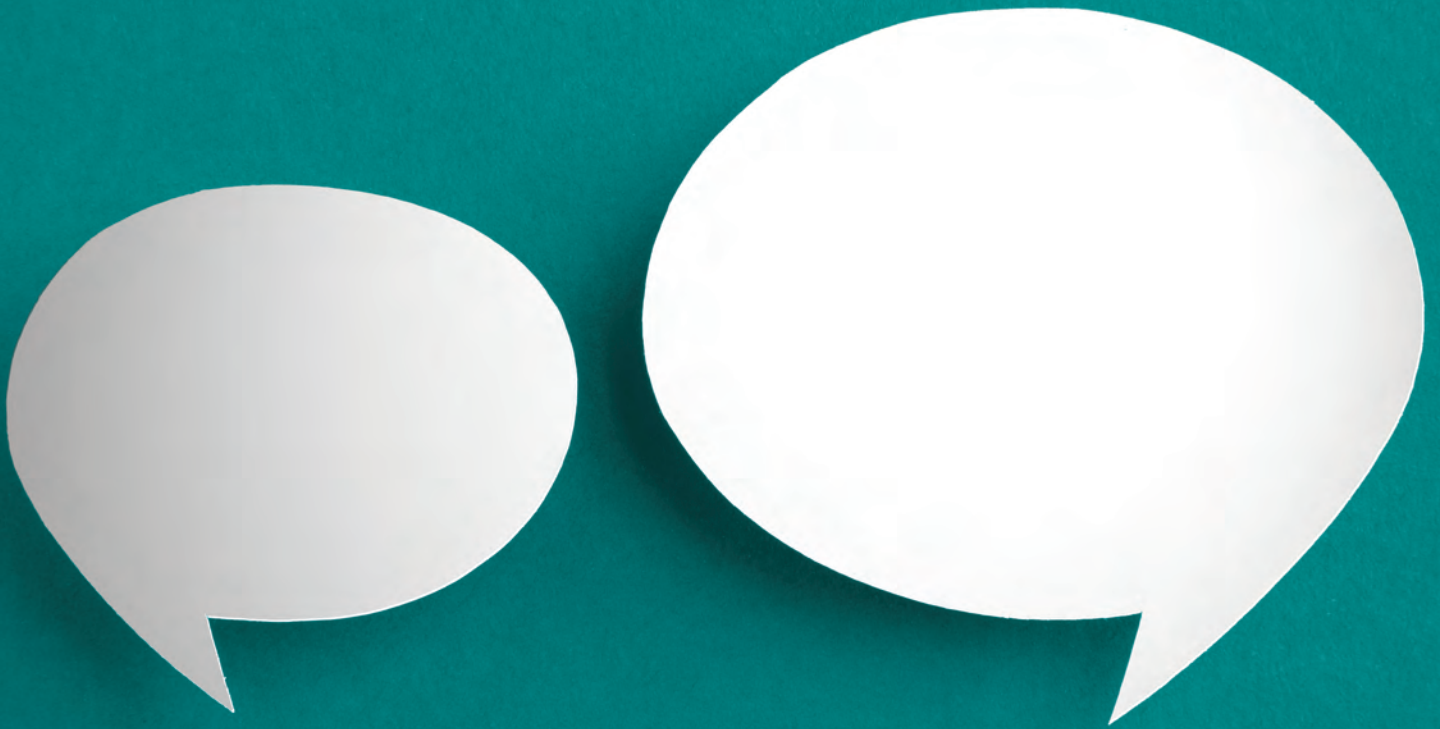
awareness and prevention services or skills building measures

**Active elderly.** These are individuals with high resilience they are ageing well and actively and we could also call them the 'discerning old'. They are likely to seek quality of experience and demand for luxury goods and leisure such as smart homes.

Based on the above baseline for user profiling, the main innovation that is needed is to estimate the real life depiction of a large-scale effort to estimate the potentially positive effect of ICT solution on AHA such as in cognitive decline and multi-morbid elderly for statistically adequate number of users which reflect the diversity of real users with actual cognitive impairments for a long period of time. Ensuring the inclusion of significant indicators for assuring successful assessment and investigation of the Quality of Life indicators ensures the extrapolation of findings and the viable transfer of knowledge to business modelling and health service provision with measurable and generalisable indicators as ROI and SROI have been accepted to be.



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## The future of science

**Adjacent Government highlights comments from European Commissioner for Research, Science and Innovation Carlos Moedas, given in a speech looking at the future challenges of science in Europe...**

Science and research is an integral part of society throughout Europe. Through research, key future challenges can be delayed and even possibly prevented. In all areas of society, whether it be healthcare, the environment or even agriculture, research and new innovations play a key role in developing our knowledge further in order to prepare for what lies ahead.

Horizon 2020 is the EU research funding programme that aims to help deliver essential research and innovation. The programme is the biggest of its kind, with €800m available between the years 2014 and 2020.

Speaking in June, in Brussels, The European Commissioner for Research, Science and Innovation, Carlos Moedas explained how he would like to chart a new path for European research and innovation policy that would fit into an open and digital world.

"I'd like to take a moment to look back at how far we've come," he said. "When we started this journey

15 years ago, the European Research Area (ERA) was conceived as a physical space. We therefore focused on the physical cooperation and mobility of researchers in different countries, and the flow of knowledge across national borders.

"If we stand back from the detailed policy discussions and look at the bigger picture, we will see just how much progress has been made. Cross-border research cooperation has become a wonderful, every-day reality.

"Around 1 in 3 researchers have been internationally mobile over the last 10 years," he added. "Today, we have a single integrated European programme for research and innovation."

Looking ahead, Moedas detailed the challenges to come, and how Europe can move forward into the next chapter for bringing together research and innovation.

He said: "I see fantastic strengths in Europe. We are open, we have diversity, and we host great institutions.

With Horizon 2020, we are funding research on an unprecedented scale. But we must be honest about the challenges we face.”

The Commissioner detailed the 3 major challenges:

- Europe rarely succeeds in getting research results to market. Technologies developed in Europe are most of the time commercialised elsewhere;
- Although Europe generates more scientific output than any other region in the world, in some areas we fall behind on the very best science. At the same time, there is a revolution happening in the way science works. Every part of the scientific method is becoming an open, collaborative and participative process;
- Europe punches below its weight in international and science diplomacy. Our collective scientific importance should be matched by a more active voice in global debates.

In order to overcome these challenges, Commissioner Moedas outlined strategic priorities: Open Innovation; Open Science and Openness to the World.

“Open innovation is about involving far more actors in the innovation process, from researchers, to entrepreneurs, to users, to governments and civil society,” he explains.

“We need open innovation to capitalise on the results of European research and innovation. This means creating the right ecosystems, increasing investment, and bringing more companies and regional into the knowledge economy. I would like to go further and faster towards open innovation.”

Moedas believes that Horizon 2020 has undoubtedly made a huge step in supporting innovation. However, he would like to see Europe have a world class scheme to support the best innovations, in the way that the European Research Council is the global reference for supporting excellent science.

“I am convinced that excellent science is the foundation of future prosperity, and the openness is the key to excellence,” he says.

“We are often told that it takes many decades for scientific breakthroughs to find commercial application. We must not be complacent. If we look at indicators of the most excellent science, we find that Europe is not top of the rankings in certain areas.

“Our ultimate goal should always be to promote excellence not only through ERC and Marie Skłodowska-Curie, but throughout the entire H2020.”

In order to push Europe further to achieve scientific excellence, Moedas suggests a new European Research Integrity Initiative. This would have clear standards and mechanisms to tackle scientific misconduct. He believes that by putting this in place the much needed boost to scientific excellence will be achieved, and it will also show the public that European science is above reproach.

“Europe is a global leader in science, and this should translate into a leading voice in global debates,” Moedas concluded. “To remain relevant and competitive, we need to engage more in science diplomacy and global scientific collaboration. It is not sufficient to only support collaborative projects; we need to enable partnerships between regions and countries.

“Challenges in areas like energy, health, food and water are global challenges. And Europe should be leading the way in developing global research partnerships to address these.” ■

The full speech given by Commissioner Moedas can be read here – [http://europa.eu/rapid/press-release\\_SPEECH-15-5243\\_en.htm](http://europa.eu/rapid/press-release_SPEECH-15-5243_en.htm) .

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# What do we still need to know about GMOs?

## What are the proven risks and benefits?

In many cases there are no clear answers. The risks and potential benefits of genetically modified organisms (GMOs) are viewed differently from one European country to another. Do GM crops support sustainable agriculture or could they harm biodiversity? Will GM crops help feed the world? What are their economic impacts and do they pose health risks? It seems that European societies have not found clear answers to such questions, so GMOs are still a highly controversial subject. As a result, the EU Member States follow different approaches. For example, some allow the cultivation of GM crops, while others have enacted national cultivation bans.

This situation is linked in part to gaps in our knowledge, which can hamper a wider acceptance of evaluations of the risks and benefits of existing GM products. Opinion making on GMOs is aggravated by the fact that each GM product has its own characteristics and has to be assessed individually. However, views regarding risks and benefits of GMOs also depend on the value systems, expectations and concerns of citizens and stakeholders. These are issues that research projects have probably not addressed in sufficient detail in the past.

Up to 200 new GMOs will reach the global market in the next ten years

and most of them will enter the EU approval process. This is another challenge facing Europe in its search for a responsible approach to GMOs.

It is a situation that demands a timely conception of aligned research programmes within Europe to support a purposeful and adequate risk and benefit analysis of the use of GMOs.

## Developing a European agenda for GMO impact research

The EU research project PreSto GMO ERA-Net (September 2013-August 2015) laid the groundwork for transnational research by EU Member States on the health, environmental and economic impacts of GMOs.

As well as mapping previous research efforts in the area of GMO risk and benefit assessment, PreSto GMO ERA-Net also identified ongoing research and future research needs linked to anticipated new GM products.

These results have been used to highlight knowledge gaps in GMO impact research. The results were recently aligned with stakeholder views in the course of multi-step stakeholder surveys. This led to the identification of future research needs, both from the researchers' and from a broader societal perspective. Identified research priorities are often still related to health and environmental risks, but a need to assess the benefits associated with

GMO applications has also emerged because there is insufficient data in this area.

The results were used to develop advice for implementing joint research activities by EU Member States within the framework of the EU-funded programme Horizon 2020. The outcome of these joint research activities is expected to improve the basis for informed decision-making on questions relating to the risk-benefit assessment of GMOs.

Detailed project results will be available from September 2015 at: [www.presto-gmo-era-net.eu](http://www.presto-gmo-era-net.eu)



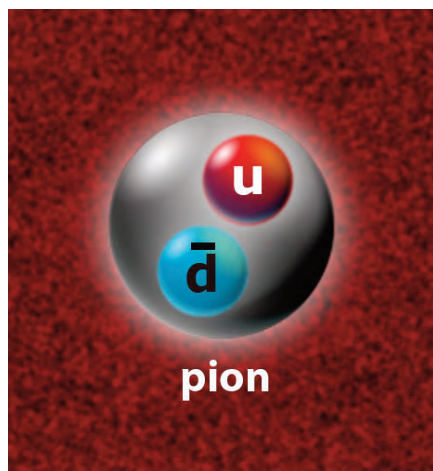
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# New Impact of Pion Research

The bulk of visible matter is made from the fundamental building blocks, quarks and antiquarks, which are bound by gluons. We know six different species of quarks but only the two lightest ones are contained in ordinary matter. The interaction of these building blocks is described by a well-tested theory of the strong interaction, called Quantum Chromo Dynamics (QCD). The understanding of the underlying principle, of how these building blocks form detectable matter and which configurations are and which ones are not realised in nature, has long been a major challenge for both theory and experiment. Only two types of configurations are well established; protons and neutrons (called baryons) contain three quarks, while mesons are made from quark-antiquark pairs. The understanding of the systematics of the configurations actually realised is directly related to the excitation of matter particles, particularly for mesons. The lightest such meson is called the pion and has been under study for more than 60 years. It thereby is used as both subject of study itself and tool for investigating other composite systems. Since it is also regarded as key particle to explain the binding of nucleons in nuclei, their interaction with nucleons is of key interest and much research has been devoted to this in the past decades with dedicated particle accelerators operated around the world. With the advance of theory the focus of interest has shifted in the last 20 years towards understanding the



internal properties of pions probed with electromagnetic fields, quantitative understanding of the interaction among pions themselves and still, revealing the principles governing bound states made of quarks and antiquarks.

Obtaining precise answers and possibly detecting new types of matter particle requires very extensive experimental efforts. Several large size experimental facilities have been dedicated to these questions with new ones joining up soon. The COMPASS experiment at the accelerator Super Proton Synchrotron (SPS) at CERN has been in operation for more than a decade, addressing the key questions related to the understanding of the strong interaction. COMPASS is much superior to all its predecessors by at least a factor of 10 in many aspects, and is occasionally partnered by complementary activities in Russia (High Energy Physics Institute/Protvino). It will be joined by several new installations currently being brought into operation in the USA (Thomas Jefferson

National Accelerator Facility), which allow for studying some of the scientific issues using alternate approaches.

In principle, mesons could be regarded as the equivalent of hydrogen atoms, but the nature of the interaction causes an excitation to require energy equivalent to the mass of the ground state (or even much more), while for hydrogen atoms the corresponding energy is only about 10 billionth of its mass. Thus, most of the mass of a meson corresponds to the energy stored by the gluons. Theoretical predictions on the nature of bound states and their mass have for long been based on models, but lately lattice calculations, which simulate the strong interaction on the computer, give first insights.

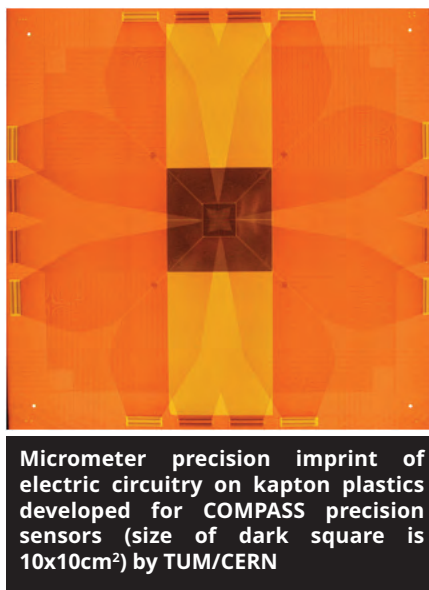
For decades, scientists have sought for bound states with signatures hinting to an explicit role of gluons to a bound state or to multi-quark states, possibly of effective molecular type nature. Some candidates for these scenarios had been found in studying systems with light quarks (glueballs, hybrids) or, very recently, with heavy quarks. Recently, the latter ones gave first evidence for an explicit multi-quark system, based on the characteristic combination of charge and flavour.

In their latest publication (Physical Review Letters, highlight) the COMPASS collaboration has revealed the existence of an unusual meson made from light quarks at a mass of 1.42 GeV/c<sup>2</sup>, thus about ten times the mass

of the pion from which it has been generated and about 1.5 times the mass of the proton. Although such excitation energies had been investigated for half a century, this new particle comes to a surprise and its finding is the virtue of the worlds largest data sample for such studies. The particle is called the  $a_1(1420)$ , reflecting its properties as e.g. of unit spin. Upon first announcements of this finding, several explanations have been put forward already. They cover the interpretation of  $a_1(1420)$  as a molecule made from quarks and antiquarks, partnering another less well established state called  $f_1(1420)$  as well as  $a_1(1420)$  being generated by the subtle interplay of several underlying physics processes just mimicking a new particle. However, despite some remarkable features, not all experimental findings can be reproduced by the latter explanations.

Thus,  $a_1(1420)$ , being experimentally well established enters the club of yet unexplained resonances, which together have spurred thousands of publications in the last 5 years.

Another key question is related to the internal structure of such a strongly bound system. Every composite system made from charged particles can be polarised by an external electromagnetic field, which separates positive and negatively charged particles. The size of this charge separation, also called "induced dipole moment", is related to the external field by the "polarisability". The "polarisability" of atoms e.g. is at the origin of the refractive index of a material and its size is in the order of  $5\text{-}10 \text{ \AA}^3$  ( $10^{-10} \text{ m}^3$ ). This value exceeds the classical volume of the outer atomic shell. Obviously, the response of a



**Micrometer precision imprint of electric circuitry on kapton plastics developed for COMPASS precision sensors (size of dark square is  $10 \times 10 \text{ cm}^2$ ) by TUM/CERN**

composite system to an external force is related to its stiffness and thus to its internal structure.

The COMPASS experiment at CERN has recently made the first reliable measurement of this quantity for the smallest "long living" composite object known, the pion. The pion has a size of about  $0.6 \cdot 10^{-15} \text{ meter}$  ( $0.6 \text{ fm}$ ), thus about one hundred thousands of the size of a hydrogen atom. In order to observe a measurable effect, the pion had been exerted to electric fields in the order of  $100 \text{ kilovolt (kV)}$  across its diameter, thus about  $10^{18} \text{ Volt/cm}$ . Such fields cannot be generated statically but are available in suitable collisions of pions with heavy nuclei as nickel or lead. As the effect of the deformation is very small, the COMPASS experiment had to perform a precision measurement, properly calibrated using non-deformable point like particles ("muons") as reference. The result for the pion polarisability is  $(2.0 \pm 0.6 \pm 0.7) \cdot 10^{-4} \text{ fm}^3$ , thus only about  $1/1000$  of its volume. The pion thus is very stiff and merely non-deformable. This result meets precise theoretical calculations, which successfully describe the strong

interaction at very low energies and thereby solves a long-standing discrepancy of these calculations with previous experimental efforts to determine the polarisability.

Pion research continues and has again proven to be a very valuable tool for understanding fundamental questions in particle physics.

#### Author:

Prof. S. Paul is full professor for experimental physics at the Technische Universität München. He is key scientists in hadron physics, co-founder of the COMPASS experiment at CERN and he is leading a scientific group with key contributions to the recent findings in pion research. Prof. Paul is head of the German Excellence Cluster "Origin and Structure of the Universe", leader of cooperative research efforts in "Fundamental Physics with Neutrons" in Germany and has been awarded the Cross of the Order of Merit of the Federal Republic of Germany.



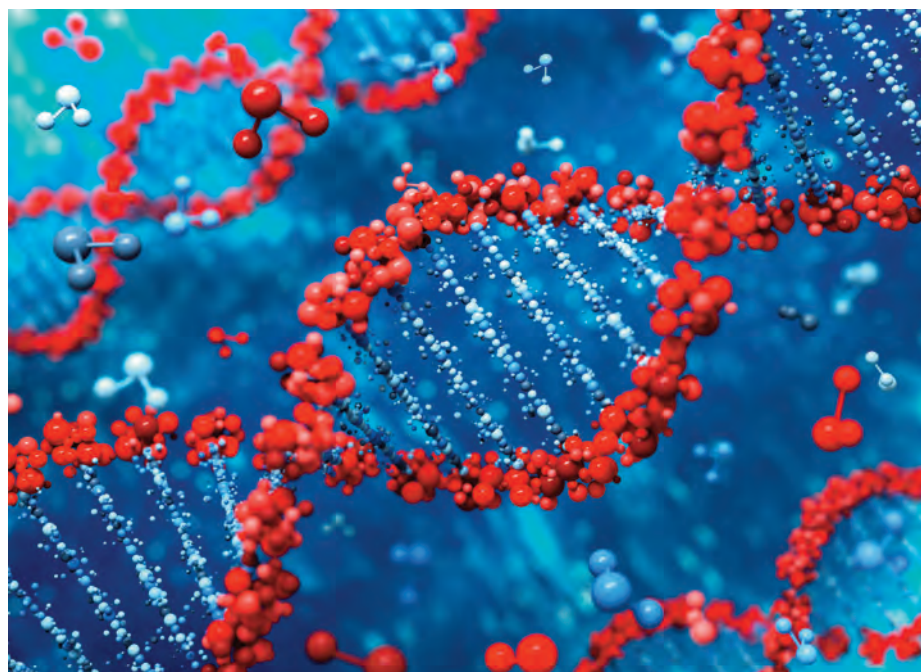
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# Histone chaperones: the builders of chromatin

**D**NA is a molecule of life, which stores all genetic information necessary for organism development and function. On itself, the DNA is a simple thread-like molecule encoding the genetic text in 4 letters alphabet of A, C, G, T nucleotides. However, just as the complexity of living organisms has increased in evolution, so does the size of DNA has grown larger accommodating new genetic texts. On average, genomes of simple organisms, such as bacteria, contain 1 to 10 million nucleotides, whereas human genome comprises 6 billion nucleotides (3 billion from each parent). A distance between each nucleotide is miniscule (less than one nanometre), but the total length of human DNA contained within single cell is astonishingly large – 2 meters, and for all cells in human body the number is astronomical –  $2 \times 10^{13}$  meters (enough to shuttle 70 times between earth and sun).

Following these numbers, an immediate question comes to mind: how such long DNA threads are packaged within cell nucleus (a cellular compartment where DNA resides in eukaryotes), if, on average, the nuclear diameter is no more than few microns. To answer this question, one can think of two solutions: either to tangle the thread like a playing cat would do, or to wind it around a spool like in a cassette tape. The former solution is attractive as it requires little energy, but the latter solution has been chosen by nature as it keeps DNA thread ordered. Using the analogy with the tape cassette, the whole process looks like this: a short



stretch of DNA wraps two times around a spool followed by an even shorter stretch, called linker DNA. Then, an adjacent stretch of DNA wraps around another spool and the process is repeated many times until all DNA is packaged. In total, in every human cell 2 meters of DNA wraps onto about 25 million of spools. The resulting structure, also known as a “beads on a string”, comprises a backbone of chromatin fibre, which is further assembled into chromosomes through a series of coiling and looping mediated by nuclear proteins. Together, this is what makes it possible to squeeze long DNA threads into a tiny nucleus in an ordered, fractal-like fashion. Eventually, dressing of DNA into chromatin affects all genomic processes. This brings mechanisms of DNA packaging into a spotlight of multiple basic and clinical studies concerning eukaryotic genome stability, replication and expression.

Histone chaperones represent a diverse family of proteins that help DNA to wind around the spools, which at molecular level comprise protein complexes of 8 histone proteins, also known as a histone core. Initially, histone chaperones were discovered by Ronald Laskey in late 70th in an attempt to reproduce the DNA packaging mechanism in a test tube. Alas, when DNA was mixed with histones no wrapping has occurred. Instead, due to the differences in charge (DNA is a negatively charged polymer, while histones are positively charged molecules) histones stick randomly all around the DNA resulting in protein-DNA aggregate, which has nothing in common with cellular chromatin. However, he has noted that Nucleoplasmin, a protein from an African clawed frog eggs, when added to reaction, all of a sudden helped DNA to wrap around a histone core. Laskey coined the term “molecular chaper-



one”, which he later renamed to “histone chaperone”, to describe proteins, which prevent histone-DNA aggregation and assist DNA wrapping around a histone core, but which, on themselves, are excluded from the final histone-DNA complex, called nucleosome. Since this groundbreaking discovery was made, many researchers went off in a quest of new histone chaperones, which led to uncovering of a zoo of such molecules. Curiously, but the same discovery also helped the development of a field of “molecular chaperones”, which focuses on general mechanisms of protein folding protein complexes assembly, and goes far beyond DNA wrapping around the histone core.

When I joined the field of histone chaperones, about 15 years ago, most of the studies were driven by biochemists, who followed molecular mechanisms of DNA packaging into histones in test tube reactions. However, little was known about the biology of histone chaperones. To address this question, I set my research on fruit flies and went into two directions: genetics investigation of histone chaperones’ developmental functions combined with proteomics survey of their interaction networks. Both approaches turned to be complementary to each other and led to a number of surprising discoveries, which showed that histone chaperones play many more biological functions than were originally anticipated from biochemical studies.

My early enthusiasm in histone chaperones research has been substantially warmed up when I have found that, in flies, histone chaperones cooperate

with ATP-dependent chromatin remodellers in gene control. ATP-dependent remodelling of chromatin is an energy driven process of histone core sliding along the DNA in small steps of about 10 nucleotides via transient unwinding and rewinding of DNA. Later biochemical studies revealed that histone chaperones may intervene into this process to capture and remove histones from DNA at the unwinding phase. Thus, depending on cellular demands histone chaperones can perform two opposite jobs by helping in wrapping and unwrapping of DNA to and from the histone core.

In addition to sliding of histone core, chromatin structure can be modified by covalent attachment or removal of small chemical groups to and from histone molecules. There are many of such groups (phosphate:  $-\text{PO}_3^{2-}$ ; methyl:  $-\text{CH}_3$ ; acetyl:  $-\text{COCH}_3$ , etc.) decorating histone proteins in intricate combinatorial patterns. These patterns constitute a “histone code”, which comprises an important layer of chromatin regulation. Sure enough, my work and the work of others has revealed that histone chaperones cooperate with enzymes responsible for histone modifications. For example, together with my colleagues we discovered that histone chaperones ASF1 and NAP1 facilitate the removal of methyl and acetyl groups from histones. This, in turn, provides a signal to the cell to shut down the genes at chromatin loci from where these two groups have been removed. Interestingly, ASF1 and NAP1 mediate histone demethylation and deacetylation at chromatin loci harbouring developmental genes, such as genes involved

in NOTCH signalling pathway. Thus, in addition to rather general DNA packaging function, histone chaperones also play significant roles in developmental gene silencing.

**“Initially, histone chaperones were discovered by Ronald Laskey in late 70th in an attempt to reproduce the DNA packaging mechanism in a test tube.”**

In the following issues, I will cover more on histone chaperones and will highlight their other chromatin and chromosomal functions, but, going back to my first published article on the subject, I wish to emphasise here that histone chaperones may act like a grease for chromatin remodelling machinery to make it work smoothly.



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## The ERA Roadmap – an opportunity for collaboration

**Amanda Crowfoot, Director at Science Europe highlights the benefits of the European Research Area (ERA) Roadmap...**

**A**t the end of May 2015, the European Competitiveness Council adopted conclusions on the European Research Area (ERA) Roadmap 2015-2020. In short, the ERA Roadmap sets out the priorities for action in strengthening the European research system and ensuring that ERA functions as a genuine 'open market' for research.

Of course, ERA itself is not a new concept. Launched in 2000 and refocused in 2007, it gained new momentum in 2012 with a European Commission Communication and with the introduction of a 'partnership approach', which gave an increased role in ERA policy to research stakeholder organisations. Much work has already been done, and indeed the EU now considers that many of the underlying conditions for ERA are already in place. However, the new ERA Roadmap is intended to accelerate concrete progress in a number of specific areas.

What is crucial about the ERA Roadmap is that it is the result of Member States and Associated Countries coming together to agree what the priorities should be for the next 5 years. The approach taken is to focus, from the many aspects that could potentially be addressed, on a limited set of objectives that are seen as having the greatest potential impact. These follow the top-line priorities of the Commission's 2012 ERA Communication – effective national research systems, jointly addressing grand challenges, research infrastructures, an open labour market for researchers, gender equality and mainstreaming, and circulation and transfer of knowledge – and add a new priority on international co-operation.

Under each priority the Roadmap identifies the top action priority identified by Member States, and outlines actions at national and European levels to promote this. To give a brief example, the top priority

in terms of gender is to translate national equality legislation into effective action. At national level, countries are called on to develop policies on gender equality in research organisations. At European level, the Commission is called on to promote Horizon 2020's approach to gender mainstreaming. All parties are called on to identify good practice and to address gaps in legislation.

Essentially, the new approach means that there is now a common vision for how the ERA project should be driven forward. Having this buy-in from all countries on these key issues is important if progress is to be made across Europe.

**“What is crucial about the ERA Roadmap is that it is the result of Member States and Associated Countries coming together to agree what the priorities should be for the next 5 years.”**

Equally important is the fact that the Roadmap recognises that whilst progress will be made across Europe, the form that this progress takes will not be identical across all countries. Not all countries are at the same stage in relation to ERA matters. In addition, research and innovation systems in Europe are diverse, and such diversity is in many respects a unique strength of Europe. This does not mean that there are no areas where harmonisation is desirable, but it does mean that there is no one-size-fits-all policy solution. That this ethos is reflected in the new approach is an extremely positive step.

A related positive development is the fact that the Roadmap has been conceptualised as a 'living document'. This recognises the European research and innovation system is not static – suggesting that it is not something that can be 'completed', to use the rhetoric of previous ERA policy. Systems evolve, policy evolves, and new approaches are tried and tested over time.

The ERA Roadmap puts EU Member States and Associated Countries firmly in the lead in further developing ERA, but also emphasises the importance of collaboration. The Roadmap itself was drawn up with increased input from a range of stakeholders, and these will also play a role in driving forward ERA progress. These stakeholders include Science Europe which, as an association of major research performing and research funding organisations, is central to ERA. Science Europe has recently signed a renewed 'Joint Statement on working in partnership in achieving the ERA', together with the Commission and 4 other stakeholder organisations.

Science Europe is fully committed to a collaborative approach to strengthening European research, and launched its own Roadmap in 2013. Many of the areas covered in this, such as open access, research careers, gender and cross-border collaboration map, closely onto the priorities in the new ERA Roadmap. The complementarities between this new document and the actions plan already being implemented by Science Europe and other stakeholders offer the opportunity to exploit real synergies between the various roadmaps and action plans, which will be to the benefit of the research system now and in the future. ■

Science Europe Roadmap:  
[http://www.scienceeurope.org/uploads/PublicDocumentsAndSpeeches/ScienceEurope\\_Roadmap.pdf](http://www.scienceeurope.org/uploads/PublicDocumentsAndSpeeches/ScienceEurope_Roadmap.pdf)

Joint Statement on ERA: [http://www.scienceeurope.org/uploads/PublicDocumentsAndSpeeches/150623\\_ERA\\_Joint\\_Statement.pdf](http://www.scienceeurope.org/uploads/PublicDocumentsAndSpeeches/150623_ERA_Joint_Statement.pdf)

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# German research excellence

**Adjacent Government highlights the work of the Federal Minister for Science and Education in Germany in supporting and promoting research excellence throughout the country...**

**G**ermany is a world leader in innovation, research, and engineering industries. According to the Federal Ministry of Education and Research, spending on research and development (R&D) has increased significantly since 2008, with around two thirds of these funds provided by business. In 2012, the government and the business community increased their expenditure to a total of €79.4bn.

The Federal Ministry is the main organisation tasked with promoting research and education excellence throughout Germany. As well as creating jobs and boosting growth throughout the nation, research also helps to tackle a number of key challenges, including healthcare, environmental, energy, and transport.

The Federal government's activities make up the majority of funding for research, development and innovation. In April it was announced the country's ruling parties agreed to invest €5bn more into science from 2018 to 2028. Although the boost is not a government commitment it does show that Germany can continue its healthy support for scientific research.

German Minister for Education and Research Prof. Dr. Johanna Wanka has outlined her commitment to excellence in research on several occasions. In 2014 Minister Wanka detailed the importance of innovation and research.

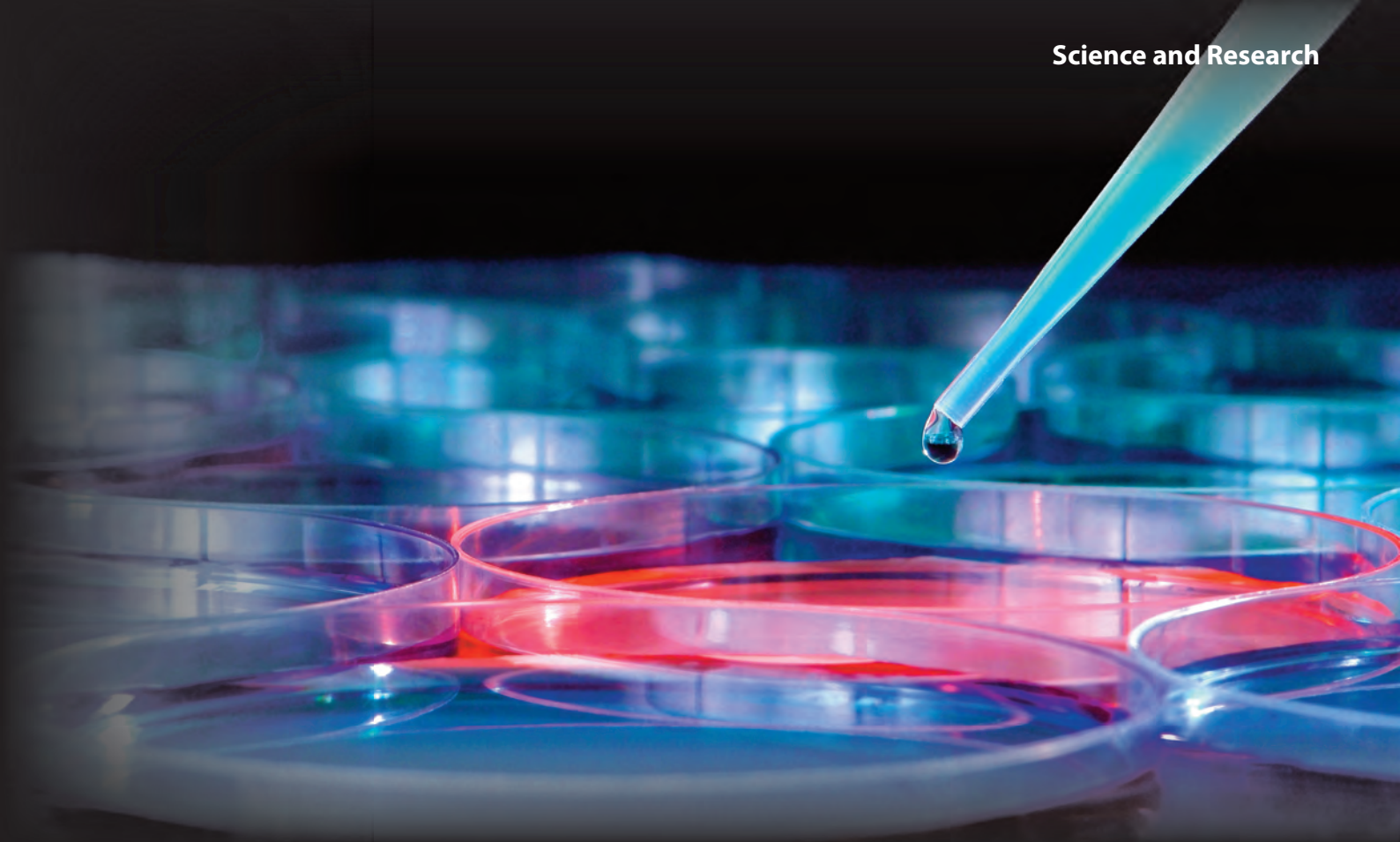
"Innovation is highly valued in Germany," she said. "R&D investments by government and industry totalled more than €79.5bn in 2012 to reach the 3% of GDP target. The Federal Government is firmly committed to strengthening research in Germany.

"German researchers are responsible for outstanding achievements in many fields. With the increased importance of information and communication technologies. Medicine and health are another key area of current and future research in Germany."

The Ministry also considers digital technologies to be an integral part of the future. They believe that "digital technologies have become a requirement for, and constant companion of, new developments in virtually every realm of society." The Science Year 2014 of the Federal Ministry of Education and Research supported the area of digitalisation and explored how in society and as individuals, we are changing as a result of this.

"Germany is shaping the future of industry, in which digital production processes play an increasingly important role," said Prof. Dr Wanka.

In October last year the Ministry launched their new High Tech Strategy (HTS) <sup>1</sup>, which hopes to enable Germany to move forward in becoming a worldwide innovation leader. The key aim of the strategy is for



good ideas to be translated quickly into innovative products and services. The Ministry believes that innovative solutions can help drive prosperity and improve quality of life. They also aim to find creative answers to the urgent challenges of our time – including: sustainable urban development, environmentally friendly energy, individualised medicine, and the digital society.

The strategy has 5 key priorities:

- Prioritising future challenges relative to prosperity and quality of life;
- Consolidating resources and promoting transfer;
- Strengthening the dynamism of innovation in industry;
- Creating favourable conditions for innovation; and
- Strengthening dialogue and participation.

Wanka hopes it will help to boost integration between the research and economic sector. “We hope that ideas will create jobs here,” she said, during a press conference to launch the strategy.

“In light of growing pressure from international competitors, we must take care to hold on to our top

scientific economic position. Germany must also become a world champion in innovation.

“For this reason the new HTS is supposed to make concrete innovations out of creative ideas. In this way it will create future opportunities and tomorrow’s jobs,” she added.

The new High-Tech Strategy aims to make Germany a global leader in solving the challenges of the 21st Century. This will not only improve people’s lives and standards of living, but it will also offer new job prospects and make better use of R&D talents in the country. ■

1 [http://www.bmbf.de/pub/hts\\_2020\\_en.pdf](http://www.bmbf.de/pub/hts_2020_en.pdf)

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# Epigenetic gene regulation in development and disease

Each cell in the human body has the same DNA sequence, however, this genetic information is used in very cell type-specific ways. For example, liver cells feature specific enzymes to regulate metabolism whereas nerve cells exhibit different proteins to mediate signal transmission. Thus, cell type-specific gene expression programs are crucial to ensure the functionality of the entire organism. If normal gene regulation is perturbed, cells will show altered properties resulting in aberrant cell function and eventually culminating in disease. This is very obvious in cancer cells, which show highly abnormal gene expression programs leading to dramatically altered cell properties like uncontrolled growth and invasiveness. The detailed understanding of how cells regulate their gene expression programs is therefore central for understanding normal development and will help to develop novel therapeutic strategies to combat disease.

Epigenetic gene regulation represents the major mechanism to establish and maintain cell type-specific gene expression programs. Epigenetic mechanisms essentially regulate the way DNA is organised together with histones and other proteins into a dynamic structure called chromatin. Highly compacted and largely inaccessible regions are called heterochromatic, and genes residing within these regions are not transcribed. Euchromatic regions, in contrast, are accessible to proteins required for gene expression. A well-investigated epigenetic mechanism is establishment of specific post-transla-



Prof. Dr. Gunnar Schotta

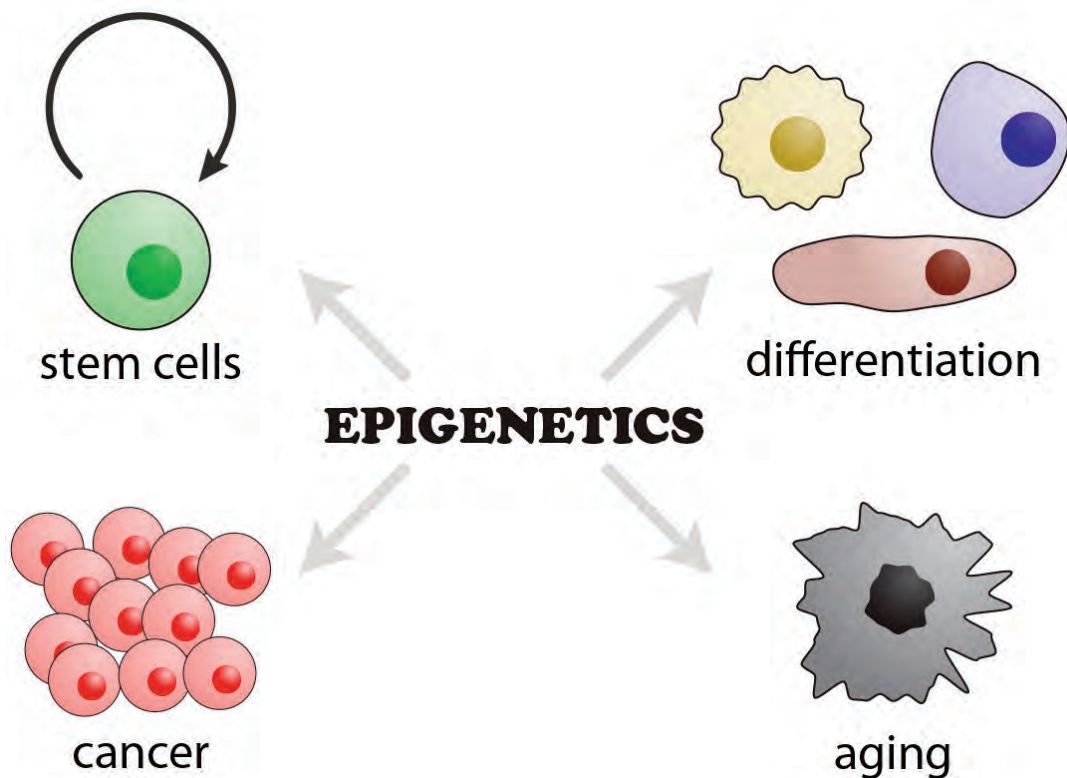
tional modifications on histone proteins. These modifications serve as “tags” to mark distinct genomic regions. For example, active promoters carry a modification pattern which is different from inactive promoters. Enhancer regions, which stimulate gene expression, show an even distinct signature. The genome-wide mapping of epigenetic modifications therefore allows identification of the important regulatory regions in the genome that are used to establish cell type-specific gene expression programs. Importantly, in cancer cells, the regulatory landscape was found to be very different from normal cells. This knowledge has already been used to develop drugs which impair cancer cell-specific gene expression programs: Inhibitors for the cellular readers of active enhancer regions block the full activation of cancer-specific genes and help to impair cancer cell growth. However, more detailed analyses of regulatory landscapes during development, in different cell types and

disease situations are necessary to better understand how cell type-specific gene expression programs are established and maintained.

More than 50% of the human genome is composed of repetitive sequences. Many of these sequences are derived from retroviruses that were integrated into the genome at some point during evolution. During the last years it became clear that the human genome has utilised some of these sequences for normal gene regulation. Retroviral sequences can serve as gene promoters, or they can act as enhancer elements to stimulate gene expression. However, this physiological function of retroviral sequences needs to be balanced with adverse effects of retrovirus activation. High retrovirus transcription can lead to the production of functional retroviral transcripts and proteins, and integration of retroviral sequences into new places in the genome can disrupt host genes or cause genomic instability. How silencing of endogenous retroviruses is regulated in different cell types is not entirely understood. We have recently identified the protein Atrx as a new player for retrovirus silencing. Atrx is crucial to establish densely packaged heterochromatin which inhibits transcription of retroviral sequences. Interestingly, defects in Atrx function occur in the context of neurodegenerative diseases and cancer. Thus it will be important to investigate if impaired heterochromatin formation in absence of Atrx contributes to the characteristic features of these diseases. Furthermore,



## Epigenetic gene regulation in development and disease



Epigenetic mechanisms regulate multiple aspects of normal development (stem cell maintenance, differentiation). Misregulation of epigenetic programs can result in aberrant development (cancer, aging). In this context we study the mechanisms of epigenetic gene regulation using a combination of mouse genetics (knock-out and knock-in mouse models), cell biology (embryonic stem cells, differentiation systems, CrispR/Cas, genome-wide sgRNA screens) and biochemical (ChIP-seq, RNA-seq, MeDIP-seq, ATAC-seq, etc.) approaches

it will be crucial to fully elucidate the regulation of retroviral sequences. Genome-wide screening approaches using the new CrispR/Cas genome editing tools will allow identifying novel players in retrovirus regulation.

Epigenetic mechanisms, such as histone modifications, index regulatory regions in the genome and can be used for identifying such regions during normal development or in disease. Although epigenetic modifications play central roles for gene regulation, surprisingly little is known how these modifications are actually established during cell differentiation or in response to environmental changes. Several lines of evidence

suggest two major ways of targeting epigenetic enzymes: Firstly, epigenetic enzymes can interact with DNA binding factors that recognise specific sequences in the genome. For example, binding of specific transcription factors to enhancer elements is likely to mediate recruitment of activating epigenetic machineries. Secondly, non-coding RNAs are thought to contribute to targeting of epigenetic enzymes to specific genomic regions. Detailed understanding of these targeting mechanisms will be absolutely crucial to develop novel strategies for specifically affecting gene regulation in the context of disease. I am confident that this aspect of basic epigenetic research has a very high potential for

providing the basis for translational applications in the future.



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# Continental trials first car tyres with Taraxagum™ dandelion-rubber tread successfully

The leading international tyre manufacturer has reached an important milestone in its research project for the industrialisation of dandelion rubber in tyre production. In autumn 2014, Continental presented the first test tyres made from the innovative material that the company is calling Taraxagum™. Manufacture of the first WinterContact TS 850 P with natural rubber from dandelion roots has taken Continental an important step closer to reaching its long-term goal of making tyre production more sustainable and less dependent on traditional raw materials. On its Contidrom proving grounds north of Hanover extensive tests of the first winter tyres with dandelion rubber tread were done under summer conditions while the winter characteristics were tested at Continental's test site in Arvidsjaur, Sweden. "After several years of intensive development work together with the Fraunhofer Institute, we are excited to be taking the first dandelion tyres onto the road," said Nikolai Setzer, Member of the Executive Board of Continental responsible for the Tyres Division. "To get the most



meaningful test results from the crop yield produced by our research project to date, we decided to build winter tyres, as they contain a particularly high proportion of natural rubber. Our goal remains to develop tyres based on dandelion rubber to readiness for series production within the next five to ten years."

"The development process of Taraxagum™ has been very promising so far and we are currently continuing the industrialisation process together with our partners. We are very confident that the results achieved with the test tyres to date will be confirmed, and that we will meet our performance targets," added Dr. Andreas Topp, Head of Material and Process Development and Industrialisation for Tyres at Continental. A very high-yield and robust kind of Russian dandelion has been cultivated as a result of extensive research carried out over recent years together with the Fraunhofer Institute for Molecular Biology and Applied Ecology (IME), the Julius Kühn Institute, and the plant breeding company Aeskulap.

The research project's long-term goal is to find an ecologically, economically and socially viable solution for the increasing demand for natural rubber. In May 2014, the dandelion rubber project was honored with the prestigious European "GreenTec Award", an environmental and business prize, in the "Automobility" category. Continental recently presented the case study



"We develop sustainability" on current goals, trends and successes in tyre development. Like all the information on the topic of dandelion rubber published so far, the study can be found at [www.taraxagum.com](http://www.taraxagum.com).

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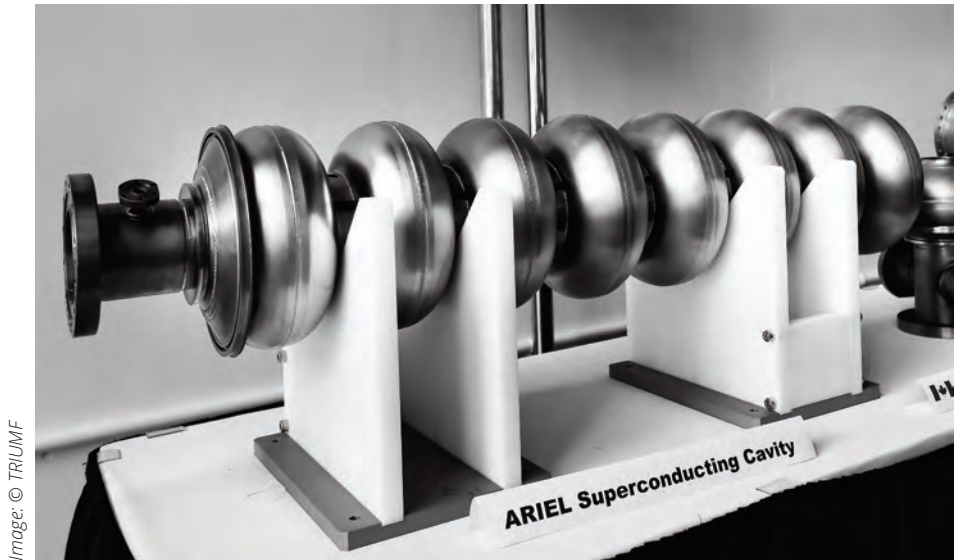
# TRIUMF – Advancing Science for Society

**H**ow did the Universe begin? Where do we come from? These are questions humans have pondered since we first looked up at the stars and wondered about our world. Particle and nuclear physics play key roles in answering these questions by identifying the fundamental building blocks of nature and how they organise themselves into the elements that make up our bodies and surroundings.

Even after the 2012 discovery of the Higgs boson, many fundamental questions remain: What are dark matter and dark energy? Why is there more matter than antimatter? Where in the Universe are the chemical elements from iron to uranium produced? Large international efforts – involving substantial research infrastructure investment – are underway that may finally bring answers to some of these fundamental questions in the next 5-10 years.

Canada has become a global leader in particle and nuclear physics<sup>1</sup>, despite its modest population size, as a result of long-term investments in its research capacity. These include support of university researchers and national facilities such as TRIUMF – Canada’s national laboratory for particle and nuclear physics.

TRIUMF is a joint venture of 19 Canadian universities that drives scientific progress in three areas:



**Fig 1: Superconducting radiofrequency cavity developed at TRIUMF for the ARIEL electron accelerator and transferred to PAVAC Industries, Richmond, B.C.**

- Understanding the basic building blocks that shape our Universe;
- Advancing isotopes for science and medicine; and
- Harnessing particles and beams for science and innovation.

Located in Vancouver, British Columbia, TRIUMF plays a special role in particle and nuclear physics as a truly global player, not only boasting a state-of-the-art accelerator facility but also leading Canada’s involvement in high-profile projects around the world.

In nuclear physics, TRIUMF currently operates one of the world’s most powerful radioisotope-production facilities. When the Advanced Rare Isotope Laboratory (ARIEL) is completed,

TRIUMF will dramatically expand its research capabilities, advancing our fundamental understanding of nuclei, enhancing the search for new forces in nature, and helping determine how and where in the universe the elements were produced.

ARIEL will also further applied research, from studying magnetism at material interfaces, to imaging biological systems and treating cancer with new medical isotopes. With ARIEL, TRIUMF and its industrial partners will co-develop globally-significant technologies, such as the superconducting radiofrequency technology used in the ARIEL electron linear accelerator and chosen for the proposed International Linear Collider, the next global accelerator laboratory. Through technology transfer from TRIUMF, a

Image: © NSERC



**Fig 2: TRIUMF scientist and student working on a medical isotope cyclotron**

Canadian company is now among a handful of vendors worldwide that can produce this advanced technology.

In addition, TRIUMF is fully engaged in international particle physics initiatives. CERN remains at the vanguard of global particle physics, where Canada contributes and benefits via TRIUMF and its collaborating universities. From participating in the discovery of the Higgs boson and trapping anti-hydrogen at CERN, to collaborating with Japan in neutrino science, TRIUMF's global engagement provides a superb training opportunity for Canadian students. At home, TRIUMF collaborates with SNOLAB, the world's premier dark matter and neutrino observatory located deep underground near Sudbury, Ontario.

TRIUMF is Canada's steward for developing accelerator and radiation-detection technologies for science and societal benefit. TRIUMF also touches the lives of thousands of people by: inspiring and training the

next generation of scientists, innovators or medical doctors; providing isotopes for medical diagnosis and treatment; and transferring leading-edge technologies to industry.

**“In nuclear physics, TRIUMF currently operates one of the world’s most powerful radioisotope-production facilities.”**

Through long-standing relationships with several industrial partners, TRIUMF is transferring and licensing technologies developed as part of its research mission. For instance, TRIUMF's 35+ year long medical-isotope production partnership with the global health science company Nordion Inc, benefits over 2 million patients each year. Similarly, TRIUMF collaborates with the Pacific Parkinson's Research Center at the University of British Columbia and the British Columbia Cancer Agency in the development and production of radiotracers for Positron Emission

Tomography, a powerful imaging technique.

Recently, a TRIUMF-led team developed a reliable, accelerator-based means to produce Technetium-99m (Tc-99m). This isotope, the world standard for medical imaging, is at risk of becoming unavailable due to a global supply shortage. Every day, 5,000 medical procedures in Canada and 70,000 worldwide depend on Tc-99m. With support from several Canadian funding agencies, the TRIUMF-led team developed technology for medical cyclotrons already in use at major hospitals and radiopharmacies around the world, securing the regional supply of Tc-99m on an ongoing basis.

In conclusion, TRIUMF, a publicly-funded laboratory with basic research mission, is driving discoveries addressing the most compelling questions in particle and nuclear physics, nuclear medicine, and materials science. Also, TRIUMF leverages its extensive expertise by transferring knowledge to industry and commercialising research for economic, social, environmental, and health benefit.

<sup>1</sup> Council of Canadian Academies, The State of Science and Technology in Canada, 2012



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# Placing cells under the microscope

**Dr Michael Howell from the High Throughput Screening Laboratory at The Francis Crick Institute outlines the importance of studying human cells...**

In our fast-moving, loud and brash urban lives it is easy to forget how inherently astonishing we are; each of us is a pile of several trillion cells all working together as an integrated whole enabling us to live, think, feel and order ever more complicated types of coffee and made all the more remarkable that everyone of us started out as a single cell. Moreover, you are in a constant state of flux; by the time you have finished this first paragraph your body will have made and lost something approaching 20 million cells. This is not a case of a production line simply churning out identical widgets. Each cell in your body is a highly specialised complex entity more resembling an entire city in its internal organisation and each capable of undertaking astonishing feats on its own. Indeed by the time you have read this article and browsed a few others, all of the cells in your body will collectively have made enough DNA to reach to the moon and back twice (and should you be 50 years old at the time of reading, your cells have already made a total of a light year of DNA so far). Changes in cell activity of course underlie many human diseases such as cancer or dementia and studying cells therefore can offer fundamental insights into our own remarkable being and knowledge that can be used to tackle diseases that would stop us being.

So how do you study cells? Any experimental assay has 3 elements; a hypothesis to test, a manipulation of, or a challenge to, the cells which is commensurate with the central question being addressed and recording the outcome of that challenge (the phenotype of the cell). For example, we may posit that specific genes are required for human tumour cells to survive in the presence of a chemotherapeutic drug (acquired drug resistance is an important problem in clinical oncology). To test this we could grow cells *in vitro*, challenge them by interfering with a specific

gene and then including the appropriate drug in their environment and recording the outcome by imaging cells in some form of microscopy, to establish how many cells remain at the end of the experiment. But, how do we know which genes to study in the first place? There are 20,000 genes to explore, so can we rely just on educated guesses or hunches alone?

It is now possible for researchers to inactivate the expression of any gene in a cell by introducing a specific reagent into that cell. Such reagents utilise and subvert the cells own endogenous machinery that normally controls the level of RNA made by a gene (referred to as RNA interference, RNAi). More recently researchers have co-opted components of a bacterial defence mechanism to a mammalian setting to create reagents that disable specific genes at the DNA level (CrispR targeted reagents). The end result using either reagent is the loss of a single protein (the ultimate end product of most genes). At the heart of both reagent types are small lengths of nucleic acid that can be rationally designed by bioinformaticians using human genome sequence information and can be chemically synthesised in huge arrays. In practice individual reagents are organised in 16x24-well arrays (or 32x48 wells) arranged in a vessel or plate slightly smaller than a regular smartphone and with each well representing a self-contained experiment (a mini test tube if you like), containing a unique reagent targeting a specific gene. If we add cells to each well we can test for the involvement of each and every gene in the cellular process we are measuring in 20,00 simultaneous, parallel experiments. Once the sole preserve of big Pharma companies, such large-scale massively parallel screening experiments are now increasingly familiar in academia and require robotic liquid handling systems to deliver cells and reagents to individual wells, automated microscopes to record the resulting



cell phenotype and computational image analysis to turn the 1-2 million images into biologically meaningful numbers. The result of this unbiased screening approach is the identification of the genes required for or influencing a particular aspect of cell biology, i.e. we can assign real world functions to genes in specific biological contexts without making any prior assumptions. Aside from the pure discovery aspect (a large proportion of genes still have little or no function ascribed to them), such screens can identify vulnerabilities in cellular activity that can be points of future therapeutic intervention. Increasingly, such cell-based screens are being used as a pragmatic way to identify molecules that form the starting point for new drugs (in this case instead of RNAi or CrispR reagents, the specific challenge might involve small chemicals that have the potential to be elaborated into efficacious drugs).

**“More recently researchers have co-opted components of a bacterial defence mechanism to a mammalian setting to create reagents that disable specific genes at the DNA level (CrispR targeted reagents).”**

But we've rather skipped over an essential problem namely, where do you get cells from in the first place? Taking cells out of a person (primary cells) and attempting to grow them in simple plastic vessels is, for most cell types, doomed to failure. The vast majority of cells in the body are not capable of endless propagation and have specific environmental needs (physical contact and chemical communication with other cell types growing in a particular spatial location etc.). Large-scale screening experiments require millions of identical cells and necessitates the use of cells that have been adapted to large-scale cultivation and growth *in vitro* i.e. they exhibit properties that are abnormal (the most obvious examples being cancer cells that have become immortalised and can grow almost indefinitely). Even working with these limitations we can and have made great progress understanding how cells work but there is an increasing trend to use



primary cells or as close to primary as possible and in more realistic environments e.g. experimental conditions that recapitulate the 3-dimensional and multicellular environment of the body. Although such assays are obviously more of a technical challenge to accomplish on a large scale, the hope is that the use of more 'authentic' assay systems will improve the quality and relevance of the data or drugs that come from their use and pave the way for using an individual patient's cells in focused screens aimed at identifying the best treatment for that specific individual. ■

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# It's the 'content' of cells that matters in biomedical research

One of the most remarkable things about life on earth, in all its forms, is how cells often only tens of microns in diameter have evolved to carry out the variety of tasks that they do. In multicellular organisms the situation is even more complicated, as different cell types need to work together in an orchestrated manner in functional units such as tissues and organs to maintain the health of the organism. Ultimately therefore, it is the function of individual cells in our body that determines our health, and our susceptibility to disease and infection. The discipline of cell biology serves to understand how cells work, and importantly what goes wrong in cells to cause disease. It is a discipline, with associated technologies, positioned at the centre of all fundamental biomedical research.

**“...we believe that our HCS approaches provide critical information about cell organisation that can be exploited by many branches of biomedical research.”**

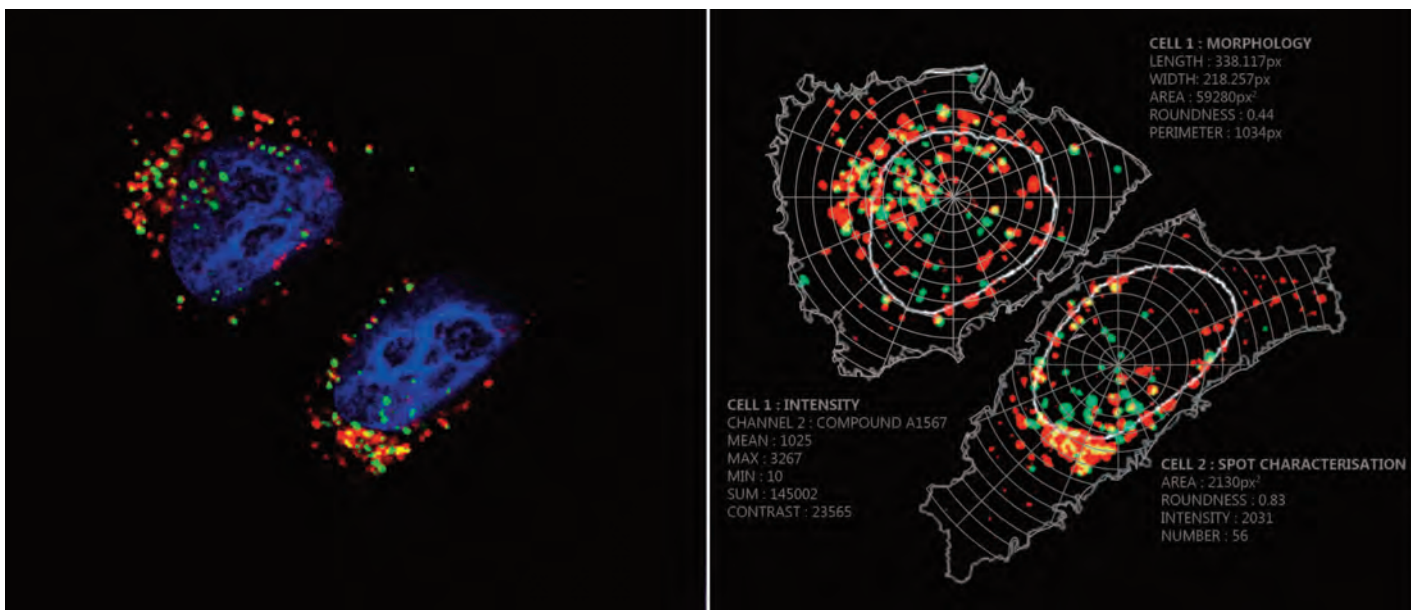
Since the mid-seventeenth century microscopy has been the primary tool for scientists to reveal the structure and organisation of cells, both in isolation and in their 'social' context. In the late twentieth and early twenty-first centuries however, the widespread application and integration of fluorescence technologies with microscopy has provided new

opportunities to reveal the innermost workings of cells. Fluorescence microscopy allows researchers to potentially view not only the cellular organelles, but also the billions of molecules – in particular proteins – that work together to provide the cell with its functionality. Therefore, in this post-genome sequencing age, how can we assign discrete function to each of the 22,000 human genes and the proteins that they encode? Furthermore, how can we identify those proteins that can cause particular disease, and those proteins that can have protective properties? Carrying out such experiments in intact and preferably living cells has obvious benefits, but clearly the scale of such experiments is challenging. Simply visualising each protein in turn (and molecular techniques in principle make this possible) requires 22,000 individual microscopy images, and so without considering any further complexity of the experiment or replicates we would need to image almost every well from 230 96-well plates in a consistent manner. Even if this is achievable, the next problem becomes one of how to interpret the images, and in such a way that we can objectively compare them. The issues are experimental scale and complexity of information.

In the last ten years this experimental approach has become a reality, and these barriers are being overcome, encompassed in a technology termed

'high content screening and analysis' – HCS / HCA. This is a fusion technology, combining lab automation, particularly in terms of the microscopy, with sophisticated software routines capable of analysing images of millions of individual cells ('high throughput') and extracting user-defined quantitative information ('content') for each cell. Since its development, labs around the world have embraced its power to address both fundamental cell biology questions and applications relevant to human health and disease. HCS can and has been used to rapidly screen massive libraries of chemical compounds to identify leads with desired cellular phenotypes, to identify host factors associated with virus infection, and reveal new triggers for cancer cell development. For cell biologists it has proved to be a particularly powerful technology when combined with RNA interference (RNAi), a molecular technique that allows researchers to inactivate genes and the proteins that they encode in a systematic manner. Carrying out RNAi experiments in an HCS format effectively allows us to dissect the function of each gene / protein in turn with respect to a particular biological question, with the output being images of cells revealing the phenotype, and also their quantitative analysis.

In the Cell Screening Lab at UCD ( [www.ucd.ie/hcs](http://www.ucd.ie/hcs) ) we have been developing and applying HCS strate-



Left: image of two cultured human cells fluorescently labelled for various subcellular structures. Right: example of 'content' that can be extracted from these cells

gies for a number of years to address questions related to how cells transport material (cargo) between their various internal organelles. Understanding how these membrane transport processes work is of vital importance, as all cargo inside cells will only facilitate cell function if it is located in the correct place. For example, signalling receptors at the cell surface are actually synthesised and assembled in internal membranes of the endoplasmic reticulum, requiring transport through intermediate organelles for further processing prior to delivery to the cell surface. Many human diseases are associated with mistargeting of such receptors – cystic fibrosis is a well-known example. Our ongoing mission is to use RNAi at a whole genome scale to systematically dissect how such transport pathways are regulated, and ultimately to use this information to gain insight into how they can be manipulated. Improving drug delivery efficacy into cells is one good example of how this approach can be utilised. Ultimately

therefore, we believe that our HCS approaches provide critical information about cell organisation that can be exploited by many branches of biomedical research.

**“In the last ten years this experimental approach has become a reality, and these barriers are being overcome...”**

There are of course both technological and political challenges to overcome if HCS is to continue providing valuable data to the scientific community. From a technological perspective there is a move towards use of more complex 3-dimensional multi-cell type models, which although may better represent the in vivo situation, they are more difficult to image and precisely quantify, requiring confocal HCS technology. Politically, HCS is a relatively expensive technique, both in terms of its hardware and the reagents needed to carry out large-scale screens. In the current challenging environ-

ment of research grant availability, funding bodies often prioritise more advanced or applied projects that might return gain in the short term. Ignoring HCS projects would be foolish, as they show real promise to deliver advanced cell biology knowledge that will inform and drive the direction of future biomedical research.



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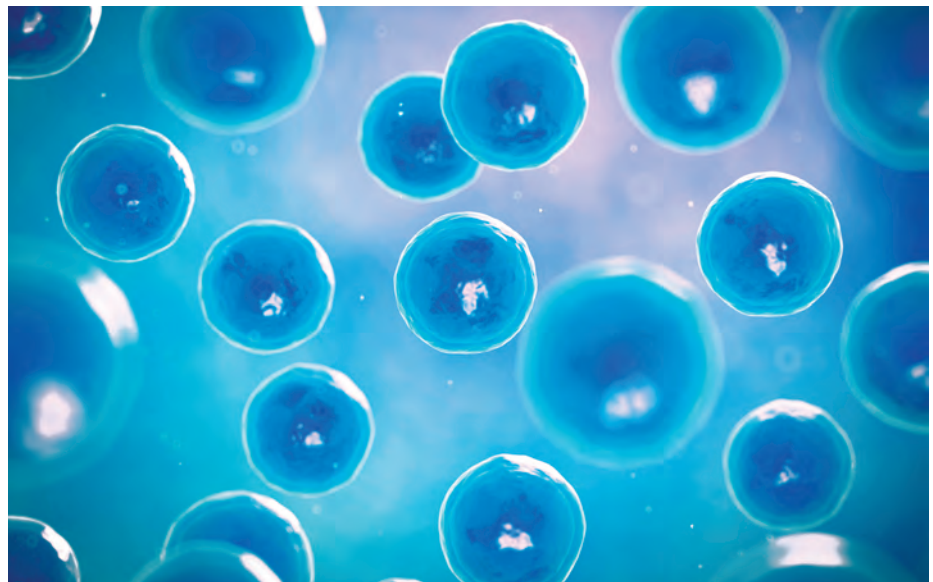
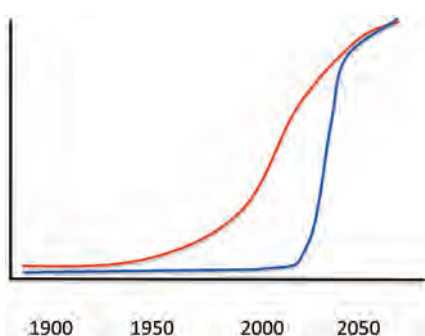


# Fields of the Cell: At a turning point

While progress is based on development, a revolution is associated with turning points and a phase-transition (speaking in the terms of physics). Over the last 10 years a tremendous progress could be observed within the network of researchers studying functional cell components that have no weight but nevertheless induce effects: the fields of the cell. This development is mainly due to advances in technology and in networking. The latter leading to and sprouting of international conferences, workshops and cooperation between research groups. In summa this bears the potential to revolutionise classical concepts that explain life basically as random encounters of molecules.

It is evident that within a cell the material components, i.e. (polar) molecules, ions as well as chemical reactions exist together with the electric currents and electromagnetic fields they induce. And yet, the deep research of that kind of cell physics appears like a satellite orbiting around tremendous investment packages for molecular biology, or Life Sciences in general.

Molecular and electromagnetic components are part of a mutually



dependent system of reciprocal causality leading to observed complex cell dynamics. This is, for example, well recognised in neurobiology in case of membrane potential switches and tunnel proteins in the context of information flow along axons. So, there we do look at the intricate relationship between molecules and electromagnetic components. We claim that there are much more effects emerging from more endogenous electrostatic and electrodynamic fields with accumulated evidence found in the newly released online book 'Fields of the Cell' (Fels, Cifra & Scholkmann, 2015, Research Signpost).

We claim that in the near future molecular and electromagnetic biology will merge (see graph) with an incredible power for emergent phenomena to study.

This qualitative graph describes the evolution of molecule-based research (red) as increasingly successful (y-axis)

over time (x-axis) regarding financing and manpower. Investigation in cell fields (blue) is considered as inevitable and hence, the two curves are predicted to approach each other (sooner or later).

## Questions and assumptions

Molecule-based research brought us a tremendous insight into life and being interested in the components of a cell one will – interesting for basic and applied research – certainly look for and find molecules. What else? Cell fields. Being interested in the non-material components of a cell one will – interesting for basic and applied research – certainly look for and find fields.

When it comes to functions we may be locked looking at molecules only. Are, e.g. substrate and enzyme within a cell really banging randomly into each other both of which being (hopefully) in the right cell space? Are cell fields playing an organising role in cell space and encounter organisation?

The latter is a question that would never arise from a classical cell description but does so from a field- and molecule-based theory about life! We would like to give a few examples that show how a field- and molecule-based theory of life can give rise to new questions and can answer some old questions.

**'Development':** What gives an organism its form? Sensu Richard Lewontin (The Triple Helix) classical biology has no answer and skipped the question over to: Which gene(s) is (are) required during development. This however, does not explain the development of form! Now we know that e.g. embryos produce a field as a result from charged cells and that this field has a form into which cells migrate by which the form of the field is altered and so on.

**'Mitosis and meiosis':** How do the microtubules find the chromosomes and why does the spindle apparatus resemble in form an electric field?

**'Random':** We say random when something occurs in a system, which we do not know. The critical question is, whether there is always such a system (if so, there would be no real random, which we do not discuss here). Quantum biology perceives a molecule as a vibrating entity. This implies phenomena like resonance and can, further, lead to attraction or distraction of similarly vibrating molecules (confer chapter 11 in Fields of the Cell, Preto et al).

**'Inheritance':** What is inherited (sensu textbooks) are genes and within egg cells a lot of additional molecules (leading also to so called maternal effects). Yet, if a cell is also a cavity

resonator (confer chapter 16 in Fields of the Cell, Pietak) or more general, bears its fields (with their organising powers) we must ask whether fields are inherited as well.

**'Natural selection':** Order and structure may have occurred due to a process of small random events followed by natural selection. Yet if fields lead to order and structure and if life can follow these field forces, we may learn that not all order and structure follows from natural selection but probably also from life intrinsic fields.

**'Exogenous fields':** Fields (either from space or Earth or technology induced ones) surround us. It remains an open question how the exogenous fields interact with the endogenous fields; assuming such interaction cannot exist appears highly improbable (think of electrotechnology).

**'Reciprocal causality':** While evidence is accumulating there is still research necessary to elaborate the mechanisms by which the fields due to polar molecules, ions, and chemical reactions feed back on polar molecules, ions, and chemical reactions thereby leading to the reciprocal causality between material and non-material cell components enabling complex cybernetic regulation in organisms.

Once better understood we will become able to interfere with fields into the process of cell dynamics. Another great responsibility we must prepare ourselves for.

## Conclusion

The Fields of the Cell allow us to understand how self-organisation functions. Independent from human reactions (territorial, psychological),

textbooks will include many more pages on the fields of the cell than so far because fields and molecules (therefore cells and organisms, too) belong together like mass and gravitation. For some this appears like an opinion. But the fields of the cell are about the truth of life and not about opinion. We believe that we are on a turning point in the Science about Life where the courage to allow the revolution will bring unforeseen fruits emerging from the tree of knowledge.

## Outlook

Over the years we became increasingly aware that the book project Fields of the Cell was overdue. Without such an introduction one may not undertake the effort of reading into the topic. For granting a continuation we intend to launch a website (Fields of the Cell) informing about research groups, conferences and relating to recent research.

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# Supporting research excellence in Ireland

In an interview with Editor Laura Evans, Dr Eucharia Meehan, Director of the Irish Research Council gives an overview of the impact of research throughout Ireland, and how the Council helps to promote excellence...

In the last 15 years, Ireland has really grown as a nation in its capacity to deliver excellent research. Now highlighted as one of 5 upcoming countries in the world to watch out for in terms of research (Nature 2012), the country is definitely making headway in this sector.

Recent international indicators have been positive towards Irish research, with Irish higher education institutions reported as being in the top 1% in the world in 20 of the Essential Science Indicators. Also, for 11 of these Indicators, Ireland is in the top 20 of world research impact rankings (Thomas Reuters 2014)

The Irish Research Council, set up in 2012 as a merger of 2 former Councils, is an agency of the Department of Education and Skills. It supports excellent research in all disciplines. Marking 2 full years of operation, the Council's Annual Report 2014, was launched in August, and among the highlights is how €2.5m is now being invested by business into 300 of the top individual emerging researchers.

In 2014 alone, 32% of all new individual PhD and Masters Scholarships awarded by the Council were jointly funded by business partners (102 of 320). This is up significantly from 16% in 2013.

Dr Eucharia Meehan, Director of the Irish Research Council, speaks to Editor Laura Evans about how the council supports research excellence, and the areas they feel need to be highlighted.

"We fund on the basis of excellence, and across all disciplines. We literally fund everything from Arts to Zoology. This is the role given to us by government and that means for our core programmes we do not screen on the basis of particular areas – it's all about the excellence.

"Our schemes are open to all higher education institutions and a number of other research organisations. And, in geographical terms, our programmes reach every corner of the country, from the south west to the north east," explains Dr Meehan.





“In covering all research disciplines, we do believe that more investment is needed to underpin basic curiosity – individual-driven research – because that type of competitive funding has decreased in the last number of years.”

Research plays an integral role in helping to tackle some of the many challenges facing future populations. Investment in these areas is key, and Dr Meehan agrees that in order to try to reduce these societal challenges, Ireland needs to be more focussed on interdisciplinary research.

“The Council is of the view that research is needed to tackle major challenges, whether they are societal, economic, or environmental. Whilst particular disciplines have a very important role to play in of themselves, there is also a need to cultivate research involving a range of disciplines,” she says.

“Because Ireland has only been investing significantly in research for a relatively short period of time – within

the last 15 years – there has been a lot of focus on developing centres, developing research leaders, and enhancing PhD output – that is developing capacity.

“Within that time there has been some inter and trans disciplinary research, but more needs to be encouraged. To help this we have initiatives, some in partnership with other agencies, in order to drive a national effort. Horizon 2020 has expedited the focus on this. ”

Horizon 2020 (H2020) is the European Commission’s main driver for research across the EU, with an estimated €80bn budget running from 2014 to 2020. The programme has 3 key pillars: excellent science, industrial leadership and societal challenges.

The Irish Research Council is a National Contact Point for the European Research Council in Ireland (a partnership with SFI), as well as representing Ireland on one of the Societal Challenges – Europe in a Changing World. The Council has also been at the forefront of helping researchers develop their proposals for Horizon

2020 and has a particular function to support the Arts, Humanities and Social Sciences community, being the only national funder for those areas.

“Horizon 2020 has impacted on Irish research significantly,” explains Dr Meehan. “Under FP7, Ireland was very active. Under H2020 a more proactive and strategic approach has been taken nationally with agencies assigned roles and functions to support the research community. One of our programmes for example helps researchers planning to apply for future H2020 calls by enabling them to develop relevant track records whilst progressing their careers. We want our programmes to be stepping stones for researchers both nationally and in H2020.

“This approach talks very much to a second key area of focus for us - offering opportunities to early stage career researchers, to develop diverse career paths. We have also developed programmes that give researchers the opportunity to work in the private sector or other organisations outside academia”, says Dr Meehan.

Through programmes such as the Enterprise Partnership Scheme researchers are able to gain experience and insight into the enterprise arena whilst conducting their research. At the end of 2014, 300 employers (many SMEs) have engaged with these programmes and the number is growing rapidly including as referenced earlier business investment.

The other key area for the Council is working with government departments, and other funding agencies in their drive to boost research and innovation.

“We have a specific programme called ‘Research for Policy and Society. This is where we partner with government departments and agencies who want to cultivate research and expertise in particular areas that in the long term will be of interest from a policy or expertise point of view. For example, this year we are partnering with the Department of Children and Youth Affairs, The Department of Social Protection, The Department of Arts, Heritage and the Gaeltacht, among others – there are 7 in total.” She highlights that the Council has also developed an ‘Engaging

Civic Society’ initiative in partnership with NGOs and voluntary/community groups.

Research is important for all dimensions of our society she says. Going forward Meehan believes that there are a number of challenges in regards to research. Despite the economic downturn, Ireland has continued to do well in the international indicators. However, she says the downturn led to an understandable, and unsurprising, focus on the short term needs of the economy. Meehan believes that a rebalancing is now needed to future proof Ireland’s long term reputation as a centre for excellent research and to ensure that the mix of skills and expertise needed for a healthy economy and society are coming through.

“At the end of the day research can have impact in a multiplicity of ways, some of which are very difficult to measure e.g. impact on education, on the global knowledge pool, on social development, on culture, on health, on the environment ...as well as direct economic impact. I think the challenge going forward is to get the balance right and to have a portfolio of research investments that focus both on the short term and long term.

In this context she is optimistic about the new National Strategy for Science, Technology and Innovation which will be published later this year. ■

More information on the Irish Research Council at [www.research.ie](http://www.research.ie)



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# Funding research for Ireland's success

**Mark Ferguson, Director General of Science Foundation Ireland (SFI) and Chief Scientific Advisor to the Government of Ireland tells Editor Laura Evans why investment in research is key to the country's success...**

2014 proved to be a significant year for Science Foundation Ireland (SFI). The Irish funding agency continued its commitment to help the nation move further up the international research rankings. Ireland is now ranked 16th in the global scientific ranking – up from 20th position in 2010. The country has also been highlighted as one of 5 up and coming countries in the world to watch with regards to science excellence.

Science Foundation Ireland is the principal research funding agency in the country which supports and promotes excellent research. In 2014 alone the agency invested €155m in 5 new world class SFI Research Centres, supported by €90m co-investment from industry.

Professor Mark Ferguson, Director General of SFI and Chief Scientific Advisor to the Government of Ireland, speaks to Editor Laura Evans about their ongoing commitment to science and research, and why investment is key.

“Science and research is very important for Ireland,” states Ferguson.

“Ireland's economy depends strongly both on indigenous industries and enterprises, for example in the food and agriculture sectors, but also increasingly on multi-national companies which are located in Ireland. These are in areas such as software, ICT, medical devices and pharmaceutical manufacturing.

“There needs to be investment from the public sector, and also the private sector. Increasingly economic studies show that if you get this right, the public investment can crowd in the private investment – in other words, if you invest the country's public funding

appropriately you can stimulate private investment, and clearly we want to do both.”

Ferguson went on to say: “We want to invest government and taxpayer money in a way that secures Ireland's future, but that also leverages in other funding, from the private sector, from the European Union, and elsewhere, really to add and build to the base.”

**“SFI funds around 3000 post doc researchers every year. These are in various fields of science. Approximately 90% of those will go on to work in the private sector.”**

SFI is part of the Department for Jobs, Enterprise and Innovation in Ireland. In 2014 SFI supported over 1,200 collaborations with industry, and invested €274m in 343 new research awards across 23 programmes. The Agency's main role is to fund the fundamental science conducted in public institutions – universities and institutions of research and technology – often in collaboration with industry.

“We are completely open to all industries,” explains Ferguson.

“We are interested in companies within Ireland, large and small, multi-national or indigenous, but we're also interested in companies that are not in Ireland. SFI operates a number of competitive grant funding schemes, like any science funding agency.

“For example, we have a competitive research grant scheme that supports investigator led research proposals that have come from the academic researchers themselves; others that support young researchers and established researchers,” he says.





Among the many programmes they support, research centres are at the heart of their commitment. The 12 world leading research centres across the country address progressive research topics, such as software, the internet of things, applied geosciences and medical devices, to name but a few, as Ferguson outlines.

“There are more than 1000 researchers in those centres, with a budget of more than half a billion euros, over 6 years. €350m of that comes from the government through SFI, and the other €150m is from more than 300 companies, who partner with these research centres.

“They develop cutting edge research, new companies, and help grow established companies. They also train people,” he says.

SFI funds around 3000 post doc researchers every year. These are in various fields of science. Approximately 90% of those will go on to work in the private sector. SFI’s Industry Fellowship scheme allows researchers

to experience industrial research. The researchers get to spend up to one year working on a collaborative research project in a company, anywhere in the world.

“It’s a career development scheme for scientists going into the private sector, which is 90% of scientists that we fund. We also have career development schemes for next generation professors and researchers,” says Ferguson.

Ferguson believes that it is an integral part of the effort to develop links between industry and academia. Many cutting edge advances happen in industry rather than academia, and often industry has insight into technologies that are important.

“It’s also really important to see new discoveries from the science base in academia appropriately translated,” he explains. The most interesting developments come at the interfaces between disciplines or they come at the interfaces between different people, e.g. industry and academia, customers and researchers.



Image: © Science Foundation Ireland

Mark Ferguson, Director General, Science Foundation Ireland and Chief Scientific Advisor to the Government of Ireland

“Companies know they need to be associated with leading edge researchers, which is a mark of excellence for Ireland. Companies can choose to work with researchers anywhere in the world, and clearly they will want to work with the best researchers and equally with people who are user friendly and interested in doing what they are interested in.”

Ireland is only a small country, with around 4.5 million people. In comparison to other public sector budgets, science funding was not as adversely affected as it could have been by the economic downturn. As one of 5 up and coming countries in the world to watch in terms of science excellence, I asked Ferguson how he felt this could still be boosted further, in order for Ireland to be a top leader in science excellence.

“The key is to be world class with an appropriate diversity and mix of research. We have to prioritise and focus on things that are really important for Ireland, and ensure we have a unique selling point or advantage,” he explains.

“For example the maximum discharge of energy from

the Atlantic occurs on the west coast of Ireland and the west coast of Scotland. This shows clearly that ocean energy is something that geographically is a USP for us.

“We also have to be attuned to new and emerging areas, which by definition can be unpredictable, and some of those will be of real interest to Ireland. It’s about having a portfolio approach, supporting basic and applied research, focusing on and prioritising various areas. It’s about partnerships with industry, with charities and with other countries. Supporting both promising young scientists and established stars. Like I said, it’s a diverse mix.”

In his other role, as the Chief Scientific Advisor to the Government of Ireland, Ferguson is an advocate for science across all departments. Through their national and regional Action Plans for Jobs and the upcoming science strategy, the Minister for Skills, Research and Innovation Damien English TD said that “the government is focused on creating an environment in which excellent scientific research that impacts positively on Ireland and creates high

value jobs, as well as increasing commercial opportunities for start-ups and SMEs nationwide.”

In his Chief Scientific Adviser role, Ferguson explained that he is committed to reminding people in Ireland of the real importance of science.

**“There needs to be investment from the public sector, and also the private sector. Increasingly economic studies show that if you get this right, the public investment can crowd in the private investment – in other words, if you invest the countries public funding appropriately you can stimulate private investment, and clearly we want to do both.”**

“Scientific research produces positive outputs and impacts which are often very diverse and people need to be reminded of that,” he says. “People are interested in seeing where science can help solve and contribute to some of the challenges that we face, whether that be in agriculture, communications or electricity. It’s important to educate people and get them excited about advances that could be transformational.”

Ireland has one of the highest rates of participation in 3rd level education of any country in Europe. Ferguson believes that brain fluidity – researchers moving to other countries to work and learn – is a great asset for the country.

“People historically thought about it as brain drain,” says Ferguson. “I don’t think about it like that, I think about it as brain circulation. People will leave, but they also return, which gives particularly small countries like Ireland a really important international focus.”

Ireland is clearly on its way to becoming a global leader in science and research excellence, however there are always challenges in getting there. Following their 2014 annual report, SFI has outlined priorities for 2015 which include developing significant strategic partnerships with industry, charities and international funders.

“Prioritisation is always difficult,” says Ferguson. “By its very nature it means that there are some things that we will choose not to invest heavily in. If you happened to be in that area you might not like it – that’s just how it goes – it doesn’t mean it’s not important.

“My key challenge will be persuading everyone: Government, Industry and Philanthropy to invest more money in the public science base,” Ferguson explains. “That will be the first challenge and that will not be easy because there are many demands on the public purse. Whether it be for schools or health or roads, there are lots of people with public funding needs. Being on the priority list isn’t good enough, you need to be at the top of that list.

“If we’re successful the next challenge will be to make sure we deploy those additional resources in what we consider to be the best possible way,” he continues. “In other words, investing for the future on behalf of the Irish taxpayer. Life will be full of a lot of challenges, but that’s good!” ■



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## Medicinal Chemistry – driving therapeutic discovery

**Professor Craig Lindsley, co-Director and Director of Medicinal Chemistry of the Vanderbilt Center for Neuroscience Drug Discovery, Vanderbilt University outlines how medicinal chemistry plays a role in drug discovery...**

**M**edicinal chemistry is the application of synthetic organic chemistry to biological problems with the end goal of developing a novel small molecule therapeutic agent to treat an unmet medical need. Medicinal chemists are charged with understanding all aspects of drug discovery (chemistry, pharmacology, drug metabolism and in vivo behavior), and utilising these diverse inputs to design molecules suitable for use in humans while also enabling intellectual property position, e.g., patent protection. Moreover, the chemistry (e.g., chemical matter) varies across programs, and the medicinal chemist must be an astute synthetic chemist with a broad repertoire of chemical knowledge to be successful. It is often unappreciated, but like medical doctors, most medicinal chemists spend more than 10 years in undergraduate, graduate and post-graduate education before landing their first pharmaceutical position.

While drug discovery is the very definition of 'big team science', medicinal chemists are perhaps the most well-rounded of all the scientists, following programs from conception to the clinic. Without question, medicinal chemistry is the major force driving therapeutic discovery and improving human health over the last 100 years – from antibiotics to chemotherapy to schizophrenia. Consider the past 25 years of medical advancement for which medicinal chemistry has led the charge. Medicinal chemists have developed revolutionary treatments for HIV/AIDS, rendering it a manageable disease from what was formerly a death sentence, fundamentally changed cardiovascular health (and CV-related deaths) with the statins (e.g., Lipitor), produced game-changing cancer therapies that can add more than 10 life-adjusted quality years, and in 2014, with the launch of Sovaldi, an HCV cure that eliminated the need for liver transplants.

Great strides have also been made in terms of brain disorders and therapeutics for the central nervous system (CNS). Here, medicinal chemists play dual roles, developing not only the small molecule drugs, but also diagnostic and imaging agents to enable personalised, effective treatments across diverse patient populations. New small molecule therapies are under clinical development for schizophrenia, Parkinson's disease (PD), major depressive disorder (MDD) and Alzheimer's disease (AD) that represent novel mechanisms of action with disease modifying potential and offer efficacy far beyond the standard of care. For schizophrenia, medicinal chemists rescued patients from asylums and electroshock therapy, with drugs that address the positive, negative and cognitive symptoms and enable them to integrate back into society. To this point, the top selling small molecule drug last year was Abilify, an antipsychotic with world-wide sales in excess of \$9.2bn. In the case of PD, scientists have studied the brain circuit modified by invasive surgical procedure known as deep brain stimulation (DBS), identified molecular targets (proteins) that can be modulated to mimic DBS output, and then, medicinal chemists created small molecules to engage these targets and normalise these dysfunctional circuits. Three new drugs have launched in recent years for Multiple Sclerosis (MS), which have transformed how this neurodegenerative disease is managed, and medicinal chemists are now focused on neuroprotection/neuro-restoration strategies that will impact a broader array of CNS disorders. Here, in CNS drug discovery, medicinal chemists truly shine. Not only do they have to design and synthesise compounds to engage the desired target, but they must be orally bioavailable (e.g., a pill), cross the blood-brain barrier (evolutionarily designed to keep foreign chemicals out), and be safe to allow daily maintenance therapy for life. These are incredibly difficult requirements and challenging obstacles, but medicinal chemists surmount these issues, as they know patients are waiting, and driven to impact human health.

Despite these successes, medicinal chemists are under great employment pressure from the fiscal realities of outsourcing in developing nations, from downsizing/lay-offs due to mergers/acquisitions in the pharmaceutical/biotech industry, as well as pharmaceutical economics. Thus, the ranks have greatly dissipated, by approximately 70%, in the United States and Europe during the past 2 decades. These trends should alarm the public. When the next "HIV-like" epidemic emerges, we will have neither the needed number nor the diversity of medicinal chemists in place to effectively rally and combat such a scenario as we did in the 1990s, with disastrous results for society. Moreover, we should all consider Alzheimer's disease (AD), forecasted to affect 1 in 5 over 65 by 2030, for which we have no cure, only palliative treatments. Scientists and medicinal chemists need to focus on AD as the drug discovery challenge of this generation to find disease-modifying treatments.

Rest assured, it is not all gloom and doom – medicinal chemists are actively and passionately working on the design and synthesis of new small molecules to address the unmet medical needs of the day, gradually replacing invasive surgical procedures and extended hospitalisations with simple pills or capsules one can take at home, with great overall savings and benefits for society. The next time you have an ailment that a physician can prescribe a drug to treat, as opposed to surgery, you have a dedicated medicinal chemist to thank. ■

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# New Anti-infective Drugs with Punch

I've written before about the contribution that academic science can make to [drug discovery](#) and at the University of Strathclyde we're now beginning to see the real benefits. In a university we can take on projects that are perceived as too risky for industry at an early stage and combine the quest for new drugs with basic scientific discovery. That's the Strathclyde philosophy. In terms of the applications of heterocyclic chemistry, our most advanced programme is producing anti-infective compounds for a number of key diseases, especially bacterial and parasitic infections.

**“The outcomes of our research are not just the important practical applications but the advancement of the underlying science.”**

On July 13th MGB-BP3, our lead anti-bacterial drug developed by our partner company, MGB Biopharma, began phase 1 clinical trials in a formulation designed to treat *Clostridium difficile* infections. MGB Biopharma has also developed an intravenous formulation for the treatment of other Gram-positive bacterial infections building upon basic science from the University of Strathclyde (see <http://www.mgb-biopharma.com>). MGB-BP3 is the first in a line of new anti-infective compounds that ultimately work by controlling gene expression by binding to the minor groove of DNA in the target organism, according to the best evidence we have. It's one of a family



Left: MGB-BP3 formulated in capsules for treating *Clostridium difficile*

Right: a freeze-dried sample of MGB-BP3 for reconstitution as an intravenous medicine (courtesy MGB Biopharma)

of compounds that we call Strathclyde MGBs (S-MGBs).

We now have S-MGBs that are effective against a wide range of infectious organisms in particular Gram-positive bacteria and trypanosomes, the disease causing agent of sleeping sickness. We've been able to make such progress and to create such impact for several reasons. Firstly the S-MGB platform uses very flexible heterocyclic chemistry so that we can tune the properties of our compounds to target different pathogens whilst remaining safe for the infected host. Secondly, we have strong team-work between many academic colleagues in chemistry and biology at Strathclyde but also at the University of Glasgow. Thirdly, we've worked in partnership with MGB Biopharma; the company's ability to raise funds in a difficult economic climate and to drive through the development programme for MGB-BP3 has been extraordinary.

The outcomes of our research are not

just the important practical applications but the advancement of the underlying science. For example, we are developing new chemical technologies to synthesise the compounds we need to evaluate. Also in studying the effect of our drugs on the target bacteria and parasites we are discovering more about the internal workings of the infectious organisms. With such information available we would hope to devise new and more effective drugs for infectious disease.



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# Everyday chemistry

**David Cole-Hamilton, President of the European Association for Chemical and Molecular Sciences (EuCheMS) explains how chemistry is all around and plays an integral role in many sectors...**

**C**hemistry pervades everything we do. It is all around us and we could not live the lives we do without it. Manmade chemicals are all around us too. Without them, we would not be able to feed the world or have safe drinking water. We would not be able to drive our cars or cure diseases. Life would be much less comfortable without modern textiles, plastics, paints, etc. and we would have no mobile phones computers or televisions.

All of these very important uses of chemicals lead to a huge economic advantage for regions which have well developed chemical industries, and Europe is a good example of this. About a quarter of the balance of trade surplus of the EU comes from the chemical industry and about 1.2 million people work in chemistry and a further 2.4 million in jobs dependent on chemistry.

### **A renewable chemical landscape**

However, there are still huge challenges. Most of the manmade chemicals now in use are made from oil

based feed stocks, but oil is becoming scarcer and more expensive, threatening our current way of life. This presents a huge opportunity for chemists to develop new processes for making the many things we currently take for granted but from renewable resources. Most of these resources will be plant based, but they have to be developed without threatening the food supply. This means that they should mostly come from by-products of food production, especially cellulose and lignin. Current research into using these chemically rich but very difficult to work with resources is growing fast and will lead to a whole new chemical landscape.

### **Tackling climate change**

Climate change arises from burning fossil fuels in power plants, vehicles and industry. If we do not stop this endless pumping of carbon dioxide into the atmosphere, the planet will not be able to sustain our children and grandchildren. It has been suggested that climate change is the very worst problem affecting future life on earth.



**David Cole-Hamilton,  
President of the  
European Association  
for Chemical and  
Molecular Sciences**

Hydrogen is the perfect fuel because when it burns it gives very large amounts of energy and produces only water – no pollution and no greenhouse gases. At the moment hydrogen is made from fossil fuels, but it can be made from water using sunlight if the right catalysts are added. Potentially, this allows us to make a fuel from abundant water and to burn that fuel to regenerate the water used. Current research is aimed at increasing the efficiency and especially lifetimes of the catalyst.

**“About a quarter of the balance of trade surplus of the EU comes from the chemical industry and about 1.2 million people work in chemistry and a further 2.4 million in jobs dependent on chemistry.”**

#### **Controlling life-threatening diseases**

Tackling diseases of ageing, antibiotic resistant bacteria and cancer are all chemical problems. Huge progress has been made but much more needs to be done. Chemists, working in collaboration with biochemists and medical doctors hold the key to conquering these and many other diseases.

#### **How can EuCheMS help?**

EuCheMS, the European Association for Chemical and Molecular Sciences is an overarching body for all the chemical societies in Europe and as such it provides an independent and unified voice for 160,000 chemists. It aims to ensure that the European Parliament and the Commission are aware of the chemical aspects of

any legislation that is being considered; it responds to consultations concerning chemical matters issued by the European bodies and provides early information on chemical issues as they arise. It does this by running awareness events in the European Parliament. Recent or forthcoming examples include workshops on:

- Energy storage through chemical means;
- Using carbon dioxide as a feedstock for chemicals production;
- Preserving endangered elements; elements that are used in everyday consumer goods such as computers and mobile phones, but for which the total supplies are only sufficient for < 100 years.

EuCheMS also attempts to raise public awareness of these critical issues with recent public lectures related to securing clean food and water supplies for an increasing population, as well as to ways to make energy without producing any carbon dioxide or other greenhouse gases.

Finally, EuCheMS, through its Divisions and Working Parties, as well as through its biennial chemistry congresses – the next one of which will be held in Sevilla in September 2016 – keeps the chemistry community updated on the very latest developments that are occurring in all areas of chemistry. ■

If you would like to be involved in this exciting work, please sign up at [www.euchems.eu](http://www.euchems.eu).

**EuCheMS**   
European Chemical Sciences

**David Cole-Hamilton  
President**

European Association for Chemical and Molecular  
Sciences (EuCheMS)  
[www.euchems.eu](http://www.euchems.eu)

# A New Catalyst for an Ancient Bulk Chemical

A research group at DTU Chemistry shows, that zeolite recrystallization allows synthesis of extremely efficient gold nanoparticle catalysts...

This latest research from DTU Chemistry could revive one of the oldest processes in the chemical industry, namely production of acetaldehyde from ethanol. This principle has the potential to apply to a range of new catalysts.

A group of researchers at DTU Chemistry and at the Max-Planck-Institute für Kohlenforschung has managed to oxidize ethanol effectively and selectively into acetaldehyde by use of a novel type of zeolite catalyst with encapsulated gold nanoparticles.

"This is likely to be a favourable, green alternative to the so-called Wacker process, which dominates the world's current production of acetaldehyde. And hopefully this is just the beginning. This type of catalyst will in principle apply to a range of other reactions," says Associate Professor Søren Kegnæs from DTU Chemistry. DTU has patented the new type of catalysts, and Søren Kegnæs and his group hope that industry will be interested in cooperation on this.

## Gold nano-particles

While most other attempts to encapsulate metal nanoparticles in zeolites have relied on expensive additives and complex procedures, this new approach is both simple and effective. Crystals of the zeolite silicalite-1 are modified by recrystallization, which creates intra-particle voids and mesopores. The recrystallization is

performed in the presence base and a surfactant, which protects the outer surface of the crystals. Since the zeolite crystals are porous, the base will penetrate into the crystals and begin to dissolve them from within. The trick is to stop the process at the right time, when the inner voids have the optimal size. The voids will then be filled with a precursor solution containing a metal salt. The confined space provides ideal conditions for preparation of small and disperse gold nanoparticles inside the zeolite crystals.

## A clever way to use bio-ethanol

To prove their creation of efficient catalysts, the researchers chose to catalyze oxidation of ethanol into acetaldehyde.

"We chose the ethanol process, because bio-ethanol receives large attention these years, since it is a renewable resource," Associate Professor Søren Kegnæs explains.

"If you want to use ethanol as fuel you need to get rid of the water content, which will cost you a rather high amount of energy. It would thus be interesting to find an alternative use of the bio-ethanol in which a high content of water is not a problem. This is the case for the production of acetaldehyde," notes Søren Kegnæs.

"Also, this revival of ethanol as source for production of acetaldehyde has some benefits in comparison with the

use of ethylene, since ethylene is produced from crude oil which is a non-renewable resource."

The results are published in *Angewandte Chemie, Oxidation of Bioethanol using Zeolite-Encapsulated Gold Nanoparticles*.

## International cooperation

Associate Professor Søren Kegnæs emphasizes the cooperation on this project between DTU Chemistry and the Max-Planck-Institute which was made possible by a grant from the Danish Council for Independent Research (FTP).

"The cooperation takes place in a very open atmosphere, with a high degree of sharing ideas and having students visit for shorter or longer periods of time."

**DTU Chemistry**  
Department of Chemistry

**Søren Kegnæs**

**Associate Professor**

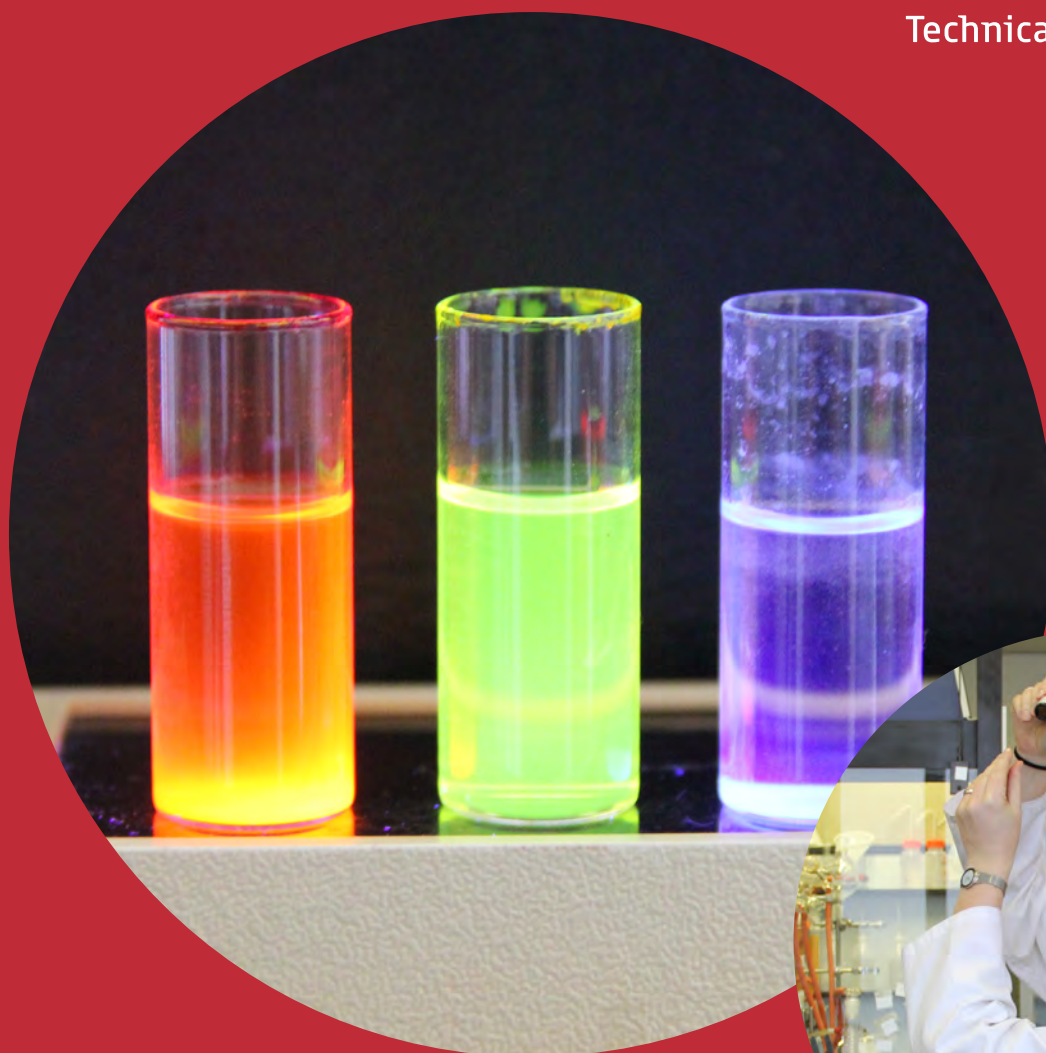
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Technical University of Denmark

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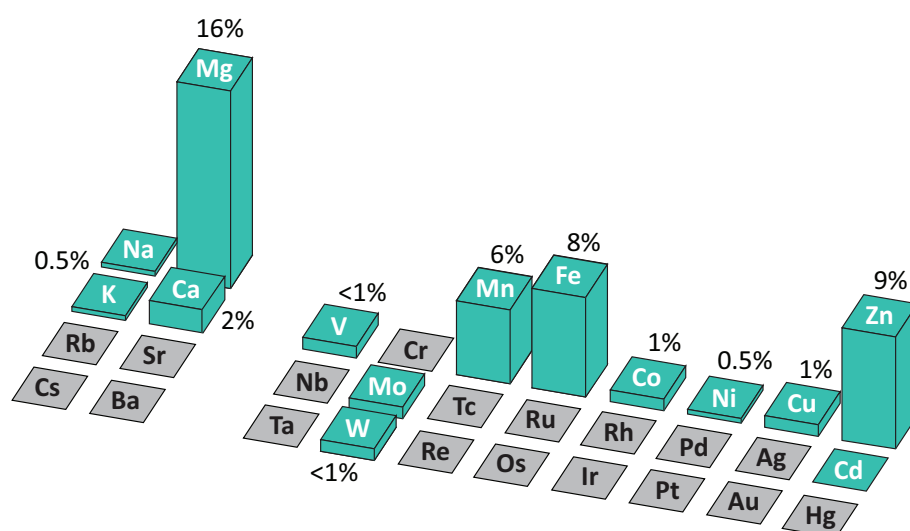
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# Metals in Biology: Elements of the Bioeconomy

At the beginning of 2014 the UK Biotechnology and Biological Sciences Research Council (BBSRC) established thirteen Networks in Industrial Biotechnology and Bioenergy.<sup>1</sup> An aim of these networks is to reduce the barriers for initiating collaborations between the academic and business communities, especially in the arena of Industrial Biotechnology. One of the networks entitled “Metals in Biology: The elements of Biotechnology and Bioenergy”,<sup>2</sup> has seven themes: Metals in bioprocessing, metals in the environment, metal-related nutrition and supplements, metallo-enzyme engineering, tools for metals in biology, metal circuits for synthetic biology and metal-related antimicrobials. Here this network is introduced, giving background to two themes with events planned this year.

Metals are used as industrial catalysts to drive reactions that produce valuable chemicals. Metals also catalyse a substantial proportion of the reactions of life.<sup>3</sup> Using cellular enzymes whose structures are known as a representative sub-set, nearly a half (47%) of enzymes are estimated to need metals. The proportions of the individual elements which make-up this surprisingly large fraction are illustrated (figure reproduced from Nature, 2009<sup>3</sup>). A second key observation is that metal-requiring enzymes readily bind to wrong metals in preference to the metals needed for activity.<sup>4</sup> This creates the potential for



Nature (2009) 460, 823-830

enzymes to become inactivated by mismetalation. In this respect life seems perilously ill-designed, but in truth it has not been designed at all, rather it has evolved in the face of changing metal supply. This has selected for ‘circuits’ to assist proper enzyme metalation. Over the past three or more decades, many of the genes encoding components of these circuits have been discovered: Genes that encode proteins which import specific metals into cells, others which export, store or deliver metals and yet more which sense metal sufficiency or deficiency.<sup>4</sup> These discoveries now create opportunities to engineer metal-circuits to enhance the metalation of desirable enzymes to the benefit of industrial biotechnology. Although beyond the scope of industrial biotechnology, this knowledge also makes it possible to study how these circuits fail in numerous chronic diseases and to devise ways to subvert metal circuits to eliminate

unwanted cells for therapeutic purposes. As an aside, a common observation from the BBSRC NIBB is that fundamental knowledge of life processes tends to spark innovation across the entire bioeconomy including biomedicine, bioenergy, agritechology, nutrition, health, ecosystem management and not solely restricted to one sector such as industrial biotechnology.

**Metal circuits for synthetic biology:** Isobutanol is an industrial feedstock which is typically manufactured from fossil fuels. It can also be made biologically through the action of enzymes such as Dihydroxy Acid Dehydratase (DHAD)<sup>5</sup>. In many organisms this enzyme uses iron in the form of iron sulfur clusters and cells have a specialised machinery for assembling and distributing these clusters.<sup>5,6</sup> To generate a commercial fermentation process for the sustainable production of isobutanol, DHAD

has been engineered into yeast cells. Patents document how the iron-sensing circuitry of yeast can be adjusted to ensure a sufficient supply of iron sulphur clusters to support the extra demand created by the introduced DHAD<sup>5</sup>. With so-many enzymes needing metals, this exemplifies an opportunity to engineer wide-ranging metal circuits in order to enhance metalation of chosen enzymes to boost targeted reactions in support of the bioeconomy. For example, key enzymes required for the capture and utilisation of C<sub>1</sub>-gases (carbon dioxide, carbon monoxide and methane) have exotic metal demands including the nickel-containing F430 cofactor and cobalt in vitamin B<sub>12</sub>. Later this year, there will be a joint event between the Metals in Biology and the C1Net BBSRC NIBB<sup>7</sup> to consider improving C<sub>1</sub> gas capture by manipulating metals.

#### **Metal-related antimicrobials:**

Historically, some unpleasantly hazardous metals have been used to treat infections such as mercury for syphilis, arsenic and antimony for Leishmania. In agriculture, copper sulphate in Bordeaux mixture is an effective fungicide for treating vines, and hospital trusts have replaced steel fixtures and fittings with copper ones, since copper surfaces (unlike those containing iron) are antimicrobial barriers. A range of products contain metal chelants such as Ethylene Diamine Tetra Acetic acid (EDTA) with preservative, antimicrobial, action. A well known shampoo, which generates multiple billions of dollars of revenue each year, contains Zinc Pyrithione (ZPT) which interferes with the iron handling circuitry of fungi through a cunning sequence of biochemical interactions which also involve copper.<sup>8</sup> ZPT treats dandruff

which is triggered by the fungal microflora of the scalp. But there is a much longer history of using metals to fight microbes, because immune systems have evolved to exploit metals to combat infections. This is emerging as a new sub-discipline called nutritional immunity.<sup>9</sup>

**“An aim of these networks is to reduce the barriers for initiating collaborations between the academic and business communities, especially in the arena of Industrial Biotechnology.”**

Iron often limits life, from restricting primary productivity in the oceans to a most prevalent human dietary deficiency, anaemia.<sup>10,11</sup> Microbial pathogens fight to obtain this valuable element from hosts, often releasing iron scavenging siderophores. This has triggered an evolutionary arms race fought on a battle ground of iron, with hosts producing defensive siderocalins to bind siderophores, in turn selecting for stealth siderophores which the siderocalins fail to recognise, combatted by stealth siderocalins from adapted hosts and so on. Host immune cells such as macrophages engulf microbes whereupon a specialised protein, Natural Resistance Associated with Macrophage Protein 1 (NRAMP1), helps to kill the entrapped invader. Some years after its discovery, NRAMP1 was found to pump vital metals such as iron from the microbe-containing compartment, presumably to starve it of essential elements. The compartment subsequently fills with a toxic dose of copper. Calprotectin is liberated from other immune cell types, classes of neutrophils, to scavenge zinc and manganese, starving microbes of these essential elements.<sup>9</sup>

As details of the cell biology of metals are uncovered, it becomes possible to tailor more precise antimicrobial treatments by design, not just stumbled upon empirically or by evolution. Metals, and by implication chelants, ionophores, and agents that interfere with the metal-handling systems of microbes and hosts, are increasingly recognised among the promising candidates for new antimicrobials.<sup>12</sup> Another upcoming BBSRC NIBB event will highlight advances in understanding metal-handling systems of microbes and hosts, explore why metals are a microbial “Achilles heel”, and encourage innovation at this academia-business interface.

1 <http://www.bbsrc.ac.uk/about/institutes/nibb/>

2 [http://prospect.rsc.org/MiB\\_NIBB/](http://prospect.rsc.org/MiB_NIBB/)

3 Nature (2009) 460, 823-830.

4 J Biol Chem. (2014) 289, 28095-28103.

5 <http://www.gevo.com/about/our-business/intellectual-property/>

6 Nature (2009) 460, 831-838.

7 <http://www.c1net.co.uk/>

8 Antimicrob Agents Chemother. (2011) 55, 5753-5760.

9 Nature Reviews Microbiology (2012) 10, 525-537.

10 Nature Geoscience (2013) 6, 701-710.

11 Nature (1999) 397, 694-697.

12 Nature (2015) 521 402.

# Metals



## IN BIOLOGY

**Prof. Nigel J Robinson**

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Image: © ETH Zurich

# Research and innovation – Investing in the future

**State Secretariat for Education, Research and Innovation (SERI) highlights to Adjacent Government how research and innovation is gaining momentum in Switzerland, as it remains one of the most innovative countries in the world...**

**R**esearch and innovation have gained increasing importance in light of social and environmental challenges. With its highly knowledge-based economy, Switzerland spends heavily on education, research and innovation and gives priority to international networking. The private sector and public sector are equally committed – and both actively contribute – to ensuring that Switzerland remains one of the most innovative and competitive countries in the world.

The Swiss higher education landscape is comprised of a diverse and comprehensive range of high-quality cantonal universities, federal institutes of technology, universities of applied sciences and universities of teacher education. Swiss higher education institutions have demonstrated internationally recognised

performance and have made significant contributions to the economic, cultural and social development of our country. The quality of the Swiss higher education sector is reflected, among other things, in international university ranking lists. Swiss universities hold strong to very strong positions in these international ranking lists. Foreign nationals account for around a quarter of all students, and over 40% of researchers enrolled at Swiss higher education institutions.

## **Mutually supportive dynamics between the public and private sector**

The traditional distribution of private and public sector roles has meant that fundamental research has mainly been the preserve of federal institutes of technology and cantonal universities. In contrast, applied research as well as the development of research

findings into marketable innovations have mainly been driven by the private sector and the universities of applied sciences.

Public expenditure for research is mainly the result of personal initiatives on the part of researchers. Research funding is awarded on a competitive basis, according to qualitative assessment criteria. The Confederation is responsible for providing research funding through 2 federal agencies: the Swiss National Science Foundation (SNSF) and the Commission for Innovation and Technology (CTI). The Confederation also provides funding to the institutions and research institutes within the ETH Domain as well as to 30 non-university research infrastructures. For their part, the Cantons are responsible for managing and co-funding cantonal universities and universities of applied sciences.

Considerable weight is given to expenditure on education and research: just under 6% of Swiss GDP is devoted to education each year, around 3% more is spent on research and development activities. It is mainly private companies that invest the most in R&D, each year spending around CHF 13 billion (2012). This corresponds to about one-third of their total expenditure.

### **Creating ideal general conditions for research and innovation**

The Swiss Confederation does not pursue an innovation policy per se – industrial policy is not an option. Nevertheless, the state does have a central role to play: it must create favourable conditions for private sector innovators as well as for researchers. These include a good-quality education system, which can provide highly trained workers for all phases of the innovation chain.

In addition to its higher education sector, Switzerland has a good-functioning system of vocational and professional education and training (VPET), which receives strong support from the private sector. Education and training is centred on the competences that are actually in demand as well as on occupations

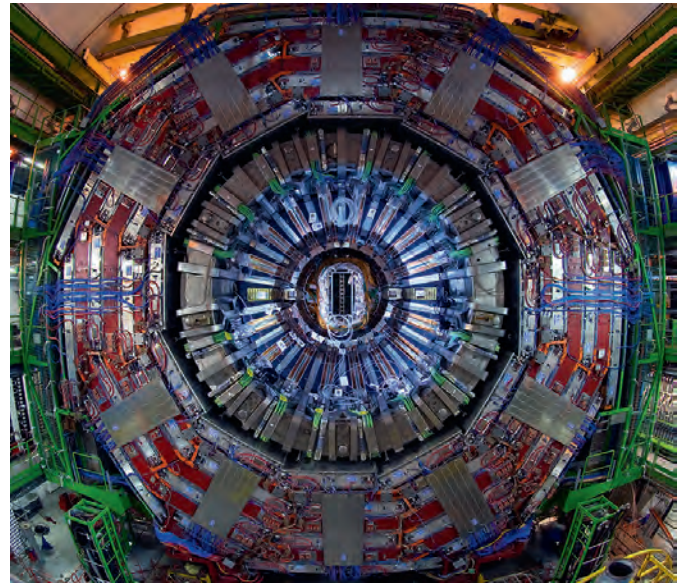


Image: © CERN

Based in Geneva, CERN, the European Organisation for Nuclear Research, is the largest particle physics research facility in the world. With help from giant particle accelerators such as the Large Hadron Collider (LHC) – the biggest of its kind in the world. CERN researchers are able to study the basic constituents of matter and how elementary particles interact

and professions for which there are existing job vacancies. This direct correlation with the labour market is the main reason why Switzerland has one of the lowest youth unemployment rates in Europe.

Other general conditions include fundamental and applied research; advisory and networking support for small- and medium-sized enterprises; reliable protection of intellectual property; removal of administrative hurdles; and finally, access to international knowledge and technology transfer. It is precisely this final point – international knowledge and technology transfer between higher education institutions and economic partners in different countries – that is of paramount importance.

### **Excellent research achieved thanks to international cooperation in research**

International research cooperation is very important for Switzerland. First of all, it enables our country to play a part in numerous international research organisations such as CERN, the European Space





Image: © SERI

Switzerland's international ERI Network

Agency ESA, the Europe-wide network for cross-border cooperation in market-driven industrial research and development EUREKA, and COST the initiative for European cooperation in science and technology, as well as in multi-year research programmes such as the EU's research framework programmes.

In addition to this foreign scientific policy focussed almost exclusively on continental Europe, the federal government has recently set a new initiative for bilateral cooperation with priority partner countries outside Europe. The federal government has 3 main instruments to implement its bilateral foreign scientific policy:

- A network of Swiss science and technology counsellors, who are stationed in strategically important regions around the world;
- Swissnex, Swiss houses for scientific and technological exchange abroad, that help raise the level of awareness of Switzerland as a location for expertise and know-how;
- Specific programmes to promote research cooperation with selected priority countries. ■

**Key figures for Switzerland**

Surface area: 41,300 km<sup>2</sup>

Population: 8 million inhabitants

National languages: German, French, Italian and Romansh

GDP: USD 440 billion (2013)

Per capita GDP: USD 54,130 (2013)

Annual GDP growth: 2% (2013)

Publication "Higher education and research in Switzerland":  
[https://issuu.com/sbfi\\_sefri\\_seri](https://issuu.com/sbfi_sefri_seri)

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# Non-Human Primate (NHP) Research in Switzerland

In the context of a Project of Cooperation and Innovation (PCI) launched by the Swiss State Secretariat for Education, Research and Innovation (SERI), the Universities of Fribourg and Zürich coordinated research activities on non-human primates in the academic domain by creating a "Swiss Primate Competence Centre for Research" (SPCCR), with the goal to unify scientific and ethical procedures at national level.

In the previous article, the Swiss State Secretariat for Education, Research and Innovation (SERI) reports on its efforts to promote research and innovation in Switzerland. Among the various initiatives taken to achieve this goal, in collaboration with the Swiss Conference of Universities (SUK – CUS), the SERI launched in 2013 a Project of Cooperation and Innovation (PCI) aimed at developing and reinforcing centres of national interest in the field of research and innovation. The universities of Fribourg (UniFr) and Zürich (UniZh) submitted a project, with the goal to coordinate at national level their research activities based on the experimental animal model of Non-Human Primate (NHP). The project financially supported by this PCI program (2013-2016) led to the creation of a Swiss Primate Competence Centre for Research (SPCCR), grouping the activities taking place on the two academic sites, at UniFr and at UniZh. On both sites, research based on the model of NHP was initiated more than 40-50 years ago, without however systematic coordination and cooperation.



Facing new challenges, both scientific and ethical, the senior researchers of the NHP laboratories of UniFr and UniZh decided to unify and coordinate their procedures in order to guarantee the best standards. In particular, the competences required to work on monkeys are rare and cannot be simply extended from those acquired on other animal models (e.g. rodents), due to the high specificity of NHPs both on the scientific and ethical levels. Indeed, working with NHPs requires a very long training with expert scientists, themselves active in the field since several decades. To this aim, and to train young scientists, a first goal of the SPCCR was to offer in Switzerland a specialised training course of 3 days (LTKE20), recognised by the veterinary authorities, to young scientists active in NHP laboratories or willing to have access to this animal model. In close collaboration with the pharmaceutical industry in Basel, also hosting NHP facilities, the SPCCR organised this training course in

autumn 2014, to which about 30 scientists attended during three days, one in Fribourg, one in Basel and one in Zürich. Numerous facets of NHP research, including ethical and welfare issues, were covered in order to prepare the young scientists active in the NHP field to become independent junior group leaders. A similar training course on NHP research will be organised by the SPCCR in winter 2016 for new comers in the field, but also addressing original aspects not covered in the training course in 2014. These efforts in the training of scientists working with NHPs also include the technical personal associated to the sites of Fribourg and Zürich, namely the animal care takers as well as the laboratory technicians. A refined training of the latter category of personal is crucial in the sense that they have long-term contract and thus they are responsible for the transfer of knowledge and competence to the Ph.D. students and post-docs joining the NHP laboratories.

On the scientific point of view, the SPCCR was created with the goal to reinforce the two academic NHP sites, Fribourg and Zürich, by exchanging expertise and competence in various domains, such surgery, anaesthesia, analgesia, animal welfare, conditions of housing, etc. In 2010, the Swiss legislation was modified, introducing new conditions of detention for macaque monkeys. They have to be hosted now in detention rooms of at least 45 m<sup>3</sup>, for group of monkeys ranging from 2 to 5 individuals. As compared to the previous guidelines, for the same number of animals, the volume of detention was increased by a factor of 3 (previously 15 m<sup>3</sup>). The present conditions of detention are illustrated on a video sequence available on the web site of the SPCCR:

[www.unifr.ch/spccr/about/housing](http://www.unifr.ch/spccr/about/housing)

Under the umbrella of the SPCCR, the two academic sites of NHP research in Switzerland, in Fribourg and in Zürich, pursued their long tradition of research in the field of neuroscience. In particular, as of 2000, NHP models of spinal injury (e.g. Freund et al., 2006, 2009), of cerebral cortex lesion (e.g. Kaeser et al., 2011; Wyss et al., 2013; Hoogewoud et al., 2013) and Parkinson disease (ongoing) were developed in order to test essentially two promising therapeutic strategies:

- Neutralisation of neurite growth inhibitors (e.g. Nogo-A) normally present in the adult central nervous system, preventing regrowth of injured axons, using an antibody against Nogo-A;
- Transplantation of autologous adult progenitor cells.

As shown by the above mentioned studies, these two therapeutic strategies promote better functional recovery either from spinal cord injury or from lesion affecting the cerebral cortex, paving the way towards clinical tests on patients. These studies gave the opportunity to develop new imaging procedures applied to the NHPs, namely MRI (magnetic resonance imaging) and PET (positron emission tomography). These imaging approaches contribute to a refinement of the NHP procedures, in line with the goal of the 3Rs initiative, to which the SPCCR fully adheres.

An additional goal of the SPCCR is to open its NHP infrastructures to researchers of other academic sites of Switzerland, where such animal model is not available. The SPCCR provides its expertise and competence to host new research projects originating from other institutions. Such collaboration already took place recently in the form of common projects with the Universities of Geneva and Lausanne, resulting for instance in the development of a non-invasive electrophysiological approach in NHPs based on EEG (Gindrat et al., 2014). As of autumn 2015, a new collaborative project will be initiated together at UniFr with the federal institute of technology of Lausanne (EPFL), with the goal to establish a model of locomotion in macaque monkeys. This model will serve as pre-clinical trial for the treatment of spinal cord injury based on electrochemical stimulation. In summary, the SPCCR project represents the ideal vehicle to guarantee access to the crucial NHP animal model in Switzerland, indispensable for both fundamental and clinically oriented research.

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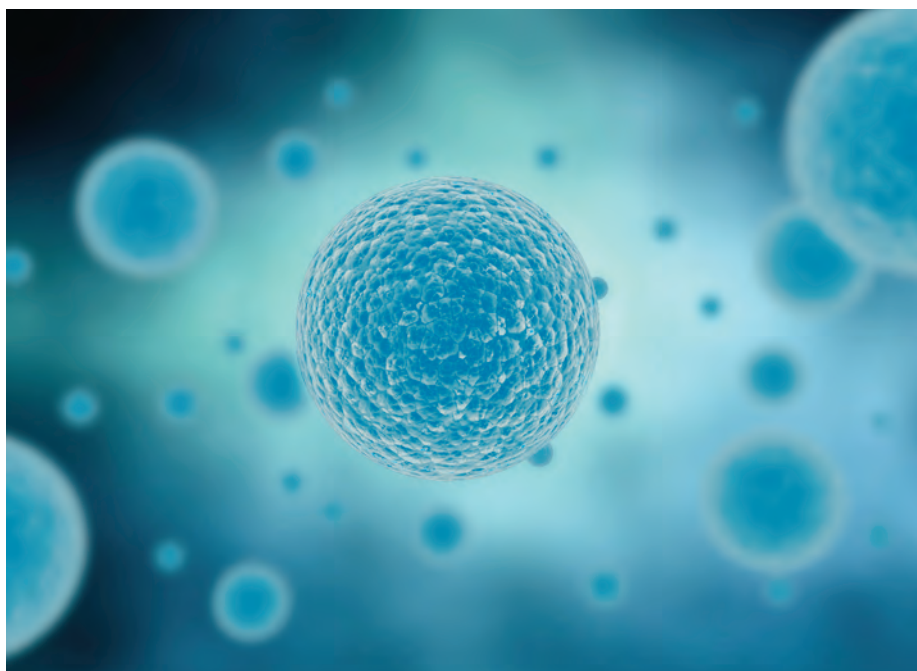
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# The formless environment of cells

Talking about non-chemical cell communication based on cell's endogenous electromagnetic fields, a Science colleague once said: ... If such non-chemical cell communication existed we would know it already for a long time. Non-chemical cell communication (NCCC) refers to cellular communication that is not based on chemical signals (such as e.g. neuro-transmitters, hormones, or kairomones) but on physical signals like electric current, electrostatic fields, and acoustic or electromagnetic waves.

Why is there so little known about NCCC in Life Sciences? Has it to do with the philosophy of Science still referring to purely material aspects of molecules. Is there a lack of emancipation from scientific dogma to look for enlarging theories and evidences? Are there competing interests with NCCC not being recognised as new research fields adding to biology in general? How much this plays (or played a role in the past) one can speculate about, however, we believe that the major reason is the current lack of information about NCCC. This is why the author had started together with Michal Cifra and Felix Scholkmann editing the open-access eBook *Fields of the Cell*, which goes online in due time.

We refer therein mainly to endogenous electrodynamic fields, i.e., electrostatic and electromagnetic fields of the cell, and wish to make aware about the



electrodynamic world of biological cells. An increasing number of scientists dedicate their research to this new field and we may ask whether they prepare the biology of the 21st century.

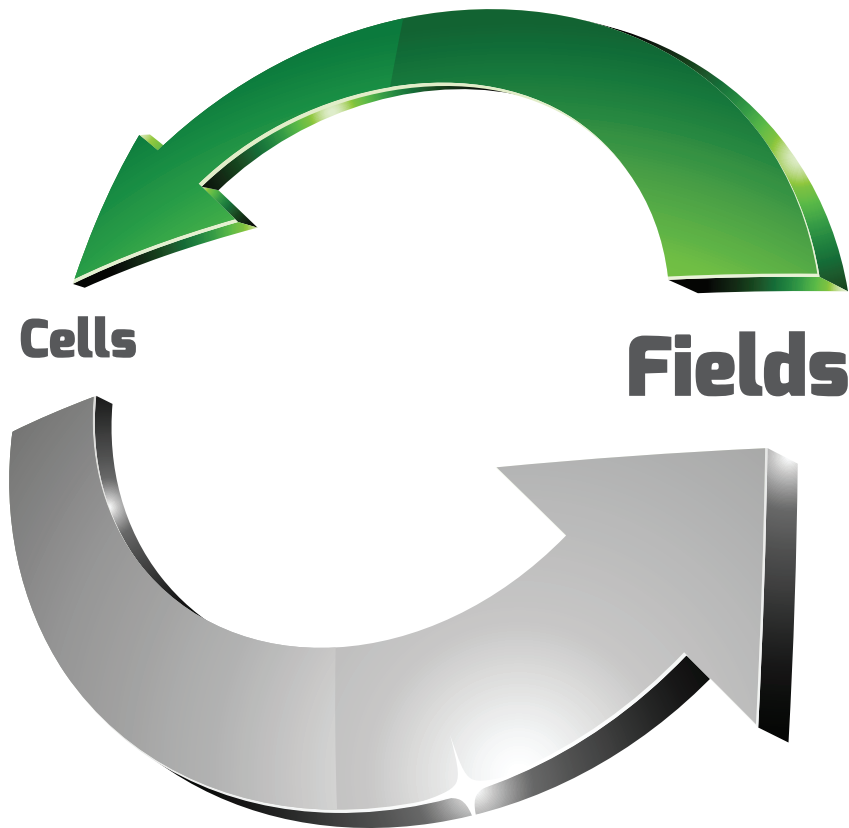
The major hypotheses of the book *Fields of the Cell* is that currents and electromagnetic fields, which occur immanently due to cellular polar structures and charged particles, affect this (polar) structures of cells. This in turn affects the electrodynamic fields of the cell (confer Figure 1). As a result cell dynamics reflect not only reciprocal causality between molecules but also between (polar) molecules, ions and the corresponding electrodynamic fields of the cell. To this end a series of specialists have been invited to write in their particular subfield a

review article. The goal of the project is that these reviews may serve as an introduction into the topic of the fields of the cell.

Over the years the author had realised that often Life Scientists think in terms of matter or molecules as limited to the boundary of their body. Yet, molecules vibrate and exhibit charge movements, creating fields that extent the sphere of influence of these molecules. A question of significant importance is whether these extensions play a role in cell dynamics, even more whether cells use these fields to induce functions that belong to life.

In a nutshell, a distinction between matter and the extension of matter is the sun and its (visible) rays: The sun





**Figure 1: The majority of molecules of cells consist as polar structures. These structures and the chemical reactions happening with and on them are the origin of fields. In turn, electrodynamic fields affect polar structures and chemical reactions**

is a physical (material) body in space and its visible rays are its extension. These rays are defined as electromagnetic waves, deliverer of the energy that drives our ecosystems. Primary responders to these sunrays are nanostructures embedded in cells and standing at the beginning of biochemical processes such as vision or photosynthesis. So, cells are able to perceive and respond to electromagnetic waves. In the book *Fields of the Cell* we focus on the capability of cells to build and use their own electrodynamic fields.

#### **A short view on the chapters of the open-access eBook *Fields of the Cell***

The first chapter introduces the history of the field concept in biology from the early 20th century to recent times covering all important milestones

and related theories on non-equilibrium, non-linear and coherent behavior of biological systems. The second chapter explains the physical view on the electromagnetic field and photons. The electromagnetic spectrum is described as well as coherence, interference, resonance and interactions of an electromagnetic field with matter. Chapter three then gives an overview of detection techniques for ultraweak photon emission, such as observed from biological systems. Chapter four describes fundamental features of living system that are nonlinear and far from thermodynamic equilibrium: a rise of order from disorder. This is possible for cases where energy is flowing through the system and the system is able to dissipate the disorder (entropy) to its surroundings. Doing so, internal ordering of the system is achieved. In chapter five we

come across experimental findings about water behavior indicating that water at hydrophilic interfaces is the simplest non-equilibrium system able to transform disordered to ordered energy. Hence, a theory of coherent water domains will be presented, explaining both, well-known and newly observed properties of water. It is concluded that water plays a central role in the dynamics of biomolecules and therefore also subsequently in the generation of the cellular electrodynamic field.

One of the manifestations of living system's non-equilibrium behavior is the permanent production of electron excitation in biomolecules leading to ultra-weak photon emission. Based on solid experimental evidence, chapter six explains the generation of electron excited molecular species due to free radical and reactive oxygen species reactions. Biological ultra-weak photon emission is of very general nature. It is detectable from every metabolically active biological species under suitable conditions. Chapter seven focuses on ultraweak photon emission from multicellular organisms, namely plants, tumor tissues and humans. It relates photon emission to development and structure as well as to tumor and normal cells comparing them with reference to growth properties. The eighth chapter explains the peculiar phenomenon of non-chemical influences between cell cultures through glass barriers. It is suspected that the non-chemical interaction between cell cultures is mediated by photon emission gener-

ated by cells. A special emphasis is given on confounding effects and the method itself in order to gain understanding about the function. As statistical properties of biological ultra-weak photon emission have been a source of controversy in past decades; chapter nine assesses available experiments studying optical coherence, quantum states and signal properties of biological ultra-weak photon emission. Chapter ten aims to explain that the electrodynamic activity of living cells involves a broad range of frequencies, namely from kilohertz to terahertz. These frequency ranges are related to electromechanical vibrations of subcellular structures. It is hypothesised that electrodynamic fields generated by such sub-cellular coupled oscillations contribute significantly to biological self-organisation.

Figure 2: Fields of the Cell was a book project that started in 2011 when it became clear that a vast amount of scientific papers was scattered over many journals, countries and scientists; a unification of that particular knowledge about endogenous electrodynamics of cells was needed. It could have taken a researcher interested in that topic years to get an idea about the amount of evidence and hypothesis. We wanted to shorten this by reviewing major aspects. At the same time we wished the book to be an introduction for all those that find the courage to step or rather think out of the box. Also, we intended to restrict ourselves (the authors of the different chapters) to a great extent to evidence-based results keeping

speculation and hypothesis building at a low but still justified level. Even though in the mean time a large body of new results appeared, we nonetheless, believe that Fields of the Cell gives a great hand for anyone who enters the field and wants to catch up with the spindrift. We are convinced that we are at the beginning of a long and vast discovery.

Can biomolecules interact over long distances within a cell in order to find their chemical partners earlier than just by diffusion? Chapter eleven explains under which conditions such interactions can indeed take place using a model that involves resonant electrodynamic interactions of biomolecules. Rising to a macroscopic level, we come in chapter twelve across the collective activity of neurons giving rise to synchronous electric events in the brain. Such events are also known as preconditions for conscious acts to occur. Both, the potential role of photons emitted from neurons and being part of a time-sensitive signal flow within the brain (and the body) as well as synchronicity between distant brains are discussed with care. Coming down again to the microscopic world, the organisation and signal processing on the level of single eukaryotic cell and especially neurons is crucially dependent on the cytoskeleton. In chapter thirteen the electric properties of microtubule and actin filaments are described as well as their possible role in cell signaling. Chapter fourteen then guides us from early biological field concepts to a modern theory of

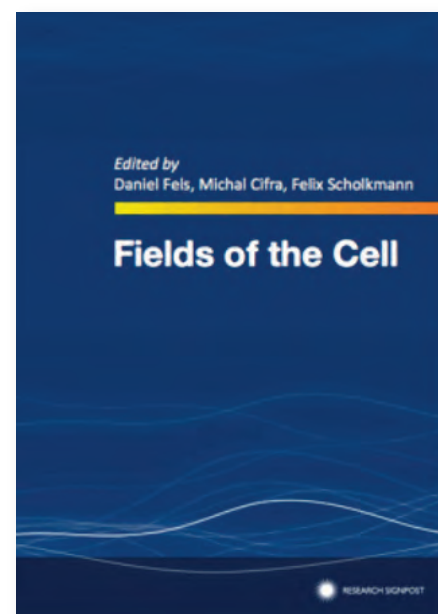


Figure 2: Fields of the Cell book

biological self-organisation involving the coupling of fields from mechanic, electric and electromagnetic origin. Chapter fifteen provides us with condensed information on how tissue and cellular electric fields modulate the transcription of genes and shows, thus, basic principles of how cellular electric fields are coupled with biochemical pathways. The final chapter introduces the fact that biological objects, as any other dielectric objects, are able to store electromagnetic energy as cavity resonators under certain conditions. In resonators, electromagnetic energy is stored only in certain shapes (modes) at a certain frequency. Here it is proposed, that the spatial distribution of electromagnetic energy in such biological resonator provides conditions for symmetry breaking which guides differentiation and pattern formation during plant organ development.

### Misunderstandings about NCCC

- NCCC is a competing theory to existing molecule-based understanding of life. No, it is not. Molecules exist, they are the material fundament of life and some of them work also as signals. These are observational truths, which nobody touches. NCCC is adding an additional function to molecules, namely their electrodynamic extension with effects on cell dynamics.
- NCCC is a purely theoretical concept. No, it is not. Cells emit electromagnetic waves from low to extremely high frequencies and build also membrane potentials of different voltages all of which has been measured.
- NCCC refers to meaningless by-products of (some) chemical reactions. No, it is not. The emission of electromagnetic waves of cells is primarily not correlated with temperature (but chemical reactions are) and there is evidence for functionality of these emitted waves. Further, electric currents are measured as well as there effects across cells and, furthermore, electrostatic fields are measured with effects, e.g., on cell migration and/or differentiation.
- NCCC is esoteric. No, it is not. One may (must) argue that those who claim this argument of a non-scientific explanation about life are simply not informed and abuse thereby the term NCCC.
- NCCC is an irrelevant, even though new branch in science. No, it is not.

NCCC is highly relevant: Strictly speaking do we have to doubt any experiment that did not control for NCCC but claims molecules solely were responsible for described effects.

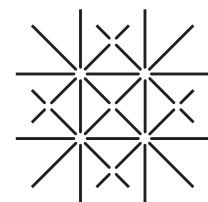
- NCCC will not help to understand open questions in science. No, this is not so. There are open questions e.g. on form giving cell migration during embryogenesis (what gives form is still a conundrum), on stem cell differentiation, on coherence among billions of cells within one organism, on fractal structures of ecosystems, on cell sensitivity to external electromagnetic sources, on heritage and more. One may even add, that NCCC not only offers answers but also highly interesting new questions. Questions drive the development of science.

### Outlook

Recent papers teach us that (i) solar rhythms can have effects on incidence rates of human pathogens or cancer, that (ii) cells, i.e. whole organs respond to thunderstorms e.g. with heart strokes. Cells also respond to microwaves as shown in a study with a switched on smart-phone in close vicinity to a cell population of the ciliate *Paramecium caudatum*: under this treatment the cells displayed decreased cell division rates and malformations of their habitual cell shape (Cammaerts et al. 2011, in: *Electromagnetic Biology and Medicine*). Evidently, cellular reactions to external non-material physical factors may not only be adaptive, they can also be detrimental. In a recent review entitled

“Life Rhythm as a Symphony of Oscillatory Pattern: Electromagnetic Energy and Sound Vibration Modulates Gene Expression for Biological Signaling and Healing” (Muehsam & Ventura 2014, in: *Global Advances in Health and Medicine*), the authors refer to a series of exogenous non-material physical factors affecting life. In order to better understand how external fields affect (the fields of) cells one may recall that resonance refers to inducing frequencies and the Eigenfrequenz of the responding (resonating) structure. In this context it is considered mandatory to study the reciprocal causality between the fields and the molecules of the cell.

D | Departement  
U | Umweltwissenschaften  
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# STEM for growth, resilience and opportunity

**Claire Donovan, Head of Engineering the Future at the Royal Academy of Engineering outlines the benefits of STEM in society and to the economy...**

A simple web search summons a great deal of published evidence of the links between a country's performance in science, technology, engineering and mathematics (STEM), and its economic resilience. A report released earlier this year by the Engineering and Physical Sciences Research Council (EPSRC) and Royal Academy of Engineering highlights that the engineering sector alone contributed £280bn gross value added (GVA) in 2011. Additional indirect benefits include, the correlation between innovation and sectors with high concentrations of applied science skills and the value of world-class STEM research to the productivity of multiple sectors.

Assuming recognition of the fact that STEM yields economic and societal benefits, how to increase the volume of highly desirable STEM skills in the country becomes a key focus area. As a nation, we are rightly proud of our industrial heritage, our inventors and our academic excellence in STEM. The danger lies in thinking that, on a personal level, STEM is for 'someone else'. This can happen when people think about STEM as an amorphous collection of facts and processes, rather than thinking about the people and organisations that use STEM to enhance our lives.

The Royal Academy of Engineering has worked with many partners over the years to address this issue. Our publication, "Thinking Like An Engineer", which was published in 2014, delved into the 'habits of mind' which engineers tend to exhibit. The picture that emerged was of individuals who are capable, in varying degrees, of a whole range of valuable thought processes. From systems thinking to visualising and creative problem-solving, to adapting existing items and processes, engineers shape and change the world around them for the better. The 'habits of mind' that make a great engineer are valuable in any career.

We already know that STEM graduates earn significant wage premiums and that STEM subjects provide the widest possible breadth of opportunity for progression. Why isn't STEM therefore the sole focus of economic and educational policy?

## Seeing STEM everywhere

Part of the reason is that STEM is often hidden in other areas and subjects. While science and maths are clearly identifiable in the school curriculum, other subjects, such as art, conceal a strong STEM element. Similarly, many careers depend on STEM-related knowledge and skills, but this requirement is not immediately apparent.

## Who is STEM 'for'?

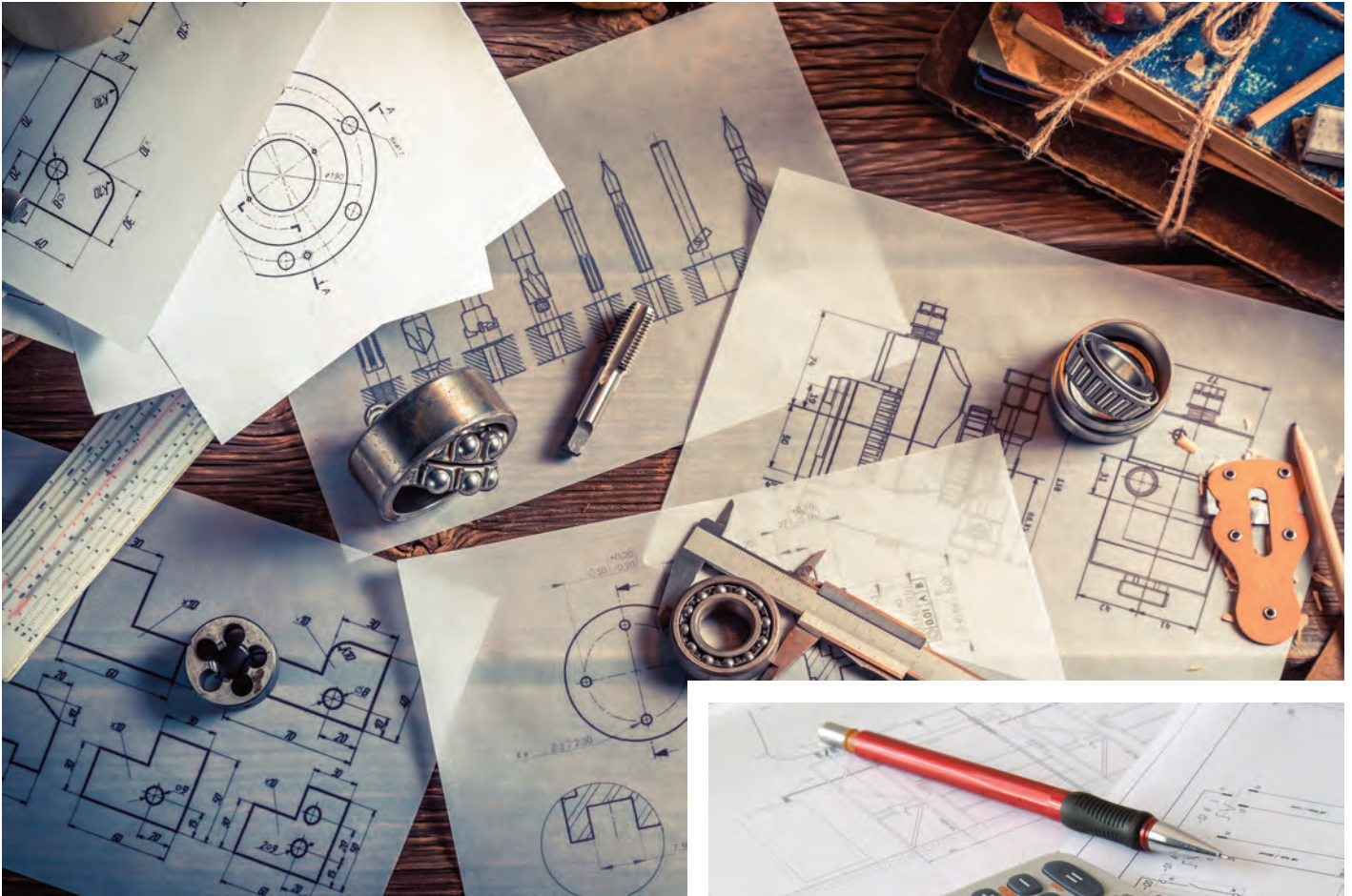
Another issue is a common misunderstanding of for whom STEM subjects are appropriate. For example, those who view themselves as 'creative' are often under-exposed to how creativity is developed and valued in many aspects of STEM. Similarly, people who have a strong intrinsic drive to help others are unaware of how STEM can help them do this.

## STEM opportunities

Young people are also often not aware of how they are restricting their future options when they make study choices that marginalise STEM subjects. Encouraging young people to study only those subjects which they find easy or particularly enjoyable, without helping them see where those subjects might take them, does them a huge disservice in the long run.

## Making STEM study appealing

The way in which STEM subjects are taught is also vital in bolstering the ambition of young people, both to pursue STEM to a high level and to combine STEM study with other subjects. If teachers of all subjects



understand how STEM underpins and informs success and are able to teach these subjects in a way which encourages students to ongoing study for a career, young people could be inspired to respond accordingly.

**“We already know that STEM graduates earn significant wage premiums and that STEM subjects provide the widest possible breadth of opportunity for progression. Why isn’t STEM therefore the sole focus of economic and educational policy?”**

We are currently remembering the great triumphs of the London Olympics 3 years ago: not just the sporting achievements, but how London performed as a host city. Thanks to STEM and people with STEM skills, the transport system ran smoothly. The media coverage was extraordinary; the venues were breath-taking. Above all, we are reminded of the Opening Ceremony and of the appearance of great Sir Tim Berners-Lee, one of the original winners of the Queen Elizabeth Prize for Engineering. His vision of the World Wide Web was displayed in lights hundreds of feet tall – *This is for everyone*. It is a vision which the Academy and all



our partners share: STEM is for everyone, a part of all our lives, and we all have a duty and an opportunity to capitalise on it for the future prosperity of the UK.

It is useful to define the estimated number of engineers required by 2020, to replace those who are retiring, but equally important to describe the value and relevance of STEM study and skills for everyone. ■

.....  
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## STEM for success

**Toby Peyton-Jones Director of HR for Siemens in the UK and assigned countries, and a commissioner for the UK Commission for Employment and Skills, explains the key role STEM plays in the UK's economic success...**

Science, technology, engineering, and mathematics (STEM) are all crucial for high value, innovative and knowledge-intensive activities – all of which in turn play an integral role in ensuring the UK can maintain a competitive economy on the global stage.

The value of STEM skills is particularly clear in the context of technological 'megatrends' which are set to play a significant role in changing the way we live our lives. The onset of innovative, cutting-edge developments such as growing use of 'Big Data', increasing automation, the use of robotics and 3D printing, as well as low carbon technologies, are all hugely dependent on STEM skills.

But STEM skills are not just crucial for supporting tomorrow's industry, they also play an integral role in securing the day to day running of a range of vital supplies and services. Sectors including communications

and IT, water, energy and food all rely on consistent utilisation of these skills.

Studies have also shown that there is a clear link between STEM graduates and innovative workplaces, and not just within the more traditional STEM industries. Around 45% of graduates working in innovative firms in manufacturing and knowledge-intensive business services have a degree in a STEM subject. By contrast, less than a third (30%) of graduates in firms classed as 'non-innovative' have studied STEM subjects.

The demand for STEM skills is therefore clearly high, but what of the supply? This issue has been the subject of much lively debate in recent years, with many opinions differing significantly. Figures show that between 2009/10 and 2012/13 the total number of individuals attaining STEM qualifications in higher education increased by 15% in the UK. Yet a 2012 study from the





Toby Peyton-Jones, Commissioner, UK Commission for Employment and Skills

Royal Academy of Engineers anticipates the opposite of this, with a predicted shortage of core STEM workers in the period up to 2020.

Research from the UK Commission for Employment and Skills indicates that an overall shortage in STEM graduates is unlikely to be the case by 2020. Rather, it seems the issue facing STEM industries is one of the quality of skills among graduates, with 43% of vacancies in STEM roles hard to fill due to a shortage of applicants with the required skills – almost double the UK average of 24%.

This issue is also reflected by a recent international benchmarking study by the department for Business, Innovation and Skills (BIS). It found STEM graduates in the UK to have poorer skills in numeracy, literacy and ICT, as well as having below-average management skills.

Employer interviews have also revealed that many find a very limited number of universities offer solid

foundations in key science disciplines, and many have had to cut back on capital intensive equipment and laboratories. The result, they claim, is graduates who lack hands-on experience and technical skills.

Clearly then, the evidence points to a need for a higher standard of skills among STEM workers. Starting to embed these skills at an earlier stage is one obvious step towards action here. The government’s drive towards apprenticeships is welcome in this regard. Such pathways into industry should allow employers greater control over the supply of the skills they need, as well as embedding the much needed hands-on skills many recruits are currently lacking – but we must ensure quality is not sacrificed in the pursuit of quantity.

For those taking academic pathways to work it is again important for all parties – individuals, education providers and employers – to work hand in hand to offer and encourage the same work-based experience. The evidence also points towards a need for academic institutions to be building closer links with employers to ensure courses do not overlook the skillsets employers are so desperate to see in applicants.

STEM qualifications open a broad range of options to individuals taking their first steps into the world of work, and can open doors to a wealth of exciting – and highly rewarding – careers. The UK has always been held in high regard for its long history of innovation and technical excellence. By investing now in the skills and expertise of a new generation of talent, we can ensure we continue to lead the way in these vibrant and eclectic industries. ■

.....  
**Toby Peyton-Jones**  
**Commissioner**  
**UK Commission for Employment and Skills**

**Director of HR at Siemens**

[www.gov.uk/government/organisations/uk-commission-for-employment-and-skills](http://www.gov.uk/government/organisations/uk-commission-for-employment-and-skills)



A large industrial pipeline, possibly for oil or gas, runs diagonally across the frame from the top left towards the bottom right. The pipeline is supported by black metal pillars and is covered in a layer of snow. The background shows a snowy landscape with trees and a sunset sky with soft orange and blue tones.

# In the pipeline

**Adjacent OIL & GAS** is the new quarterly digital publication bringing key intelligence to the international oil and gas industry. As essential reading for senior decision makers, the title places an emphasis on quality content, featuring expert analysis and best practice case studies on projects and developments in the oil and gas sector globally.

We welcome contact from experts interested in making an editorial contribution.

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# Delivering the Urban Agenda

**Corina Crețu, Commissioner for Regional Policy at the European Commission outlines how the Urban Agenda not only benefits cities, but citizens also...**

**A**s Commissioner for Regional Policy, my job is to ensure that European Structural and Investment Funds have the greatest impact on the ground in terms of job creation and sustainable growth. It is a fact: evidence has shown that urbanisation and growth go hand in hand. That is why half of the €199bn envelope of the European Regional Development Fund (ERDF) for 2014-2020 will be invested in urban areas. More specifically, around €15bn from the ERDF will be invested in sustainable urban development; a substantial part of which will be directly managed by cities, according to our new regulations.

Europe's cities have indeed the capacity to find new ways to deal with fast-changing societal, economic and environmental realities. They are the engines of the European economy, providing jobs and services, and serve as catalysts for creativity and innovation.

After 20 years of debate, we are no longer discussing if we need an EU Urban Agenda but rather how we can begin to make it happen. The ambitious objectives set in the EU 2020 Strategy will only be reached with the support and active participation of our cities. The EU Urban Agenda is not an isolated objective in itself. The Agenda is about enabling cities to fully contribute to our shared priorities and deliver concrete benefits for our citizens.

Furthermore I want to underline that the EU Urban Agenda will not be about the EU grabbing new policy competences. It will not bring more regulation; on the contrary, it will be about better regulation, more transparency and coordination in what the EU is already doing.

On 2 June, at the Second European CITIES Forum in Brussels, we unveiled the results of the public consul-



Corina Crețu, Commissioner for Regional Policy at the European Commission

tation on the EU Urban Agenda that we had launched in July 2014. Stakeholders clearly expressed what they expected and on this basis we propose a four-pronged approach: to be able to show results we will focus on a few priority areas, such as support to the low carbon economy, sustainable mobility and social inclusion. We will apply better regulation tools effectively, with stronger stakeholder involvement. We will better coordinate existing EU policies with an urban dimension. We will also ensure the availability of quality data, monitoring and benchmarking.

On 10 June in Riga I met the 28 Ministers responsible for territorial cohesion and urban matters and we have been able to agree on the Riga Declaration "Towards an EU Urban Agenda". The Declaration identifies the key elements and principles that should be taken into account in future work on the development of the EU Urban Agenda.

Particular attention within this declaration is paid to small and medium sized urban areas, as an integral part of the EU Urban Agenda, acknowledging their significant role and potential for balanced territorial





development and achievement of common European goals. These cities and towns are close to my heart. Not only do a quarter of our population live in them, but they also function as bridges between the bigger cities and the rural areas and as centres of services and activities in the more sparsely populated areas.

**“Furthermore I want to underline that the EU Urban Agenda will not be about the EU grabbing new policy competences. It will not bring more regulation; on the contrary, it will be about better regulation, more transparency and coordination in what the EU is already doing.”**

We need a better understanding of the different types of challenges that cities, towns and regions face across Europe.

I am thrilled to have been able to gather the necessary support from our partners in the Members States. We

will now work to consolidate and implement the EU Urban Agenda in the coming years.

We have put on a table a roadmap with key deliverables that will help us define and agree upon concrete objectives and actions. This will be crucial in order to arrive at an operational EU Urban Agenda during the Dutch Presidency of the Council of the European Union in 2016. The Riga Declaration and the conclusions we have drawn from our public consultation give us a strong direction where to go. Now it is up to the EU, the Member States and the Cities to deliver. ■

.....  
**Corina Crețu**  
**Commissioner for Regional Policy**  
 European Commission  
[www.ec.europa.eu/commission/2014-2019/cretu\\_en](http://www.ec.europa.eu/commission/2014-2019/cretu_en)





New Station

New

# Reinventing the City Building on Creativity

Creativity, innovation and a strong focus on sustainable and attractive growth are at the very heart of the vision for the City of Varberg to become the Swedish West Coast's Creative Hot Spot by 2025. The municipality is growing quickly and has a population of more than 60,000 residents, mainly due to its location between two expanding regions – Göteborg (the West Sweden region) and Malmö (the Öresund region). Varberg is a stronghold for culture and tourism, and is especially renowned for its 13th Century fortress, long stretches of beautiful beaches and inland deciduous woodland with plenty of small lakes. It is also well known among surfers from all across northern Europe as one of the best places in Scandinavia for all kinds of surfing.

The City of Varberg is focusing strongly on sustainable development and has been acknowledged for its success in bridging the gap between public service and the diverse interests of various partners in society (e.g. commerce, business, industry, development, conservation, culture, etc.). The municipality has a sharp focus on the way ahead, and a portfolio full of solid strategies. In our vision for the future, the City of

Varberg has unique opportunities and we are acting on them. We are building a city converging around means of public transportation in a rapidly expanding region. The railroad, which has long created a barrier between the seaside and the city centre, will now be relocated into a tunnel underneath the city. To expand on this opportunity we are moving the harbour in order to further free up land for letting the city reclaim its position as a seaside town. In total, the project will result in more than 500,000 m<sup>2</sup> of land for development of our future city front. For people living, working or visiting the city of Varberg, the change will dramatically increase the freedom to experience the coastline. More places of residency, places for eating and meeting, places to shop and work, etc. – comes as a bonus.

In our vision for Varberg 2025 we are striving to be at the forefront of supporting social and cultural aspects of sustainability. The municipality is localised in the middle of a strong academic region. The University of Göteborg and Chalmers University of Technology, the University of Lund and Malmö, the University of Borås and the University of Halmstad are all located well within





# v Cityfront

comfortable commuting distance from Varberg. This is of great importance for our local business climate and for our young. We are focused on consolidating the relationship with our academic allies even stronger, strengthening the position of our own Campus Varberg. The same is true for cultural institutions. For our growth it is key to attract enterprises and institutions that share our idea of building a more sustainable future, in the heart of a progressive region. This means that we are especially on the lookout for academic and cultural institutions, and enterprises with profiles that fit our idea of a modern sustainable city and trying to attract them into investing in Varberg.

It is often stated that the place, and the people and lifestyle associated with it, is everything. If this is true, then the City of Varberg has everything to offer.

**Come to Varberg.** Share our vision.



The City of  
**Varberg**

[www.varberg.se](http://www.varberg.se)



# Designing a resilient Don Watershed in Toronto

The city of Toronto is a massive never ending blur of concrete. The immense redevelopment of the waterfront consist of apartment towers as far as one can see. Looking at the city from the Sky-tower the outskirts have a green look, but don't let the image fool you: down at the ground asphalt and cars are the main occupants of space. In this context resilience is necessary and difficult at the same time. Nevertheless reconsidering the ecological qualities as contributor to the quality of life is an important issue, especially in a city that is confined, busy and traffic jammed. Climate change adds up to this need to create bigger green spaces and give water a more prominent role in landscape forming. This subject raised interest at the City government and the Dutch Consulate and has led to a Resilient City Summit in May 2015, where future resilient planning was discussed amongst academics and practitioners from Canada and the Netherlands.

## Don River Watershed

One of eight watersheds in Toronto, the Don River watershed covers an area of approximately 36,000 hectares and stretches almost 38 km in length, flowing south from its headwaters on the Oak Ridges Moraine to the Keating Channel, where it empties into Lake Ontario. The Don River watershed is almost entirely urbanised, leaving very little undeveloped land. Almost half of the watershed is dedicated to

housing its 1.2 million residents. On average, 35% of the urbanised areas along the Don are paved with impervious surfaces. One of two North-South highways, the Don River Parkway runs along the mid to lower section of the Don River. A system of bike and walking trails makes the Don a heavily used recreational corridor. Due to the intense urbanisation in the Don watershed, hard paved surfaces increasingly prevent storm-water from slowly seeping into the soil, or from being taken up by vegetation. Therefore, much of the storm-water runs off the surface into the Don River, resulting in stream-bank erosion and increased flooding during large storm events, particularly from combined sewers. The challenge is to protect and restore the natural heritage features of the watershed, while trying to accommodate the competing recreational demands.

The design task for this area lies on two scales. The entire watershed should be enhanced in its ecological quality, the amount of water storage and the connectivity, both for recreation as ecological purposes. At lower scale three design sites have been used to elaborate the design solution at watershed level on the urban design scale. An upstream (Hoggs Hollow), middle stream (Thornclyff Park) and mouth (Port Lands) site were chosen where in the near future developments and changes are expected.

## Design Charrette

For these design tasks students and staff participated in a design charrette (Roggema, 2013) of three days. A total of 16 students participated, originating from University of Toronto, John H. Daniels Faculty of Architecture, Landscape & Design and from Delft University of technology, Faculty of Architecture, Landscape Architecture and Urbanism departments. The first day consisted of site visits to the three project sites. The second day started with introductions on general design theories and the resilience concept and concrete expectations for the design projects. After this the students worked on identifying the crucial interventions that changed the area 30 years ago and which ones they expect to do the same 30 years ahead. This exercise delivered for the themes of climate change, urban development, economy and society the ingredients for the first design sketches. Based on this, by the end of the day four groups presented their concepts for a resilient watershed. The design of the water flow should be designed to minimise the negative impact on the entire urban region while increasing its resilience by looking for space and means in the public realm for water storage, re-use and treatment, and slow release, and link other green uses with water propositions (such as park, leisure, food). The third day the groups detailed their concepts and designed at the lower scale site detailed pro-

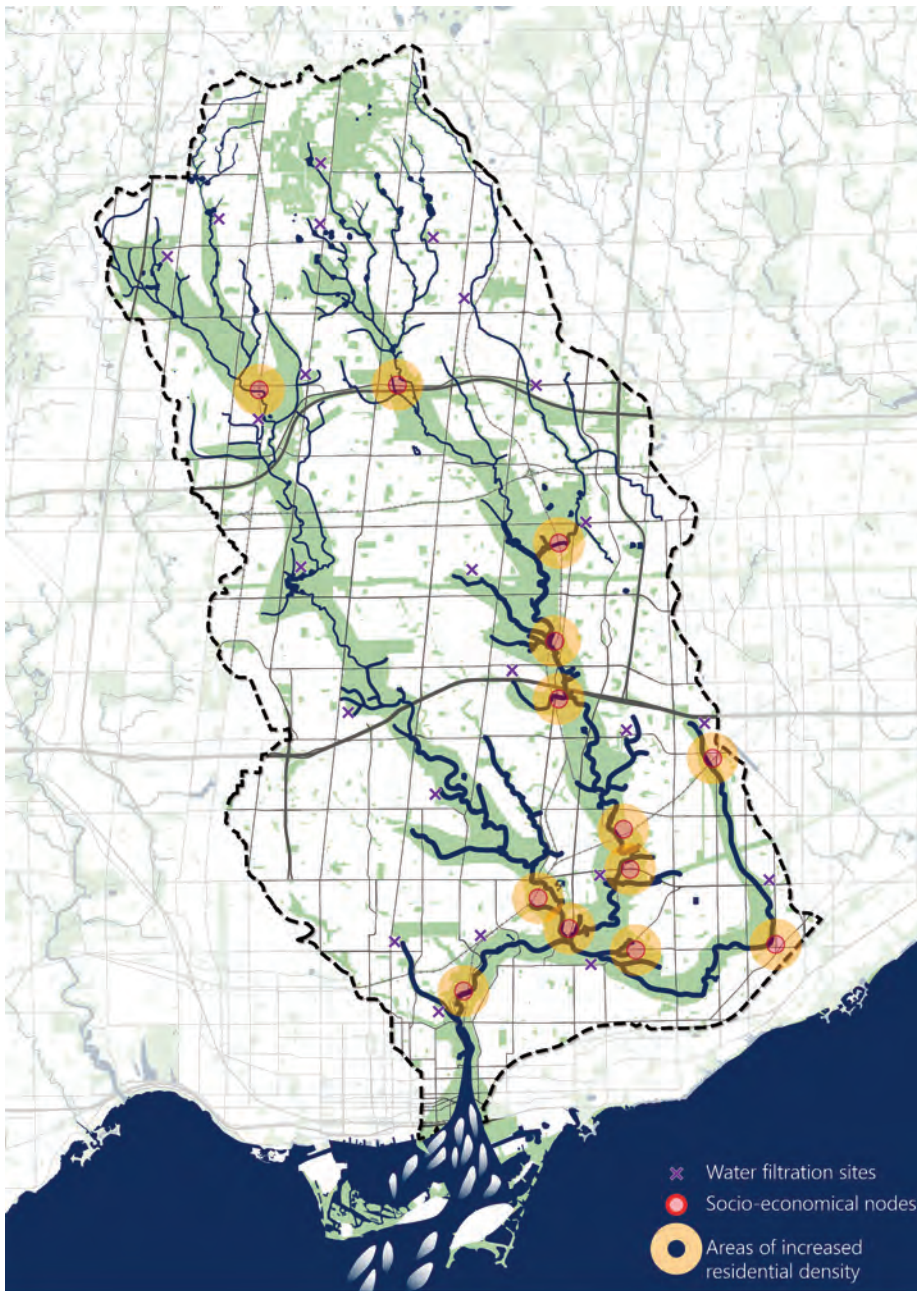


Image: © Agate Kalnpure, David Kosowsky, Jergus Oprsal and Anna Rosen

**Figure 1. Erosion in the Don river increases the space for water and ecology along the waterways, connecting social and economic hubs at crucial points**

posals. These designs should address integral sustainability issues (such as energy, mobility, ecology) and their implications on the urban patterns and structures of each pilot site. In the afternoon these designs were enriched using a 3D-modelling technique. The day was concluded with final presentation for an audience of experienced scholars, high-level government officials and urban sustainability

entrepreneurs. All four presentations were very well received.

**Results**

The design charrette is an intensive and creative way of tackling complex problems in a design-led way. The four groups of design students each came up with a strategic plan for the entire watershed and a detailed proposition for one of the pilot sites.

The project for Hogg’s Hollow proposes to stage the water discharge at the level of the watershed, introducing so-called hydro-corridors, in which the upstream water is collected and redistributed. One of the locations the water is distributed to is Hogg’s Hollow, where leisure, ecology and energy supply are integrated in the design for water capture and storage.

**“The Don River watershed is almost entirely urbanised, leaving very little undeveloped land. Almost half of the watershed is dedicated to housing its 1.2 million residents.”**

The ‘Cars are the cigarettes of the future’ project emphasise emergent urbanism. It proposes to create separate autonomous sewer-sheds, which take control over the water quality and quantity of their own area. The design proposal for Thorncliff Park estimates the car use in the future will be semi-automatic hence doesn’t require much space, which can be use for other purposes such as food production, water storage and public green.

The ‘Flood Fingers’ project increases the capacity of the water system in the fingers of the system, which feed the main river. The natural topography of the steep river edges are used to generate energy, filtrate water and store water for future use in the city.



In Thorncliff park several of these filtrating energy generating hillsides are proposed.

**“The challenge is to protect and restore the natural heritage features of the watershed, while trying to accommodate the competing recreational demands.”**

The fourth proposition, Eroding to a new future, embraces the natural process of erosion in the riverbeds. Due to climate change the number and intensity of extreme storm events increases. This begs the question whether it is prudent to continue resisting change or to utilise the change in propelling us forward in a new direction. Following this idea erosion is no longer the culprit but rather the catalyst of progress. The process of erosion that occurs throughout the Don watershed would then be allowed to occur naturally and is further intensified by removing channelisation and slope stabilisation techniques, resulting in widening the riverbanks. This natural process carves a new central conveyance system within the city, and allows the creation of socio-economic nodes at places of intersection with major infrastructure (figure 1). These nodes are adaptable to changing water conditions, with floating markets and buildings, creating a dynamic riverine landscape that becomes an integral part of the urban network.

Water filtration sites along the river corridors allow filtration of runoff and



**Figure 2. Detailed designs for newly developed islands using eroded sediments**

household water, which is fed back into the system assisting with sediment release and conveyance. The eroded sediment extracted from the river beds, is deposited downstream, feeding the growth and development of island communities (figure 2), which will add additional prime real-estate to the city and provide an opportunity for productive islands from where food and produce can be transported

up the riverine network back into the city. This dynamic system ultimately both adopts and adapts to ever-changing conditions.

**A resilient watershed**

The designs developed during the design charrette provide solutions and spatial directions to increase the resilience of the watershed of the Don River, and also increase the resilience

Image: © Agate Kalnpure, David Kossowsky, Jergus Oprsal and Anna Rosen





Image: © Rob Roggema

**Figure 3. The Dutch Royal Couple interested in the designs and plasticine models for a resilient Don River Watershed**

of the city and its inhabitants. The results achieved in one day of site visits and one and a half day of intensive design studio work are innovative, relevant and realistic. The short time available to develop the proposals shows that the approach to limit the time available increases the originality of the designs and the accuracy in responding to the fundamental research question. It is clear that each of the models and designs require further detailed elaboration.

The groups each presented strategic designs for the entire watershed, which determines the possibilities and challenges at a lower scale of the urban design. This phenomenon, to rise above the individual project site or plot was relatively new for the Canadian designers and was received with great interest.

The students presented the results at the Resilient Cities Summit and had the opportunity to explain their

propositions to the Dutch Royal Couple (figure 3), who attended the summit and were very interested in the innovative character of the design proposals and plasticine models.

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Rob Roggema with Liat Margolis (University of Toronto) and Frits van Loon (TU Delft), and Master students Landscape Architecture, Urbanism and Architecture of University of Toronto and Delft University of Technology.



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# Towards the EU Urban Agenda: results of the Latvian Presidency

**The Ministry of Environmental Protection and Regional Development of the Republic of Latvia details the importance of small and medium sized urban areas in the context of the EU Urban Agenda...**

Approximately 70% of Europeans live in cities and towns. They play a significant role in territorial development of the EU, and in achieving the strategic European Union goals, due to the concentration of people, economic and social activity. On the other hand they face different challenges which require purposeful and coordinated actions at all governance levels. Therefore, for a number of years EU level discussions have taken place on the need for an EU Urban Agenda. However, no political agreements have been taken on its content until now.

In order to advance the previous work during its presidency, Latvia proposed to have an intergovernmental agreement on the overall framework of the future EU Urban Agenda. On 10th of June during the informal meeting of Ministers responsible for territorial cohesion and urban matters, EU Member States, institutions and relevant stakeholders agreed on the Riga Declaration "Towards the EU Urban Agenda". It is a significant step in EU Urban Agenda development, as the Declaration gives clear guidelines how the EU Urban Agenda shall be developed, what principles should be respected and what elements need to be included. It also defines the recommended actions to be taken at different governance levels (EU, national, regional and local), in order to foster sustainable development.

According to the Declaration, it is proposed to develop an EU Urban Agenda which provides an operational framework and effective instruments to improve the urban dimension in European policymaking. This includes better policies, territorial impact assessment, more tailor made and place sensitive EU-funds, opportunities to exchange knowledge and best practices, research, and promote cooperation.

It highlights the importance of such principles as subsidiarity and proportionality; true partnership among involved parties; diversity of different urban areas; integrated, crosscutting, territorially based approach focussing resources where it is really needed; coherence between urban and other territorial development issues; respect of national and regional specificity.

With this Declaration the Ministers agreed to contribute to the further development of the EU Urban Agenda. The European Commission is invited to make EU Urban Agenda a priority, as well as to take concrete and immediate actions in that regard. The regional and local authorities are also invited to take a more active role in this process, taking into account that their specific knowledge on the local circumstances, needs and opportunities, can provide the best solutions for its inhabitants.

Particular attention within the draft Declaration is paid to the small and medium sized urban areas, which was a specific priority and contribution of the Latvian presidency to the EU wide debate on the future Urban Agenda. It includes statements acknowledging the significant role of small and medium sized urban areas in a wider territorial development, as well as emphasising the need to respect these areas when developing and implementing the EU Urban Agenda.

Small and medium sized urban areas (SMUAs) have been less explored both in policies and studies so far. Up to now the focus has been mainly on the role and issues of metropolitan areas and large cities. Nevertheless it deserves undivided attention, taking into account that 24.2%<sup>1</sup> of the Europeans live in small and mediums sized urban areas with a population of 5,000 to 50 000. In total there are 8,350 SMUAs in



Informal meeting of Ministers responsible for Cohesion Policy, territorial cohesion and urban matters (June 2015)

Europe. These urban areas fulfil important economic and social functions, being centres for jobs, public and private services, modes of local transport, as well as centres for local and regional knowledge production, innovation and infrastructure for a large share of the European population. Therefore, they are essential to avoid rural depopulation and urban drift, promoting more balanced overall regional development. There is a significant existing and potential collective contribution of SMUAs to EU common strategic goals, especially regarding employment, climate change and energy sustainability and fighting poverty and social exclusion.

The development of the EU Urban Agenda is significant in terms of better competitiveness and economic development of cities and towns, high quality of life of its inhabitants, and sustainable development. Urban development must be both socially responsible and environmentally innovative. The better economic, social and environmental performance of urban areas will have a positive impact on surrounding areas, thus balancing territorial development.

There is still a lot of work to be done in order to agree on the content of the EU Urban Agenda. The most immediate work relates to the agreement on the

priorities of the EU Urban Agenda, also the common working methods. These issues will be discussed among EU Member States, EU institutions, partners, involving also regional and local authorities. The political agreement regarding the content of the EU Urban Agenda is expected during the Dutch Presidency. ■

1 Research report “Challenges of Small and Medium-Sized Urban Areas, their economic growth potential and impact on territorial development in the European Union and Latvia”, written by HESPI and EUKN and consulted by ESPON on behalf of the Latvian Presidency of the Council of European Union (The Ministry of Environmental Protection and Regional Development)



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 Ministry of Environmental Protection and Regional Development of the Republic of Latvia  
[www.varam.gov.lv](http://www.varam.gov.lv)



# European Green Cities

Creating cities of the future...

European Green Cities, EGCN comprises 85 members from 14 countries, working with innovation projects, implementation of best practice in planning and building projects, education and, last but not least, dissemination.

We send out a newsletter with an update on European research and development projects, and, two to three times a year, we send out a magazine with results from EU projects and others. Our actual activities involve arranging seminars and webinars.

On the EGCN website ([www.european greencities.com](http://www.european greencities.com)) you will find information on the network's EU projects – building up a knowledge database for members so that they can save time and effort in finding the latest news.

Our members aim to support each other in progressing sustainable development and sustainable projects. The EU has the large programmes Intelligent Energy Europe and now Horizon 2020, which have the means to support progressive development. We participate in and disseminate the results of projects within these programmes.

We want to use the results of these much more actively for concrete planning and building, and as a basis for new projects.

Two examples are Green Solar Cities, a CONCERTO project with great results, and AFTER – about commissioning. You can download magazines inform-



ing you about the projects on our website.

You can also use EGCN as your personal network of city guides, helping you to arrange and manage contact with actors at the sustainable 'scenes' in the member cities.

Join EGCN and use the organisation to get wiser on the sustainable cities and buildings in Europe, to exchange experiences with others working in the same field, to educate, and to make use of us as a platform for the dissemination of your projects.

Membership is not free, but it is affordable and has a lot of advantages. Contact us and hear all about it.

## Green Solar Cities leading on to Nordic Built Active Roofs and Facades in Sustainable Renovation

The main aim of the Green Solar Cities book which was published by Eartscan by Routledge in January 2015, is to provide people with a vision of how cities and buildings of the future can be implemented with high energy quality, with an optimised energy supply which, to a high extent, is based on renewable energy, and with an equal focus on how to secure best practice by introducing a clear policy for performance documentation. This can be done by looking at experiences showing where the risks of bad performance results lie in practice.

So the basic idea of the book is to present examples from practice, including experiences from the EU-CONCERTO Green Solar Cities project (2007-2013), to show that the idea of making low energy building is about introducing a quality agenda for buildings. Without this approach, buildings and large renovation projects will be built in the traditional manner, which



To order the Green Solar Cities book, please click on the link: [www.routledge.com/books/details/9780415731195/](http://www.routledge.com/books/details/9780415731195/)

This sets a good background for securing the next step of low energy buildings – buildings with easy access to all basic energy uses on a direct online basis. This is possible for different electricity and heating uses, as well as for basic comfort indicators like indoor temperature and humidity, CO<sub>2</sub> level and even daylight. The latest Wi-Fi technologies make it possible to obtain proof of an overall energy quality, documenting that users get what they have paid for.

In the Green Solar Cities book there is a focus on this and how this can be done as part of an Active House approach ([www.activehouse.info](http://www.activehouse.info)), and there is a presentation of the Nordic Built Charter which together with Active House is forming the background of the new Nordic Built project, Active Roofs and Facades in Sustainable Renovation, which is also detailed in the book.

means that they will leak, be full of thermal bridges and have a poor indoor comfort. The ‘passive house’ movement in the 1990s, mainly in Germany and Austria, demonstrated that high quality constructions without thermal bridges and air leakages, combined with heat recovery of the ventilated air, resulted in buildings with almost no need for heating.

When the passive house results were first discussed in Denmark after 2000, the ambition was to go in the opposite direction and mainly work with natural ventilation. And since many architects were used to this, the new passive house agenda was difficult to understand: “Does that mean we will have to introduce mechanical ventilation again?”

This was actually the case. However, like introducing passive house qualities to the constructions, it was very important to communicate that a high quality version of mechanical ventilation was needed. In other words: the efficiency of the heat recovery should be high and the electricity use for the fans should be low.

However, due to a lack of clear standards of documenting these things in practice, it has unfortunately proved very difficult to control this.

The experience is that it is very difficult to ensure that a mechanical ventilation system actually has a low electricity use, unless you can ensure a direct survey of this with the users and building owners.

Here partners from all the 5 Nordic countries are cooperating and there are actual demonstration projects in both Denmark and Sweden as well as full-scale testing in all countries.

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# Liverpool's pound house revolution

**Homes which have lain derelict in Liverpool for decades are being brought back into use by people who have bought them for a pound. The city's Mayor Joe Anderson explains...**

**W**hen I became Leader of the Council back in 2010, one of my priorities was tackling the huge issue of empty properties across the city.

I found it astonishing that at a time when the city was facing huge cuts in central government funding, homes which could provide valuable Council Tax income to help support services were lying empty.

It was a harsh reminder that the city's recent rebirth as a global cultural destination following European Capital of Culture in 2008, hadn't yet spread across the whole city.

Take Granby Four Streets, a set of once-grand and imposing Victorian properties close to Toxteth. Over several decades, a number of regeneration schemes had been brought forward, mainly involving razing most of the homes to the ground. The council had bought many of them, but a small number of dedicated and loyal residents refused to move out of the area and argued passionately that the existing properties were worth saving and investing in.

I thought: "Why can't we hand over some of these properties to people for £1 and get them to do them up?" It was a case I had heard made by empty homes campaigners, but few places had tried it because they feared it was too risky. To manage the risk, we set a few rules:

We would run it as a pilot scheme involving around 20 properties, and we would spread them around, with some of the homes dotted around the Four Streets and others located elsewhere.

We wanted Homes for a Pound to enable local people to get on the housing ladder, so you couldn't apply

unless you lived or worked within the city, and you needed to be a first time buyer.

As this was about rebuilding communities, it was vital that the successful applicants committed to the area, so we required them to live in the property for 5 years and not sub-let in order to make a quick profit.

The response was overwhelming and we had around 4,000 expressions of interest which resulted in around 1,000 formal applications.

It's not all been plain sailing, and we have learned a lot as we have gone along. Some people walked away when they saw the size and scale of the work needed. There were issues securing home insurance because the properties weren't being lived in during the refurbishment. Although some of the applicants were competent at DIY, we had to help them find tradespeople for the structural work.

It was a great moment to hand over the key to the first successful applicant, Jayalal Madde, and it was incredible to return a year later and see how he had totally transformed a rundown and neglected property into a beautiful home for his family.

Work is well underway on transforming the other homes which form part of the pilot, with one other family already moved in and others almost ready to complete.

Such has been the success of this scheme that we have recently opened applications for an ambitious expansion of Homes for a Pound which will see 150 properties in Picton – a part of the city which is already undergoing a lot of regeneration, including the city's new hospital and a secondary school.





Make no mistake, Homes for a Pound is absolutely not a panacea for dealing with empty homes. In some cases it is simply not economically viable to refurbish properties. But, it is one bit of the complex jigsaw we are piecing together to tackle the issue.

In the Four Streets, alongside Homes for a Pound, some of the properties are being transformed by housing associations. Others have been taken over by a Community Land Trust led by local people in a project which has been shortlisted for the prestigious Turner Prize.

Over in Anfield, in the shadow of LFC, we are carrying out a wholesale regeneration project for this long neglected area, in partnership with the football club and a housing association. Small terraced properties are being transformed into family homes by knocking 2 of them into 1 and creating gardens to replace the cramped backyards. For the first time in decades, there is a waiting list of people wanting to move into the area.

Overall we are committed to bringing back into use another 2,000 properties in addition to the 1,000 we have already completed, and another 1,000 that we are on with tackling. We are working in partnership with developers to build 5,000 new homes, as we know that people want to live in Liverpool but have moved to neighbouring areas because we simply don't have enough modern family properties.

Put simply, we are driving up the quality, standard and range of properties to make sure that people wanting to live in the city have a choice of good quality properties to live in, whatever their budget. Even if it's only £1. ■

.....  
**Joe Anderson**  
**Mayor**

Liverpool City Council  
[www.liverpool.gov.uk](http://www.liverpool.gov.uk)

AUDIO

comfort

## Audio Comfort - Listen and learn

Saint-Gobain, the world leader in the sustainable habitat and construction markets, has identified five key elements that contribute to our comfort levels in buildings; visual, indoor air quality, audio, thermal and economic comfort. Stacey Temprell, Residential Sector Director at Saint-Gobain, explains how audio comfort in buildings can affect health and wellbeing, the second article in a series examining each of the five elements of the Multi-Comfort building concept.

Buildings have a big impact on our lives, as we now spend up to 90% of our time indoors – either in buildings or vehicles – whether at work, home, or in our spare time. Yet very few people think, and really challenge, how our buildings are actually performing and how they affect our health and wellbeing.

Through years of research and development of these five qualities, Saint-Gobain has created and recently launched 'My Comfort' – the Multi-Comfort building concept which delivers benefits for occupant wellbeing and the environment.

The Multi-Comfort concept and 'My Comfort' starts from the central premise that all buildings can be designed to:

- Provide the highest levels of all-round comfort for their users;
- Genuinely and positively contribute to our health and wellbeing;
- Deliver the highest levels of efficiency for their owners – saving home owners and bill payers money on energy;
- Achieve the Passivhaus standard of energy efficiency.

The four factors of thermal, audio, visual, and indoor air comfort are better understood today than ever before. However, in combination, these factors become powerful tools for designing happy, healthy, energy-efficient buildings that deliver all-round positive wellbeing effects for everyone, as well as considerable economic benefit – the fifth comfort. When designing and constructing buildings, a holistic approach is the best way to guarantee user comfort.





**WE TYPICALLY SPEND 90%  
OF OUR TIME INDOORS  
OR IN VEHICLES**





## Audio Matters

Today's world is often noisy. More than half the population now lives in cities, while 73% of UK residents live in a home with adjoining neighbours. To create an audibly comfortable environment, we want to amplify some sounds, such as music and speech, but also minimise others, such as background noise and traffic outside. This balance is achieved by the absence, or reduction, of unwanted sounds combined with adequate levels and quality of desired sounds.

There are two ways of assessing the effects of audio comfort: by looking at the way good acoustics can make living indoors easier, and by explaining the far-reaching consequences of noise on our bodies and minds.

Poor audio comfort can have a significant impact on health and wellbeing. A recent survey by Which? Magazine found that more than a quarter of UK adults have had a problem with nuisance neighbours in the past year. The main concerns were loud voices, loud music, TVs and noisy pets<sup>1</sup>.

Research suggests that these noises can be more disruptive than we think, and can even affect sleep patterns. In homes, protection from outside noise contributes to a sense of security and privacy, as well as reducing stress. Traffic noise alone affects the health of nearly one in three Europeans, including hearing loss as a result of high sound levels. Epidemiological studies have shown that the risk of heart attack for those living close to frequently used streets is around 20% higher than for residents of quieter streets, and that the risk of obesity increases with the proximity of an airport.

Other consequences of noise exposure have been identified, including cardiovascular disease, high blood pressure, headaches, hormonal changes, psychosomatic illnesses, sleep disorders, reduction in physical and mental performance, stress reactions, aggression, constant feelings of displeasure and reduction in general wellbeing. To improve wellbeing through audio comfort, we need to understand where sound disturbances are coming from.

The quality of sound in an indoor space is determined firstly by the sources of sound or noise (indoors and outdoors). Four types of sounds may be experienced within a building: exterior noise, mainly from transportation; interior noise; impact noise, such as footsteps; and equipment noise, from appliances and ventilation systems.

These noises can either be transmitted through the air or through the building fabric. With the latter, they may be transmitted from the outside inwards through the envelope, vertically from floor to floor, or laterally through internal partitions.

The way sound behaves within the space will depend on levels of reverberation and adsorption within the building. The acceptance of a given sound depends on many factors, which vary according to the type of building, the type of activity performed, and the social and cultural habitats of the occupants.

Audio comfort in a building can:

- Protect you from outside noise disturbances;
- Prevent you from hearing your neighbours;
- Allow you to make noise without disturbing others;

While allowing you to:

- Hear the sounds you want to hear clearly;
- Hear perfectly anywhere in the room;
- Not get distracted by background noise.

When designing for acoustic comfort today, we must first understand the needs of the building's occupants, taking into account the activities to be performed. The variety of external and architectural factors will need to be considered in terms of what types of noise need to be managed from external spaces and inside the building. The spectrum of noise frequency levels will have an impact on the design requirements.

However, the change in living habits will mean that more activities will have to coexist in the same buildings; people will increasingly work from home and rest at the office. Therefore, indoor acoustic landscapes will undoubtedly change further in the coming decades.

For new build projects, the Multi-Comfort standard sets out four criteria for achieving audio comfort, including acoustic sound insulation, acoustic absorption, speech clarity and intelligibility and harmonious resonance.

Audio comfort in a building is dependent on the acoustic characteristics of the building fabric, in regard to acoustic transmission and absorption. Materials that provide sound insulation by having a low acoustic transmission, such as glass in windows and facades, will help protect building occupants from outside noise.

Absorbing materials, such as Isover's Acoustic Partition Roll (APR1200) mineral wool, will also help reduce airborne and impact noises inside the building, meeting the highest building regulation standards.

## The facts

The evidence to support the effects of improved audio is clear:

- Research has proven that well-designed sound environments in offices and schools favour concentration and facilitate communication, so having a positive effect on the interaction and behaviour of people within such buildings. Learning is more effective and less tiring when pupils can comfortably hear and understand.
- A study in 2005 found that 99% of people surveyed reported that their concentration was impaired by office noise such as unanswered phones and background speech<sup>2</sup>.
- Not only is noise a clear distraction that hinders office workers carrying out their work accurately and efficiently, it can also have a detrimental impact on health and levels of stress<sup>3</sup>.
- A study in 1998 found that there was up to a 66% drop in performance for a 'memory for prose' task when participants were exposed to different types of background noise<sup>4</sup>.
- In hospitals, avoiding stress generated by high sound levels and improving sleep quality helps patients recover faster and facilitates the work of the staff.

## The importance of wellbeing

Wellbeing is increasingly being acknowledged as a valid yardstick in public policy. The UK government began to collect data on 'national wellbeing' in 2011 to complement existing financial and economic measures of the nation's progress.

Taking a holistic approach to the importance of comfort, health and wellbeing in buildings is the way forward. By carefully considering all the different areas of comfort that a building can – and indeed should – provide, we are able to improve people's wellbeing within buildings, regardless of the types of buildings and the specific activities taking place inside them.

At Saint-Gobain, we believe that sustainable habitat is within our reach, and by providing sustainable products and solutions, this vision can be made a reality.

Read more about Multi-Comfort here: [www.multicomfort.co.uk](http://www.multicomfort.co.uk)

To find out more about Saint-Gobain, visit [www.saint-gobain.co.uk](http://www.saint-gobain.co.uk), Like the Facebook page and Tweet @SaintGobainUK

<sup>1</sup>Source: [www.bbc.co.uk](http://www.bbc.co.uk), 16 September 2014.

<sup>2</sup>Source: Banbury SP. and Berry DC. (2005) Office noise and employee concentration: identifying causes of disruption and potential improvements. *Ergonomics* 48:1, pp 25-37.

<sup>3</sup>Source: Shepherd D. Welch D. Dirks KN. And McBride D. (2013) Do Quiet Areas Afford Greater Health-Related Quality of Life than Noisy Areas? *International Journal of Environmental Research and Public Health* 10, pp 1284-1303.

<sup>4</sup>Source: Banbury SP. and Berry DC. (1998) Disruption of office-related tasks by speech and office noise. *British Journal of Psychology* 89:3, pp 499-517

# BIM and the necessity to participate

**Raj Chawla, Vice Chair at BIM4SME analyses the challenges, issues, and benefits that the SME community face in the BIM process, arguing that to participate is necessary to gain efficiency...**

**W**hat is Building Information Modelling (BIM)? It is a revolution that is occurring in construction and the built environment. BIM is a process that allows the structuring of digital information for use in design, construction and management of facilities and assets and is a progressive way of working. Unlike other industries, this sector is very slow in the uptake of technology and has been extremely inefficient.

The government's construction strategy has mandated the use of this process for its projects from 2016. At the heart of the strategy is cost savings and efficiencies. 99% of the industry is made up of small to medium enterprise – SMEs – and it is this group that will be instrumental in making this strategy a success.

So does the SME community need to engage with BIM? The answer is very obvious to some, but the SMEs wishing to engage are asking a very basic question. Is BIM for me? This stems from the various definitions or interpretations of the mandate. Is BIM to be used on “all central government construction procurement”, or “all public funded projects greater than £1M”, or “the adoption of BIM technology by both public and private sector involved in the procurement and delivery of buildings and infrastructure”. These are just some of the many other citations that are offered. It is all about clarity and tidying up mixed messages.

This confusion “deters participation and more significantly, the necessity to participate”. This uncertainty has been voiced right across the supply chain. It is even prevalent in local government and within quangos, but it will eventually need to embed.

## **BIM as Digitising the Built Environment**

The acronym BIM is also a culprit here. The acronym was contrived by software vendors and sends the message that BIM is some kind of software. To shed this acronym and adopt a strategy of “Digitising the Built Environment” makes the uptake agnostic. It is a delight to see that the next evolution in this journey is referenced as “Digital Built Britain”.

While a lot of us know that BIM it is about migrating structured information and data seamlessly, it is not that obvious to the masses. Once you drive this home, the idea becomes more receptive. How this information is migrated is academic.

The software vendors are providing crucibles for the migration of this information – some do it well and some not so well. If one puts their mind to it, the information can be migrated using a spreadsheet. The industry is bombarded by software vendors and it is causing serious affixation to a point that it “deters participation and more significantly, the necessity to participate”. There is still a huge impression that software is BIM. For the avoidance of doubt, software are tools to support the implementation of BIM.

When described not as BIM, but a technological advancement in digitising their business processes, the reception is very different. With the analogy; the BIM process is like quality management; it is embedded in a business as a back office activity and is considered daily in the work place.

The SME community has a wide berth and encompasses lawyers, financial institutions, consultants, professionals, contractors, a huge supply chain, operators, and not



Raj Chawla, Vice Chair at BIM4SME

forgetting clients. These are the masses and the masses are very significant in ensuring that Digitising the Built Environment is a success.

To distil – in the first instance clarity must ensue in the definition of the mandate. Secondly, the staged delivery of information for use in “Construction” must be structured as prescribed in the various process documents and standards – the focus being the ability to migrate this information once, accurately, and error free into a database. If you can do this, you are starting to practice BIM.

### **Embedding efficiencies**

Now for a little bit of business school regurgitation – usually for a business to consider efficiency there is an underlying threat. Until the threat is prevalent, efficiency measures do not kick in. There is a lot of hype about cost and efficiency savings with BIM. These benefits are usually further up in the food chain and not ordinarily at SME level. What isn't explained is the savings and benefits due to lean working. There is a philosophy of Kaizen which has been around for years and is the practice of continuous

improvement. If you are doing a task that takes 10 minutes and now you can do it 1 minute, you are saving 9 minutes. As they say, time is money. Embedding efficiencies in a business is also cost saving and appears as profit in the balance sheet if done right.

When talking to SMEs, I tend to use a simple analogy of the hammer. At present the industry is using a hammer, whereas all that is being asked is to use a nail gun. It does the same job, but with enhanced speed with more accuracy and consistency. Now you have to make the investment in the nail gun and the air cartridges. For BIM, this is an investment in time, resources and educating oneself to continue to better oneself. Kai (change) zen (good). Change for good.

The connection and understanding between the prophecy of BIM and lean and efficient working is still leagues apart in the construction industry. Some do it very well, and some not at all. The industry is very fragmented and works at different speeds.

Trying to convince businesses, especially in the construction industry, is not easy. There is too much jargon, mixed messages and distracting pollutants and it “deters participation and more significantly, the necessity to participate”.

Each business needs to test itself to see what level of investment is required. The majority of the SME businesses I have visited recently already have most of the essential components in house. A little bit of restructuring of their business processes and appending the BIM process is usually all that is required. It is a business strategy with the mantra, “do it once, do it right”.

### **Wider appeal**

The BIM seminars and conferences are becoming like old school reunions, and incidentally, also becoming very incestuous. There is a desperate need to have a wider appeal. But how to get the wider appeal?

To digress a little. Neuroscience is a very specific subject and once again the academics and laureates in this field eventually stalled. This was not due to them not being knowledgeable in their field, it was



because their conferences did not have a wider audience. The field needed an accelerant to catalyse the advancement. It hosted a conference – Mathematicians can't count & IT is for children. It had an audience of some 900, where a usual turnout was 100. The neuroscientist described their problem and within a relatively short period found that their field had accelerated beyond their imagination. This was with help from outside their science.

Digitising the Built Environment, Digital Built Britain and not BIM should be the opening line. The conferences should be advertised and published in the national press. In addition to the architects, engineers, contractors and facility managers it should be able to capture the interest of financiers, lawyers, IT professionals, ontologists, telecom and telemetry specialists, instrumentation specialists, mathematicians, systems and solution architects etc. all becoming stakeholders in Digitising the Built Environment.

It may be acknowledged that there is a need, but the masters of the conferences need to change the direction and become agnostic.

**Collaboration and risk**

There is a misnomer that collaboration is a deterrent to BIM as it exposes how people work. Projects, no matter how large or how small do not get delivered without collaboration. There are joint ventures, alliances and coalitions being formed to deliver projects on a daily basis. If this is not collaboration, then I don't know what is.

If we trickle down to the SME level, this is not so apparent. There exists a tension, in particular in the construction and maintenance arenas, that collaboration is singular and is expected from smaller towards the larger, and there are many cases where this is true. The reason this occurs is the simple misunderstanding of risk. It is this misunderstanding that "deters participation and more significantly, the necessity to participate".

Collaboration is a sociological and human trait and it is not necessarily enforced by applying processes or legal structures. The basic idea of collaboration is to

mitigate risk, but the idea of migrating risk is very endemic in the construction industry. The legal structures in the construction industry haven't attained maturity in how to handle risk and has caused this short fall in the understanding of how to mitigate, and not migrate risk.

What BIM brings to the party is a high degree of visibility, more resilient information and the ability to test and mitigate risk without migrating it. The measure of collaboration is the ability to mitigate risk between the stakeholders and where the stakeholders are able to do this, collaboration ensues.

**Delivering the message**

There is huge effort being deployed by the BIM4 communities in rolling out the message. Like BIM4SME, this is voluntary and is being relentlessly championed by groups of people who see the benefits of the process and are transferring knowhow – ensuring others catch-up quickly.

There is a huge change in the design fraternities and the adoption of tools to facilitate BIM. That said there needs to be a lot more done at client level to ensure that the requirements and the compliance burdens are stable for any future BIM project. ■



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# The Opportunities from 4D Simulation

To enable the people involved in a project to gain an easy understanding of project progress and the planned sequence of works, 4D simulations are well recognised as an excellent medium to communicate.

The same applies at tender stage, when representations prepared by multimedia teams are often used in Client presentations to help explain the Contractors plans.

However, the next level of opportunity, connecting the Building Information Model (BIM) to the programme, an option previously constrained by the lack of available easy use tools, has now become a realisable opportunity.

It is commonly accepted that about 10% of design and construction time can be saved by the use of BIM, 4D communication is part of the step change to realise and improve upon this opportunity. Wherever and whoever you are trying to communicate to, operatives at site inductions, directors at project reviews, visitors to site, or for your own purposes, the power of a visual representation, or indeed an interactive time-lined visual representation is immense.

Technology to date has not made it quick or easy for people to repeat the process of linking dates with objects in a model and enabling rapid re-sequencing, this is a critical downfall as activities are commonly amended and dates changed frequently during project delivery. This is caused because currently, a single model and a single

programme are fused together for this one off exercise. This fusion is permanent, so when amendments are required the whole task needs repeating from scratch, wasting time and resource.

## Traditional 4D tools are too restricting to make them practical in the delivery phase

The traditional way to link the 3D model to the project programme is to take individual activities and associate them with modelled components. Projects naturally range in size but a good size complex project can easily yield 10,000+ activities and tens of thousands of objects in the model. Currently, the task of association is not for the faint hearted and will only be possible if your viewing software can handle the file size of the model in the first place. Once the model and programme are hard-wired, pushing another programme into the same model is generally not possible.

## Accessing the BIM at a data level enables new faster ways of working

In BIM we know a lot about the object; we know what it is, its size, its location, potentially its cost and the labour associated with it. Indeed, in a data centric solution to BIM such as the Clearbox BIMXtra solution, all the associated information is held in a central data environment. This can be accessed readily by project stakeholders through a variety of interfaces within the system.

If the model and data association is undertaken in a data environment the

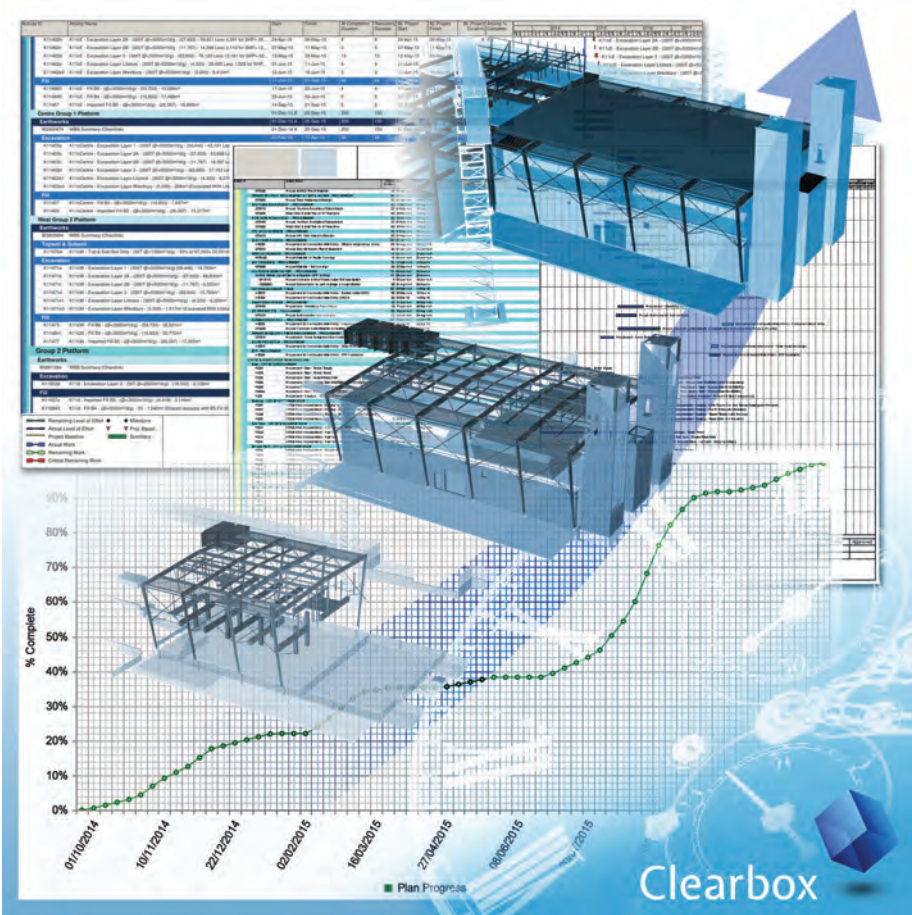


connections, including those between programme and object, can be re-created at will. This is especially important when consultants update models as the re-association can take place with minimal effort. The BIMXtra process relies on its toolsets within the system to find the right objects to associate with the activities, as opposed to current solutions which require the manual adding and updating of codes in the model, which is a task that constantly causes frustration to the numerous people that need to participate to provide the output.

**“It is commonly accepted that about 10% of design and construction time can be saved by the use of BIM, 4D communication is part of the step change to realise and improve upon this opportunity.”**

## Associate via a data platform and we can add value to the outcome

This approach of associating the model and programme within BIMXtra



superfast time changes our ability to be able to use 4D visualisation on the main construction model and in doing so enables better communication to all, and more accurate association of the work scope with a most essential aspect of our project controls.

At Clearbox we have a unique blend of people, mixing people with many years of project delivery with software engineers to provide focussed technology solutions to overcome project delivery issues.

Our solution to provide 4D simulations is targeted to provide ease of use to those involved in project delivery, not limited to those with specialist training in CAD solutions. It allows you to quickly develop and subsequently change and visualise build sequences with the objective of opening up the benefits to the whole project team, saving time and money in the development of the visualisations and the project delivery.

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**“At Clearbox we have a unique blend of people, mixing people with many years of project delivery with software engineers to provide focussed technology solutions to overcome project delivery issues.”**

The flexibility and speed of this solution which allows you to derive 4D

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# The water sector's journey to BIM

**Jon de Souza, Business Improvement Manager, Galliford Try and Chair, BIM4Water details the challenges of incorporating BIM in the water sector and how BIM4Water are addressing the issues...**

Over the last few years there has been an increasing push for Building Information Modelling (BIM) across the built environment sector. This momentum has been driven by a selection of government and industry reports, culminating in the introduction of the mandate to achieve Level 2 BIM for all central government construction projects from 2016.

This introduction of BIM for central government is part of a strategy to achieve improved outputs and outcomes from construction procurement. Indeed, July 2013's 'Construction 2025' document set targets including:

- 33% reduction in both capital and whole life costs;
- 50% reduction in the time taken to deliver or refurbish assets from inception to completion;
- 50% reduction in carbon emissions from the government estate.

Evidence from other sectors has demonstrated that the use of BIM can support, amongst other things, better time and cost predictability in capital delivery through visualisation and clash detection, better exploitation of opportunities for off-site manufacture and standardisation, improved resource efficiency in construction and operation, facilitation for collaborative working and, crucially, better asset data to enable optimum decision making.

The UK water companies are faced with challenging efficiency targets throughout AMP6 (Asset Management Programme 6) and as such, are seeking ways to drive performance improvement through both their capital delivery and asset management processes. Therefore,



interest in BIM in the water sector is gradually increasing. As Chair of BIM4Water, I am delighted that we have involvement from all of the UK's Water and Sewerage companies and a number of the water only clients.

However, despite the interest shown, the government mandate does not apply to the water sector, and as such, there has not been a burning platform to force the water companies to adopt the BIM process. Therefore, although there is some recognition that BIM has supported improvement in other sectors, there are still a number of barriers to BIM adoption in water.

At present, the level of knowledge regarding BIM across the water sector is very mixed. There is still a perception that BIM is only for buildings, and some of those I speak to consider BIM to be a technology solution rather than a process, with a small number of people thinking it's possible to "buy a BIM".

There is still uncertainty around some aspects of BIM. A number of water companies have invested heavily in their asset management systems in the last few years. At present there is still work to do to ensure that the digital data from a BIM process can be seamlessly incorporated into these systems.

**“...interest in BIM in the water sector is gradually increasing. As Chair of BIM4Water, I am delighted that we have involvement from all of the UK’s Water and Sewerage companies and a number of the water only clients.”**

There is also a recognition across the sector that BIM adoption across the sector needs to be coordinated. There is a real risk that there could be significant inefficiency if different organisations, be they clients, contractors, consultants or companies in the supply chain, adopt different BIM standards.

Finally, at present there is insufficient evidence of the value from BIM use in the water sector to make a compelling business case for many senior decision makers. It is recognised that a better evidence base is required.

BIM4Water is a cross-industry group open to all organisations involved in the management and delivery of water and wastewater assets, operating as a partner to the UK Government BIM Task Group. The group’s make up is reflective of the sector, involving clients, contractors, consultants, suppliers, sub-contractors and other bodies. Our mission is to support organisations in the water sector with the adoption of Building Information Modelling. At present we have over 100 organisational members.

In order to address a number of the barriers mentioned above we have formed 4 task groups:

- Case studies and evidence;
- Influence senior leaders in client organisations including producing a business case;

- Creating and signposting guidance and communications;
- Standard libraries.

We have recently launched a Demonstration Programme where we track live projects utilising BIM. Through this approach we hope to generate sufficient evidence to demonstrate the value of BIM. We would encourage any organisations in the water sector with BIM projects to contact us to support the development of the sector.

We recognise that BIM is a significant enabler of collaborative working. This collaborative approach is at the centre of our ethos – we recognise that in moving together as a sector we can generate significant value for all.

Building Information Modelling (BIM) is a digital representation of the physical and functional characteristics of an asset; creating a shared knowledge resource for information about it and forming a reliable basis for decisions during its life cycle, from earliest conception through design, construction and operation to demolition. ■

BIM 4 WATER



.....  
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# Challenges for civil engineering in a changing world

Prof. Dr. Bernhard Elsener from ETH Zurich, Institute for Building Materials details how civil engineering must evolve with a changing society...

Civil engineering is traditionally focused on construction – bridges crossing valleys, tunnels under the mountains, high skyscrapers, but also the less spectacular but essential infrastructure for society. Concrete and reinforced/pre-stressed concrete is and will be the main construction material for civil engineering infrastructure. But society is changing, and so the way of construction, maintenance and use of the civil engineering infrastructure, maybe the way to look at civil engineering, must change, too.

## Environmental footprint

In many countries around the world, Portland cement has for decades been the most used type of cement to build reinforced concrete infrastructure. For new structures that will be built in industrialised and emerging countries to expand the civil engineering infrastructure, the challenge is to achieve long service life, practical, cost-effective solutions with materials having a reduced environmental footprint. To achieve this, the cement industry made great efforts in substituting clinker (responsible for great part of the CO<sub>2</sub> emissions) with supplementary cementitious materials (SCM). This substitution is ongoing and reflected in the decreasing amount of Portland cement and the increase of blended cements. These modern binder systems containing limestone, fly-ash, geopolymers etc. in a complex blend are suitable for achieving strength similar to Portland cement, thus can be used to build concrete structures. From the point of view of the end user (engineer, owner of the structure, society) the final product concrete and its durability, especially when reinforced with steel, is more important. Concrete for a bridge in the Swiss mountains exposed to a harsh climate and de-icing salts must be of much higher quality, compared to concrete inside a building. The term “quality of concrete” includes the care with which it is executed but also its composition – thus



water to cement ratio and the cement type. Whereas long experience is available with concrete structures made with Portland cement, new blended cements have in general a much shorter track-record. In addition, due to the reduced clinker content, the pH of the pore solution will be lower and questions arise regarding the corrosion protection of the steel, thus the long-term durability of these new structures both regarding the resistance against carbonation and against chloride-induced corrosion. Despite the ongoing massive use of the new blended cements convincing answers are lacking.

## Live-cycle perspective

The civil engineering industry is currently, in many industrialised countries, in a transition phase from building new constructions to maintaining the large stock of valuable assets. These reinforced concrete structures are aging and very often show premature deterioration due to corrosion of the reinforcement, with increasing costs for maintenance and repair. Taking into account that the average lifetime of a repair is shorter than that of the original, a dramatic increase of structures have to be repaired and the associated costs can be predicted. The indirect costs,



energy consumption, pollution, traffic jams etc. are equally important for society. Today engineers and owners try to extend the service life of these assets with minimum interventions, with sophisticated management systems, and maybe with more effective and durable repair methods – but a new approach is lacking. Life-cycle thinking is urgently needed: in education, continuous formation of professionals, for the stakeholders and society. Why, for instance, a car is carefully designed for easy inspection, contains a wealth of monitoring systems – a much more expensive civil engineering structure with expected service life of 100 years instead not? Why, even at the most exposed points of a structure in harsh environments, do we still use normal reinforcing steel and not a more resistant material like stainless steel that is fully corrosion resistant? Live-cycle calculations prove the long-term benefit both in durability and costs – but short-term thinking seems to prevail.

New needs of a changing society face civil engineers with new challenges, like a reduced environmental impact and the preservation of ageing infrastructure. The traditional way of construction, the known technologies might not succeed. What we need is a paradigm change towards a life-cycle perspective. Here academics and practitioners, owners and stakeholders need to take a step forward. ■

.....  
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# Benefiting the community in Wrexham

**Gareth Thomas, Housing Press Officer at Wrexham Borough Council explains how communities in Wrexham are seeing extra benefits from housing improvement works...**

**E**mployment and Modern Apprenticeships in Wrexham County Borough have received a boost as a result of the comprehensive improvement works programme Wrexham Council's housing service are carrying out to ensure their properties meet the Welsh Housing Quality Standard.

A range of other local groups, schools, Community Centres, and Youth Sports Teams, have also been receiving a variety of donated materials, sponsorships, and funding help.

Since the Community Benefits initiative was introduced by the Welsh government to maximise the local value for every pound spent in achieving WHQS, clauses have been included in Wrexham Council's housing service major work contracts, requiring firms to develop a range of Community Benefit schemes. These can include taking on a specified quota of local labour, purchasing materials and supplies from local businesses, offering work experience placements, and setting up funding and sponsorship schemes for community groups.

Wrexham are currently carrying out extensive improvement works to ensure all 11,300 of its social housing properties meet the Welsh Housing Quality Standard (WHQS) ahead of the 2020 deadline, set by the Welsh government. A £38m spending programme has recently been agreed for 2015/16 to help continue funding the work.

The scale of the current spending programme has allowed a variety of Community Benefit schemes to be set up across the County Borough. These are set to continue to grow over the next 4 years as the works programme continues.

Over the last 12 months, Community Benefit schemes

in Wrexham have resulted in:

- 114 weeks of work experience provided;
- 36 employees have been provided with short term employment;
- 34 employees have been given long term employment;
- £63,197 has been donated as cash or in-kind to organisations or projects within Wales.

Wrexham County Borough Council's Lead Member for Housing, Councillor Ian Roberts commented, "It's vitally important that our local economy is able to benefit from the extensive work being carried out on our social housing stock. It's great to see the positive contributions which have been made to communities across Wrexham as a result of these schemes, and we are committed to ensuring this can continue as we work with our partners to achieve the Welsh Housing Quality Standard."

With youth unemployment remaining a huge local and national issue, Modern Apprenticeships are one of the significant success stories of the Community Benefit schemes in Wrexham.

James Riley is one of 36 apprentices employed by contractors working in partnership with the housing department. Wrexham born James, 19 is currently completing an Apprenticeship scheme, specialising in painting and decorating for Novus Property Solutions. A Stoke based company, who also have an office on Wrexham's Industrial Estate, and who are currently heavily involved with Wrexham Housing's extensive Kitchens and Bathrooms replacement programme.



The picture is of James Riley, the Modern Apprentice interviewed in the article

The scheme has given James the chance to get into paid employment, receive on the job training, and focus his career path. "After I finished school, I did a BTECH in construction while working part time in a café," explains James. "I still wasn't completely sure what career I wanted to go for at that point. Then a relative suggested trying a Modern Apprenticeship. I found this one, managed to get the job, and it's turned out to be a great move. Studying in college is one thing, but the advantage here is the experience you get from actually working on site with professional colleagues."

James' Apprenticeship has also allowed him to take part in the international charity work that Novus Property Solutions are involved with, travelling to locations in Holland and Slovenia, and learning about the international construction industry. James was

also highly commended in Novus Property Solutions' Apprentice of the Year awards.

"My Apprenticeship has helped me a lot in deciding where I want to go with my career," explains James. "Once I've completed my NVQ here, I'm hoping to move onto a Level 3 HNC and progress from there." ■

.....  
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# A responsibility for fire safety

**David Smith, Export Manager and FIRESA Council Secretary at the Fire Industry Association explains the Fire Safety Order and asks if you know who is legally responsible for fire protection in your premises?**

The Regulatory Reform [Fire Safety] Order, usually referred to as simply the Fire Safety Order [FSO], was enacted in England and Wales in October 2006 with comparative legislation existing in Scotland and Northern Ireland. It pertains to virtually all non-domestic premises, replacing most fire safety legislation with a single Order and accompanying guidance. The key element is the annulment of fire certificates issued by fire authorities in favour of the identification of one or more 'Responsible Persons', having a legal requirement in respect of fire safety for those premises.

The Responsible Person is liable for the safety of his/her employees and relevant persons through the fire safety management of risk assessments, safety policy, procedures and drills, means of escape (including emergency lighting) and a range of preventative and mitigating measures including fire alarms and extinguishers, fire doors and compartments, and signs and notices. As part of this, they must keep records on risk assessments, policy, procedures, training and drills as well as fire safety systems maintenance. This is responsibility writ large, and failure to meet these legislative demands can result in a 2 year prison sentence and a £5,000 fine, not to mention the matter of a record that an assigned legal duty has not been met and has put lives at risk.

The Prosecution Register (freely available from the Chief Fire Officers Association website) shows that there have been over 10,000 prohibition, enforcement or alteration notices served, and that between 2009 and thus far in 2015, 86 prosecutions undertaken. What is worrying however, is that not all Fire & Rescue Services [FRS] are equally active and/or consistent in their executive roles since Lancashire, Cheshire and West Yorkshire FRSs contribute 24, 19 and 18

prosecutions respectively, accounting for over 70% of prosecutions made by the current 46 such services in England.

The Department for Business, Innovation and Skills [BIS] published a review on FSO Enforcement in August 2013 based on evidence from a range of trade bodies, businesses and regulators. While there was some evidence that Fire & Rescue Authorities provide effective support, the findings are overwhelmingly a cause for concern. Many see the official guidance documents as confusing and sometimes contradictory, while the view is widely held by Enforcing Officers that many small businesses are simply unaware of their specific obligations. Officers are critical that some fire risk assessments are not carried out competently while businesses contend that some officers have questionable capability and training to carry out their enforcement roles. What is manifest is that there is inconsistency across the FRSs and that businesses have a difficult job in complying with their responsibilities and, in fact, the Fire Industry Association [FIA] has heard from a number of commercial premises owners that suggest that a more prescriptive approach to fire safety in the UK would be welcomed. This, of course, takes us beyond the jurisdiction of the FSO itself into the realm of fire safety legislation generally and the requirements encompassed within Approved Document B – Fire Safety published by the Department of Communities and Local Government [DCLG].

Interestingly, the BIS report fails to identify a key difficulty inherent in the FSO, namely, who is defined as the Responsible Person. Under the definition given in the Order, it is the employer 'if the workplace is to any extent under his control', otherwise, 'the person who has control over the premises', or the owner 'where the person in control of the premises does not



David Smith, Export Manager and FIRESA Council Secretary

have control in connection with the carrying on by that person of a trade, business or other undertaking'. In practice, therefore, it could be the employer or self-employed, but equally it could be a managing agent or owner of shared premises or a contractor with a degree of control over those premises. In other words, the designation of the Responsible Person is not explicit.

It is helpful then that a recent debate on fire safety at Westminster Hall in London contributed to the public discourse on this element of the FSO. Jonathan Evans MP (Conservative, Cardiff North) related the tragic story of the loss of life of a young lady at Meridian

Place, a residential property in London's Docklands, who tried to rescue her boyfriend who was trapped in the blazing building. It has emerged that the fire alarm had not been working for 2 years, there were problems with fire doors and there was inadequate smoke ventilation – issues which should have been revealed had there been a fire risk assessment conducted more recently than 1997.

This led to deliberation regarding the adequacy of the current legislative framework and questions concerning just who is responsible for fire safety in large scale developments. Evans asked; "who is accountable... is it the owner, the property management company, the residents' association or the individual tenant? When failings are found, the lines of accountability are not clear enough".

Further evidence offered during the debate showed that the broader picture is equally alarming. While it is an offence to wedge fire doors open, a recent survey by fire risk assessors exposed that 85% had their self-closing mechanism disconnected and that 80% of escape routes in buildings were obstructed. In 2009, a major fire broke out in Lackanal House in Camberwell, London, which claimed 6 lives and it was found that the local council had scheduled the building for demolition on fire safety grounds 10 years previously. The London Fire and Emergency Planning Authority in its report on the tragedy stated that; "the Authority wishes to explore whether the regime (the FSO) is achieving all that is desirable" and goes on to highlight that; "there are issues about complexity; understanding among responsible persons".

They felt that there are contradictions or omissions in the overall legislative framework and that the system of devolved managerial and democratic oversight of fire safety lacks common methodologies or performance measures. They cast doubt also on whether the guidance properly informs Responsible Persons.

The Order, therefore, has arguably been inadequately publicised and is insufficiently clear. We might suggest that enforcement is suspect both in terms of coverage of relevant premises and the approach that each Fire Authority takes as the enforcing body.

In response to Jonathan Evans, Stephen Williams, Parliamentary Under-Secretary of State for DCLG, stated that; “fire prevention is always better than cure” and referred to the Fire Kills campaign which provides fire prevention advice to householders. To clarify the situation in residential properties, he referenced the Housing Act 2004 which places responsibility for whole building safety on owners (landlords or freeholders) and housing authorities, while for commercial premises he cited the FSO, and furthermore indicated a review of Approved Document B to be completed by 2016-17.

The previous coalition administration and now the Conservative government has adopted a strategic policy in fire safety that engenders a ‘hands-off’ approach from central government departments, devolving responsibility to individual authorities as part of its Localism agenda and encouraging sector stakeholders to do what they can to improve fire safety in this country. This is in addition to stringent public spending cuts and a reluctance to bring new regulations to the statute book, with the notable exception of requiring landlords to fit smoke and carbon monoxide alarms within their rented properties.

If this sounds like a viable approach with localist democracy at its heart, in reality it is profoundly problematic. DCLG has diminished its personnel count by over 35% since 2010 and is to save a further £230m as part of George Osborne’s efficiency drive announced shortly after the election, and this coming in addition to major cuts expected in the July budget. This is conspicuous in the absence of central government direction on fire safety over the last 5

years and a lack of investment in projects that can solve some of the problems we have identified.

If this central government policy vacuum is to be filled by local authorities, trade bodies and others, then what is the problem? For the authorities, they are labouring under drastic cuts in their Fire and Rescue grant awards from central government so their own finances are stretched. In addition, there’s a cultural tendency for them to act autonomously, creating regional diversity and rendering a concerted national approach to fire safety issues difficult.

For other bodies such as the FIA, we’re sure we can help and we do as much as we can to achieve tangible progress, but we have no legislative or regulatory powers at our disposal. If the Fire Safety Order is to function as it was intended, and it is imperative that it does, we need not just the will but the means to implement the changes needed. ■



**Fire Industry Association**

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# Driving culture to local communities

## Adjacent Government outlines how DCMS and the Museums Association help to encourage local communities to engage with the culture and heritage sector...

**M**useums and galleries play an integral role in our local communities. As well as preserving local history and heritage, they also help to educate. Heritage and culture throughout the UK helps also to encourage tourists to our shores. As a key component in the UK economy, tourism is vital for creating jobs and growth to local areas.

In July this year, the Prime Minister and Department for Culture, Media and Sport (DCMS) announced a boost to tourism through a 5 point plan. The 5 key areas will focus on: <sup>1</sup>

- A better coordinated sector;
- Skills and jobs: driving and retaining talent in the sector to encourage growth;
- Common sense regulation: reforming regulation sensibly to drive competition and improve the tourism offer for visitors;
- Transport: forging innovative links between the transport and tourism sectors to help visitors travel outside of the capital;
- An improved welcome: delivering a world class welcome at the border.

Speaking about the announcement, Secretary of State for Culture, John Whittingdale, said: "Tourism is a vital industry that brings jobs and growth to local communities across Britain. There are so many world-class things for people to do in the UK, and we need to make sure visitors are experiencing as many of them as possible.

"We want every visitor to the UK, whether from home or abroad, to have a brilliant experience and shout

about it, encouraging even more tourists to choose Britain," he said.

According to the Department for Culture, Media and Sport (DCMS), 3 of the world's top 5 most-visited museums are in England. The UK's national museums and galleries generate around 40 million visitors each year. National museums are funded directly by DCMS – the government department tasked with making Britain the world's most creative and exciting place to live, visit and do business.

As well as national museums, England has a large network of specialist and regional museums that are run by charities, local authorities and educational establishments. Many of these receive public funding from the National Lottery.

In May this year, the government announced that 9 museums and heritage projects would receive a funding boost from National Lottery investment <sup>2</sup>. The projects, which included Jodrell Bank in Cheshire and Dorset County Museum, are to receive a share of £98m to help make a lasting difference to local areas. The funding hopes to also use culture to inspire young people to learn more about science and technology.

"National Lottery money continues to make an absolutely vital contribution to our culture and heritage in the UK," said Whittingdale. "I'm thrilled that 9 exciting projects across England and Scotland will benefit from this significant £98m investment.

"Whether it's a new railway museum in Leicester, The Lovell Telescope at Cheshire's Jodrell Bank or saving the UK's most vulnerable sound recording at the British Library – these grants will not only make a lasting difference to local areas and the UK's wider





The Museums Association said of the campaign: “As public expenditure continues to be cut, it is more important than ever to have a strong sense of social purpose. Funders and policy makers expect museums to achieve greater social outcomes and impact.

“Individuals and communities are under stress and every museum must play its part in improving lives, creating better places and helping to advance society, building on the traditional role of preserving collections and connecting audiences with them.” ■

- 1 <https://www.gov.uk/government/news/new-plan-to-drive-tourists-beyond-london>
- 2 <https://www.gov.uk/government/news/uk-heritage-projects-awarded-nearly-100m>
- 3 <http://museumsassociation.org/download?id=1001738>

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heritage, but will also use culture to inspire young people to learn more about science and technology for generations to come.”

The Museums Association aims to enhance the value of museums to society by sharing knowledge, developing skills, inspiring innovation and providing leadership. The ‘Museums Change Lives’<sup>3</sup> campaign is the Association’s vision for the increased social impact of museums. The campaign explores the impact of museums under 3 areas: wellbeing; better places; and ideas and people.



**The highly important settee (and chairs) from the Penshurst suite c.1730**  
Valued as part of an entire collection valuation on behalf of Leicester Museums and Galleries

# Value it!

**Knowing what their collections were worth in the marketplace was, for many museum directors and curators, almost unthinkable only a few years ago. Now it is an essential part of good housekeeping and obligatory.**

But still curators of local authority museums live in fear of having their collections valued, because their elected members might be alerted to the financial possibilities if pieces are sold with little regard for the ethical issues involved.

The reality is that very rarely does a valuation trigger a sale for financial rather than curatorial reasons, but more often than not it highlights important parts of collections that have been in store for years, that can be newly interpreted and displayed; as well as drawing attention to areas of the collections (frequently of little financial value) that perhaps will never serve a purpose, which are being stored at great expense and could find a new home even if they are given away to another museum which might have a specialist use for them.

**Art & Antiques Appraisals Ltd** is an independent advisory and valuation business working with expertise from the museum, gallery, auction and academic worlds. Director James Glennie has been working in liaison with museums, galleries and heritage bodies over the past three decades and has an appreciation of the complexities and ethical issues facing the sector.

We advise on sale and acquisition, negotiate private treaty sales, advise on auction consignment and purchases and undertake valuations, mainly for insurance and loan purposes, across a wide range of disciplines for single objects or entire collections.

We receive instructions from, English Heritage, The Church of England, The Supreme Court, The Royal College of Art, The British Museum, The British Council, numerous independent and local authority museums and have undertaken valuations at National Trust Houses. Our valuations are widely accepted by grant giving and similar bodies such as the Heritage Lottery Fund,





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To learn more about having your collection valued, or how to apply for a grant from the Museum Valuation Charitable Trust contact:

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**Joseph Stannard Off Corton c.1825**

Valued for acquisition fund applications on behalf of Norfolk Museum Services



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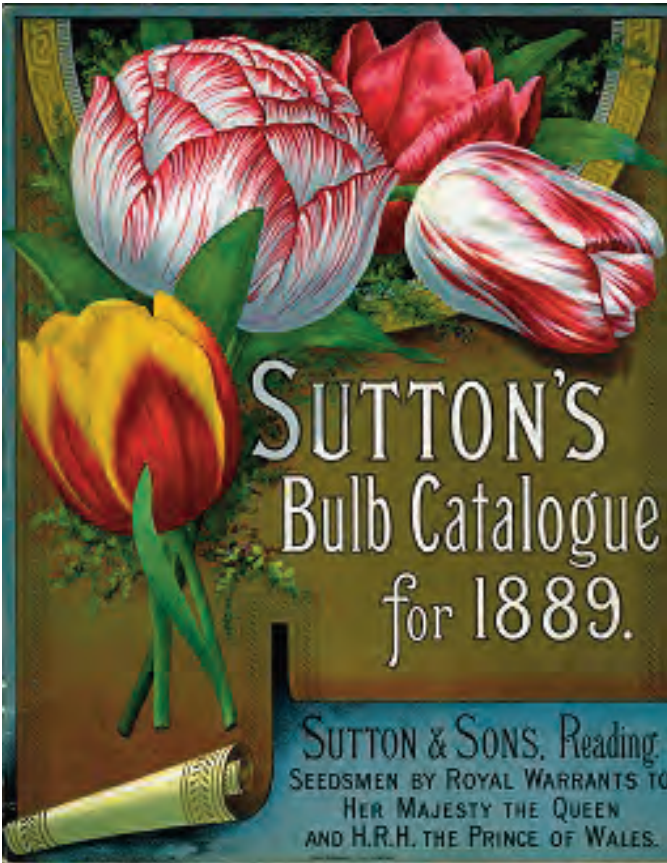
## Reading Connections

**Kate Arnold-Forster, Director of the Museum of English Rural Life and Brendan Carr, Community Engagement Curator at Reading Museum, describe how a joint project between Museum of English Rural Life and Reading Museum has helped to engage local communities...**

**R**eading Connections, funded by Arts Council England, is an example of a new kind of collaboration between a university and local authority museum. Its purpose was to build a new form of working relationship between the Museum of English Rural Life (MERL), part of the University of Reading, and Reading Museum (RM), managed by Reading Borough Council, focusing on the complementary strengths and contrasting skills of our collections and staff. Through a new model of joint curatorial practice we aimed to explore how to share and exchange expertise between two very different types of museum. The intention was to demonstrate the potential of our combined collections to engage and connect with existing and new audiences. This was achieved in various ways including improved

digital access to collections, joint programming and new collections-focused approaches to public engagement.

The project had ambitious objectives in terms of exchanging and adding to our collections knowledge and to the accessibility of online content, but also in how we could reinvigorate the use of under-exploited collections for exhibitions and other public programmes by working together. It was designed to achieve these goals through an approach that centred on using the power of collections to make connections: to illuminate themes and issues with relevance and significance to our audiences and by enhancing links and interaction between our museums, between colleagues, with sources and local communities and with our online users. This approach challenged both museums in 2



exciting and sometimes demanding and difficult ways. It required us to become flexible and adaptable in our working practices: welcoming colleagues to work on each other's collections by exchanging expertise across our two museums. We worked together to engage local communities and experts to gain new insights into the stories behind our collections.

In the course of a year we catalogued well in excess of 10,000 items from our collections: 10,000 high quality photographs from the Reading Chronicle press collection and important local history images have been both catalogued and digitised, the basis of a planned major shared exhibition on Reading and Photography; the MERL Evacuee Archive and 600 historic World Cultures objects have also been catalogued; introduced online access for the first time to Reading Museum's catalogues; developed a range of initiatives that have forged links with new community groups and source communities, including oral history, exhibitions and public engagement programmes.

Examples of the outcomes included an exhibition at Reading Museum, Reading at War, drawing on material from both collections and incorporating a video installation, created by the University Department of Film,

Television and Theatre. This was designed to animate the history of Huntley & Palmers during wartime, prominent local biscuit makers and a local firm, with important holdings spread across both the University and Reading Borough Council collections.

We also shared the development of a programme of fair access internships. This built on our existing expertise in volunteer management, offering opportunities to those normally excluded from volunteering or gaining work experience for financial reasons to acquire a level of skills and experience to aid their ability to secure employment or gain access to further training or education. Before the end of the project one intern had already found employment in the sector and others had moved onto other related positions.

This project has enabled both museums to re-energise and re-focus on the fundamental importance of their collections as the key to effective engagement with audiences. This has been a highly complex project, designed to build a strong collaboration between our two organisations as well as to deliver a variety of outputs and outcomes. Twelve months is a relatively short time frame in which to establish a successful new form of working and achieve a step change in working practices, with a team comprised of staff with varying levels of experience and professional knowledge and expertise. However, its success has been marked by a further ACE Strategic Fund award for a second collaborative project, Reading Engaged, that has aimed to embed and deepen our partnership and the lessons learned. ■

.....  
**Kate Arnold-Forster**  
**Director of the Museum of English Rural Life**  
**Co-chair - University Museums Group**

**Brendan Carr**  
**Community Engagement Curator at**  
**Reading Museum**

[www.reading.ac.uk/merl/research/merl-readingconnections.aspx](http://www.reading.ac.uk/merl/research/merl-readingconnections.aspx)



# Sustaining and transforming heritage

**Gareth Maer, Head of Research and Evaluation at the Heritage Lottery Fund (HLF) highlights the impact of their investments to heritage sites across the UK...**

The Major Grants research we've just released looks at the impact of the biggest investments the Heritage Lottery Fund (HLF) has made. Thanks to National Lottery players, we have been able to make awards of more than £5m to 173 projects since 1994, and a first 100 of these are now complete. In many cases they were finished 10 or more years ago so we have a good idea of their long term impact.

BOP Consulting carried out the research for us across 2013 and 2014. They interviewed the leaders of the organisations concerned, collected standard data by survey and looked at organisations' own evaluation data.

The picture we get from this research is of a heritage sector that has changed with the times. In the early pre-millennium years – and half our set of 100 were funded between 1995 and 2000 – the emphasis was overwhelmingly about repair and renewal. These were often projects that opened up areas of heritage that had not had major funding; industrial, maritime and transport heritage, science and technology, and social and cultural history all benefitted from major HLF funding. There were big acquisitions too – paintings, archives, buildings and entire landscape is were purchased.

These projects often did achieve much more than repair and the creation of better visitor facilities. In many cases they were transformational for the organisation as a whole and certainly the experience for visitors was hugely enhanced. Across all 100 projects, visitor numbers went from a total of 41m pa to 94m pa – an increase of 130%.

Our research also shows that urgency to mend the roof and put in a better café soon evolved into a much



**Gareth Maer,  
Head of Research  
and Evaluation**

more deliberate desire to use the scale of a large HLF project to help achieve long-term ambitions. This is the key message – organisational change has become the motivating force for major projects. A capital project is no longer a goal in itself. It needs to fit within a wider framework and support bigger organisational aims. We have (largely, if not completely), moved on from 'fixing the roof' and now we're more likely to help an institution refocus for the future.

This year HLF gave support to 8 major grants requesting £98m. There is still ambition out there and we are convinced that projects over £5m are needed. But the competition at this level is stiff and the research has bolstered our belief that we must always be looking to support organisations with the will to transform not just what they have, but what they offer. ■

The full review and detailed case studies are available at: <http://www.hlf.org.uk/heritage100>

.....  
**Gareth Maer**  
**Head of Research and Evaluation**  
Heritage Lottery Fund  
[www.hlf.org.uk](http://www.hlf.org.uk)



# Museums – protecting the nation’s heritage

**Katie Childs, Policy and Projects Manager at the National Museum Directors’ Council outlines how museums offer a vast amount of benefits to local communities...**

**M**useums preserve, promote and protect one of the few irreplaceable public assets: the nation’s collective memory, knowledge and history. They are a civic institution that simultaneously serves a local, regional, national and international audience, and an online audience who may never cross the threshold. Museums matter because they uniquely serve a public past, a public present and a public yet to be born.

Public investment in museums matters to local and central government because of the impact museums have on some of their most pressing public policy priorities. Museums are critical to place making and developing regional prosperity. There are very few public services where the public finance received is a multiplier investment. Museums generate much greater economic value than the sum of their public investment: £3 for every £1 provided by the public purse. Museums make places attractive to visit, to do business and to live in. They are the catalyst for long-term economic revival, as in Salford Quays, St Ives and the Albert Docks in Liverpool. Tourism is the UK’s fifth largest industry and museums are the country’s most popular visitor attractions. Museums strengthen the UK’s soft power by being popular and trusted institutions, and the UK has recently been assessed as the country with the greatest soft power. In quickly changing and challenging times, cultural dialogue is crucial to helping us make sense of the world around us.

Museums offer inspiring educational opportunities for people of all ages. There is Baby Art Club at Manchester City Gallery, and thousands of school trips (4% of all UK children visit a museum each week). Museums provide apprenticeships in a range of skills from traditional craft to digital, and are

partners in world-leading research on subjects as diverse as fashion and West African cities, turtle diversity and food distribution networks.

Museums are good for health and well-being, and have a particularly positive effect on mental health. Projects which provide access to museum collections for people with dementia (and their carers) – such as House of Memories at National Museums Liverpool or the activities run in the 1940s Orchard Cottage at Beamish – are promoted by public health professionals.

Communities need community spaces, and museums are safe, welcoming and open to all. They enrich people’s lives by creating a thriving, vibrant and diverse cultural life. Visiting a museum has never been so popular: 52% of UK adults visit museums each year. The collections held in trust by national and local governments belong to the public, and museums recognise this with sophisticated public engagement in research, exhibitions and gallery re-development. Museums adapt their public offer to make sure no-one misses out: the RAF Museum and Science Museum both provide special access for people with autism; whilst closed for refurbishment both the Whitworth Art Gallery and Oxford University Museum of Natural History displayed objects in public places across Manchester and Oxford respectively; and the Wallace Collection is one of many museums that takes staff and handling collections into care homes.

Museums are now cultural enterprises. Catering, retail and venue hire have been expanded, membership schemes set up, and admission fees introduced for special exhibitions, historic sites and events. Independent charitable trusts have been established to maximise fundraising, touring exhibitions created for commercial revenue, and staffing restructured. In



order to be cultural enterprises, museums must be able to maintain their public trust and popularity, as well as their reputation for expertise and quality collections care. This requires core and secure investment. In the wider context of local and central government spending, the amount allocated to museums is very small. Cutting this will have only a minimal bearing on budget reduction, yet it places the public's collections at risk and the impact museums have across public policy priorities will be diminished, not just for this generation but for generations to come.

The UK museum sector is more vibrant, popular and internationally respected than it ever has been, but this position is now at risk. Investment in museums by central and local government has reduced since 2010, and as the Chancellor announces that non-protected departments have to model up to 40% budget cuts, this will continue. This fantastic public offer – including free admission, blockbuster exhibitions and the re-development of museum spaces – requires core investment in collections care, staff expertise and the fabric of the building.

There is huge public affection for museums, and the National Museum Directors' Council (NMDC) is harnessing this with a new campaign: I Love Museums. The campaign provides the public with a way to sign up and say why they love museums and what museums mean to them. Museums are using it locally, and NMDC will use it nationally to illustrate why museums matter. Museums of all sizes – from the biggest nationals to the smallest volunteer-run collection – are united behind the campaign. Future generations will not forgive this generation should it be the one which fails in its duty to protect the nation's heritage. ■

.....  
**Katie Childs**

**Policy and Projects Manager**

National Museum Directors' Council

[www.nationalmuseums.org.uk](http://www.nationalmuseums.org.uk)

[www.twitter.com/nmdcnews](https://www.twitter.com/nmdcnews)

[www.twitter.com/ILoveMuseums](https://www.twitter.com/ILoveMuseums)

# The value of museums for local communities

**Joanne Orr, CEO of Museums Galleries Scotland details how museums are cultural assets in communities throughout Scotland...**

**W**hat comes to mind when you think about a museum? Is it the fascinating objects which link us to our past? A place to take the kids on a rainy day? Or do you, like the many people in Scotland whose lives are vastly improved through their pioneering work, see museums as a lifeline within your community?

Museums and galleries hold a crucial place at the heart of Scotland's communities but the needs of our communities are changing. As well as protecting and promoting Scotland's material and intangible cultural assets, museums have a core mission to deliver on social responsibility agendas. Scotland's communities are benefitting greatly from this shift in the role of museums.

Auchindrain Highland Farm and Township in Argyll is a fine example of how a museum can help to keep a community alive. Through its work with vulnerable members of the public, including disabled people, unemployed school-leavers and people with health issues, the museum has established itself as a key player in helping to tackle the depopulation, social deprivation and mental health issues facing the community. The museum is making it possible for people to remain in the area by helping them to develop relevant skills such as building maintenance and growing organic crops. The experience of working on the land brings its own rewards too.

Reminiscence work has been widely recognised as having a direct, positive impact on older people in communities. Football Memories – a partnership between the Scottish Football Museum and Alzheimer Scotland – is changing the lives of dementia sufferers, their families and carers. The project offers professional training for volunteers, enabling them to use football



Joanne Orr, CEO of Museums Galleries Scotland

reminiscence to work with people with dementia. Photographs from the Scottish Football Museum are being used to stimulate the memories of dementia sufferers and enable them to engage with their peers, families and the volunteers. The project has been up and running since 2010, and currently more than 90 groups meet in day centres, football grounds, care homes and community venues across Scotland.

Realising Potential, a project run by Inverness Museum and Art Gallery, the Scottish Prison Service and Fife College, works with inmates at Inverness jail. The project has helped prisoners to express themselves in



Image: © Auchindrain Highland Farm and Township. Taken by Lewis Houghton



At Auchindrain Highland Farm and Township the older generation is teaching the younger one traditional Traveller skills of “tattie howkin” or lifting potatoes by hand. The Museum works with local Gypsy-Travellers to engage the community with the museum and support the development of a sense of pride in the community's distinctive heritage and culture

a meaningful way while learning about Scottish history, raising self-esteem and developing skills.

Nearly 60% of people in museums give their expertise and time for free. This is support which museums don't take lightly and a lot of importance is placed on developing mutually beneficial relationships with their volunteers. Recent research commissioned by

Museums Galleries Scotland has shown the transformative effect of volunteering: by giving back to their communities, volunteers increase their confidence, skills and knowledge, and find it easier to express their individual value to the local community.

Museums are incredibly enterprising organisations but a lot of people's ideas of the role of a museum has yet to catch up. The sector needs to challenge the lingering perception of what museums do to highlight what could be achieved through increased partnership working and support. Museums need to have more confidence in embracing their wider role and to be more visible in delivering it as it has never been more important for museums to showcase how they're delivering across health and wellbeing, education and social agendas.

**“The museum is making it possible for people to remain in the area by helping them to develop relevant skills such as building maintenance and growing organic crops.”**

Museums have not moved away from their traditional role as custodians of our past they have definitely diversified and many museums now consider their social impact as part of their core mission and every day work. This shift means that museums will remain relevant to modern society while continuing to preserve the past for future generations. ■

.....  
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## Amsterdam culture – an unforgettable experience

As Rijksmuseum wins European museum of the year, Dr. Jet Bussemaker, Minister for Culture, Education and Science in the Netherlands details why it plays an integral role to the countries culture and heritage...

**“**You and the Golden Age” is a teaching project of the Rijksmuseum in Amsterdam. Primary school pupils play the role of a character from the 17th century, in a theatre in the museum with professional actors. They meet Rembrandt, hide themselves in a copy of the book chest of Hugo Grotius – which he used to escape from Loevestein Castle – and experience snow and freezing temperatures during the voyage of the arctic explorer Willem Barentsz. The objects of the museum are part of the experience. “You play history and then it becomes alive”, one of the children says. It’s a lesson in history they will never forget.

Through arts and heritage we experience the ideas of the past and present. We learn to experience beauty

and to explore and develop new ideas. Especially for children, education in arts and heritage can be the first experience with the history of their city, their country and the world.

Cultural education allows children to develop their talents, experience beauty and to understand the value of art. It contributes to their sense of history. My goal is that every child comes into contact with arts and heritage. Not just once a year in a visit to a museum, but structured and integrated as part of their learning program.

I am delighted that so many people are interested in the Dutch art treasures. This year, The Late Rembrandt exhibition at the Rijksmuseum Amsterdam attracted





more than half a million visitors, on top of the more than 2 million yearly visitors. Other exhibitions in the Netherlands also attract large numbers of people. Many foreign tourists visit the Mauritshuis or the Van Gogh Museum as part of their stay. The Rijksmuseum Amsterdam won the European Museum of the Year Award in May this year. The historic centers of cities as Leiden, Delft and Deventer are also very popular.

Artists and cultural institutions continue to surprise visitors and enrich (new) audiences. The artistic quality is always the starting point. That quality lies at the origin of the important social and economic values culture has for our society. Innovation and collaboration are essential to make this power more visible. This also involves links with parties outside the cultural sector, such as schools, universities and companies.

A good example of this is the Rijksmuseum Twente in the city of Enschede, near the German border. The museum was founded by the family Van Heek, the founders of the textile industry in the city. In our time, the museum works closely with institutions in the region, but also with institutions abroad, such as the Swedish National Museum in Stockholm. The museum accommodates the creativity of our time. Artists and designers work in the laboratories of the museum,

and companies can connect. An example of a strong profile, and cooperation – within and outside the cultural sector.

Collections are not isolated objects; they tell stories. Those stories interpret our world of today and illuminate the past. In this way, museums make an important contribution to our identity. As Orhan Pamuk wrote in *The Museum of Innocence*: “In poetically well-built museums, formed from the heart’s compulsions, we are consoled not by finding in them old objects that we love, but by losing all sense of time.” ■

.....  
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**Minister of Education, Culture and Science**  
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# Protecting Europe's biodiversity

**Karmenu Vella, Commissioner for Environment, Maritime Affairs and Fisheries at the European Commission outlines key plans for the EU Biodiversity Strategy to 2020...**

**B**iodiversity is the web of life that surrounds us, our life support system and the backbone of our economy. Europe has a strategy to protect it, with nature at its core, but spanning many other policy areas, because everything is impacted by our dependence on biodiversity.

The strategy the EU adopted in 2011 aims to halt biodiversity loss and the degradation of ecosystem services, restore them to the extent possible by 2020, and help avert global biodiversity loss. It sets targets in 6 main areas: the full implementation of EU nature legislation; maintaining and restoring ecosystems and their services; more sustainable agriculture, forestry and fisheries; tighter controls on invasive alien species and a bigger EU contribution to averting global biodiversity loss.

2015 will be decisive, as we are assessing progress towards the EU's own biodiversity targets, and helping develop an ambitious global Post-2015 Sustainable Development Agenda, where nature and biodiversity will play a central role.

It is already clear that while some of the EU targets might be reached, others will require more focused and sustained efforts in the period up to 2020.

A recent report on the State of Nature showed some local success stories, such as the return of the bearded vulture, the European otter and the Eastern imperial eagle, thanks to targeted and adequately funded conservation actions. Natura 2000, the largest network of protected areas in the world, now covers over 18% of EU territory. As well as protecting areas of high biodiversity value, it showcases how sustainable economic activities can be carried out in harmony with nature. Around 4.4 million jobs in the EU depend



**Karmenu Vella,  
Commissioner for Environment,  
Maritime Affairs and Fisheries  
at the European Commission**

directly on healthy ecosystems, and many of these jobs are on Natura 2000 sites. The network brings financial benefits worth €200 to €300bn per year. But despite this, the overall status of species and habitats in the EU has not yet improved: we need to step up efforts and ensure that legislation that safeguards our most important species and habitats is fully implemented and fit for purpose.

Policy continues to develop. Once implemented, the EU Green Infrastructure strategy – working with nature – will deliver multiple benefits across a range of EU policies and sectors. A new regulation has entered into force to fight the introduction and spread of invasive alien species that cause damage worth €12bn a year, and work is underway to establish a list of invasive species of Union concern by early 2016. Progress has also been made in integrating biodiversity concerns into agriculture, rural development, forestry, fisheries, regional and trade policies.

But having policies on paper is not enough – measures need to be implemented on the ground at a sufficient scale if we are to see real results. Sufficient funding and the engagement of public bodies, businesses, citizens and communities will be essential.

Business has an important role to play in protecting biodiversity. Many companies have recognised that





working with nature rather than against it presents a huge business opportunity, and are already deploying innovative technologies and creating good practices that bring us nearer to the biodiversity strategy targets.

Nonetheless, Europe still suffers from inadequate investment in this area. That's why, in February this year, together with the European Investment Bank, the Commission launched a new Natural Capital Financing Facility in an effort to mobilise public money to generate new private investment in nature and climate adaptation, showing how it can help put Europe on the path of sustainable growth.

Biodiversity loss is a problem that needs to be tackled on many fronts. To get to grips with it, we need to address underlying issues like our unsustainable consumption and production patterns. In a world of limited economic resources and continuous population growth, we have to rethink the way we work, produce and consume. This is why the Commission will come forward by the end of 2015 with an ambitious Circular Economy Strategy to help nudge Europe towards the path of sustainability. Transition to a circular economy

requires action at all stages of the life cycle of products: from the extraction of raw materials, through material and product design, production, distribution and consumption of goods, repair, remanufacturing and re-use schemes, to waste management and recycling.

Biodiversity loss and the degradation of terrestrial and marine ecosystems continue, but there is a lesson to be learned from our experience: biodiversity loss can be fought. With careful planning, coherent goals, committed and coordinated efforts, we can still take advantage of the remaining window of opportunity to solve the problem. We must do it, and I know we can. But to get there, we have to make sure that EU policies are all working in that same direction. ■

.....  
**Karmenu Vella**  
**Commissioner for Environment,**  
**Maritime Affairs and Fisheries**

European Commission  
[www.ec.europa.eu/commission/2014-2019/vella\\_en](http://www.ec.europa.eu/commission/2014-2019/vella_en)





# RESIDUES OF ANTICANCER DRUGS POSE THREAT TO AQUATIC ENVIRONMENT

It is estimated that in Europe more than 3000 different pharmaceuticals are in use which represents consumption of around 100 000 tons per year. Part of these compounds is released to the aquatic environment predominantly through patients' excretion either in form of the parent drugs or as metabolites. The crucial question is what happens to pharmaceuticals after they have been used. Are they degraded in wastewater treatment plants? Do active forms reach rivers and drinking water? What are the concentrations and do they affect aquatic organisms or even human health?

A group of pharmaceuticals that is of particular concern are anticancer drugs, also termed as cytostatics or antineoplastics, that are used for cancer treatment. These drugs are designed to kill cancer cells, for example by interfering with the genetic material and the processes governing their replication. However, these effects are not restricted to cancer cells because the organisation of genetic material as well as the mechanisms of cell replication remained through the evolution highly conserved and are thus similar in different organisms. Therefore, if present in the aquatic environment, the residues of these compounds can potentially harm aquatic organisms in particular during the expected chronic exposure.

These questions have been systematically addressed in the frame of EU FP7 CytoThreat project coordinated by Prof. Metka Filipič from the National Institute of Biology. Within the four years of intensive research new highly sensitive chemical analytical methods were developed that enable detection of the residues of the most consumed anticancer drugs in different environmental samples, and the systematic analysis of hospital and municipal waste waters samples confirmed constant presence of the residues of several anticancer drugs although their concentrations in the effluents were low; in the range of several ng/L.

The comprehensive ecotoxicological studies of selected anticancer drugs (5-fluorouracil, cis-platin, etoposide and imatinib) in different aquatic organisms were focused on detecting adverse effect of exposure to low, for environmental contamination relevant, concentrations of the drugs. Indeed upon chronic exposure in certain aquatic organisms (daphnids and zebrafish) adverse effects, including reduced reproduction, damage to genetic material and molecular changes in gene expression were observed at these low concentrations. These findings are not relevant only for aquatic environment but also for humans because through the use of surface waters for the preparation of drinking water and



the use in agriculture the residues of anticancer drugs can potentially enter the food chain and affect also human health.

The results obtained in the Cytothreat project are the first that showed that residues of anticancer drugs which, compared to many other environmental contaminants, occur at much lower concentrations represent threat for aquatic environment. However, there are still many knowledge gaps that do not allow for a reliable environmental and human health risk assessment. Therefore, further research, which should focus on environmental monitoring to obtain data on the distribution of these compounds and ecotoxicological studies to obtain toxicological data for other existing and new anticancer drugs as well as their mixtures are required and should be supported.

More information: [www.cytothreat.eu](http://www.cytothreat.eu)

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# Performance materials, inspired by nature

One of the greatest challenges of our time is to decrease the human's negative impact on the environment. This involves everything from reducing greenhouse gas emissions to improved waste management. An important aspect for the environment is also to phase out toxic chemicals and to increase the use of renewable materials. Cellulosic materials are very common in today's society. Cellulose is one of the world's most easily accessible raw materials and is the main element in wooden products, textiles, and paper based products used in e.g. packaging. By adding new properties to the cellulose, the applications for these materials can be increased dramatically. Enhanced cellulosic materials have the potential to replace several petroleum-based materials and thus make substantial contributions to improving the environment.

OrganoClick AB (publ), a Swedish company listed at Nasdaq First North, supplies functional materials based on cellulosic fibers and green chemistry. Based on research conducted at Stockholm University and the Swedish University of Agricultural Sciences, OrganoClick has developed a technology to modify cellulose in order to give it new properties.

## **Biomimicry – a growing field of science**

In biomimicry, naturally occurring materials, functions and chemical

processes are studied and reproduced in man-made applications. Examples of products are extremely light and strong materials inspired by the spider web and swim suits mimicking the shark skin.

Biomimicry is a growing research field which also has laid the foundation of OrganoClick. Our scientists have studied how natural chemical catalysis are involved in creating functions in trees, plants and fruits. From this basic science, a technology has been developed in which functional molecules can be attached to the surface of cellulosic fibers adding new properties to the materials. Examples of properties are water repellency, fire resistance, anti-fungal properties and increased mechanical strength.

## **Substitution of toxic chemicals**

The current methods to add new properties to cellulosic materials often involve use of toxic or hazardous chemicals. In Sweden alone, more than 5 000 tons of biocides and heavy metals are used annually to impregnate wood. By modifying the fibers in the wood with silicon molecules derived from sand, a completely non-toxic modified wooden material named OrganoWood has been developed with both high durability and fire resistant properties. The inspiration of the technology came from natural occurring wood fossils which has been petrified with silicon and other minerals. OrganoClick's wood treat-

ment product was first in kind to be eco-labelled by the Swedish Society for Nature Conservation as Good Environmental Choice. OrganoWood has gained big acceptance in the Nordics and are used by global construction companies such as Skanska.

**“Cellulose is one of the world's most easily accessible raw materials and is the main element in wooden products, textiles, and paper based products used in e.g. packaging. By adding new properties to the cellulose, the applications for these materials can be increased dramatically.”**

Another of our examples is a water repellent technology for textiles named OrganoTex. Traditionally, perfluorinated compounds (PFC's) have been used to add water repellent properties to e.g. textiles. The PFC's and in particular PFOA and PFOS are bio-accumulative and are potent hormone disturbing and carcinogenic molecules. Green peace has made it a priority to phase out the PFC's from the global market and released a report in 2013 highlighting the problems that PFC's are creating. By studying the Lotus flowers water repellent properties, OrganoClick has developed a textile treatment process in which the textile fibers are modified with water repellent and biodegradable hydro-carbon-polymers. The technology gives





similar water repellent properties as the PFC's and has currently been successfully implemented in garments of several leading Swedish fashion brands.

### **Reduction of greenhouse gas emissions**

By modifying paper fibers with biopolymers that have the ability to create cross-links between the fibers, the strength of paper material can be improved. In many paper applications such as corrugated board or paperboard, the mechanical strength is of utmost importance. The strength can be increased by using more paper pulp in the material or by adding traditional paper strength chemicals such as starch. By cross-linking the fibers in the paper material, the strength can be increased even more. This can be used to lower the surface weight of the paper by reducing the amount of pulp, but still maintain the strength of the paper. As the produc-

tion of pulp and paper are a highly energy consuming process, reducing the surface weight creates dramatic energy savings. In 2009, the World Wildlife Fund – WWF launched a program called Climate Solver in which they yearly study and select new technologies that have the potential to reduce CO<sub>2</sub>-emissions with more than 20 million tons annually. So far, some 50 companies have been appointed a Climate solver. The WWF calculated that if OrganoClick's technology was implemented in 30 % of the manufacturing of cardboard, more than 22 million tons of CO<sub>2</sub>-emissions could be reduced annually which appointed our technology a Climate Solver.

### **Wood fibers – the raw material of the future**

The world's forests are our largest source of renewable materials and also the biggest source of bound carbon. By looking at the forest as our

most valuable source of raw material, and thus grow and harvest it in a sustainable way, it will be the raw material of the future. Using re-engineered forest products have not only the potential to replace toxic fossil based chemicals, but will also bind even more carbon during its use. Modification of biofibers can thus not only create new functional materials but also be part of solving the global warming.



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# Biopolymers: Research challenges

## Polymers & Biopolymers

Since World War II and with advances in chemistry, technological progress and the growth of material science, a new class of synthesised or manmade materials, called polymers or plastics, has been introduced. Due to their remarkable performances, polymers or plastics are everywhere in our world and used in everyday life in a wide range of applications such as food packaging, automobiles, electronics, building materials and furniture. In terms of properties, polymers are generally lighter than glass, metals or ceramics, can be rigid or flexible and, opaque or fully transparent. Most of the plastics used worldwide are still made from petroleum; a non-renewable resource. These petroleum-based polymers are extremely resistant to natural decomposition. Consequently and after using they accumulate and damage the environment and the ecosystem. The lack of biodegradability, environmental concern and the depletion of the oil have promoted worldwide research to develop biopolymers, bio-based and biodegradable polymers, as an alternative to petroleum-based plastics.

Biopolymers can be natural or synthesized from renewable resources. They can be extracted from biomass, such as polysaccharides from cellulose, produced from biomonomers using conventional chemical processes as polylactic acid, or directly in microorganisms as polyhydroxyalkanoates.



## Challenges for biopolymers

Use of biopolymers brings additional challenges. Indeed, biopolymers exhibit lower end-use properties, crystallisation kinetics and processability than conventional polymers. Consequently, a major research effort is currently in progress to improve mechanical properties, crystallisation kinetics, and thermal resistance and barrier properties of biopolymers.

## Research challenges

Our research activities at Sherbrooke University are mainly focused on i) understanding crystallisation and nucleation mechanisms of pure biopolymers such as PLA to find out the best bio-additives to improve crystallisation kinetics, ii) developing new surface treatments of natural fiber biopolymer-based bio-composites, and, iii) developing bio-nano-

composites made of nanocrystals or nanofibers derived renewable resources or agricultural wastes.

**“Our research focuses on trying to create an inter-phase that can exhibit surface properties closer to those seen in the biopolymer matrix.”**

## i) Crystallisation of biopolymers

Poly (lactic acid) or PLA, is a biodegradable polymer that can be produced from renewable resources. This biopolymer is regarded as the most promising bioplastic. As a result, it has raised particular attention as a potential replacement for petroleum-based polymers in many areas such as textiles, bottles, thermoformed containers, paper and cardboard coating. PLA has a low heat resistance

unless it can be fully crystallised. However, PLA suffers from low crystallisation kinetics unless it is subjected to high orientations. Hence, increasing the crystallisation rate in processing techniques, such as injection moulding, where orientation levels are relatively low, is required to improve its thermal resistance. One way to improve the crystallisation kinetic is to find out a suitable bio-additives. However, understanding of nucleation and crystallisation mechanisms is required to optimise the crystallisation kinetics and subsequently to identify or develop the best bio-based additives.

**“Due to their remarkable performances, polymers or plastics are everywhere in our world and used in everyday life in a wide range of applications such as food packaging, automobiles, electronics, building materials and furniture.”**

#### **ii) bio-composites: surface treatment of natural fibers**

Naturally derived (i.e. not synthetic) and renewable materials are very intriguing in many applications because they are environmentally friendly, and naturally available. Among the renewable materials natural fibers appear very intriguing for their high specific strength, compostability, and their low cost. These fibers have been used to reinforce composite materials used in structural and semi-structural industries as well as automotive industries. Natural fibers are also

increasingly being used in bio-derived and bio-inspired materials.

Most of the plant natural fibers contain a relatively high cellulose content (37- 78%). The cellulosic natural fibers are inherently hydrophilic and have a very poor interaction with most thermoplastic polymers. This results in the creation of weak interfaces between fibers and matrices in addition to non-uniform dispersion of the fibers within the matrices. Another drawback of using the fibers is the processing temperature of plant fibers which is less than 200° C. Natural fibers undergo degradation at higher temperature, thus the polymeric matrices with processing temperatures above this critical temperature would become redundant. Moreover, the high moisture absorption of natural fibers can pave the way for swelling and formation of voids at the interface which leads to poor mechanical properties and so impairs the dimensional stability of the composites. Many attempts have been done to modify surface properties of natural fibers including physical, chemical, and physico-chemical treatments but none of them are able to enhance the interfacial adhesion.

Our research focuses on trying to create an interphase that can exhibit surface properties closer to those seen in the biopolymer matrix. In other words, we try to graft a nano-metric ceramic-based coating on natural fibers to enhance the properties in order to be used as reinforcements in biopolymer-based composites.

#### **iii) Bionanocomposites: Bio-based nanocrystal or nanofibers as reinforcing nanoparticles**

Similarly to natural-fiber-based biocomposites, we are, presently, trying to improve the performances of biopolymers by adding reinforcing bio-based nanomaterials. Among these bio-based nanomaterials, cellulose-based nanoparticles and nanocrystals seems to have promising potential as reinforcing biomaterials for biopolymers. Thus, we extract cellulose-based nanocrystals or nanofibers from renewable resources and, particularly, agricultural wastes and perform surface treatments of those nanocrystals and nano-fibers to improve their heat resistance, thermal stability and interfacial adhesion with biopolymers.




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# Re-use of glycol – a perfect example of a circular economy

The economical consumption model that has been dominating for decades is a linear model that assumes that the resources in the world are infinite, available and cheap. It is known to everybody that this model has no future.

Today, we talk about circular economy. In a circular economy, there is no waste. There are resources in the waste flows of the society that just can't be wasted away.

In an ideal circular economy, not only the resources are recycled and reused. In a circular economy system also the value of the material is recovered and the money circulates – instead of letting them be lost to a throwaway system. This system is driven by business just as much as sustainability.

However, to create a circular economy system, technical and institutional innovations are necessary, and favourable business models needs to be created. In Sweden, a new innovation introduced by the company Recyctec has completely changed the market of used glycol. From until now having been destroyed by incineration, it is now possible to purify and concentrate the glycol until the extent that it reaches its original quality – and can be re-used over and over again.

## Background

Glycol is extracted from crude oil – a finite resource. In addition, glycol is a scarce commodity since demand is consistently higher than the supply.

Various types of glycol are used in a number of different industries. The most common, is when glycol is used as an anti-freeze agent in combustion engines. The largest volume is used is for polyester and PET production. But glycol is also used in a number of other applications, for example, de-icing aircraft, as part of solvents, in pharmaceuticals, in food industry, etc.

From the production process of glycol, as well as from the different applications, used glycol, a hazardous waste stream, is generated. A large quantity of the used glycol worldwide ends up in sewage and groundwater systems, contaminating our water courses. Until now, the only safe treatment method for used glycol has been destruction by incineration. There are no energy savings, as the glycol during the use is diluted in a low concentration and low-calorific form. This secures the handling of the hazardous components – but the resource gets lost.

## The innovation

With Recyctecs new innovation, the glycol in a combination of purification steps and evaporating can be restored to original condition, and introduced to the market again. The glycol itself remains intact, so the process can be repeated over and over again.

Recyctec provides the cleaning service. But the client delivering the used glycol also needs to contribute to make this a success. Just like all kind of waste treatment, it is not only about technology. It is not at least about behaviour and habits. This new method has led



to the need of separate not only the glycol itself, but also the different types of glycol at its source. Common source separation.

However, the client's efforts are rewarded. The business model is favourable for everybody in the circle. With an end product having a good market value, the treatment fee can be kept low compared to other options.

Recyctec has managed to achieve a symbiosis between the commercial and the environmental friendly. An example of a circular economy in its perfection!



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USING A GLOBALLY UNIQUE METHOD,  
**WE PURIFY USED GLYCOL**  
 SO THAT IT **CAN BE RE-USED**

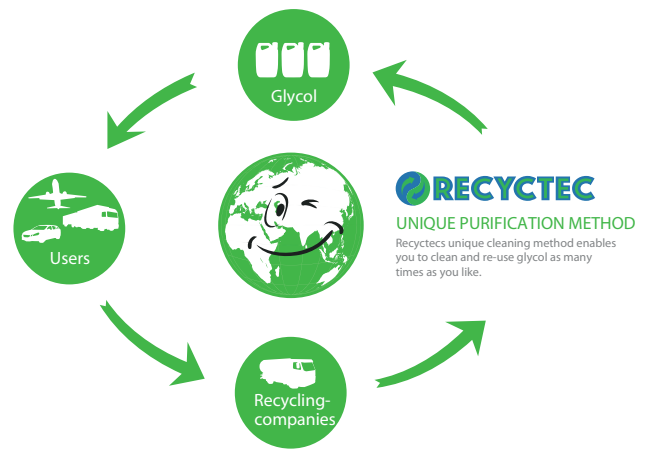
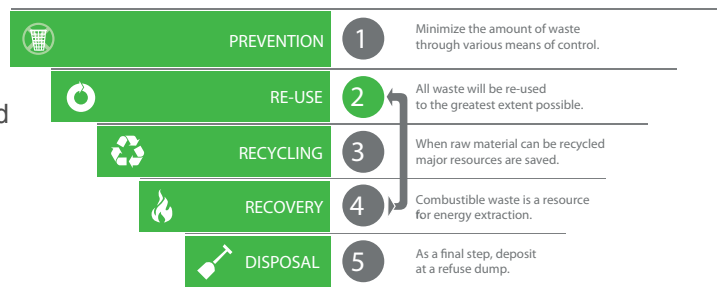
**We have developed a globally unique purification method** whereby we purify and concentrate used glycol so that it can be re-used. In this manner, we will save the earth's resources since glycol is extracted from crude oil and is a non-renewable resource. In addition, glycol is a scarce commodity since demand is consistently higher than the supply.

Glycol is used in a number of different industries and there is an abundance of areas of use.

**Our vision** is to spread our knowledge throughout the world and thus contribute positively to our common environment and to a better world.

**Our business concept** is to refine used glycol and restore it to an industrial product using an efficient and unique eco-friendly method.

EU's WASTE HIERARCHY



Read more about us? Visit [www.recyctec.se](http://www.recyctec.se)



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# Effective management of fisheries and fish quality: UNU-FTP and SDG No 14



In September 2015 the UN will release the Sustainable Development Goals (SDGs) to guide international development for the next 15 years. Out of the 17 goals, number 14 is to “Conserve and Sustainably Use the Oceans, Seas and Marine Resources for Sustainable Development”, and is a topic of particular interest to the United Nations University – Fisheries Training Programme (UNU-FTP). Unless this goal is achieved, the probability of meeting other goals and targets relating to poverty alleviation, health and nutrition is slim.

## Where does the fish come from?

In the mid 1980s developing countries accounted for less than 50% of world catches, but today they account for more than 75%, although the total world catch has stayed the same. Overfishing of stocks in developed countries has been compensated for by expansion of fisheries in developing countries and increased trade in fish and fish products. In a sense the problem of overfishing has been exported, from the rich to the poor. At the same time, fish has become ever more important as a

source of animal protein and various nutrients in the diet of people in poorer countries. Almost half the global catch comes from 25-30 million small scale fishermen in developing countries, each fisherman contributing on average less than 1.5 tons per year. About 75 million people make their living from processing and trading the catch, but poor handling and processing means that much of the nutritional value is foregone and so is the opportunity for most to make a good living from the exploitation of living aquatic resources.





### Managing natural wealth

The benefits people and societies derive from resources depend on how we manage them. Fisheries resources are renewable but undermanaged and overexploited in many developing countries. Excessive fishing pressure has both biological and economic consequences. Lack of appropriate policies and capacity to evaluate the status of stocks and the health of the sector make it challenging to formulate and implement adequate management measures. This not only influences the stocks, but also the ability of people to increase the value of fish through good handling, processing and marketing.

potential development possible through careful management of fisheries resources.

Since the establishment of the UNU-FTP, about 300 professionals from 50 countries have completed the 6 month training programme in Iceland, specialising in various fields of fisheries. In addition, over 1000 people have attended our short courses and workshops in our partner countries. The programme in Iceland is funded through the ODA budget of the Ministry for Foreign Affairs but also seeks partners in implementing strategic actions towards capacity enhancement in its partner countries.

In 1998 the UNU-FTP was established, reflecting the global importance of fisheries and the increasing concern of the state of world fisheries. The core element of the UNU-FTP is an annual 6 month training programme of about 20 fisheries professionals (UNU-fellows). This is conducted in Iceland, where fisheries are one of the main pillars of the economy. The UNU-FTP's close cooperation with the industry, academia, and research entities in Iceland illustrates to UNU-fellows the value of human capital to societal development and success in fisheries.

Iceland uses a rights-based system of fisheries management, based on rigorous science, with quotas set according to total allowable catch, determined for all major species. Although neither perfect nor universally applicable, the system has resulted in healthier stocks, reduced cost of fishing, improved quality and increased value of the fish, and thus demonstrated to the world that fisheries can be managed sustainably. By introducing UNU-fellows to the Icelandic fisheries sector UNU-FTP gives them an appreciation for the



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# Impacts of human activities on changing Arctic ecosystems

Since the beginning of the industrial revolution, environmental contaminants have been transported from temperate latitudes to the Arctic via the atmosphere, ocean currents and river systems...

Research and monitoring in the Arctic have revealed how pesticides, industrial chemicals, metals, and also radionuclides, have found their way into animals and human bodies, and that levels of persistent organic pollutants (POPs) in some animals are high enough to cause negative effects. Even though levels of some conventional POPs now are decreasing due to international regulations, many new contaminants, that may have similar effects, are today released into the environment. Recent research has also documented that contaminants that was deposited in snow, ice and permafrost many years ago, now are remobilized and become available for organisms (i.e. an increased importance of secondary sources). The true consequences of the total

contaminant load that organisms and ecosystems are exposed to are still largely unknown, especially the effect of long-term exposure to low levels of contaminant mixtures combined with other stressors.

The recent climate changes has also increased the presence of local contaminant sources in the Arctic region, as it has become more accessible for various industrial development. In August 2011 the first super tanker escorted by two nuclear icebreakers successfully passed through the Northeast passage, cruise ship traffic to Arctic destinations has increased, fishing vessels follow fish stocks further north, and the petroleum and mining industry are seeking to initiate activities in new regions in Northern

areas. Knowledge of the combined environmental impacts of long-range transported contaminants and industrial development is a key to sustainable governance of arctic ecosystems.

Additive or synergistic effects of multiple contaminant exposures (e.g. cocktail effects) and other stressors (multistress) may push biological systems beyond the threshold at which individuals or populations are affected. A consequence of multiple stressors may be that even if the levels of environmental contaminants are generally decreasing, this is not necessarily the case for their effects. Increased fitness costs associated with multiple stressors may significantly alter genetic diversity and species survival over time.



In order to ensure an environmentally sustainable development in the Arctic region additional research is required. The Fram – the High North Research Centre for Climate and the Environment was established in Tromsø, Norway, in 2010. The centre is a research collaboration between 21 research and management institutions, with focus on Arctic environmental issues. The centre has several research programs, some of which are dedicated to study impacts of human activities on Arctic ecosystems and human societies. The research encompass a broad range of applied and interdisciplinary research questions demanding a diversity of approaches from the natural and social sciences. Accordingly, many multi or interdisciplinary projects, drawing on the diversity of competence found within the institutions in the Fram Centre, are currently ongoing. For more information, see <http://www.framsenteret.no/english>.

Some important research tasks related to impacts on Arctic ecosystems, currently investigated by research programs within the Fram Centre, are:

- Cause-effect relationships of contaminant mixtures to Arctic ecosystems through integrated effect studies across different levels of biological organisation (molecular to population);
- Investigation on how multiple contaminant exposures, in conjunction with other anthropogenic and natural stress factors, are affecting Arctic organisms and ecosystems;

- Assessments of how climate change affect contaminant transport (to and within the Arctic), remobilisation, and uptake in food-chains. Further, the importance of primary (long-range transport, local industries) versus secondary sources (frozen soil, snow, glaciers) are investigated;
- Studies of bioaccumulation processes (uptake kinetics, metabolism) and effects under different climate scenarios;
- Investigations on the temporal dynamics between contaminants and other stressors in sentinel species (i.e. how is climate and feeding conditions related to contaminant levels and effects);
- Development of modelling tools that can be used in contaminant risk assessments and for predictions of contaminant flow in an era of climate change;
- Identification and quantification of effects of relevant stressors produced by specific industrial activities on habitats, organisms, populations, and ecosystems;
- Investigations of combined impacts of long-range transported contaminants and local sources (emissions from local industrial activities), as well as combined impacts of industrial co-existence.

Other aspects that are important in the context of environmental research are communication of results to

different stakeholders, such as national authorities, international conventions, industries and local communities. Therefore, it is important to investigate how communication from the international research communities is received, interpreted and used by the stakeholders, how the results are used in national decision processes, and how important they are for international decision-making. To ensure a robust management of the Arctic, clear communication between the research community and all pertinent stakeholders is essential. Solid research and good communication will ensure an environmentally sustainable development in the Arctic region.



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# Hydropower vs ecology

Society's conflicting demands for more renewable hydropower and improving the ecological status of European lakes and rivers: Is it possible to meet both requirements?

The water management authorities face a contradicting dilemma in EU directives regulating the management of water resources in Norway and Europe. The European Water Framework Directive (EU WFD) and the Nature Diversity Act seek to preserve and improve the ecological status of lakes and rivers, whereas the European Renewable Directive and the el-certificate market promote increased production of renewable energy to reduce greenhouse gas emissions.

Norway has the potential to export renewable and flexible hydropower energy, and to serve as a “green battery” for Europe, but the above-mentioned market drivers and environmental considerations call for knowledge based and applied solutions that optimise the trade-off between renewable energy production and the preservation of local environmental conditions, and multiple user interests in existing and planned hydropower projects.

## The RIVERCONN research project

The research project “Hydropower and Connectivity in Inland Rivers” – RIVERCONN, funded by the Norwegian Research Council, aims to provide new knowledge of the ecological requirements of migratory fish species in inland rivers in Norway. The key species are the salmonids European grayling (*Thymallus thymallus*) and brown trout (*Salmo trutta*). The E.

grayling are declining in numbers across Europe and are even redlisted by some countries. Many grayling populations in Norway are still viable, but several new hydropower projects give rise to a growing concern amongst fishermen as well as environmental management authorities. Hydropower dams have already fragmented many river systems in Norway, and they represent barriers or hindrances for migratory fish species. In the Glomma river, which is the largest river in Norway, 12 hydropower dams are established in the main river. These obstacles and river development raises an important question for both the hydropower companies and the water management authorities: What is the ecological significance of preserving migratory life histories? Is the preservation of a variety of naturally evolved life histories relevant to the EU WFD?

## Why stress fish migrations and life histories?

Fish migrations are adaptations that allow fish to utilise several habitats to optimise survival, growth and reproduction, i.e. obtain greater net benefits and thus lifetime reproductive output. Hence, human actions that reduce or prevent fish migrations, reduce habitat quality and water flows are expected to cause reduced individual and population fitness. As a consequence, this may lead to declining populations and poor resilience capacity. Mitigation measures have primarily

focused on the stocking of hatchery reared fish to sustain and support sport fishery in regulated inland rivers in Norway, and partly on safeguarding upstream migration past hydropower dams. However, the obvious requirements for wild fish to perform return migrations past hydropower installations have by far been neglected. The EU WFD focuses on improving the ecological status of lakes and rivers, and one of its main goals is to restore the ecological connectivity of fragmented river systems. The Norwegian water management authorities have clearly stated that stocking hatchery-reared fish does not improve the ecological status of degraded water localities. Hence, it is urgent to develop new measures that safeguard natural recruitment and production of wild fish populations.

Traditional mitigation measures in fragmented rivers, such as the stocking and construction of fishways, need to be evaluated in light of new knowledge and legislative recommendations regarding their ecological effects. Fishways in European rivers have rarely been evaluated for functionality, and dysfunctional passage routes may cause high mortality and traceable evolutionary responses in wild fish populations. The scientific literature also reports an increasing body of studies showing that compensatory fish stocking programs may have limited positive or even detrimental effects on wild fish populations.

## Suspension of compensatory stocking of brown trout in large river in Norway

In 1991, the environment authorities ordered the hydropower companies in the Glomma to release more than 50,000 two-year old hatchery-produced brown trout annually. The main goal of the stocking program was to maintain the important sport fishery in the river. However, relatively few resources were allocated to evaluate the effects of the program, which is also due to common practice. Fish stocking is a relatively inexpensive and simple measure to mitigate the negative consequences of hydropower development. However, the authorities and fishermen experienced a lack of success. The artificial produced brown trout had higher mortality and grew slower than wild fish. Few cases of large and attractive stocked fish in the catches of anglers were reported. In 2010, NINA implemented boat electrofishing as a new survey method in large rivers like Glomma, and the results showed that few stocked trout survived their first winter in the wild (NINA Report 1056). A big proportion were eaten by the piscivorous northern pike, and 80% of pike diet constituted more than 80% hatchery-reared trout in some reservoirs during the weeks after release. At the same time, boat electrofishing surveys gained new knowledge about the wild populations of grayling and trout, and NINA concluded that their population status should be improved despite the hydropower production. In addition, one could not exclude that the fish stocking could have a negative effect, e.g. because of undetectable outcome from competition for food and shelter, on the wild fish populations. In 2014, the water management authorities decided to revoke the stocking program.

The decision was made without major protests from municipalities or fishermen. For many anglers, both locals and visitors, wild fish are increasingly more sought after compared to stocked trout.

### Is it possible to improve the ecological status in regulated rivers?

Society has decided to produce renewable hydropower in Glomma, and undamming the river is not yet considered a relevant question in Norway. The concept of environmental design seeks to optimise the trade-off between continued hydropower production and environmental considerations and preservation, e.g. how to safeguard migrations or habitat requirements of fish without losing too much hydropower. This is a research-demanding challenge, but NINA and partners in the "Centre of Environmental Design of Renewable Energy" ([www.cedren.no](http://www.cedren.no)) have developed this concept in regulated salmon rivers in Norway. Our advice to the water management authorities in Glomma is to start the process to develop this concept also for fish species like the European grayling and brown trout. To succeed with the concept of environmental design, we first have to reveal the ecological bottlenecks necessary to improve the ecological status of grayling and trout, and thereafter work out the most effective mitigation measures. Some emphasis should be placed upon threshold values for spillwater release necessary to maintain ecological connectivity. The results from the RIVERCONN-project imply that it will be mandatory to pay much effort into improving facilities for safeguarding two-way fish migrations past many hydropower dams in the future.

In conclusion: It is beyond doubt that hydropower developments generally have a negative impact on river ecosystems, but there is a great potential to reduce negative effects using environmental design to reveal ecological bottlenecks and work out goal-oriented mitigation measures. This will demand a more proactive approach applying dose-response trials designed by fish ecologists, hydropower companies and water management authorities in Norway. Supplementary stocking of hatchery-produced fish in the Glomma river is a past regime, and we should probably realise that preserving wild fish and ecological functionality after hydropower development in complex river systems like Glomma are far more demanding and expensive than continuing the supplementary stocking program. But on the other hand it will be more effective and the ecological status will be improved according to EU WFD.



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# Circular Economy: A win for our economy and environment

MEP Sirpa Pietikäinen details how radical steps to increase Europe's resource efficiency could help improve the environment, as well as the economy...

Forecasts suggest that global demand for resources will triple by 2050, including some 70% increase in demand for food, feed and fibre. We already consume some 1.5 globes worth of resources every single year, and following the estimates, would need around 4 planets full of resources to satisfy the demand by 2050 under business as usual. There are however limits to growth and we only have this one planet.

We are in overshoot mode, and that mode has to be switched to a more sustainable one. What we need is a true paradigm shift, one that will benefit both our economy as well as our environment.

Europe is extremely dependent on imported raw materials and energy, much more so than many of our competitors. Resource scarcity increases prices – that is simple economics. Almost 90% of European companies expect their material input prices to continue to rise, according to a Eurobarometer survey. With raw materials running short, Europe is either going to be hit the hardest by resource scarcity or benefit the most from resource use efficiency.

If we look at these facts, it is clear that European economy can't survive – let alone grow – unless we take some radical steps to increase our resource efficiency and move towards a true recycling economy. We have to stop wasting precious resources and start using them more efficiently.

In this challenge there is also a huge opportunity. The one who can deliver solutions for the resource efficiency dilemma, is also the winner of the new economic race: this means solving the problem of doing more with less – getting more added value with less resources. In a circular economy there is no waste,



products are designed to be durable, reusable, repairable and recyclable, and when they come to the end of their life the resources contained in these products are pumped back into productive use again.

Business-driven studies demonstrate significant material cost-saving opportunities for EU industry and a significant potential to boost EU GDP. The Commission has for example calculated that increasing resource productivity by 30% by 2030 would create 2 million new jobs while boosting our GDP by 1%.

Many businesses have already recognised these facts and started to act accordingly. They have taken a leap to a different mind-set, to one where the whole logic of successful business is turned upside-down. These firms have created new business models to deliver greater resource efficiency and circular models including increased renting, sharing, leasing, bio-innovations, remanufacturing.





However, in order to support this change we also need to change the rules of the game. A lot of our thinking and the bulk of the current legislation is created for the needs of consume-and-throw-away-society. We need a new regulatory framework that fits the new world order. That is the work of us politicians. Regulation is never neutral. Legislation is one of the essential drivers of the business revolution, as businesses and investors alike need a stable and predictable regulatory environment in order to change.

To drive the business revolution, we need commonly-agreed and harmonised indicators to measure the change. We need clear targets. We need to draft such legislation that will make sure that what is considered waste nowadays is not considered such anymore – but a resource. This requires a change to how things are being produced: products need to become more durable, easy to upgrade, reuse, refit, repair, recycle and dismantle for new resources. A reformed and enlarged EU eco-design directive is a crucial tool to ensure resources stay in the loop.



Perhaps the most compelling reason to embrace resource efficiency and circular economy models is that we don't really have a choice. Further pressure on supplies of resources as demand increases in emerging markets will force us – sooner or later – to use those resources more carefully. ■

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# Working with residents to separate more waste

‘Reversed Waste Collection’ huge success in Arnhem...

The Netherlands is also striving to establish a ‘circular economy’ that avoids depleting natural resources and fossil fuels. Consequently, the country has set a national target of recycling 75% of household waste by 2020. Municipalities have a key role to play in achieving this target. Last year, the municipality of Arnhem demonstrated just how much can be done. They launched ‘Reversed Waste Collection’, an alternative waste collection system, in three neighbourhoods. The project resulted in a drastic increase in the quantities of separated waste collected in low-rise, high-rise and priority neighbourhoods. The key to success is interaction with the residents.

The idea behind this system is to make it easier for residents to offer separated waste and make it more difficult for them to dispose of residual waste. Paper, cardboard, plastic packaging,

kitchen and garden waste is therefore collected from people’s homes. The residents are required take residual waste to underground containers in their neighbourhoods located no more than 150 metres away.

In Arnhem three trial neighbourhoods (with a total of 7,800 residents) were set up with all the necessary facilities for Reversed Waste Collection: underground containers, mini-containers and waste passes to open the underground containers. But the success of the system depends on the residents cooperating and changing their behaviour.

Geert Boonzaaijer, the municipality’s Reversed Waste Collection project leader, wasn’t sure how successful the project would be at first. ‘I wondered if people would really be prepared to walk to containers with their rubbish bags. It turned out they were. In fact,

the project worked really well. It achieved eight of its nine objectives (see box) within one year. And 82 per cent of residents say they are satisfied with the system.’

The project’s success is mainly due to the strong emphasis placed on communicating with the residents. First of all, the municipality invited all neighbourhood residents to suggest locations for the underground containers. ‘No one wants a waste container in front of their door,’ says Boonzaaijer. ‘So we discussed the municipality’s proposal for all container locations at length with the residents during evening meetings. If they had objections, they were welcome to suggest alternatives. We decided on the eventual locations in close consultation with the residents. That secured support for the plans and meant we could avoid objections and complaints afterwards.

Another inspired move was the appointment of four ‘waste coaches’ in each neighbourhood. ‘Residents had a lot of questions: what was permitted in the containers? How do the waste passes work? What’s the point of it all?’ recalls Boonzaaijer. ‘So we decided to train twelve people as waste coaches. They are in the neighbourhoods daily, as well as in the evenings and in the weekends, to answer people’s questions. They’ll even give people advice when not asked and they spot problems, such as

Collected amounts of separated and residual waste

Trial neighbourhood	Recyclable material / waste material	Baseline measurement	Goal	Results after 1 year
High-rise area	Paper / cardboard	26	35	43
	Plastic packaging materials	4	12	18
	Other (residual) waste	206	186	205
Low-rise area	Paper / cardboard	31	43	61
	Plastic packaging materials	5	17	22
	Other (residual) waste	270	238	212
Focus area	Paper / cardboard	26	35	36
	Plastic packaging materials	2	6	18
	Other (residual) waste	305	287	225

(Amounts are in kg per capita on an annual basis)





Noticeboard indicating amounts of waste collected separately

refuse left next to the containers. It was a hefty investment, but one that's paying off nicely. Waste coaches are people with limited chances on the labour market and the job is also an opportunity to gain new work experience.'

The municipality has also placed noticeboards in all neighbourhoods. Scores on these boards show how successful the neighbourhood is doing at separating its waste. A new score is entered each quarter. The good scores encouraged residents to continue their efforts.

To gauge satisfaction with the system, Arnhem conducted three surveys among residents, one prior to the launch of the project, one after six months and one after a year. Two thousand households were invited to complete digital and paper-based surveys. For the third survey, the municipality invited all households to participate and also held group interviews, which shed even better light on what the residents actually thought of

the project and resulted in a number of small adjustments to the system.

Arnhem paid special attention to the elderly and disabled. Boonzaaijer: 'There was the notion that people from these groups would have difficulty taking their bags to the containers. Consequently, we started talking to representatives of both groups early on and kept in touch with them throughout the trial year. But so far only very few people have had difficulties getting their bags to the containers. And where people do encounter problems, we can offer a customised solution, such a care institution which picks up people's bags using a cart we provided or the waste collection service that passes by once a week. What is remarkable is that the resident survey shows that the elderly are particularly satisfied with Reversed Waste Collection. They consider being able to get rid of residual waste any time they want as a huge advantage.'

The close cooperation with the residents ensured that Reversed Waste

Collection got off to a successful start in the first pilot neighbourhoods in Arnhem. In June, the city council decided (almost unanimously) to roll out the system across the rest of the city. Boonzaaijer: 'Reversed Waste Collection is one of the few systems where we can make environmental gains on a ongoing basis. In due course, it will also result in reduced costs of waste collection and processing. The cost of processing residual waste decreases, while reusing waste as a resource in a circular economy generates income.'

Soon the municipality will be meeting with residents from other neighbourhoods to consider the best locations for the underground containers where they live.

Arnhem received a subsidy from the European Life + Fund to finance the Reversed Waste Collection pilot.

Arnhem is sharing its experiences with the pilot on [www.arnhem.nl/ReWaCo](http://www.arnhem.nl/ReWaCo).



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# Enabling a competitive and resource-efficient circular economy

Views by the packaging supply chain in Europe...

The EU institutions have promised ambitious policy goals towards a Circular Economy in Europe. The related policy review aims to set an enabling EU policy framework while not being too prescriptive respecting the sovereignty of the 28 Member States in moving towards a sustainable and growth oriented European economy. A resource restrained Europe urges us all to use our resources in a more secure, smarter and competitive way and make our production and consumption more sustainable. The means to these overarching goals will be different for Member States, business sectors and consumer life styles.

An optimised EU policy framework would further unleash the potential of packaging as part of the solution in enabling a resource efficient and competitive circular economy, underpinned by the economies of scale provided by

the Internal Market, which is the backbone principle of the EU. The packaging supply chain from raw material suppliers, packaging converters to brand owners, represented by EUROPEN, is therefore fully engaged in the related policy debate and has identified key guidelines and recommendations of which some are highlighted in this article.

As a general principle, respecting the life-cycle approach (LCA) along packaged product value chains in existing and future EU policy should remain a key priority. A life-cycle approach ensures net environmental improvements, taking into account trade-offs as changes in one part of the value chain will inevitably affect another part. For packaging, changing the type, weight and design of packaging solely based on the end of the pack's useful life may negatively impact the

pack's ability to protect, preserve and market a particular product. This is why policy-makers should continue to consider packaging in the context of the product it contains. This holistic approach is appropriately reflected in the EU Packaging and Packaging Waste Directive (PPWD), which is part of the current legislative review. A life cycle analysis will for instance lead to the result that certain used packaging types cannot be recycled at reasonable cost or due to technical, infrastructure or safety reasons. In this case energy recovery should remain a viable option where the recovered energy can be used to power a.o. manufacturing plants or the local grid.

We caution against one size fits all regulatory solutions across all the concerned EU laws which address different products, sectors and/or waste streams which all have different

legal bases, policy and business needs. For instance, common prescriptive measures related to sourcing, product design or end-of-life for a washing machine, smartphone or packaging will not necessarily deliver more resource efficiency or achieve the EU's Circular Economy objectives for all. Tailored regulatory approaches, such as for packaging and packaging waste in the PPWD, are still needed.

A key driver for a circular economy is Extended Producer Responsibility (EPR); an end of life tool applied in 25 Member States to help them reach EU and national recycling and recovery targets for used packaging. One of the key opportunities now where EU policy can support is by setting binding EU minimum performance requirements for EPR to increase transparency, accountability and enforcement of national packaging waste management. A strengthened EU regulatory framework for EPR is needed to address market changes and failures and policy gaps in the implementation and enforcement of separate collection and sorting of used packaging. Levelling the playing field among existing EPR schemes (both for profit and non for profit models), will alleviate the compliance burden on producers and aid Member States to help meet legal targets at the lowest sustainable cost to society. Improved EPR will ultimately deliver more quality secondary raw materials which can be re-injected into the manufacturing process; the essence of a Circular Economy.

EPR should be implemented according to national conditions and based on defined roles and responsibilities for each and all actors involved in national



Virginia Janssens, Managing Director

packaging waste management. A strengthened legal framework for EPR will also provide public and private actors with the necessary legal predictability and security to make long-term investments in for instance more efficient packaging waste management infrastructure and innovative packaging solutions in (secondary) raw materials along with their supply chain partners.

By answering multiple challenges spanning the life of the product for which it is designed (e.g. product protection, food waste prevention, extending a product's shelf-life, consumer safety, convenience, information needs and also end-of-life considerations), packaging is vital to our modern societies and life styles. These functionalities of packaging should be further acknowledged, along with efforts to continuously improve the end-of-life considerations for used packaging. Further investments and innovation in our industry require a

balanced, sustainable and growth-oriented EU policy framework that increases the global competitiveness of industry in Europe and enables more job generation.

Read more on EUROPEN's policy recommendations for a competitive, resource-efficient and growth-oriented Circular Economy [here](#).

**About EUROPEN**

EUROPEN – the European Organization for Packaging and the Environment – is an EU industry association in Brussels presenting the opinion of the packaging supply chain in Europe, without favouring any specific material or system. EUROPEN members are comprised of multinational corporate companies (raw material producers, converters and brand owners) plus national packaging organizations which are committed to continuously improving the environmental performances of packaged products, in collaboration with their suppliers and customers.



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# I'm green™ – the renewable alternative to fossil plastic

## What is Green PE?

I'm green™, often referred to as 'Green PE', is a bio-based plastic resin. 'PE' is short for polyethylene, the most widely used and biggest selling plastic in the world today. What is truly innovative about I'm green™ is that it uses a renewable feedstock, sugarcane, to produce a non-fossil version of polyethylene, which is recyclable. It can therefore be used to reduce a plastic product's carbon footprint as a result of the significant greenhouse gas (GHG) emissions savings compared with regular fossil PE.



## What sort of products is it used to make?

The material's versatility means it can be used in a wide variety of different applications: from food packaging and home care products, to more durable uses such as wheelie bins and water storage tanks. This thermoplastic resin is sold all over the world: in South America, Europe, the USA and Asia.



## Who makes it?

Formed in 2002 as a result of a merger between six companies, Braskem is now the Americas' leading thermoplastic resins producer. In 2010 Braskem opened its green ethylene unit, and immediately became the largest biopolymer producer in the world, with a capacity to produce 200,000 metric tons of Green PE per year. Braskem has set itself the target to become a global leader in sustainable chemistry, innovating to better serve people, and is looking for clients and partners to facilitate the transition to a low carbon economy.

## How is it produced?

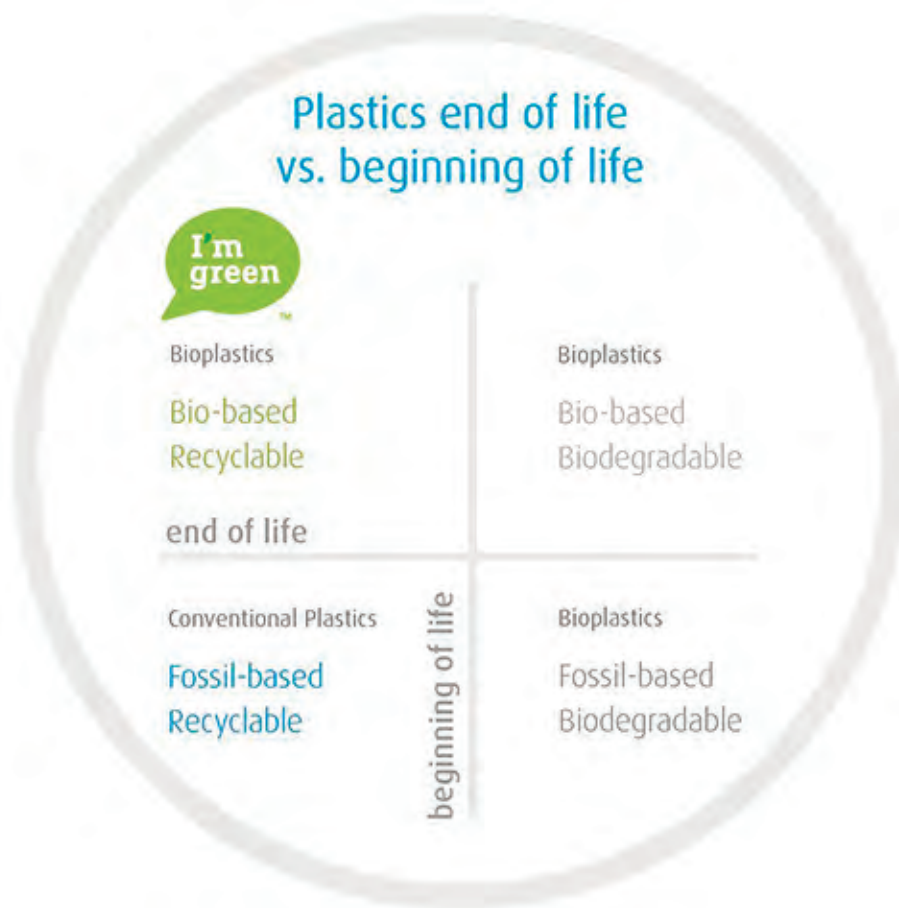
The raw material used to make Braskem's Green PE is bioethanol derived from sugarcane. The crop is harvested and sent for processing, where it is pressed to extract a sweet juice. This syrup is used to make both sugar or ethanol, via fermentation and distillation. Bagasse, the fibrous

matter that remains after the sugarcane is crushed, is used as a biofuel to power part of the ethanol or sugar production process, with the surplus being fed to the grid to further reduce Brazil's energy dependence on fossil fuels.

## How does I'm green™ contribute to sustainability?

Not only are most grades of I'm green™ between 80 and 100% bio-based, but they can be blended with other polymers according to a product's needs. Braskem therefore offers a high quality, fully recyclable, bio-based polymer which is versatile and 'drop-in', i.e. it does not require investments in new plastics manufacturing machinery. Furthermore, by using the resin, Braskem's partners can offer unique products made from renewable resources that make a significant contribution to reducing the level of greenhouse gas emissions throughout the chain. For example, PE pro-





duction in Europe is around 12 million tons per year. If the whole of this was replaced by I'm green™ it would provide a carbon footprint saving of 48 million tons.

**Is it biodegradable?**

I'm green™ is not suitable for composting. Products made using I'm green™ have several 'end-of-life' options. The first is, after the appropriate sorting, recycling. Studies show that the material acts well within existing recycling streams, and can even improve the quality of recycled PE yields. However, I'm green™ can also provide a material which is suitable for incineration with energy recovery as it is renewable. Furthermore, the resin doesn't absorb moisture and so releases twice the energy of paper during combustion.

**What are the land use impacts?**

Braskem doesn't farm sugarcane, but it has a responsibility to ensure that

the cultivation of the crop is done responsibly and sustainably. Braskem's relationship with the ethanol supply chain is based on our Supplier Code of Conduct. The social and environmental practices established in the code aim to ensure continuous improvement in sugarcane and ethanol production and, most importantly, respect for Brazilian laws and regulations. Ninety percent of Brazil's sugarcane cultivation is concentrated in the country's Center-South region. The expansion in sugarcane planted area is regulated by the country's sugarcane law: the Sugarcane Agroecological Zoning Policy (SAZP). This law prohibits the expansion of sugarcane cultivation into high-biodiversity areas, such as the Amazon Rainforest and the Pantanal Wetlands. Sugarcane cultivation currently occupies 8 million hectares of Brazil's land mass but there are still 65 million hectares identified as suitable for this activity, according to the SAZP.

**Was a life cycle assessment carried out?**

Braskem conducted an LCA in 2010, in partnership with its suppliers, to assess the environmental impact of I'm green™. The results were impressive and indicate that Braskem's biopolymer, captures 2.15 kg of CO<sub>2</sub> equivalent for every kg of green plastic produced. Moreover, 80% of the energy consumed in the entire life cycle is renewable, with the use of bagasse being the main differential compared to fossil polymers.

**Who can use the I'm green™ logo?**

The I'm green™ seal can be applied to finished products that use Green Polyethylene in their composition. The seal can be used by clients at their discretion. However its use must be accompanied by communication of the renewable content of the product or packaging verified based on C14 analysis in accordance with standard ASTM D6866.

**Does Braskem use GMOs?**

Genetically modified sugarcane is currently not commercially cultivated in Brazil. Braskem has no plans to use GM sugarcane in the future.



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# Improving extreme weather warnings

**Charlie Neese, Meteorologist and Severe Weather Expert outlines how despite technology being advanced, how we communicate weather warnings to the public has a major impact on how people respond...**

**A**pril 27th, 2011, was a day that seemed nearly impossible in the modern era of severe weather prediction and warning. Even here in the U.S. which sees an average of more than 1000 tornadoes each year, it was clear several days in advance that this would be a unique, potentially historic event. As the storms developed that day, meteorologists tracked the dangerous weather on advanced Doppler radar and used a variety of ways to warn the public including tornado sirens, social media and local news sources. It all seemed to be unfolding as expected. But on this day, something went very wrong. To be sure, this was an extreme tornado outbreak with 211 tornadoes raking across 14 states – a figure high enough that a certain number of deaths was inevitable despite good warnings. Several of the tornadoes were

extreme with winds exceeding 200 mph; strong enough to flatten homes, completely de-bark trees and even lift pavement off roadways. Still, a death toll of 316 (238 in Alabama alone) seems hard to comprehend. Years of weather prediction research and improvements in weather warning technology have afforded meteorologists huge leaps in understanding and tracking nature's most violent storms. However, there is still need for improvement – especially in the methods used to convey the message of impending dangerous weather to the public.

Amazing strides have been made since the early 1990s when the U.S. National Weather Service first implemented NEXRAD Doppler radar technology on a widespread scale. Today, Doppler radar not only

detects where it's raining and how hard, it's able to track the velocity and direction of raindrops which shows if a storm has the rotation needed to produce a tornado. Relatively recent advances allow the radar to even detect lofted debris indicating whether a tornado has touched down – no more waiting for someone on the ground to verify. Along with massive advances in radar technology, much research is currently directed at refining computer models which try to simulate the weather in a virtual environment hours, days or even months ahead of time. Specifically in the case of tornadoes, models are being developed to predict where and when a tornado will touch down perhaps 12 to 24 hours ahead of the event. The goal is to give those in the path more than enough time to protect lives and property. Perfecting that technology is still a few years away but it is indeed coming.

So what led to so many deaths on April 27th, 2011? The event unfolded much as meteorologists had expected and once the storms began, the tornado warnings were very good. Aside from the sheer number of storms and the incredible strength of many of the tornadoes, two factors may have played a significant role. First, a line of storms earlier in the morning had knocked power out to tens of thousands of residents of Alabama which made it difficult for many to hear the warnings for the bigger storms later in the day. Secondly, in the weeks after the storms, meteorologists and social scientists conducted interviews with storm victims. They discovered something disturbing. People often delayed their actions after receiving critical storm information and waited for "confirming information." The warnings alone weren't enough. They wanted a secondary source to validate the warning before they believed a tornado was indeed on the way. Waiting to take action put people at unnecessary risk – especially considering there was up to 30 minutes notice with several of the tornadoes. This would provide plenty of time for most anyone to seek proper shelter.

Due in part to this research, the National Weather Service is now in the process of experimenting with new impact-based warnings which contain strong wording highlighting specific dangers. Phrases such as, "considerable damage to homes, businesses and vehicles is likely and complete destruction possible," are used to emphasise not only the type of weather that's on the way but the direct impact it may have on those in the path. Obviously, the hope is that the more descriptive language will reduce the desire for confirming information and will convince people the storm demands immediate action.

**“Along with massive advances in radar technology, much research is currently directed at refining computer models which try to simulate the weather in a virtual environment hours, days or even months ahead of time.”**

There's no stopping the massive advances coming over the next few years that will make tornado prediction and tracking even better. Now, the challenge is to make sure we pay as much attention to how we share the information with the public as we do obtaining it. When it comes to severe weather, we now know social science is just as important, if not more, than physical science. ■

.....  
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# Tornado Prediction

Progress in the detection and prediction of tornado-bearing thunderstorms is described. Examples of the type of systems current used in the U. S. are given...

While most would associate tornadoes with the U. S. Great Plains, tornadoes are also known to occur throughout Europe. European tornadoes are less frequent but still are the cause of some 10-15 fatalities per year (compared with the long-term average of 69 per year in the U. S.). Statistics on tornado damage in Europe are hard to come by, but a recent report estimates some 60 M€ of damage from the tornado that recently hit the largest steel plant in Europe (Taranto, Italy, 28 November 2012). Hence tornado research should be of interest to readers of this journal.

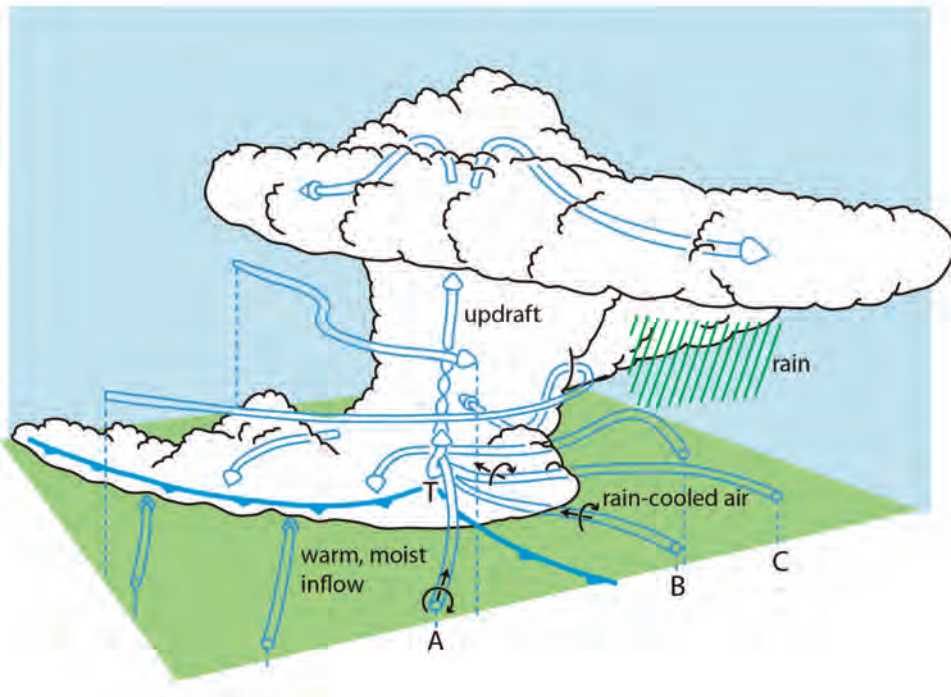
Although speculations on the nature of tornadoes can be traced back to Aristotle, the modern era of tornado research began with the advent of radar technology during WWII. The radar (then and now) detects a thunderstorm by the reflection of the radar beam (reflectivity) from the thunderstorm's rainy core; the typical thunderstorm was observed to drift with the average winds at approximately 5km above ground level, however, every now and then, a large cell would be observed to deviate sideways from the average-thunderstorm motion and often have a distinctive appearance in its reflectivity pattern. These latter storms were often found to be associated with the occurrence of tornadoes. Through large-scale research projects in the late 1940s in the U. S., a clearer



picture of the life cycle of an average thunderstorm emerged, and by 1964, it was also clear that there existed a special thunderstorm called the supercell that could account for deviant storm motion and the distinctive radar-reflectivity pattern. The year 1964 also saw the first recorded storm chase (car pursuit of a thunderstorm) by a scientific eyewitness. The years of storm-chase research that followed gave a very good picture of the phenomenology of the supercell thunderstorm from ground-level observers, and in particular, the features that attend tornado formation. The 1970s saw the maturation of the science and technology of Doppler-radar surveillance of thunderstorms allowing a look at the fluid flow inside the supercell thunderstorm. At around the same time, computers and numerical models were gaining the

capability of simulating supercell thunderstorms; the contemporaneous increase in Doppler-radar capabilities allowed for convincing comparisons of models with observations. In the 1980s, it became apparent that Doppler radars fixed to the ground would have to wait for many years to collect enough useful information on tornado formation. Accordingly the next big advance was the mobile Doppler radar; that is, storm chasers would increasingly be equipped with Doppler radars mounted on trucks to get near enough to the tornado to see the airflow near the ground.

To get an idea of the dynamics of the supercell thunderstorm, the Figure illustrates its three-dimensional storm-relative flow. The illustration is from the point of view of an observer



situated at some height above ground level in the warm, moist air of the environment. The supercell updraft is fed primarily by airstream A originating in the environment which is characterised by the horizontal wind increasing with elevation. This environmental wind increasing with height implies that there is fluid rotation (black arrow with rotation indicated by the curled arrow) that is redirected to the vertical as it encounters the supercell updraft. The Figure illustrates how the flow in a supercell is arranged such that precipitation does not fall directly back down the updraft axis (as it would in an ordinary thunderstorm), but rather away from it; evaporation of this precipitation cools the air at low levels and thus sets up a thermal boundary at the surface. The thermal boundary produces horizontally oriented fluid rotation on the forward-flank airstream B directed toward the updraft; this horizontal rotation is also redirected upward beneath the main

storm updraft and enhances the updraft rotation about a vertical axis at lower levels. In the vicinity of the tornado T, this redirection of horizontal rotation to the vertical occurs on airstreams such as C which is still descending as it approaches the updraft and thus arrives near ground level with vertically oriented rotation as it enters the updraft.

While current-day high-resolution numerical forecast models routinely produce the above-described rotational features of the supercell thunderstorm, the ability to forecast which supercells will produce a tornado, and its duration and severity, is still beyond the grasp of models and routine observations. This notwithstanding it is still extremely useful to predict the motion and intensity of the potentially tornado-bearing supercell. Nowcasts of supercells based on Doppler radar in the U.S. currently provide tornado-warning lead times

of approximately 16 minutes. Experimental numerical-weather prediction models seek to provide forecasts of supercell evolution with lead times of approximately one hour (<http://www.nssl.noaa.gov/projects/wof/>) and probabilistic outlooks of supercell potential with lead times of 12-36 hours (<http://ensemble.ucar.edu>). It should be noted that a network of Doppler radars together with the afore-mentioned forecast models deployed in other parts of the world, would also be useful for the prediction of diverse forms of thunderstorm-associated severe weather such as high winds, large hail and flash flooding.



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# Preparing Europe's cities for climate change impacts

**Climate change is impacting and will continue to impact Europe. Are cities ready to face rising sea levels and temperatures and more extreme events like floods, droughts or heat waves? We asked this question to Birgit Georgi, working on regional vulnerability and climate change adaptation at the European Environment Agency (EEA)...**

## **What is a resilient city and why do we need resilient cities in Europe?**

More than three quarters of Europeans live in urban areas. Cities are the backbone of European economy and wealth and are closely linked to quality of life. At the same time, cities provide many services like workplaces, production of many goods, education, culture, etc., both to rural and urban residents.

The impacts of climate change differ from one city to another. Some will experience more frequent and severe heat waves, while some will face growing water scarcity. Others will have more floods and intense rain episodes. These are not the only impacts cities will face. For example, drier summers will increase the frequency of forest fires, which in turn will affect the air quality in suburbs as well as city centres close by. This wide diversity in climate impacts but also specific socio-economic and cultural conditions in cities require actions tailored to cities' needs. There is no one size-fits-all solution.

Whatever the impacts they are facing, cities have to prepare and respond to them. In this context, 'resilient' cities mean cities that are able to manage change by recovering from extreme weather events and transforming their infrastructure and the way they are organised to adapt to long-term climate changes. A climate-resilient Europe needs resilient cities.

## **What does the EEA do in the area of urban adaptation?**

Climate change adaptation in general requires a combination of actions and a supportive framework to carry them out. The appropriate legislation, incentives and

financial support all need to be in place to enable the local and regional stakeholders to implement relevant measures. The European and national levels aim to provide these framing conditions. Knowledge is essential for determining and formulating policy measures.

Our role at the EEA is to compile and assess the information, knowledge and tools available in Europe needed for developing adaptation strategies and actions. We make this knowledge available to all types of stakeholders, including, countries, regional and city administrations and the European institutions through the European web platform Climate-ADAPT<sup>1</sup>. This platform is an initiative of the European Commission that we maintain in collaboration with the European Commission's Directorate-Generate Climate Action.

We have recently published a series of interactive maps on Climate-ADAPT which illustrate various climate threats European cities face as well as cities' capacity to respond to these threats. This new 'map book'<sup>2</sup> provides background information and allows users to view the maps, selecting different parameters.

We also produce assessments. Our report 'Urban adaptation to climate change in Europe'<sup>3</sup> from 2012 assesses vulnerability of cities across Europe, lists options to act and describes the role each governmental level – from local to European – can play in it. Implementation works best when there is a joint approach between all levels from the European to the local level. In 2016, we are planning to publish a new urban adaptation report which will focus on the state of adaptation action, its integration in other policy areas and the need for transformative approaches.





### **Does the EEA work with cities or city networks?**

We support several European Commission projects such as EU Cities Adapt<sup>4</sup> finalised in 2013 and the currently ongoing Mayors Adapt<sup>5</sup> initiative.

Mayors Adapt has been set up by the European Commission to encourage and acknowledge local efforts. Signatory cities commit to contributing to the overall aim of the EU Adaptation Strategy by developing a comprehensive local adaptation strategy or integrating adaptation into relevant existing plans. All the adaptation knowledge from such projects is also accessible through Climate-ADAPT, for example, the city-tailored adaptation support tool.<sup>6</sup>

Another strand of our work consists of facilitating capacity-building through events, where we collaborate closely with different European city networks. For example, in cooperation with the local governments network ICLEI and supported by other partners, we have brought together more than 100

representatives from cities across Europe to facilitate city-to-city learning.

### **What are the main issues cities facing?**

The levels of preparedness for climate change impacts and of awareness vary considerably from one city to another. Their concerns can be grouped into three broad questions: how to assess a city's vulnerability to climate change, how to finance adaptation and how to organise a multi-level governance approach among others.

Assessing a city's specific vulnerability to climate change and its actual level of preparedness to climate change is not an easy task. Climate models are often available only for global levels or large regions, while cities need locally tailored information to act upon. However, over the last years there has been some progress in this area thanks to several research projects and closer cooperation between the scientific community and local administrations.



Birgit Georgi, European Environment Agency (EEA)

Once cities know where they stand, they can identify the actions they need to actually become more resilient. Some of these actions require funds. Naturally, financing, infrastructure investments in particular, is another key concern. Infrastructure adaptations require long-term investments and are usually very costly.

The governance issue is closely linked to providing a supportive framework of legislation, incentives, knowledge etc. and concerted actions. Adapting to certain events, such as floods or droughts, requires action far beyond city boundaries involving multiple stakeholders in a region or even a trans-boundary region. Implementation works best when there is a joint approach between all levels from the European to the local level.

**Where does Europe stand in terms of urban resilience?**

In my opinion, we still have a long road ahead of us to adapt our cities to climate change, but I also think that the level of awareness has gone up in recent years and that more action is taken on the ground.

In 2012, around 200 cities took part in the EU Cities Adapt survey. Three quarters were considering taking adaptation action although the majority still standing

at the beginning. As participation in the survey was voluntary, we can assume that these 200 cities are probably more aware than the cities that did not take part in the survey. Some cities like Copenhagen, Rotterdam, Barcelona, Bologna, Ancona or Bratislava are already quite active in adaption. Their increasing engagement over the last years is inspiring other cities.

Financing possibilities have improved as well. More funding is clearly earmarked to climate change adaptation and urban resilience. The EU's multi-annual financial framework 2014-2020 earmarked 20% of the EU budget for climate change action – mitigation as well as adaptation. For example, a share of LIFE+, the EU's main funding programme for environment and climate, is explicitly earmarked for adaptation. Similarly, the European Regional Development Fund sees disaster risk management and adaptation as an area for funding. In addition, 5% of its budget is allocated to urban action. The European Investment Bank offers loans to cities, e.g., through the Jessica Instrument <sup>7</sup>, developed in collaboration with the European Commission. Such European funds complement the funds made available by countries and regions.

Funds are certainly important, but strong leadership and political support are equally, if not even more, important for kicking off the process and achieving results on the ground. If adaptation is considered a priority and an investment in the future of a city, it is surprising to see how much some cities can achieve with even limited funds. ■

<sup>1</sup> <http://climate-adapt.eea.europa.eu/>  
<sup>2</sup> <http://climate-adapt.eea.europa.eu/tools/urban-adaptation/introduction>  
<sup>3</sup> <http://www.eea.europa.eu/publications/urban-adaptation-to-climate-change>  
<sup>4</sup> [http://climate-adapt.eea.europa.eu/viewaceitem?aceitem\\_id=8724](http://climate-adapt.eea.europa.eu/viewaceitem?aceitem_id=8724)  
<sup>5</sup> <http://mayors-adapt.eu/>  
<sup>6</sup> <http://climate-adapt.eea.europa.eu/tools/urban-ast/>  
<sup>7</sup> [http://ec.europa.eu/regional\\_policy/en/funding/special-support-instruments/jessica/](http://ec.europa.eu/regional_policy/en/funding/special-support-instruments/jessica/)

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# Safeguarding Europe's bathing waters

**Karmenu Vella, EU Commissioner for Environment, Maritime Affairs and Fisheries outlines how the quality of Europe's bathing waters continues to improve...**



**W**ith its 21 000 bathing sites, Europe is a top holiday destination. Every summer, thousands of Europeans head for the coast in the hope – or the knowledge – that the bathing water will be clean and safe, and that their swimming experience will be a pleasant one. Clean and safe bathing waters are vital for the health of our citizens and for tourism. The EU is working to safeguard both.

And it's working. Today, bathing water quality in the EU is better than ever before, with 95% bathing sites meeting minimum water quality standards. Looking back to the early 1990s, only around 70% of the bathing water sites met the minimum standards and only 60% of the sites where citizens went swimming had excellent quality water.

The change has come about as a result of EU action to improve citizens' daily lives. The great majority of urban waste water is now getting appropriate treatment, fewer nitrates are flowing into our seas,

and our rivers are cleaner than they have been at any time in living memory.

The result is also good for the economy, as the socio-economic value of clean bathing waters is high, and good quality waters helps protect many jobs around the continent. And, the legislation is fit for the future. The Bathing Water Directive, the main piece of EU legislation involved, is one of the major success stories of EU environment policy with high implementation rates across the EU.

EU rules to safeguard public health and clean bathing waters date back to the 1970s. There have been important improvements since then, especially due to major investments in water infrastructure and sanitation. But the legislation has evolved too.

Nearly a decade ago the rules were updated and simplified, incorporating recommendations from the World Health Organisation (WHO). The revised Bathing



**Karmenu Vella,  
Commissioner for Environment,  
Maritime Affairs and Fisheries  
at the European Commission**

Water Directive requires Member States to monitor bathing waters for at least 2 types of bacteria, which indicate pollution from sewage or livestock. Depending on the levels of bacteria detected, and taking into account a long-term trend rather than a single year’s result, the quality is then classified as ‘excellent’, ‘good’, ‘sufficient’ or ‘poor’. As of 2015, the poor water quality class will be phased out, requiring all bathing waters to reach at least “sufficient” status. If a site isn’t up to scratch, Member States will have to advise bathers to stay away, or actually prohibit bathing there.

The revised Directive also makes it easier for citizens to access information on bathing water quality through “bathing water profiles”. These online profiles contain information on the kind of pollution and sources that affect the quality of the bathing water and are a risk to bathers’ health.

The main source of polluted bathing water quality comes from agricultural run-off or misconnected domestic toilet drains. But another great cause of pollution is raw sewage which overflows in times of heavy rain, when untreated sewage is washed directly into water bodies. This means that in areas where the infrastructure isn’t sufficiently robust, a wet summer can cause a pollution spike in bathing water.

Preventing bathing water pollution requires an integrated approach, so it’s vital that the waste water treatment plants and collection systems required under the Urban Waste Water Treatment Directive are working well, and that agricultural areas control the run-off of manure into water courses in line with the Nitrates Directive.

Other European environmental legislation, such as the Water Framework Directive, which designates bathing waters as protected areas, also comes into play. The overall aim of the Water Framework Directive is to achieve good ecological and chemical status for all EU waters by 2015. Unfortunately, a lot of work still needs to be done, as only 53% of surface waters are in good shape nowadays.

In 2016, European-level bathing water legislation will have been in place for 40 years. Every year, before the start of the bathing season, to help Europeans in their choices, the EU releases an assessment of bathing water quality in Europe. The report is a collaboration between the European Commission and the European Environment Agency. It pulls together information on over 21000 bathing waters in the 28 EU Member States, Albania and Switzerland. So, if you are going to the beach this summer, check the report, then lie back and relax. And don’t forget the part the EU played in keeping your bathing water clean! ■

Relevant internet sites:

BWD: [http://ec.europa.eu/environment/water/water-bathing/index\\_en.html](http://ec.europa.eu/environment/water/water-bathing/index_en.html)

EEA: <http://www.eea.europa.eu/publications/european-bathing-water-quality-in-2014>

Urban Waste Water Treatment Directive: [http://ec.europa.eu/environment/water/water-urbanwaste/index\\_en.html](http://ec.europa.eu/environment/water/water-urbanwaste/index_en.html)

Nitrates Directive: [http://ec.europa.eu/environment/water/water-nitrates/index\\_en.html](http://ec.europa.eu/environment/water/water-nitrates/index_en.html)

WFD: [http://ec.europa.eu/environment/water/index\\_en.htm](http://ec.europa.eu/environment/water/index_en.htm)

.....  
**Karmenu Vella**  
**Commissioner for Environment, Maritime Affairs**  
**and Fisheries**  
 European Commission  
<http://ec.europa.eu/environment>



➔ For more information, please visit:  
[www.iwec-water-reuse.eu](http://www.iwec-water-reuse.eu)

✉ For enquiries, send an e-mail to [info@rwbalmelo.nl](mailto:info@rwbalmelo.nl) or call RWB Almelo, The Netherlands (NL): +31 (0) 546 545 020

## Optimal Use of Ground Water for Drinking Water Production by Implementation of Ceramic Membrane Filtration:

### Filter Backwash Water Reuse

#### Increasing Our Water Source Efficiency

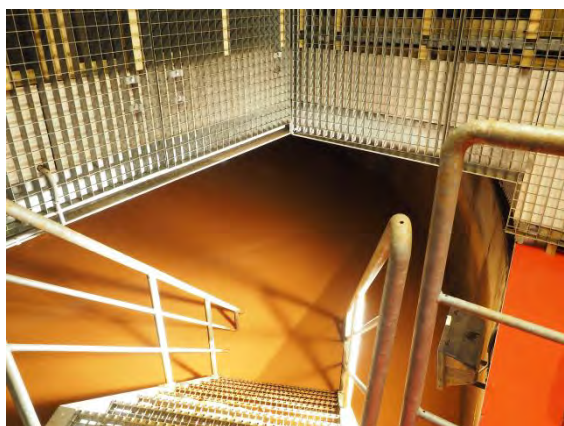
An optimal use of our fresh water resources for drinking water production is becoming increasingly important, also in the Netherlands.

Increasing our water source efficiency by water reuse will result in a more environmental friendly- and a more sustainable use of our fresh water resources.

#### Filter Backwash Water Reuse

The annual consumption of drinking water in Europe is around 37 billion m<sup>3</sup>. The main water sources are groundwater (60 %) and surface water (40 %).

The most common filters used in the purification of fresh water to drinking water are sand filters, which need to be cleaned periodically. Cleaning of the sand filters is done by reversing the flow (backwashing), resulting in the production of spent filter backwash water (see **Figure 1**).



**Figure 1.** Spent filter backwash water. Vitens drinking water treatment site Wierden, the Netherlands (NL)

The amount of filter backwash water produced lies in the range of 5 – 10 % of the amount of source water.

For the European region this would mean that 1,85 – 3,70 billion m<sup>3</sup> of filter backwash water is produced each year. These numbers roughly equal twice the amount of drinking water consumed per year in the Netherlands!

Reuse of filter backwash water by ceramic membrane filtration will not only significantly increase the source water efficiency, but also reduces the environmental impact created by wastewater discharged to the surface water.

#### Chemical Reduction

Currently, it is common practice to treat the backwash water by gravitational sedimentation and sludge thickening. Supernatant water is discharged to the surface water. To enhance settlement/thickening, the backwash water is treated with chemicals like coagulants (FeCl<sub>3</sub>) and/or flocculants.

By implementation of ceramic membrane filtration the filter backwash water is almost completely reused (99 %), resulting in an almost 100 time reduction of the amount of wastewater discharged. As a result, also a drastic drop in coagulant usage (FeCl<sub>3</sub>) is realised, directly reducing the environmental impact.



➔ For more information, please visit: [www.iwec-water-reuse.eu](http://www.iwec-water-reuse.eu)      ✉ For enquiries, send an e-mail to [info@rwbalmelo.nl](mailto:info@rwbalmelo.nl) or call RWB Almelo, The Netherlands (NL): +31 (0) 546 545 020

## Demonstration Plant

The first full-scale system for reuse of spent filter backwash water by ceramic membrane filtration was realised and commissioned in 2014 as a demonstration plant at the Vitens drinking water production site in Wierden, The Netherlands (NL).

### Features

- Reduced ground water intake to produce the same amount of drinking water;
- Reduction of chemical consumption(s), lowering the environmental impact;
- Low energy input due to dead-end operation, low OPEX;
- Continuous 100 % integrity due to robust monolith ceramic membrane;
- Long membrane lifetime of up to 20 years due to use of durable ceramic material;
- Ceramic membranes reduce ecological footprint.

### Plant Design

The demonstration plant was designed and constructed by RWB in close collaboration with Vitens and Eurosteel.

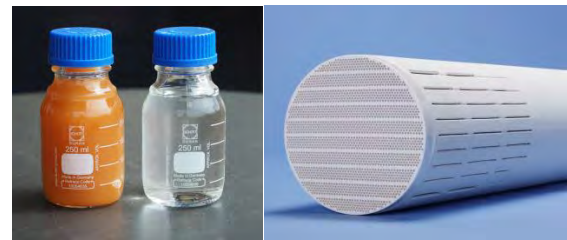


**Figure 2.** Picture of the ceramic membrane filtration demonstration plant at Vitens production location, Wierden, NL

Basic Properties	
Membrane pore	0,1 µm
Element membrane area	25 m <sup>2</sup>
Installed element no	2x 12
Max. capacity	70 m <sup>3</sup> /h

## Key Performance Data

Treatment of the backwash water results in the production of a clear permeate with an average observed turbidity of **0,042 NTU**. This permeate is ready for direct reuse in the production plant to produce drinking water, see **Figure 3**.



**Figure 3.** Left to right: spent filter backwash water, produced MF permeate (reused to produce drinking water), ceramic MF membrane (METAWATER Co., Ltd.)

Performance data	
Drinking water production	620.285 m <sup>3</sup>
Sand filter backwash water	20.058 m <sup>3</sup>
MF permeate	19.771 m <sup>3</sup>
MF backwash water	287 m <sup>3</sup>
MF recovery	99 %
MF energy consumption	3.024 kWh
MF specific energy consumption	0,15 kWh/m <sup>3</sup>
Reduction coagulant consumption	>90 %

For the reported data, around **3,0 – 3,5 %** of the drinking water produced, is originating from treated backwash water. Observed E. coli reduction is **log 7-8**.

## Outcome and Future Prospective

With its low specific energy consumption (**0,15 kWh/m<sup>3</sup>**), minimum coagulant use, integer filtration properties and extremely high recovery, ceramic membrane filtration is a sustainable solution for spent filter backwash water treatment. The drinking water production price does not increase due to the treatment.

In addition, with its flexible design, small footprint and easy operating principles, the technology is also suitable for implementation in small scale drinking water treatment plants and for decentralized treatment and reuse.

# Reducing construction site stormwater impacts on water resources

For thousands of years, humans have been changing the landscape to suit their needs. Unfortunately, this does not always bode well for the surrounding environment. Initially, widespread impacts occurred when humans developed various means to ‘turn the soil’ for crop production, resulting in high erosion rates that eventually left large areas bereft of useful soil. A great deal of study of soil erosion in agriculture has led to a clear understanding of the causes and ultimately the methods for minimising it. This has resulted in agricultural erosion rates steadily falling over the past 50 years.

In contrast, there has been much less attention to erosion and the resulting sediment coming from road and building development sites, even though the amount per hectare can be an order of magnitude, higher than from farms. Erosion rates have been estimated at  $>100 \text{ t ha}^{-1}$  on these construction sites, and without proper controls, much of this can end up in nearby waterways. When added to the other two main sources, farming and streambank erosion, sediment is often the biggest contributor to water resource impairment. This is critical when almost half of EU waters do not meet the ‘Good’ status as outlined in the Water Framework Directive in 2000<sup>1</sup>. The statistics are similar in the United States, with sediment being one of the leading causes of stream impairment<sup>2</sup>.



Example of a construction site sediment basin featuring a piped inlet, porous baffles, and a skimmer outlet

There has not been nearly as much research on reducing construction site sediment compared to agricultural erosion prevention, but we have enough information to suggest how to manage construction sites to reduce their impacts on water quality. One reason construction sites produce so much sediment is that there is so much disturbed, bare soil that is exposed to erosion as part of the grading process. For large projects, this can be minimised through staged grading, or only opening up as much land as necessary to complete a section of the project. This applies mostly to highways and large tract development. A lesson can be learned from agriculture in that exposed soil that is not being actively graded should be covered up using straw or other mulches. This alone can reduce erosion rates by more than 90%.

There will inevitably be water running off sites under development during rain and snow melt events, and it will carry large amounts of sediment no matter how well managed the project may be. The initial efforts to detain this sediment involved small ponds or rock dams designed to pool the water temporarily in order to at least drop out some of the sediment by gravity. Unfortunately, studies have shown that these may be capturing less than 50% of the incoming sediment. Adding some inexpensive engineering can bring the capture rate to over 90%. Examples include basins which have a surface outlet, which forces the basin to fill and release only the cleanest water at the top of the water column, and installing porous baffles which remove much of the turbulence which interferes with settling. In fact, in the most recent (2012) US



**During construction projects, large amounts of soil may be exposed to erosion**

Environmental Protection Agency Construction General Permit, surface outlets are now required for sediment traps. Many US states are now requiring porous baffles as well.

Even with efficient settling devices on a construction site, the finer fraction of the sediment is not going to settle in a reasonable amount of time. However, even this problem has been solved. Inexpensive, environmentally safe chemicals can be introduced into the runoff at relatively low concentrations (1-5 mg L<sup>-1</sup>) to cause the fine particles to stick to each other and fall out of the water<sup>3</sup>. The result is that the water discharged from the sediment basin may be cleaner than the stream it drains into. Numerous methods to introduce these chemicals have been developed, some of which require very little additional effort by the construction site managers. Many of these products, such as anionic polyacrylamide, have been demonstrated to be extremely safe

for aquatic organisms and are commonly used for drinking water treatment. In fact, compared to the sediment that might have been in the water, discharges treated to reduce fine sediments are much better for them than untreated, turbid water.

In some areas in the US, aquatic species sensitive to sediment, such as trout, salmon, and mussels, are present in waters adjacent to or near developing areas. In many cases, portable water treatment plants are required to achieve strict water quality standards in construction site runoff. In fact, the US EPA proposed a national rule in 2009 which would have required all construction site runoff to be below a set turbidity guideline they believed was economically achievable based on recent research. This rule was withdrawn primarily based on procedural issues in how they came up with the guideline value (280 nephelometric turbidity units, similar to coffee with cream).

However, these developments indicate that regulators are increasingly becoming aware that we have the technology to greatly improve development site stormwater discharges at little increased cost. There do not appear to be any EU Directives addressing development site stormwater management similar to the US EPA Construction General Permit<sup>1,4</sup>. Education and implementation of recently developed practices during road and building construction can greatly reduce potential impacts on streams, lakes, and estuaries.

<sup>1</sup> COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL. The Water Framework Directive and the Floods Directive: Actions towards the 'good status' of EU water and to reduce flood risks. <http://eur-lex.europa.eu/legal-content/EN/NOT/?uri=CELEX:52015DC0120>

<sup>2</sup> US Environmental Protection Agency. [http://iaspub.epa.gov/waters10/attains\\_nation\\_cy.control?p\\_report\\_type=T#causes\\_303d](http://iaspub.epa.gov/waters10/attains_nation_cy.control?p_report_type=T#causes_303d)

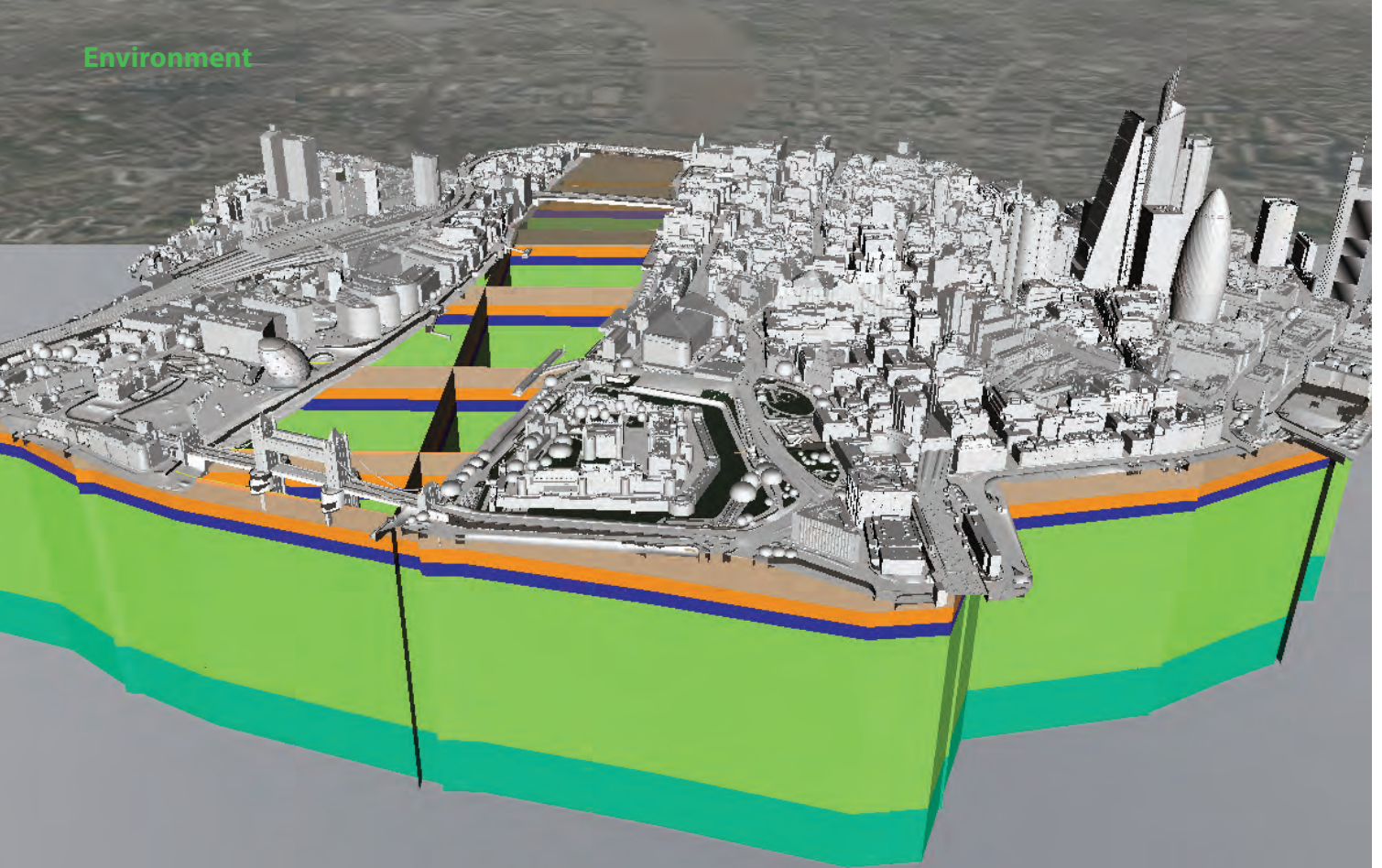
<sup>3</sup> Examples can be found at the author's web site: <http://mclaughlin.soil.ncsu.edu/publications.html>

<sup>4</sup> Sweden Green Building Council. LEED BD+C 2009 European ACPs Analysis SSp1 – Construction Activity Pollution Prevention. <http://figbc.fi/wp-content/uploads/2013/08/LEED-BD+C-2009-ACPs-Analysis-SSp1.pdf>

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## Collecting geological data in a 3D digital world

**Leanne Hughes, Survey Geologist at the British Geological Survey (BGS), outlines how digital technology can help to better quantify and understand geological data...**

**T**echnological advances in GPS, mobile computing and remote sensing have changed the face of geological mapping at the British Geological Survey (BGS). In the space of 15 years the process has developed from a largely paper-based 'fieldslip' system, to one which is entirely digital. Geological mapping has been a core role of the survey for 180 years, with early geologists colouring sections of their maps to represent the different rock types and mineral resources that lay beneath their feet. Today geologists at the BGS continue to collect observations to develop the next 3D and 4D generations of geological data, which will tell us everything we need to know from earthquakes to energy and from aggregates to agriculture. Traditional paper maps have been supplanted by digital data delivered via the web, and an entire map library of information on Britain's rocks and soils can now be accessed using smart-

phone apps and carried in a small pocket. How has this changed the traditional image of field geologists with their maps, geological hammers and notebooks?

### **Pre survey remote sensing**

Before any fieldwork takes place it is common to conduct a desktop survey of existing remote data such as digital aerial photographs or geophysics, gathering specific information relevant to the questions such as; "Are the ground conditions suitable for a wind turbine?", "What is the best location for this tunnel?" and "Which aquifers are at risk of pollution?" This survey identifies landscape features and changes in vegetation that indicate changes in geology, using stereo aerial photographs and a Geographic Information System (GIS). Geophysics enables the geologist to look below the Earth's surface and map the properties and processes that occur beneath.



### Field data

Preliminary interpretations from the pre-survey are imported into the BGS digital mapping system 'SIGMA'. This uses a typical tablet PC with integral GPS, camera and long-life battery, running purpose-built software applications designed by BGS. SIGMA holds data such as aerial photographs, historic maps and 3D terrain models that provide data on the landscape, and boreholes, reports and geological cross sections that provide data on the ground beneath. Field geologists are no longer isolated from such data while in the field and can make new interpretations in the context of all the information available. By integrating all this data, a geologist can build up an interpretation of the subsurface, and use a range of data input tools in SIGMA to capture a map and 3D model of the geology while still working efficiently in the field. But SIGMA has evolved way beyond its original brief as a geological mapping tool, and now has versions that enable scientists and international disaster relief teams to record vital information on the aftermath of natural hazards such as landslides, earthquakes and tsunamis.

### Visualisation and modelling

Once field data has been collected it can be modified, developed and checked in the GeoVisionary™ (Virtalis/BGS) software, which enables the subsurface environment to be visualised in the same way that apps like Google Earth™ help us to visualise our landscape. We use software originally developed for oil and gas exploration to build 3d models of the geology of the

subsurface. Each rock formation in those models carries a unique, digital code, which enables other attributes of the rocks such as engineering properties, permeability and resource potential to be displayed and queried. Such models have proved particularly useful for our end users, who may not be skilled or experienced in interpreting a traditional geological map. Overlaying 3D terrain data such as buildings and infrastructure helps to put the geological information into a context. The geological data from these models is provided digitally for users such as engineers and planners to integrate with their own data and systems.

### Products

Access to geological data has been made much easier since online web mapping systems have been widely available. The BGS 'Geology Viewer' uses a web-GIS to display bedrock and superficial polygons overlaid on a map of the UK. For a general audience the iGeology app has been developed by the BGS for use on mobile devices and tablets and has been downloaded by over ¼ million individual users. It presents geology overlaid on topographic maps and uses the device's GPS to locate the user. The data can be queried and is hyperlinked to detailed descriptions on the BGS website. The more advanced iGeology3D app employs 'augmented reality' to overlay geological polygons on the terrain as viewed by the device's camera in real time giving the user a geologist's eye-view. The map data, amongst many other datasets such as ground stability and geohazards, are also available as a digital product for government regulators and industry to licence. Far from being out of sight and out of mind, our geological foundations are now an essential and integral part of our 3D digital world. ■

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# Supporting rural communities

**EU Commissioner for Agriculture and Rural Development Phil Hogan believes rural areas hold many of the solutions for 21st Century challenges, and EU programmes are making this a reality...**

**R**ural areas cover some 80% of the EU's territory and are home to about half of our 500 million citizens. The lives of people living in rural areas can vary greatly from village to village, region to region, country to country – but many of the challenges and opportunities facing those communities are the same.

We cherish our rural areas in the EU, and we have been refining strategies for their development over many decades, evolving a vision where rural communities are key drivers of shared prosperity and sustainable growth.

Rural Development Programmes (RDPs) aim to support Europe's vital agri-food sector, but they also seek to widen the type of quality jobs available in rural areas. They also seek to support and reward rural entrepreneurship. This is crucial if we are to incentivise young people to stay or move to rural communities.

Total public spending on Rural Development Policy in the 2014-2020 period is €161bn, of which €100 bn comes from the EU budget.

Most of the support is grant-based, which means that certain projects will be prioritised and rewarded, in particular those linked to actions on competitiveness, environment, climate, and the widening of the rural economy – to name but a few.

Every single programme is built on strategic priorities broken down into clear targets.

To give just a few examples of how this money will be invested, Rural Development Policy for the 2014-2020 period expects to achieve the following targets:

- Investment aid expected to be paid to 350 000 farmers;

- Start-up aid expected for 155 000 young farmers;
- Start-up and development aid expected for 58 000 rural SMEs;
- 3.6 million expected places on training courses;
- 18% of rural citizens expected to have improved access to broadband.

These may seem like impressive targets, but the mechanisms for achieving them are detailed, targeted and precise.

Take the start-up aid for young farmers. The overall goal is to support those willing to fully take the risk of running the business as a head of the holding either solely or jointly with other farmers.

Payment is granted to a farmer in at least 2 instalments over a maximum of 5 years, with a maximum total aid of €70 000 available per young farmer.

This is serious investment, but the conditions are serious too. Support is conditional on the submission of a business plan, which has to start being implemented within 9 months of the date of the decision approving the grant.

The business plan must ensure that, within 18 months of the date of setting up, the young farmer meets the definition of "active farmer" set out in EU regulations.

Finally, aid will be paid out only in the case of farms whose standard output falls between predetermined thresholds. In other words, the young farmer is incentivised to be productive, thereby boosting the conditions for growth and further job creation.





Phil Hogan, EU Commissioner for Agriculture and Rural Development

To further drive these changes, we will be prioritising the roll-out of high-speed broadband to rural areas. Providing genuine connectivity will be essential if we are serious about enabling rural areas to be full partners in achieving these goals.

It is also important to remember that Rural Development policies are not only for the benefit of those who live in the countryside: Rural areas provide much that is needed by our urban neighbours: food security above all, but also renewable energy, clean air and fresh water, and open spaces for renewal and refreshment.

Europe is fortunate to have some of the most beautiful rural areas on the planet, where human populations have sustained themselves for thousands of years. Our challenge as policymakers of the new century is to design blueprints for sustaining them in the years to come.

Broadly speaking, our goal has been to empower rural areas to meet the wide range of challenges and opportunities that face them in the 21st century: economic, social and environmental. With a continued commitment to enlightened and targeted policies, we believe EU funding can ensure that rural communities survive and indeed thrive in the coming years. ■

.....  
**Phil Hogan**  
**Commission for Agriculture and Rural Development**  
 European Commission  
[www.ec.europa.eu/commission/2014-2019/hogan\\_en](http://www.ec.europa.eu/commission/2014-2019/hogan_en)

# Arthropods in Biological Control

Arthropods are characterised by the presence of an exoskeleton and articulated legs. The phylum Arthropoda includes more than 80% of the known species with many of these being important agricultural pests. Arthropods, such as insects and mites, inflict billions of dollars in damage worldwide every year. Tons of pesticides are sprayed in efforts to reduce their populations and damage to crops. However, pesticides are not considered sustainable means to manage economically important arthropod mainly because of the development of resistance. In addition, pesticides are highly toxic to beneficial arthropods especially natural enemies of arthropod pests. This induces a continuous dependence on the use of pesticides because the elimination of natural enemies favors exponential growth of pest populations. In addition, pesticide resistance forces the development of new, potentially more toxic chemicals, which can accumulate in the environment generating a new set of problems.

Biological control, defined as the use of these natural enemies to reduce and manage pest populations, can be an alternative to pesticides for reducing agricultural losses due to arthropod pests. Arthropod natural enemies include predators, which prey on other arthropods, and parasitoids, which differ from true parasites in that they kill the host at the end of their development. Predators and parasitoids exist naturally in the environment and normally maintain the population of their prey or host at

low levels preventing them from becoming pests. An arthropod becomes a pest when population outbreaks reach a level sufficiently high to cause economic damage. Outbreaks occur when the damaging species escape their natural enemy complex of parasitoids and predators. Current agricultural strategies mainly use a monoculture system which favors the escape of herbivore arthropods from their natural enemy complex by providing them with abundant new habitat with almost unlimited resources. It takes time for the natural enemies to find their host or prey in the new environment and multiply in sufficient numbers to regulate pest populations. By the time this occurs, economic damage has already been done to the crop and the pesticide spray cycle commences.

Pest outbreaks can be prevented by preserving a more diverse environment that favors natural enemy conservation. However, monoculture is the preferred method to produce crops in developed countries because it is conducive to mechanisation. To apply biological control in a monoculture environment, natural enemies must be mass produced and released at the appropriate time to prevent pest outbreaks. Producing large numbers of arthropod natural enemies economically and competitively has been a continuous challenge. The use of arthropod natural enemies in propagation and release efforts has been most successful in greenhouse crops. Some examples of arthropods commercially available for biological

control of pests in greenhouses and closed environments are listed in Table 1.

Scientists at the USDA-ARS Biological Control Laboratory develop new strategies to produce natural enemies at low cost and associated methods for packing, transporting and releasing these natural enemies in the field.

## Insects Used for the Management of Invasive Aquatic and Wetland Plants

*Dr. Michael Grodowitz*

Invasive aquatic and wetland plants cause manifold problems across the world. Overall impacts, while dependent on plant species, can include hindrance of water delivery systems; adverse changes in water quality; decreases in native flora and fauna; increased damage to bridges; weirs and other structures due to increased plant biomass during flood events; impacts to navigation, transportation and recreation; as well as increases in human health hazards due to expansion of mosquito breeding habitats. A variety of traditional management methods are employed and include both chemical and mechanical technologies though these often only provide short-term control. More long-term and sustainable management occurs through the application of biological control technologies mainly through the introduction of host-specific insect agents from the home range of the target plant species. Over 15 aquatic and wetland plant species have been targeted for biological control activities with 48 agents introduced in various parts of

Pest Group	Parasitoid Wasps	Insect Predators	Mite Predators
Aphids	<i>Aphelinus abdominalis</i> <i>Aphidius colemani</i> <i>Aphidius matricariae</i> <i>Aphidius ervi</i> <i>Aphidius matricariae</i>	<i>Aphidoletes aphidimyza</i> <i>Chrysoperla rufilabris</i> <i>Chrysopa carnea</i> <i>Hippodamia convergens</i> <i>Scymnus creperus</i> <i>Adalia bipunctata</i>	
Mealybugs	<i>Angyrus pseudococci</i>	<i>Chrysoperla rufilabris</i> <i>Symphorobius barberi</i> <i>Cryptolaemus montrouzieri</i>	
Scales	<i>Aphytis melinus</i>	<i>Lindorus lophanthae</i>	
Thrips		<i>Orius insidiosus</i>	<i>Neoseiulus cucumeris</i> <i>Hypoaspis miles</i>
Whiteflies	<i>Encarsia formosa</i> <i>Eretmocerus eremicus</i>	<i>Delphastus pusillus</i>	<i>Amblyseius swirskii</i>
Caterpillars	<i>Trichogramma brassicae</i> <i>Trichogramma minutum</i> <i>Trichogramma ostriniae</i> <i>Bracon hebetor</i> <i>Cotesia plutellae</i>	<i>Podisus maculiventris</i> <i>Chrysoperla rufilabris</i>	
Spider mites		<i>Stethorus punctillum</i> <i>Feltiella acarisuga</i>	<i>Phytoseiulus persimilis</i> <i>Amblyseius andersoni</i> <i>Amblyseius cucumeris</i> <i>Galendromus occidentalis</i> <i>Mesoseiulus longiseps</i> <i>Neoseiulus californicus</i> <i>Neoseiulus fallacis</i>
House Flies	<i>Muscidifurax raptor</i> <i>Muscidifurax raptorellus</i> <i>Spalangia endius</i>		

**Table 1: Commercially available arthropod species to be used against pests of greenhouse crops**

the world. New targets are continually being studied world-wide and include such species as *Lagarosiphon major* (African waterweed) and *Butomus umbellatus* (flowering rush). Highly successful introductions have been noted for *Melaleuca quinquenervia* (paperbark tea trees) and *Salvinia molesta* (giant salvinia). One of the most successful suite of biological control agents include four insect species introduced for the control of *Alternanthera philoxeroides* (alligatorweed); an inva-

sive emergent plant species native to South America. These include *Agasicles hygrophila* (alligatorweed flea beetle), *Arcola malloi* (alligatorweed stem borer), *Amylothrips andersoni* (alligatorweed thrips), and *Disonycha argentinensis*. The combination of the first two species can be devastating to alligatorweed infestations with almost complete suppression occurring in as little as six months. *Lythrum salicaria* (purple loosestrife), a problematic species introduced from Europe and

possibly Asia in the early 1800's in ship ballast and as an ornamental or medicinal herb, has also been managed to a large extent by the introduction of host-specific insect agents. Five agents have been released for its control and include two leaf feeding beetles (*Galerucella pusilla* and *G. calmariensis*), a root-boring weevil (*Hylobius transversovittatus*), the flower feeding weevil (*Nanophyes marmoratus*), and the aphid (*Myzus lythri*). The use of biological control technologies for aquatic and wetland plant management continues to show great promise in suppressing damaging infestations across the world.

Additional resources:

<http://www.ars.usda.gov/main/main.htm>

<http://www.anbp.org/>

<http://www.iobc-global.org/>

<http://www.biocontrol.entomology.cornell.edu/index.php>



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[www.ars.usda.gov](http://www.ars.usda.gov)



# Designing trees for the future

Forest tree breeding has taken place in Europe for more than 60 years. In addition to deeply increasing our knowledge in the genetics of forest tree species and overall on their biology, breeding has substantially contributed to the increase of wood production (genetic gains of over 20-30%) and the improvement of wood quality in plantations of main commercial forest tree species across Europe. Through breeding and selection, forest tree breeding programs aim indeed to better adapt forest species to biotic and abiotic agents together with improving their growth, stem architecture and wood properties. Maintaining a large genetic diversity for future progress is also a major concern.

With climate change perspectives and the fast evolution of socio-economic needs, new challenges are facing forest tree breeders. They are more than ever key actors in designing trees and forests planted in these new contexts. Adaptation to higher temperatures, dryer summers and extreme climatic events, resistance to new pests and diseases emerging with climate changes and globalisation, designing trees suited for new forestry management options (eg. dedicated forest for biomass production) and industrial needs (eg. bio-fuel, durable wood) are some of the many challenges to be tackled. In the 'stable' environmental and economic forestry context of the last decades, breeders



could still handle things at national or regional levels (we identified more than 180 breeding programs across Europe!). However, the new global context imposes on breeders reactivity and efficiency to breed, select and deploy new varieties and eventually assist shift or migration of species. The complexity of the demand and its up-scaling over whole Europe (and beyond), together with the multiplication and sophistication of new scientific and technical methodologies (eg. biotechnology, phenotyping) enforce European breeders to join efforts and to adopt a multi- and interdisciplinary approach. This becomes even more urgent when one knows the many cuts in staff and budget devoted to forest tree breeding in many European countries. Working with perennial species requires

continuity and forest tree breeding hardly supports ups and downs.

## **Towards a European Tree Breeding Centre**

Thanks to FP6 and FP7 EU programs for Research Infrastructures Networks, European breeders together with scientists from other disciplines could start settling down scientific and technical basis for a future European Tree Breeding Centre. The TREEBREEDEX project (coordination action, 2006-2011) aimed primarily to network European breeders' and forest geneticists' teams and to survey the status of breeding progress across Europe, of scientific knowledge on the genetics of major forest tree species, of skills and facilities devoted to breeding, and to identify research gaps and needs. Since their launching, breeding

programs have gathered huge genetic resources (breeding populations) for most forest tree species. Altogether, they form a unique patrimony at European level, both quantitatively and qualitatively (genetic diversity): if conserved and managed properly, they constitute the reservoir for future genetic progress at European level. Forest genetic trials are another facet of this rich patrimony which allows species adaptation and genetic diversity study in an incomparable set of ecological conditions. Long-term conservation of these resources, archiving of related data for future investigations and globally access to experimental facilities appeared as key issues together with the standardisation of phenotyping and genotyping protocols.

TREES4FUTURE forestry project (13 action, 2011-2016; 28 partners from 13 countries) moved several steps forward with an interdisciplinary approach and the creation of thematic networks, the provision of access to a diversified set of research infrastructures (28) and, the development of scientific tools of great interest firstly for the scientific community but also for forest stakeholders. Among these, let us mention: information systems on genetic and environmental resources; an open-source integrated platform for statistical and genetic data analysis (BreedR); consolidation of molecular tools for a European platform for fingerprinting and traceability of forest material; climate matching tool and spatial models for species site-matching; large scale

tools to assess goods and services, sustainability, and mitigation and adaptation strategies to climate change; high-throughput phenotyping methodologies for tree adaptation traits and wood properties; catalogue of standardised protocols for field experimentation. Development of these tools has been initiated to directly support breeding and more largely forestry research but above all, they are the cornerstones for a future European Tree Breeding Centre.

**“Through breeding and selection, forest tree breeding programs aim indeed to better adapt forest species to biotic and abiotic agents together with improving their growth, stem architecture and wood properties.”**

This European Tree Breeding Centre which is envisioned is seen both as a repository platform, an incubator for innovative research in breeding, genetics and biotechnology of forest trees and as a stimulator for reinforced cooperation in breeding; it will also be a vitrine for forestry stakeholders with whom interaction is crucial. It will provide and maintain tools and develop initiatives for collection, conservation and enrichment of genetic resources and associated data; it will facilitate and organise access to these resources; it will encourage and support ambitious trans-national breeding programs for current major forest tree species but also for emergent ones; it will foster joined front-science research related to forest tree adaptation, genetics,

breeding and biotechnologies. Training of researchers and interaction with stakeholders are also seen as key features of the missions for this European Tree Breeding Centre.

In a context of uncertainties but also of unprecedented challenges, the European Tree Breeding Centre will provide a stable, sustainable and incentive framework to researchers for a more reactive and efficient improvement of European forests resources.

Trees4Future (<http://www.trees4future.eu/>) consortium includes 28 partners from Austria (AIT, BFW, BOKU); Belgium (INNOVAWOOD, VLAGEW, U.GENT); Germany (ASP, SBS, vTI); Italy (CNR, CRA, FEM); Finland (LUKE); France (CEA, FCBA, INRA, IT); The Netherlands (ALTERRA); Portugal (IICT); Poland (IBL, IDPAN); Romania (ICAS); Sweden (INNVENTIA); Spain (CIDTG, INIA); United Kingdom (FR); + EFI and JRC.



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# Food Security Strategies for Metropolitan Regions

by Dirk Wascher, Esther van Asselt, Ine van der Fels and Leonne Jeurissen (Wageningen UR)

Funded by the European Union and running over a period of three years, the project FOOD-METRES project ([www.foodmetres.eu](http://www.foodmetres.eu)) has developed a series of decision support tools to guide a knowledge-driven approach to food planning at the scale of Global, Local and Metropolitan Agro-food Systems (GAS, LAS and MAS), focussing at concrete case studies in and around Rotterdam, Berlin, London, Milano, Ljubljana, Rotterdam and Nairobi. This contribution highlights aspects of food safety and food security at the example of Rotterdam.

Conventional food production operates in a global food supply network, which has been increasing exponentially since the 1960s. Figure 1 illustrates that the per-capita trade activity at the level of GAS is largest for The Netherlands. In combination scoring fourth in terms of trade volume between partners, the Dutch agro-food-sector must be considered as the most critical one in terms of its demands on system resilience and sustainability. Pointing at the risks of global food hubs to act as potential vectors for microbiological or chemical contaminations, Ercsey-Ravasz et al. (2012) stress the need to monitor, understand, and control food trade flows as it becomes “an issue no longer affecting just single countries, but the global livelihood of the human population”.

It is hence not surprising that consumers perceive local food chains products (LAS) to be environmentally more reliable, operationally more

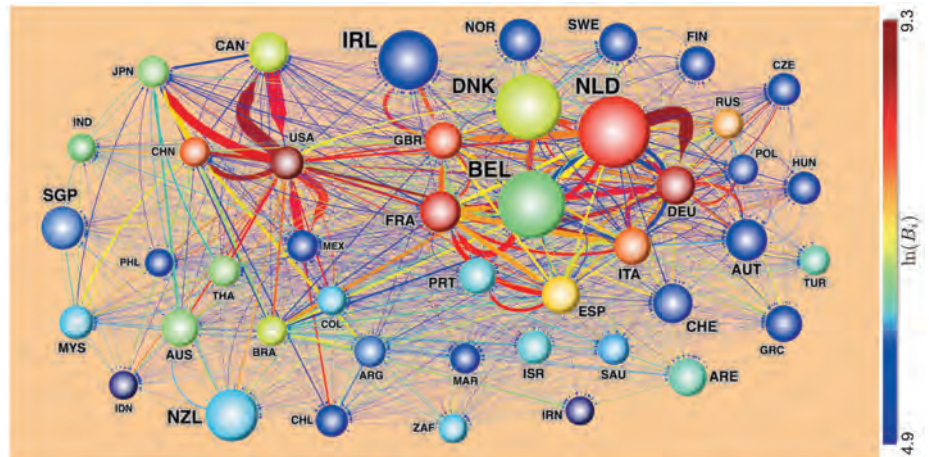


Figure 1: International trade activities in 2007 at the level of GAS (Ercsey-Ravasz et al., 2012)

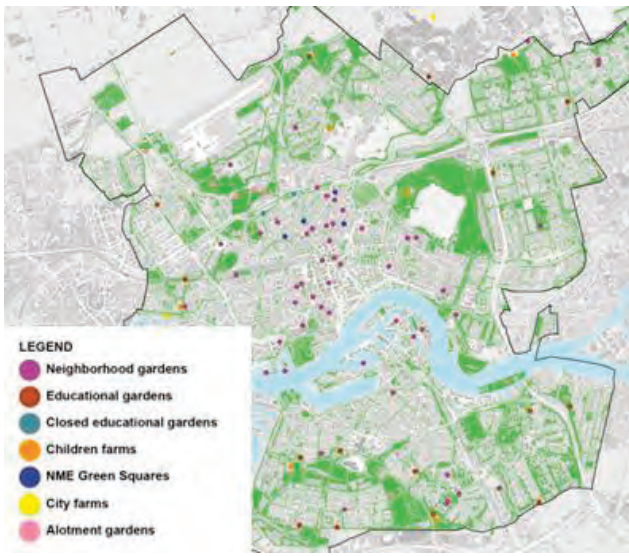
transparent and socially more responsible (Van der Jagt et al., 2014). Especially urban agriculture and its many variations such as vertical farming and roof-top-gardening are a social phenomenon that enjoys increasing popularity, not only as a resource for food, but also as a new quality of life in cities.

In urban LAS, food safety and quality usually depend solely on one person or a small team of persons, and are therefore prone to conflict with other daily activities and transparency issues. On the other hand, raw materials usually come from local sources, and food storage, processing or transactions are clearly restricted, which may diminish possible food safety risks associated with LAS (FASFC, 2014), certainly when compared to the inevitable delays when tracing contamination pathway within the complex nature of GAS (Ercsey-Ravasz et al., 2012). The limiting factor of LAS, however, is the size of the area available for food production: the 105 urban agricultural initiatives within

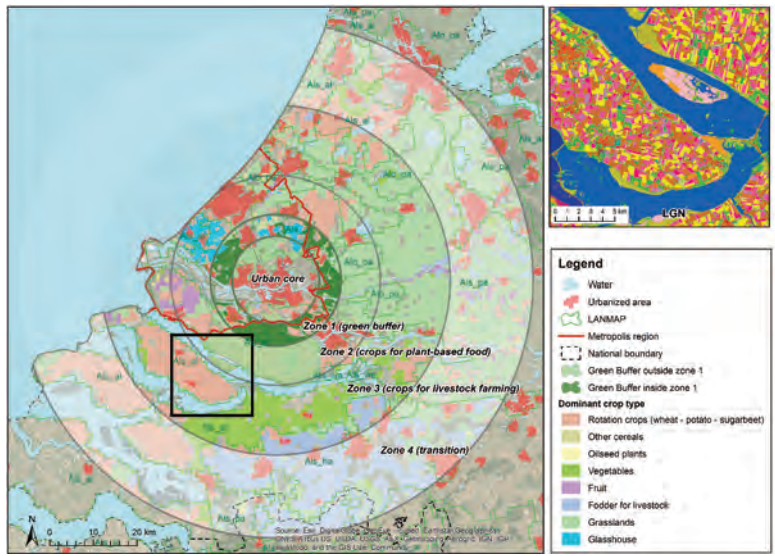
the Municipality of Rotterdam cover about 31.5 hectare in total (Kirisi 2013) which amounts to less than 0.05% of the area needed for 600.000 citizens (Figure 2).

Being the global hotspot for agricultural world trade, the Metropoolregio Rotterdam – Den Haag (MRDH) holds extremely high stakes in food logistics, safety and quality. At the same time it is a place where local, regional and global agro-food processes have a great potential for generating synergy. It is hence not surprising that Dutch researchers and policy makers have coined the notion – if not the vision – of metropolitan agriculture as being “a deliberately designed system of intelligently connected production sites that uses the available resources, conditions and infrastructure in metropolitan areas to produce material and immaterial demands for the same metropolitan area” (Latesteijn 2008). The latter suggests nothing less than to fundamentally rethink and redesign the agricultural value chain with the goal of establishing a more





**Figure 2: Urban farming activities in Rotterdam at the level of Local Agro-Food Systems (LAS)**



**Figure 3: MFP zonation for both Rotterdam city (Zones 1 – 3) and Metropoolregio Rotterdam Den Haag (zone 4) at the level of Metropolitan Agro-Food Systems (MAS)**

resilient link between food security and food safety at the level of metropolitan regions. Such an approach needs to adhere to the following principles: (1) resource efficiency measures for saving energy, water, nutrients and space, (2) circular economy to minimize waste and optimise value chains, and (3) spatial zonation to better manage health risks that may arise from intensive livestock farming, such as Q fever, MRSA, ESBL, and the threat of an H5N1 pandemic (CEG 2012).

Inspired by the spatial-economic concept of von Thünen (1883), we have developed the Metropolitan Foodscape Planning tool (MFP) which is based on the following zonation:

- urban core with LAS-style urban agricultural activities,
- green buffer reserved for nature and recreational activities,
- crops and processes for plant-based diets,
- crops and processes for livestock farming, and

- transition zone for both plant-based diets and livestock farming.

Zones 3 and 4 are considered to fully satisfy the yearly food demand of the urban core area – in this case the 1.2 million citizens of the Rotterdam City Region. Transition zone 5 is meant to provide sufficient food for the whole Metropoolregio Rotterdam – Den Haag accommodating for another one million people (see Figure 3). Driven by the ecological footprint of urban food consumption, this dynamic zonation can provide both guidance and incentive to successively change human diets and optimize logistics. Food quality and safety issues of human diets in cities and their surrounding metropolitan regions should be further investigated.

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# Pesticides and sustainable agricultural productivity

**Gavin Whitmore, Biodiversity Manager at the European Crop Protection Association (ECPA) explains the importance of crop protection for sustainable agriculture...**

**P**esticides are perhaps one of the most misunderstood technologies used in modern agriculture. There are currently no viable alternatives to chemical crop protection, and in spite of an enormous volume of misinformation, when used correctly, pesticides offer safe and effective protection for both conventional and organic crops, and make an essential contribution towards the sustainable agricultural productivity required to meet the global food supply challenge.

The rural scenes that soften the hard edges of the suburbs and provide space for recreation and relaxation are the frontlines of agricultural production. This is where we grow our food and where – with their complex interactions and interdependencies – agriculture and biodiversity coexist.

The toil and technology of traditional and modern farming practices weave an attractive patchwork of

cultural landscapes and are one of Europe's great sources of biodiversity. Myriad organisms find food and shelter on farmland. Half of all species endemic to Europe are reliant on agricultural habitats, so it is not surprising that several critical conservation issues are linked to changes in farming practices.

Natural resources and investment in knowledge, innovation and technology have supported an intensification of agricultural productivity, in turn contributing to decades of economic growth and improvements in health and wellbeing. Whilst this is no small achievement, the job is not done. The demand for agricultural produce is expected increase 70% by the year 2050, whilst 60% of the ecosystems that support the production of these resources suffer degradation and unsustainable use.

The need for agriculture is clear, it is the how that is the subject of endless debate. The location and scale

of farming, the intensity, the crop and the practices used for cultivation – these are parts of an equation that science and politics struggle to balance.

We are faced with a harsh reality, in the long-term the unchecked use of fresh water and soil and the degradation of biodiversity threatens our ability to supply the quantity and quality of produce demanded by society. Farmers will be required to double production over the next 30-40 years and there will be pressure to achieve this with more efficient use of land, water, and inputs.

Inputs are traditionally used to optimise yields, – for example by minimising the damage caused by agricultural pests. Whilst many of the organisms that live on, or move through farms contribute to the delivery of essential ecosystem services, such as the regulation of soil and water quality and the pollination of crops, some of these organisms are pests that pose risk to human health and productivity, and must therefore be managed.

Globally, food crops face severe competition for survival. Some 30,000 species of weeds, 3,000 species of nematodes and 10,000 species of plant-eating insects result in a loss of 20-40% of annual production potential, despite the use of chemical pesticides. Simply put, failure to protect crops is an unnecessarily wasteful use of natural resources that is incompatible with sustainable productivity. Without chemical crop protection, products yield losses would be catastrophically high. At the cost of natural habitats, the area of land required to grow sufficient food would be enlarged to compensate for losses; ultimately, the range, quality and safety of agricultural produce would be reduced.

There is an increasing awareness that society is faced with food security and environmental challenges; however, the tools and practices that enable the sustainable intensification of agriculture do not enjoy wide acceptance. Pesticides and other plant science innovations are too often vilified as a threat to sustainable agricultural productivity, in spite of evidence to the contrary.

On average, it takes a decade of research and development and in excess of \$250m to get a new crop protection product on the market; a market that is frequently described as one of the most regulated in Europe.

Pesticides undergo compulsory risk assessment which evaluates whether, when used correctly, products can be shown to have no direct or indirect harmful effect on human or animal health and do not adversely affect groundwater quality. The environmental risk assessment also evaluates the potential impact on non-target organisms when the products are correctly used.

The risk assessment process – overseen by EFSA – the European Food Safety Authority – is an essential contribution to ensuring the protection of organisms such as bees, earthworms and soil microbes that make much of our agriculture possible. Complementing this, the EU Sustainable Use Directive sets out rules for the sustainable use of pesticides to reduce the risks and impacts of pesticide use on human health and the environment; but the measures don't stop here.

Compulsory in Europe since 2014, Integrated Pest Management (IPM) is a system of pest management that relies on a combination of cultural, biological and chemical means of controlling pests. IPM practices encourage that pesticides are used only when necessary, and when they are used, that applications do not exceed requirements.

Additional environmental protection and benefits for biodiversity can be delivered through the implementation of a variety of on-farm management practices. Farmers have at their disposal a range of tried and tested best management practices (BMPs) that can improve habitat and forage for beneficial species, and manage the risk of spill or drift of crop protection products.

From flowering field-margins to cover crops to spray-drift technology; farmers have the means to protect both harvests and the environment. A plentiful supply of safe, healthy and affordable food need not cost us the earth. ■

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# THE EVOLUTION OF YIELD IN CORN

*Dr. Ronnie Heiniger  
North Carolina State University*

## Why is Corn Yield so Important?

The key to feeding a growing world with less demand on scarce resources and lower environmental impacts lies in increasing yield. Research has shown that increasing corn yield results in better efficiencies in nutrient and water use thanks to the fact that corn plants that yield more also have bigger root systems and more effective leaf area. The challenge for corn producers is to find management practices that allow them to maximize yield given the soil and environmental constraints they are operating with. Among the many management options that corn producers have what practices will provide the best return on investment in terms of increasing yield with the lowest cost and risk. This publication discusses some of the key principles and practices corn growers should consider when seeking to increase yield in corn.

## It is All About Intercepting Light

At the most basic level corn is a starch factory that depends in turning light energy into starch. Therefore the most critical practice in managing for higher yield is maximizing light interception. There are three management practices that can be used to increase light interception. These are growing longer season hybrids, increasing seeding rate and plant population, and decreasing row spacing. Of these three the most effective practice is increasing seeding rate and plant population. While growing hybrids that require a longer growing period increases the amount of light intercepted it also increases water requirements and does not improve root mass or leaf efficiency. Using narrow rows only increases light interception for a short period of time. In contrast high plant populations increase light interception across the entire growing period, result in improved efficiency in light interception, and along with other key management practices increase root mass in the field. Figure 1 shows the impact of increasing plant density on the morphology of corn plants. As plant population increases the corn

plant grows taller resulting in more effective placement of leaf area to intercept sunlight. This results in optimum yield potential. However, there is a limit to this response. As plant density increases so does the need for water and nutrients. When the demand for water and nutrients exceeds the ability of the environment to provide these to the plant the corn plant responds by reducing its height and yield potential is reduced. Note that in Figure 1 there is a narrow range of plant densities over which the plant reaches maximum height and productivity. Corn producers must precisely match plant population to the environment of the field.



*Figure 1. Change in plant density from 29,343 plants ha<sup>-1</sup> on the left to 107,593 plants ha<sup>-1</sup> on the right.*

## Supporting Plant Density with the Right Management Practices

As is apparent in Figure 1 planting at a higher seeding rate is not the only step producers should use to achieve higher yield. Higher plant densities result in individual plants that have smaller root systems and thinner stalks.

These negative effects must be compensated for. There are two key practices that must be used in a systems approach along with higher seeding rates to make higher corn yield possible. These two key practices are starter fertilizer and multiple applications of nitrogen. The root is the first plant part to be developed in the growth cycle of the corn plant. The faster the corn plant grows from germination to flowering the more root mass will be produced. Since the root system is the key to better nutrient and water use efficiency this is a critical component of a high yield corn plant. Starter fertilizer which contains small amounts of nitrogen and phosphorus increases the early growth of the corn plant (Figure 2). Research shows that increasing early growth by using starter fertilizer results in a plant with more root mass and thicker stalks overcoming the negative effects of higher plant populations.



*Figure 2. No planting or starter fertilizer was used on the four-row plot on the left while 22.5 L ha<sup>-1</sup> of 11-37-0 was applied in a 2 x 2 band at planting to the four-row plot on the right.*

Likewise, a corn plant depends on nitrogen to maintain leaf chlorophyll levels and efficient conversion of light into starch. Unfortunately, most growers only apply nitrogen at the beginning of the season or, at most, twice at planting and again at canopy closure. Since nitrogen is mobile in the soil and subject to loss these applications often don't cover the full season nitrogen demands of the plant (Figure 3). Growers often apply more nitrogen than the plant actually needs to cover the fact that some nitrogen will be lost by the time the plant reaches the reproductive stages. A better system for producing high yield corn is to apply small amounts of nitrogen throughout the season. This approach allows growers to just meet the needs of the plant at a given time resulting in little or no waste while ensuring optimum growth and

yield. Furthermore, nitrogen rates can be adjusted as the growing season progresses to match changes in weather (particularly rainfall) resulting in maximum nitrogen use efficiency.



*Figure 3. Nitrogen was applied at four different times during the growth cycle of the corn plant to the four-row plot on the right while nitrogen was only applied at planting to the four-row plot on the left.*

### **In Summary – A High Yield Corn System**

Capturing more light while increasing root mass and light use efficiency requires a systems approach to corn production. The future of high-yield corn production lies in precisely matching plant population with the environment of the field and then supporting that population with starter fertilizer and regular feeding with small amounts of nitrogen. This approach has the potential to increase yield resulting in less demand on land resources. Research at the Vernon G. James Research and Extension Center at North Carolina State University over the past three years documents that this systems approach consistently produced maximum corn yield ranging from 21.1 to 23.7 mt ha<sup>-1</sup>. Only by using a systems approach can growers increase water and nutrient use efficiency in corn production resulting in better utilization of scarce resources and improving the amount of carbon fixed in a corn field resulting in less climate impacts.

# The National Organic Program – Ensuring organic integrity from farm to table

**Miles McEvoy, Deputy Administrator of the U.S. Department of Agriculture's (USDA) National Organic Program outlines the importance of organic farming for the U.S...**

The organic sector is one of the fastest-growing segments of U.S. agriculture, and consumer demand continues to increase. Today, there are more than 19,000 certified organic farms and businesses in the United States alone. Around the world, there are more than 27,000 operations in 120 countries certified to the USDA organic standards. With support from the U.S. Department of Agriculture (USDA), organic farmers and businesses have achieved \$39bn annually in U.S. retail sales. With a rigorous certification process, robust standards, and strong enforcement, the USDA Organic Seal has become the gold standard around the world.

USDA's National Organic Program (NOP), part of the Agricultural Marketing Service, protects organic integrity through a rigorous and comprehensive certification process, ensuring that all organic products comply with the organic standards. Organic operations must demonstrate that they are implementing practices that foster the cycling of resources, promote ecological balance, and conserve biodiversity.

The USDA organic standards also describe specific production and handling requirements for farms and processors, including the use of approved substances. For example, organic products must be produced using methods that avoid genetically engineered organisms and most synthetic materials, such as pesticides and antibiotics.

USDA also supports the continued growth of organics by developing clear standards that drive consumer demand for organic products. In fact, USDA continually adjusts the organic standards in order to meet the needs of the rapidly growing sector – there are new standards on the horizon related to aquaculture, pet

food, apiculture (bees and honey), and enhanced animal welfare provisions.

One element of the organic standards, the National List of Allowed and Prohibited Substances, identifies substances that may and may not be used in organic production and processing. In general, synthetic substances are prohibited unless they are specifically allowed, while non-synthetic substances are allowed unless specifically prohibited. The National Organic Standards Board (NOSB) is a Federal Advisory Committee that assists in the development of standards and makes recommendations to the U.S. Secretary of Agriculture regarding implementation of the organic program, including what substances should be on the National List. The board's 15 dedicated volunteer members serve 5-year terms and represent the entire organic community – farmers/growers, handlers/processors, environmental/resource conservationists, consumer/public interest advocates, scientists, and certifying agents. The diversity and expertise of board members makes the NOSB a direct link to organic community.

USDA accredited certifying agents must verify compliance with organic standards before products can be labelled as USDA organic. Becoming a certified organic farm or processing operation is a multi-step process that requires a written Organic System Plan, annual on-site farm inspections, sampling and residue testing, and label reviews. In addition to a rigorous certification process and robust standards, USDA protects the organic label with strong oversight of organic production, processing, and distribution. From farms to retail stores, USDA conducts and coordinates investigations of suspected violations of the organic standards and takes legal action when





necessary. With meaningful standards and a rigorous oversight system, consumers can be confident that the organic label deserves its reputation as a leading global standard.

Organic agriculture is a strong contributor to USDA's goals for rural economic development, and we are committed to supporting continued growth of the organic community by assisting organic farmers and businesses. USDA has initiated a number of new and expanded efforts to connect organic farmers and businesses with the resources they need to ensure the continued growth of the organic sector. Some

programs assist organic farmers, ranchers, and handlers. Other programs are open to the general public, including organic operations.

For more information on what organic means, the certification process, organic labelling, the Organic 101 blog series and the Organic Literacy Initiative check out USDA's one-stop-shop for information on all of our programs and opportunities for the organic community at [www.usda.gov/organic](http://www.usda.gov/organic). ■



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# An ideological challenge to organic commodity farming

A collaborative research project sheds light on the shift to more profitable and environmentally friendly farming methods by dispelling some misconceptions surrounding organic production...

Conventional, chemical farming cultivates crops using inorganic chemical inputs like fertilisers and pesticides. By contrast, organic farming methods do not rely on inorganic chemical fertilisers or feed additives, instead using techniques like crop rotation, organic composts and biological pest control. With many, many variations, contemporary agriculture spans this broad continuum from conventional, chemical to organic production.

Organic farming has experienced a boom in recent decades. Since 1990, the market for organic produce has grown rapidly, reaching US\$63 billion worldwide three years ago. Of course, this has driven demand for organically managed farmland. According to the latest data on organic agriculture, in 2012 approximately 92,000,000 acres were farmed organically. Currently, this amounts to less than 1 per cent of total world farmland. Despite the

demand for organic food, it appears many farmers are reluctant to make the transition, sticking with conventional methods instead.

Recognising that this can impede agricultural progress, Professor Eric Arnould, a marketing expert from the University of Southern Denmark and Melea Press (Hanken School of Economics, Finland) began a study of the factors preventing farmers changing methods. Together with Professors Jeff Murray (University of Arkansas, USA), and Katherine Strand (McGill University, Canada), they set out to study organic commodity agriculture in America's Northern High Plains.

Change is particularly important for this region; farming is critical to rural communities in the High Plains, but many farms are challenged not only by a harsh climate but also rising input costs. In 2002, 97 per cent of Wyoming farms had annual sales

below \$500,000. Farmers here are in urgent need of alternative production methods that protect cropland, reduce costs, increase profitability, or add value. Organic production methods could be one answer. Because of their increased sales value, they can increase profit and alleviate financial difficulties. Arnould's team and other members of the broader research project thus aimed to ease the transition to organic farming by addressing the region-specific needs and providing information on organic approaches.

## An agricultural riddle

The researchers' investigations of the challenges and opportunities for organic producers in the High Plains forms part of a larger three-year US Department of Agriculture-funded project. As part of this, in November 2014 the team released a groundbreaking report published in the *Journal of Marketing*. The report analysed the production and market-

ing strategies of commodity producers: those who provide basic inputs to common prepared foods. Using wheat farmers in the High Plains as their subject, they assessed the challenges to strategic change in agriculture, specifically asking why chemical farmers resist converting to more profitable organic methods.

Indeed, the economic incentives are clear. Over the past 30 years, organic wheat production has consistently yielded profits. On average, price premiums have been 47 per cent above chemical wheat production. Organic wheat production is profitable, while chemical production is only profitable due to government subsidies, but it still represents only 1 per cent of the overall market. Why?

In answering this question, the team focused on ideology, a rarely addressed aspect in this type of research. "Widespread business practices, that is, strategies, can be thought of as ideologies because they exhibit features that social science ascribes to ideologies," explains Jeff Murray. The team revealed a clear link between the two, as ideologies have a measurable impact on business decisions. These in turn have significant social and economic consequences. As ideology is so closely linked to strategic orientations, considering personal beliefs may help explain why moving to new production methods is so challenging in agriculture.

Meantime other participants in the US Department of Agriculture project



under the direction of Professor Jay Norton (University of Wyoming) focused on agronomic elements. They noticed organic farmers often relied entirely on rotations and frequent mechanical weeding to control weeds, manage moisture, and improve fertility. However they generally did not use organic soil amendments because of their cost and uncertain benefit. These researchers found that in contrast to farmers' beliefs, absent soil amendments these techniques lead to a steady decline in soil organic content and in turn, soil fertility, over time. On the other hand, they found using perennial legume crops and organic soil amendments, particularly composted manure, in organic crop rotation systems favours greater soil microbial substrate availability, and more microbial biomass compared with other management systems with conventional inputs, which improve soil fertility. This research also found that integrating grass and legume following into long rotation cycles where possible through government

funded soil conservation programmes pays off in improved soils quality. Not surprisingly, Arnould's team found that new farm enterprises springing up to supply composted manure to organic farmers quickly experienced demand outstripping supply. This part of the project showed that more research into the agronomics of organic commodity production and more entrepreneurial innovations in input supply could pay off for organic farmers.

### Transitioning roadblocks

To directly understand the barriers to transitioning to organic production and marketing, interviews were conducted with producers and other actors in the High Plains, including both chemical and organic farmers. By speaking to the farmers multiple times over several years, they found that both groups had passionate beliefs underlying their choices, which were often competing.

The dialogues identified a number of factors that help explain why chemical





farmers resist transitioning to organic methods. Many were related to cost: "Organic certification has measurable economic benefits, but it also comes with costs that are not factored into a standard balance sheet," Melea Press elucidated. These include research, certification, and marketing costs. Marketing costs are perhaps one of the biggest obstacles to transitioning to organic agriculture. Organic farmers often must absorb storage costs as off-farm segregated storage of organic production is unavailable or costly. Moreover, buyers often prefer to source organic wheat on a just-in-time basis, pushing storage costs back to producers. Similarly, finding segregated transport whether in truck or train is also costly and unpredictable. In addition, farmers and buyers, such as millers, bakeries, breakfast cereal pro-

ducers or even organic animal feed blenders, often have trouble locating one another. And finally, some large scale buyers demand production volumes that may far surpass the production capabilities of individual producers. The team found that when small groups of organic farmers work together to solve these problems, significant benefits accrue to them.

However, the underlying roadblock in the transition to organic production and marketing is a general belief that organic agriculture represents a faddish, non-scientific, agronomically suspect form of radical environmentalism. Associated with this scepticism is social pressure, as farmers in small rural communities tend to employ "roadside farming" to assess one another's farming practices. Thus, as

Strand uncovered in her work for the project, unconventional practices or field appearance in organic fields may lead to negative appraisals by conventional farmers. These negative appraisals can be manifest in epithets such as "weed farmer," or social exclusion, but also in social sanctions with tangible outcomes. "One very successful organic farmer in our study tried to purchase land from a chemical neighbour, but he refused to sell to an organic producer," stated Melea Press.

It appears that obstacles to the organic transition are not primarily agronomic or material, but instead are based on ideological tensions. Murray believes that until these tensions are resolved, the transition will remain in a 'stage of crisis'. The study concluded by explaining the

value of understanding the influence of ideology on farming methods. If agricultural managers recognise conflicting belief systems, they are more likely to encourage successful strategic change. Such understanding can be a route to finding new ways of inspiring farmers to embrace change, for example, linking new strategies to cultural beliefs.

### Ensuring a dynamic future for agriculture

With this landmark study, the team showed that strategic marketing orientations can be thought of as ideologies. Deep-rooted beliefs, which are legitimised by normative, cultural and regulatory sources, constrain farmers from making rewarding shifts in farm strategy.

But by understanding the ideological tensions, they can be managed. It is hoped that agricultural extension workers in the US will use the findings to consider the ideological basis of different agricultural production and marketing strategies, and, crucially, address the myths surrounding them. Likewise, specialists in agroeconomics should develop new models for organic farm enterprises to address the extra storage certification, and marketing costs incurred by organic farmers. And developing new agronomic approaches to crop rotation and fertilisation, particularly in semi-arid regions like the High Plains of North America that overcome the drawbacks of existing strategies remains a priority. In turn, farmers may be able to see the benefits of change. This

realisation is vital, as the future of agriculture requires farmers to adapt to new market realities.

### Obstacles to transitioning to organic commodity agriculture are not agronomic or technological, but instead based on ideological tensions

#### Framing a disputed agricultural landscape

Arnould and his team describe the competing ideals of chemical and organic farmers in the High Plains as an 'ideological map'.

#### Conventional chemical farmers tend to believe that organic farming threatens the following beliefs:

- Pride in farm planning;
- Scientific farming;
- Weed and pest suppression;
- Soil is a growth medium;
- Crop yield as the key measure of good farming;
- Making money requires chemical approaches.

#### Organic farmers tend to believe that conventional chemical farming threatens the following beliefs:

- Rotations are the key to sustainable farming;
- Chemicals are hazardous for land and people;
- Soil is a living entity;
- Profit is a better measure of success than yield;
- Time in the field is a mainstay of good farming;
- Farming is about tradition, 'Farm like grandfather'.

#### However, both groups share an ideological commitment to the following:

- Passing on the farm to future generations;
- Hard work;
- Stewardship of the land;
- Independence;
- Staying out of debt;
- Careful innovation.

Consequently reframing organic agricultural practice as consistent with the ideals of conventional farmers, in particular the ideals with which they share a commitment is one mechanism to move beyond an unhelpful either/or debate.



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## Salsolinol – good or evil?

**Professor Tomasz Misztal, Head of the Department of Endocrinology of The Kielanowski Institute of Animal Physiology and Nutrition in Jablonna, sheds light on new features of an old substance...**

**S**alsolinol is a dopamine derivative that can be found in many areas of the brain that are rich in dopaminergic neurons. The highest salsolinol concentrations are detected in the basal ganglia, especially in the striatum, substantia nigra, frontal cortex and hypothalamus, as well as in the neurointermediate lobe of the pituitary gland. Interestingly, it is synthesised during specific physiological and/or pathophysiological stages in humans and animals. Numerous studies evaluating the function of salsolinol and, in particular, its methylated derivatives revealed their involvement in the progression of diseases characterised by dysfunctional dopaminergic neurons. This compound has a molecular structure similar to neurotoxin 6-hydroxydopamine, which is known to induce loss of dopaminergic cells and elicit symptoms almost identical to idiopathic Parkinson's disease. Salsolinol may exert its negative effect by acting at the level of mitochondria through a reactive oxygen species-activated cascade or may induce changes in protein synthesis in the endoplasmic reticulum. It has also been suggested that salsolinol has a role in the

etiology of alcoholism. Elevated concentrations of salsolinol have been determined in the blood plasma of alcoholics. Early animal studies revealed that salsolinol promotes alcohol drinking. However, results from different experiments may vary extensively because of different experimental protocols, sampling methods and/or drinking procedures.

During the last decade, attention has also been focused on the physiological aspects of salsolinergic activity within the brain. Several studies performed on rats have clearly indicated that salsolinol may represent at least one of the neuronal factors stimulating prolactin release. This compound was also shown to be present at a high concentration within the hypothalamic median eminence in lactating sheep. Evidence exists that the extracellular concentration of salsolinol in the median eminence increased in response to suckling and was closely related to the suckling-induced increase in the plasma concentration of prolactin. Intracerebroventricular infusion of exogenous salsolinol in lactating sheep stimulated prolactin



release and increased expression of prolactin mRNA within the pituitary cells. Moreover, a similar infusion of 1-methyl-3,4-dihydroisoquinoline (1-MeDIQ), a structural analogue of salsolinol known to antagonise some of its endogenous actions, inhibited basal prolactin release and reduced the prolactin surge induced by suckling. Further studies have shown that salsolinol may mediate in the stimulatory action of endogenous opioid peptides on the secretion of prolactin in nursing sheep. The above data indicate the potential character of salsolinol as a hypothalamic prolactin-releasing factor in lactating females. It is suggested that it may be an important terminal element in the sucking stimulus, encouraging the release of prolactin and making it possible to sustain increased secretion of this hormone during lactation.

Lactation is characterised by many adaptive changes in morphology, physiology and maternal behaviour to ensure proper care and development of the offspring. The post-partum adaptations, in addition to the milk production regulated by prolactin, include suppressed reproduction, increased appetite, and maternal behaviours (i.e., nursing of new-borns). There are also relevant changes in basal and stress-induced activity of the hypothalamic-pituitary-adrenal (HPA) axis, which have a pivotal role in the metabolic demands of lactating females and developing offspring. Attenuation of stress-induced activity of the HPA axis has been observed in almost all studied lactating females, including rats, sheep and humans.

Suckling appears to be a crucial stimulus that triggers the suppression of the HPA axis stress response during lactation. It has been demonstrated that suckling significantly suppressed increases in both plasma adrenocorticotrophic hormone and cortisol concentrations in response to isolation stress in lactating sheep. Using different experimental *in vivo* techniques, i.e. intracerebroventricular infusion combined with push-pull perfusion of the hypothalamic median eminence for simultaneous administration of salsolinol or 1-MeDIQ and identification of the substances released from the nerve terminals into the hypophyseal portal system, it was possible to show numerous changes in the components of the HPA axis under stress conditions. The research points to profound changes with

respect to regulating the stress response that occur during lactation and the relevant role of salsolinol at this physiological stage. It is suggested that salsolinol mediates the inhibiting effect of suckling on stress-induced HPA axis activity in lactating sheep, which would associate this molecule with the mechanism responsible for reducing the sensitivity of lactating mothers to stressors.

Suckling, which stimulates milk production, especially its intensity in the early period after birth, is also a factor leading to the inhibition of reproductive function. This is reflected in the reduction of gonadotropic axis secretory activity, compared to other phases of the reproductive cycle. It was shown that early weaning piglets or calves causes a quick return to the LH secretory activity, which was associated with the increase in LH pulse frequency and could lead to the occurrence of estrus and ovulation. In sheep, which are a species with marked seasonality of reproduction the speed, with which the pituitary LH cells would be provided with hormone depends on whether the lactation occurs during seasonal anestrus or during the estrous period. In a study conducted on sheep and cows, it was also demonstrated that extending the duration of infertility is proportional to the number of offspring fed and frequency of suckling. Whether salsolinol is also involved in the inhibition of gonadotropins secretion in lactating females is a challenge to take further investigations. ■



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# In the interests of animal and human health

Our mission at the Kielanowski Institute of Animal Physiology and Nutrition (KIAP&N) in Jablonna is to conduct fundamental and applied research in the field of animal science.

The studies related to animal nutrition encompass both physiological fundamentals and elements of feed science. Their objective is to determine the nutritional requirements of animals, which change as the result of genetic improvement and consumer expectations as to the health-promoting qualities of animal products. To reach these goals it is necessary to understand the metabolism of particular nutrients in the digestive tracts of animals, including the involvement of microorganisms colonising its various sections, and the role of these nutrients in the metabolism of the animal itself. As the digestive tract is formed at an early age, the influence of various feed components on its development and functions is investigated, including the quality and quantity of protein, fiber and biologically active supplements.

A well-developed stream of research concerns modifying diets in order to obtain a functional product with health-promoting characteristics. This applies to supplementation of diets with vegetable and/or fish oil, as well as antioxidants protecting against oxidation of unsaturated fatty acids. The final meat product is to have a balanced omega-3 and omega-6 fatty acids ratio and a high nutritional



Piggery with laboratories

value, thus playing a role in prevention of cardiovascular disease. It is also important that these health parameters could be maintained after food processing, since numerous treatments may reduce the health promoting traits.

An important social problem is the lack of acceptance for using feed containing genetically modified crops for livestock. The results obtained at the KIAP&N showed the safety of such materials used in animal feeding. The use of genetically modified soybean meal and maize in broiler diets did not affect performance or immunological status, intestinal morphology, epithelial cell turnover rate in the small intestine, intestinal ecosystem composition and activity.

However, it is possible to partially replace them with non-modified legumes which meet the expectations

of a substantial group of consumers. Among others, different varieties of pea and lupine seeds, raw or processed, as well as rapeseed products were used in pig and broiler diets supplemented with enzymes or probiotics. It was found that partial replacement of soybean meal by protein from different legumes or rapeseed products in diets for growing pigs and broiler chickens is possible without adverse effect on feed utilisation and digestive tract physiology.

## Insight to animal physiology

The main research areas on animal physiology are these related to the endocrine mechanisms regulating growth, maturation, and reproduction of animals as well as the development of the structure and function of the digestive tract. The topics of study include the activity of neural tracts at the central nervous system level and



Piglets in the lab



Broiler chickens

secretory activity of the pituitary gland and other endocrine tissues i.e. gonads, adrenals, pineal gland, thyroid, and pancreas in various physiological states. The KIAP&N is a recognised entity in the study on the functioning of the hypothalamic-pituitary neuroendocrine axes of sheep and rats. The stereotactic equipment conforming to the atlases of the rat and sheep brains enables precise implantation of cannulas into the brain ventricles or chosen hypothalamic nuclei. Currently conducted studies address a wide range of topics especially related to gonadotropic and somatotrophic axes.

Much attention is also being paid to environmental factors, especially those that disrupt the normal functioning of organisms (nutritional deficit, stress, and inflammation). Biologically active substances that are ingested with feeds and interact with endogenous regulatory compounds i.e. hormones and growth factors are also an important research topic. Detailed knowledge about regulatory mechanisms may enable better control over important life functions and may also have a bearing on human physiology and be of value in the treatment of diseases stemming from the disordering of these mechanisms.

Only a few centers specialise in the study of the development of the structure and function of the gastrointestinal tract in newborn animals. Research conducted in the KIAP&N focuses on bioactive colostrum and milk compounds, which may affect gut maturation as well as motor functions of the small intestines on both *in vitro* and *in vivo* models. Our researchers established the unique animal model that enables nursing and rearing of neonatal piglets in controlled laboratory conditions. They have shown that leptin, ghrelin and obestatin – gastrointestinal peptides involved in energy expenditure – are also present in colostrum and milk, and, when given orally to suckling animals, they significantly influence intestinal maturation. Studies in newborn pigs have an impact not only on progress in these animals' breeding, but to a large extent can be transferred to man. Especially the early-born piglets may be regarded as the only model for premature babies.

### Publications and future prospects

The KIAP&N publishes its own quarterly international scientific journal, The Journal of Animal and Feed Sciences, in which papers on animal nutrition, breeding and physiology, and feed

science, submitted from Poland and abroad, are published.

In 2016, The KIAP&N will be a co-organiser of the scientific conference 'The 5th EAAP International Symposium on Energy and Protein Metabolism and Nutrition' to be held in Krakow, the former capital of Poland.

It is open to co-operation with scientific institutions, feed and food producers, as well as with pharmaceutical industry, in terms of participating in research and implementation.



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# Agroforestry and its impact

**Dr. Thomas J. Sauer, Research Leader at the National Laboratory for Agriculture and the Environment, U.S. Department of Agriculture details the importance of agroforestry for the environment...**

**A**groforestry is a land use practice that involves growing perennial woody vegetation (trees, shrubs, or hedges) integrated with forages, crops, fruits, berries and nuts, herbs, or medicinal plants on the same land. Many agroforestry systems mimic the multilayered canopies of natural ecosystems that have tall trees above smaller trees or shrubs with a layer of non-woody plants beneath. A distinctive feature of natural ecosystems is the wide diversity of species that can be found even in an area of similar soils and climate. However, as agriculture and forestry evolved, the cultivation of crops and trees became specialised and separate leading to the modern production practices typified by monocultures of single crop or tree species grown on large parcels of land.

Why is there currently so much interest in a land use system that represents such a stark contrast to modern agricultural practices? Climate change, food security, and dwindling land resources are the main drivers behind the surge of interest in agroforestry. Climate change effects impose 2 contrasting environmental stresses on agricultural production. Long-term, gradual shifts in temperature and precipitation (total amount and its annual distribution) may create “normal” conditions that are outside the optimal range for current crop species. The other climate-related environmental stress is extreme, episodic events. The severity of one isolated event (e.g. unusually high winds and heavy precipitation) may produce damage that results in near-complete crop failure and severe damage to soil and water resources. Only the most resilient of soils and agroecosystems will be able to adapt to shifts in climate or to fully recover from catastrophic events and return to pre-event levels of productivity.

Agroforestry systems are inherently more resilient to weather extremes than many traditional cropping



**Dr. Thomas J. Sauer,**  
**Research Leader**

systems. Agroforestry practices utilise perennial vegetation and multiple species that provide greater plant diversity with less vulnerability to climate stress than is provided by monocultures. The perennial woody vegetation itself also modifies the local microclimate. The trees and shrubs influence airflow and sunlight interception patterns, protecting the understory and adjacent plants from extremes in temperature and damaging winds. The deep rooting by the perennial vegetation also affords greater resilience to drought and increased exploitation of soil water and nutrients from soil layers not readily available to more shallow rooted annual crops. Greater efficiency of agroforestry systems in water use and nutrient cycling is a key strength and further enhances their efficacy under the uncertainties of climate change.

Although agroforestry practices are inherently more resilient to environmental stresses, sharply increasing global demand for food, fuel, and fiber is creating intense pressure to produce more of all of these products. Meeting the food security challenge of feeding an estimated global population of 9 billion by 2050 is daunting enough without considering the

competing demands for renewable bioenergy, timber, and fiber production. The diversity of species and design features of agroforestry practices offer greater opportunities to produce multiple commodities from the same parcel of land. The combination of species, their distribution/arrangement, and water and nutrient sources are also all manageable features. Agroforestry systems can thus be designed for anticipated changes in climate including greater fluctuations of or long-term trends in precipitation and temperature or to create systems that are more resilient to climate stresses by including species, design features, or management practices that are more adaptable.

The overriding objective of future agricultural land use will be on optimising productivity from the available land base. Agroforestry systems are easily adaptable to the concept of sustainable intensification. Each component can be managed to optimise production while the perennial species provide system resilience and ameliorate climate stresses. Soil degradation by erosion, salinity, and pollution and loss of prime quality farmland due to urbanisation and development continue to reduce the amount of land available for agriculture. Some new areas can be brought into production but often with lower productivity and at great cost due to the necessary investment in infrastructure (roads, irrigation, utilities, etc.). By intensifying production on current lands using sustainable agroforestry practices, multiple products and ecosystem services (air and water quality, wildlife habitat, carbon sequestration, etc.) can be provided efficiently. In many cases, existing crop and forest systems can be modified to incorporate the production of multiple products from the same land. Some examples are thinning forests to allow grazing while the remaining timber matures (silvopasture) or planting rows of trees in a semiarid grain cropping system to improve water use efficiency and grow bioenergy feedstock (tree windbreaks).

One of the greatest climate-related threats to agriculture in the USA occurred during the 1930's when persistent drought, poor soil management, and severe wind erosion in the Great Plains region created a major environmental crisis. These "Dust Bowl" conditions were exacerbated by a deep economic depression and accompanying social disruption. To address this dire situation, the federal government

developed a novel tree-planting program to bring physical and economic relief to 6 of the most severely-affected Dust Bowl states. The Prairie States Forestry Project (PSFP) was designed to alleviate drought conditions by creating multi-row tree windbreaks that would stabilise the soils and create a more favorable microclimate for crops. From 1935 to 1942 the PSFP program succeeded in planting over 217 million trees in almost 30,000 km of windbreaks. Many of these windbreaks planted over 80 years ago are still protecting crops in the region today. The principles behind the PSFP were largely borrowed from the Russian steppes, which have a long tradition of tree windbreak planting to protect crops from hot, dry summer winds that historically lead to repeated crop loss and famine.

Successfully addressing global climate change effects on agriculture will require a holistic, sustained approach incorporating a suite of strategies at multiple spatial scales and time horizons. In the USA of the 1930's, bold and innovative leadership at high levels of government was needed to enact a unique program over an extensive area to successfully address severe drought conditions. Agroforestry practices offer excellent opportunities to adapt current agricultural production systems to future climates, build more resilient agricultural systems, and also provide climate change mitigation through carbon sequestration in biomass and the soil. Agroforestry also provides multiple additional ecosystem services including enhancing wildlife habitat, improving local microclimate and esthetics, and expanding renewable energy sources. The challenge now is to engage similar decision-making methods as demonstrated by the successful PSFP of the 1930's to craft effective policies and programs for adapting agriculture to global climate change effects and enhancing global food security. ■

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# Researching soil and the climate

**T**om Sauer joined the U.S. Department of Agriculture's Agricultural Research Service (ARS) as a Research Associate at the National Soil Tilth Laboratory (NSTL) in Ames, Iowa in the fall of 1993. He had just obtained his Ph.D. in environmental biophysics from the University of Wisconsin-Madison under the direction of John Norman. After two years in Ames, he was hired into a permanent Soil Scientist position with the Poultry Production and Product Safety Research Unit on the University of Arkansas campus in Fayetteville, Arkansas. In 1999 he came back to the NSTL where he is now the Research Leader of the Soil, Water, and Air Resources Research Unit of the National Laboratory for Agriculture and the Environment (name changed from NSTL in 2010).

While he always had the title of Soil Scientist in ARS, his research program has covered a wide range of topics utilising many aspects of his training in soil, water, atmosphere, and plant interactions. A common factor to nearly all of these studies has been a connection to the transfer of water and energy in the environment. In Arkansas the focus was on a byproduct of agricultural production, the land application of poultry litter (manure and bedding material from chicken production). Poultry litter is typically applied to pastures of the Ozark Highlands to fertilise the forage as litter contains nitrogen, phosphorus, and

other essential plant nutrients. Due to the soils and climate, however, some of these nutrients can be transported from the pastures to streams and groundwater. Reducing this transport was the goal of his research program that focused on identifying soils with lower surface runoff potential by assessing the variation in soil hydrologic properties with landscape position.

**“A collaborative grant from the Civilian Research and Development Foundation enabled Sauer and Chendev to combine their interests to study the effects of tree windbreaks on soil properties in the Russian steppes and U.S. Great Plains.”**

Reducing animal manure impacts on water and air quality soon led to research in agroforestry systems including a long-term alleycropping study in Arkansas and a tree windbreak study in Iowa. The alleycropping experiment, funded by the U.S. Forest Service and Natural Resources Conservation Service, included monitored nutrient cycling through soil, trees, forage, soil water, and groundwater and demonstrated that long-term poultry litter application at typical rates would likely result in concentrations of phosphorus in the surface soil that would lead to excessive transport of this nutrient during storm events. With support from the National Pork

Board, a field study combined with wind tunnel experiments were used to determine the optimum placement of tree windbreaks near animal confinement buildings based on air-flow patterns around the structures. Proper placement of trees upwind from the facilities reduces the wind speed and therefore transport of dust and odor while trees downwind served as effective filters of odor constituents.

With his return to Ames also came a redirection into climate change research that led to a series of studies involving agroforestry, afforestation, and reforestation effects on soil properties. The focus of this research was on the dynamics of soil organic matter (SOM) and especially the ability of tree plantings to protect or restore SOM. Soil organic matter is a key property as it has a strong influence on many physical, chemical, and biological processes in soil especially soil water retention and water and energy flow through soil layers. Data from field sites in Nebraska and Iowa using stable carbon isotope techniques indicated that significant amounts of SOM in the surface layer beneath trees had accumulated from tree sources over a period of less than 50 years. The amount and rate of SOM change following tree planting was greater than expected and led to additional studies to discover the factors controlling SOM dynamics in these settings.



Image: © Aleksandr Petin, Belgorod State University



Sauer in wheat field near tree windbreak at Streletskaya Steppe, Russia

An important element of subsequent studies on this topic was collaboration with Yury Chendev of Belgorod State University in Russia who was a visiting Fulbright Scholar at Iowa State University in 2007-2008. Chendev was interested in measuring the evolution of soil properties with changing land use. A collaborative grant from the Civilian Research and Development Foundation enabled Sauer and Chendev to combine their interests to study the effects of tree windbreaks on soil properties in the Russian steppes and U.S. Great Plains. Both of these regions have a rich history of tree windbreak planting to improve the local microclimate for crop production and to control wind erosion. A field expedition in Russia and two expeditions in the U.S. allowed the researchers to document changes in

soil properties, including SOM, to a 1.5 m depth across a range of climatic conditions. Although tree species and soil types varied between study sites, a strong relationship was discovered between a climate index and the change in thickness of the SOM-rich surface soil layer. Most tree plantings still resulted in increased SOM in the soil profile but the increase was lower at warmer and drier locations.

Currently, Sauer is continuing his study of the evolution of soil properties following tree planting. With funding from the North Central Region Sustainable Agriculture Research and Education program he is expanding the suite of soil properties being measured to include hydraulic properties and moisture retention. He is interested to discover whether the

observed changes in SOM also lead to a soil moisture regime that provides greater protection from drought for both the trees and adjacent crops. This study also includes measurements of tree biomass to assess the bioenergy production potential of trees grown on marginal agricultural lands. Future efforts now in planning stages include measurement of greenhouse gas production and the microclimate modification potential of tree windbreaks in semiarid regions.



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# Regulation of agricultural waste in Scotland

Scottish Environment Protection Agency (SEPA) outlines the importance of effective waste management...

Conserving and protecting the world's natural resources is vital, and effective waste management is an important step in reducing the amount of waste we produce.

The Scottish Government has a vision for the management of waste, where it is seen as a resource: waste is minimised, valuable resources are not disposed of in landfills and most waste is sorted, leaving only limited amounts to be treated. As more waste is prevented, less waste is sent to landfill, and more resources are reused, recycled and recovered.

**“However, the introduction of the Waste (Scotland) Regulations 2005 means farmers now have a duty of care, like any other business, to dispose of waste safely with no harm to the environment.”**

This vision has meant that Scotland places the responsibility of managing waste on its creators. Business and industry all have a ‘duty of care’ to ensure that their waste is dealt with in line with the Scottish vision.

This duty of care extends to the agricultural industry, which is expected to manage its waste in the same way as the rest of Scottish business and industry.

The organisation charged with the monitoring of Scottish waste management legislation is the Scottish Environment Protection Agency (SEPA).

## Managing agricultural waste

Until relatively recently, agricultural waste was excluded from the regulations that controlled the management of household, commercial and industrial waste in Scotland.

However, the introduction of the Waste (Scotland) Regulations 2005 <sup>1</sup> means farmers now have a duty of care, like any other business, to dispose of waste safely with no harm to the environment.

Some of the agricultural waste that is included in the legislation is:

- packaging;
- silage plastics;
- redundant machinery;
- tyres;
- netwrap;
- oils;
- batteries;
- old fencing;
- scrap metal;
- building waste.



Waste such as packaging, silage plastics, redundant machinery, tyres, oils and batteries can pose significant risks to the environment and human health, if not managed appropriately.

The waste 'duty of care' requires farmers and agricultural businesses to ensure that:

- all waste is stored and disposed of responsibly;
- waste is only handled or dealt with by individuals or businesses that are authorised to deal with it;
- a record is kept of all waste received or transferred through a system of signed 'waste transfer notes'.

To help farmers and the wider agricultural industry understand and meet these requirements, SEPA has been working closely with partners, such as agricultural quality schemes, the National Farmers Union Scotland and the Scottish Government. The partners help inform the agricultural industry on all their obligations for protection of the environment, and not just their responsibilities for waste management.

**Support for the industry**

The introduction of the 2005 waste regulations saw a need for a change in the way that farmers deal with waste. The changes included:

Burning of waste on farms – farmers in Scotland can only burn small amounts of plant tissue on their farm in the open by registering to do so. Controlled burning of other wastes using a drum incinerator is only allowed in certain circumstances, and the farmer must also register an exemption with SEPA first. Exemptions are considered where the farmer demonstrates that the activity will not pollute the environment or harm human health. This includes the burning of branch waste and brush.

Reuse, recycling and storage of farm wastes – brick, stones and plastics now all require to be reused or stored under registered exemptions or removed by a professional waste company. SEPA has provided the option to register for exemptions to the waste regulations online.

Tracking waste—the 'duty of care' associated with the waste regulations means that any waste not dealt with on the farm under waste exemptions must only be handled or dealt with by individuals or businesses that are authorised to deal with it. This means having documentation, known as waste transfer notes, between the farmer and the company dealing with the disposal of the waste. In addition, waste must only be passed to registered waste carriers.

**Special waste**

In Scotland, since July 2004<sup>2</sup>, waste from agricultural premises that has hazardous properties and is listed as hazardous in the European Waste Catalogue<sup>3</sup> has been controlled by the Special Waste Regulations. This definition includes agricultural waste, formerly not included under the Special Waste Regulations. Special waste that might be discarded in agricultural businesses includes:

- asbestos;
- waste oil and fuel oils such as diesel;
- certain veterinary medicines or infectious veterinary wastes;
- pesticides and herbicides;
- cleaning chemicals such as disinfectants and bleach;
- sheep dip.

Special waste has to be handled differently from other controlled wastes to ensure no damage to the environment. ■

<sup>1</sup> the Waste (Scotland) Regulations 2005  
<http://www.legislation.gov.uk/sdsi/2012/9780111016657/contents>  
<sup>2</sup> Special waste regulation, July 2004 amendments:  
<http://www.legislation.gov.uk/ssi/2004/112/contents/made>  
<sup>3</sup> European Waste Catalogue:  
[http://www.sepa.org.uk/media/139107/euro\\_waste\\_catalogue.pdf](http://www.sepa.org.uk/media/139107/euro_waste_catalogue.pdf)



# A Global Perspective on Agriculture Research

The USDA National Soil Dynamics Laboratory (NSDL) has a long history of research on developing sustainable agriculture. Originally founded as the Farm Tillage Machinery Laboratory in 1933 on the Auburn University campus in Auburn, Alabama, USA, it was initially charged with researching tillage, associated traction practices, and machines used in cotton production. The lab was instrumental in the development of engineering principles for modern agricultural equipment design. Currently, NSDL's mission is to develop tools, practices, and products to better manage soil for environmentally sustainable and economically profitable agricultural production systems. While the research is centered around Southeastern USA production systems, implications of findings clearly have a more global prospective, especially in the context of efforts to understand how agriculture influences global change.

The Laboratory solves agricultural problems in three major areas:

- Conservation systems;
- Organic waste management; and
- Global change.

Specific objectives include developing conservation systems that reduce drought risk and sequester soil carbon, developing environmentally sound waste management systems, and determining the effects of atmospheric CO<sub>2</sub> levels on above- and below-ground processes that affect crop



production, soil carbon storage, and trace gas emissions.

Currently, there are many uncertainties concerning agriculture's role in global environmental change including the effects of rising atmospheric CO<sub>2</sub> concentration. Agricultural practices have the potential to increase soil C storage which can positively influence soil quality and help mitigate this rise in atmospheric CO<sub>2</sub>. Research at NSDL is examining the effects of atmospheric CO<sub>2</sub> on both biomass production and soil C sequestration.

The concentrations of trace gases (nitrous oxide and methane) in the atmosphere are also increasing with agriculture being a primary contributor. The NSDL has a multi-disciplinary research team investigating ways that agriculture can help reduce greenhouse gas (GHG) loss through improved practices and fertiliser use in cropping and horticulture systems. This work is evaluating new, innovative application techniques that reduce

GHG emissions, including determining fertiliser N use efficiency and fate of fertiliser N in these systems as well as changes in C and N cycling processes. This work showed that soil C storage is sensitive to soil N dynamics and that the decomposition of plant material grown under elevated CO<sub>2</sub> depends on crop species and indigenous soil properties. It has also led to research on the use of microbial inoculations to reduce nitrous oxide emissions.

Research at NSDL develops conservation systems that improve soil quality, conserve natural resources, and increase production efficiency by considering input costs and profitability. A major focus is to evaluate the use of alternative fertiliser sources, such as poultry litter (a poultry manure and bedding material mix), compared to commercial fertiliser in tillage systems designed to enhance soil organic matter accumulation, crop productivity, and grower profitability. Application of poultry litter to soil can improve soil

conditions and provide nutrients needed for plant production. This seems to be a viable option for South-eastern USA producers due to rising costs of inorganic fertilisers and the fact that the growing poultry industry generates large amounts of manure. Field and laboratory studies are being conducted to develop improved methods to utilise waste products for soil and crop benefits while minimising environmental degradation since improper manure application can increase hypoxia, eutrophication of

surface waters, human health problems, and GHG emissions. Furthermore, using poultry litter in conservation agricultural systems could sequester atmospheric C in soil. Research has shown that the use of poultry litter in long term research plots resulted in increased soil C levels and thus higher atmospheric C sequestration. However, best management practices must be developed for poultry litter application that maximises nutrient uptake and minimises GHG loss.

Tillage and fertilisation practices used in row crop production can alter GHG emissions from soil. A new prototype implement for applying poultry litter in subsurface bands in the soil was used in studies to determine the impact of management practices and fertiliser source and placement methods on GHG emissions. As part of this effort, a new method was developed for calculating Effective Gas Flux from soil following band application of manure or fertiliser. Banding of fertiliser resulted in the greatest concentration of gaseous loss compared to surface application and conventional tillage resulted in a higher concentration of CO<sub>2</sub> and N<sub>2</sub>O loss. These results suggest that poultry litter can be used to sequester soil C, but application by banding has the potential to increase GHG emissions.



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## Biodiesel's benefits in Europe

**Raffaello Garofalo, Secretary General of the European Biodiesel Board details how biodiesel is the most viable solution to reduce emissions from transport...**

**B**iofuels are the only sustainable and immediately commercially available alternative to fossil fuels. Liquid biofuels such as biodiesel can be used in all diesel vehicles at an inclusion rate of 10% or higher. Biodiesel is currently the most viable European solution to reduce emissions from transport.

Conventional biodiesel can largely save more than 50% of greenhouse gas (GHG) emissions. Biodiesel from agricultural biomass improves its GHG emissions saving profile thanks to a number of developments concerning the production process and the agricultural land management. Both policymakers and public opinion need to realise that crop diversification is highly beneficial for the soil and for limiting pest and disease risks.

At the same time, recent figures confirm a rise in advanced biodiesel, in comparison to biofuels made from other feed stocks. Advanced biodiesel made from

waste oils, such as used cooking oil (UCOME), residues of animal fats (TME) and sewage oils can even entail GHG emissions savings up to 95% when compared to conventional fossil diesel. According to a recent study performed by the Institute for Energy and Environmental Research (IFEU), in Heidelberg, biodiesel made from waste and residues can save at least 85% of GHG emissions compared to fossil diesel fuels.

Europe has the infrastructure, the producers and the possibility to fight climate change and to achieve energy independence. Biodiesel has a crucial role to play improving the future transport energy supply of Europe. The role of biodiesel is potentially very important; however, the lack of a stable legislative frame is hampering its further development. Reliable targets and support schemes are needed in order to support the will of investors to continue developing this sector.



Specific targets for 2030 would restore investors' confidence and support the deployment of a sustainable and advanced alternative to diesel. Biofuels are the only sector abiding by strict sustainability criteria. Should the current framework be abandoned, it would simply erase the efforts made by the industry so far.

Biodiesel in Europe represents the main alternative to fossil fuels in transport. Since the publication of European directives, the biodiesel industry has been extremely successful in ensuring that the 10% target of use of renewable energy in transportation would be met. EBB also promotes the use of biodiesel in heavy duty vehicles as well as aviation not only on a European level, but also on a global scale.

Transport emissions are rapidly rising – now accounting for more than 25% of EU total greenhouse gas emissions – they are projected to become the largest source of CO<sub>2</sub> emissions by 2020. Aviation is the fastest growing transport modality worldwide with an estimated growth of 4.5% annually up to 2050.

Considering that the aviation sector is responsible for at least 2% of the global manmade greenhouse gas emissions, the so-called “bio-jet” will have an increasing role in climate change mitigation.

Aviation biofuel can play a safe and effective role in the world's transport system. Lifecycle analysis confirmed that sustainably produced biofuels reduce carbon emission by 50 to 80%, compared to petroleum, and should play a key role in supporting aviation's growth while meeting environmental goals.

EBB members offer EU – made products, reducing greenhouse gases up to 85% compared to diesel. Europe can make the choice of promoting both European growth and employment by playing a leading role in tackling climate change adverse effects.

The biodiesel industry should push forward the discussion about the benefits of biodiesel in the post-2020 climate and energy framework. Despite the fact that the biodiesel industry lacks confidence in its future and in EU institutions, it keeps making investments in innovation and sustainability in line with EU policies' developments. A robust biodiesel industry creates high-skilled jobs, while helping to reduce EU dependence on foreign oil.



Biodiesel creates and maintains green jobs in a wide range of sectors. In addition to environmental concerns, Europe faces an energy security gap, triggered by a high dependence on fossil fuels imports and particularly diesel from third countries. Biofuels account for nearly 220,000 jobs in Europe, proudly supporting Europe's green economy. In addition to reducing Europe's imports of fossil fuels and animal feed, biodiesel's main by-product – glycerine – replaces harmful chemicals in food, pharmaceutical or cosmetics industries.

Being the only viable possibility to reduce EU's future GHG emissions and therefore lay the fundamentals for sustainable road and aviation transport, the EU biodiesel industry wishes to become part of a real solution to the problems the EU transport sector faces today. ■

.....  
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# Innovative technologies Vs climate change

**In a speech given at a roundtable debate on the environmental goods agreement in Brussels on June 3rd 2015, Commissioner Miguel Arias Cañete details the role of innovative, environmentally-friendly technologies in EU climate policy...**

In 6 months' time we hope to conclude a strong and ambitious global climate agreement in Paris that will kick start the transition to low-carbon development worldwide.

I want to talk about how innovative environmental technologies can help us achieve both our domestic and global climate goals. Green technologies are already part of our daily lives. Some are invisible to the eye, concealed beneath the bonnet of our car or inside our fridges and dishwashers, quietly saving us energy – and money. Do you know just how much money energy efficient products have saved us in the last 5 years alone? Let me tell you: €100bn. Perhaps more importantly, we estimate that they have avoided the equivalent of around 360 million tonnes of CO<sub>2</sub> emissions over this period.

Other more obvious symbols of sustainability, like solar panels and wind turbines, are very much part of our city, country and coastal landscapes. These energy efficiency and renewable technologies are not only contributing to our 2020 climate and energy goals, but also to Europe's competitiveness and long-term sustainable development. The green economy is proving to be one of the most promising areas for job creation in the EU, even seeing a 20% increase during the recession years.

Today, the environmental goods and services sector provides jobs for more than 4 million people in Europe.

Our 2030 climate and energy targets could create a further 700,000 jobs. And if we raise our ambition further on renewable and energy efficiency, this could reach 1.2 million.

However, while we have been leading in clean technologies including renewables, others are catching up – and, in some cases, even overtaking us. So, I'd like to focus on 3 specific questions:

- Where we are now in terms of innovative and environmentally friendly technology in the EU?;
- How do we plan to maintain our leadership role? And;
- How can our trade policies help us?

## **Where we are now?**

Where do we stand today? In short, we are doing well, but we need to keep up with the competition.

Europe is home to some of the best cutting edge technologies in the world. I got to see this first-hand just a few weeks ago, when I visited the HelWin Alpha converter platform in the North Sea. It connects the offshore wind farm to the onshore grid – bringing energy directly to customer's homes. We also recently saw the launch of the German Verbiostraw project, which turns straw into biogas. Who'd have thought 5 bales of straw could produce enough energy to run a car for a year? And, the best part is that it doesn't require the use of farmland. The biogas is produced from 100% agricultural residue. The project is co-financed through a special fund – called NER 300 – raised through the EU Emissions Trading System for large-scale demonstration of low-carbon energy technologies. This is exactly the kind of innovative technology the programme is aimed at. It is creating agricultural and industrial jobs in the region and making use of a raw material source that has remained unused up to now.



Renewables are an essential part of the EU's Energy Union strategy for a sustainable energy and climate-resilient future. They will play a key role for all economies in the transition towards low-carbon development. They will contribute to decarbonising our economy, making our power system much more flexible, improving our energy security and lowering our energy bills. Over the last 2 decades we have seen renewables move from the fringe into the mainstream in Europe. We have 3 times more renewable power per capita in the EU than anywhere else in the rest of the world.

Today the sector has a turnover of around €130bn and employs more than 1 million people.

Our policies have brought down costs and made technologies more accessible and widespread. But we are no longer the only ones seriously investing in renewables.

I am not just talking about China (which invested \$83 bn in renewable energy last year), and the US

(which invested over \$38 bn). Brazil, South Africa and India were also in the top 10 investors last year. At the same time, renewable energy investment in the EU increased by less than 1%. Of course, competition is good. It helps bring down costs – the price of solar PV modules fell by 80% in the space of just 4 years.

We mustn't forget that a lot of technology that is being installed around the world comes from Europe.

- Every year we export €35bn worth of renewable equipment;
- Some 40% of the world's wind turbines are built by European companies;
- Our companies lead the world in the number of patents for renewable technologies, with 40% coming from Europe.

But, as I said, we need to keep up with our competitors – and to do that we need to keep innovating. There is work to do to become the world





Miguel Arias Cañete, Commissioner for Energy and Climate Change

number one in renewables – one of the priorities of the Juncker Commission.

This brings me onto my second point – what we are doing to get there?

**What are we doing?**

If we are to succeed in becoming the world number one, we will need to be ready with the next generation of renewable technologies, and energy storage systems. We will need new grid management technologies that are fit for renewables and can transport power more effectively from one place to another. This will give consumers greater control over their energy use. Also, we will need intelligent transport solutions to meet our 2020 target of having 10% of the transport fuel of every EU country come from renewable sources such as biofuels. So we need to ensure that Europe remains a destination for world-class researchers and that we provide the right support to get their innovations to market.

Horizon 2020 is the biggest EU Research and Innovation programme ever, with some €80 billion available between 2014 and 2020. At least 35% of this is ring fenced for climate-related research. We need to get the most from every euro invested. This means combining EU and Member States programmes around common goals. And, ensuring effective links between research and industry that will bring new technologies to the EU market. I will shortly be proposing a renewed Integrated Strategic Energy Technology Plan as well as a strategic transport research and innovation programme to sharpen the focus of our research and innovation efforts.

Our aim is to leverage as much private investment as possible. This is the thinking behind both the new €315 billion European Fund for Strategic Investments and the NER 300 low-carbon technology demonstration programme that I mentioned earlier. So far, 38 renewable projects and Europe’s first large-scale carbon capture and storage project have been

awarded NER300 funding amounting to €2.1 billion. This is expected to leverage a further €2.7 billion of private finance. These projects will bring huge climate benefits. Together with the CO<sub>2</sub> stored by the CCS project, the impact will be the equivalent of taking more than 3 million cars off the EU roads. The programme will be renewed under the 2030 climate and energy framework and extended to low-carbon innovation in the industrial sector.

On top of this, our policies, such as CO<sub>2</sub> standards for cars and Eco-design, as well as eco and energy labelling schemes are also driving technological innovation. Just one example: thanks to some of the toughest standards in the world, a new car today is 22% more efficient than in 2007. And by 2021 it should be 40% more efficient. What's more, the EU is already the world's second biggest market for electric cars – with 30% of global sales. We have a lot to be proud of in Europe and a lot to look forward to. The global green technology market is expected to increase to 4.4 trillion euros over the next 10 years. We can expect to have a good share of this market.

This brings me to my third and final question. How can our trade policies support innovative environmentally friendly technologies and help us achieve our climate goals?

### **How trade policies can help our goals.**

Climate technologies have an essential role to play in meeting the globally agreed below 2 degrees objective and avoiding dangerous climate change. As well as helping to reduce emissions and adapt to the adverse effects of climate change, these technologies will also contribute to job creation and sustainable economic growth in Europe and across the globe. Trade is an excellent tool to promote green technologies. In Europe, we have the technologies that are needed, so we should share them. For instance, the EU support the UN's Climate Technology Centre and Network which helps exchange of information about best practices to increase market uptake of climate technologies in emerging economies and developing countries. The network provides a good opportunity to promote European technological solutions worldwide.

The EU has a number of bilateral agreements with its free trading partners that promote climate goals and

the use of innovative energy technologies. These include Canada, Singapore and South Korea, with negotiations currently ongoing with the US. Globally, Europe needs to keep the world's leadership in green innovation as major exporter of clean technologies. For that end, we are also working with our trade partners to speed up the dissemination and uptake of climate-friendly technologies and create a level-playing field.

We hope to conclude a significant international agreement on the liberalisation of trade in environmental goods and services before the end of the year.

One conclusion we can already come to is that it makes good business and climate sense to make it easier to trade green technologies internationally. This Commission is working very hard for the timely conclusion of the tariff negotiations and a political agreement that will contribute to the Paris climate deal.

To be successful, Europe must play to its strengths. The world's most competitive economies are the most innovative and energy-efficient. For Europe, quality and innovation are the way to go.

This way, we can prove to the world that green growth is not just a utopian vision. It is the smart answer to many of the challenges the world is facing: more intelligent ways of producing, less pollution, energy efficient homes, lower energy bills and cleaner sources of energy. ■

This is a speech that was used with permission from the Commissioner's office – [http://europa.eu/rapid/press-release\\_SPEECH-15-5111\\_en.htm](http://europa.eu/rapid/press-release_SPEECH-15-5111_en.htm) .

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### **Miguel Arias Cañete**

Commissioner for Energy and Climate Change  
European Commission

[http://ec.europa.eu/commission/2014-2019/arias-cañete\\_en](http://ec.europa.eu/commission/2014-2019/arias-cañete_en)

# Micro – Supercapacitors from Nanowire Electrodes. The NEST Project

Nanomaterials are called to play key roles in the solution of a myriad technological challenges directly related to essential societal needs, especially those related to bio-medicine to information and communication technologies (ICTs) and energy and the environment.

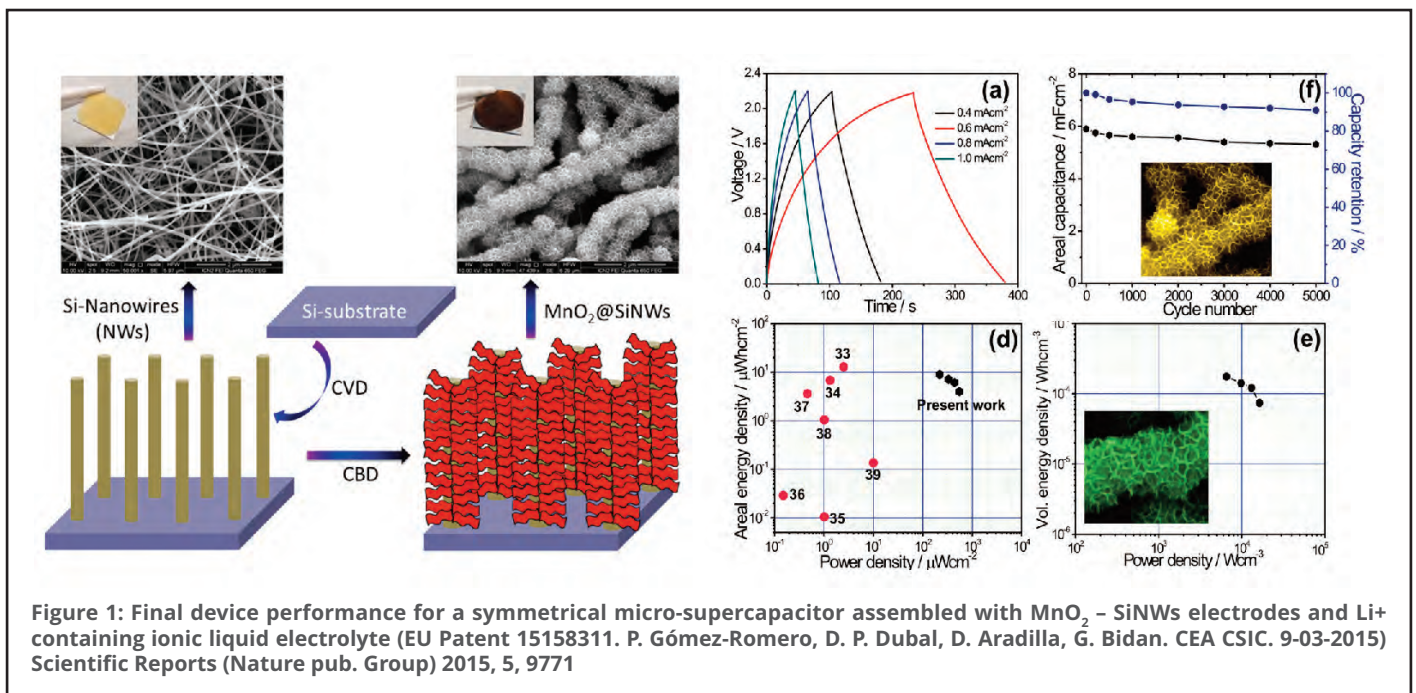
Half way between ICTs and Energy, between microelectronics and energy storage, the development of micro-supercapacitors stands as a doubly strategic R+D topic. ‘small size’ and ‘high performance’ merged into a single energy storage unit constitute a winning combination for industry. Devices able to stand harsh manufacturing conditions (reflow soldering conditions, 280°C for 40 s) are sought for in the microelectronics industry.

Project NEST (Nanowires for Energy Storage, FP7-ENERGY-2012ID 309143-2)

has developed several micro-supercapacitors based on silicon nanowires electrodes (SiNWs) coated with a variety of other materials and integrated in a device with Ionic Liquid (IL) electrolytes. They are micro, they are high performers, stand reflow conditions and could go beyond microelectronics. (Nano Energy, 2014, 9, 273-281).

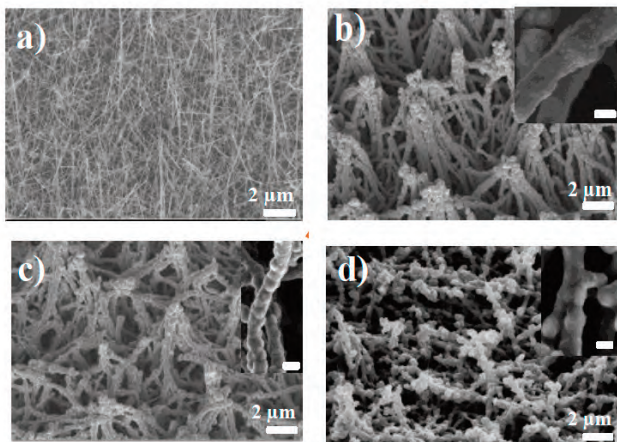
The consortium (see below) has explored several types of nanowire electrodes, namely, i) SiNWs, ii) Diamond-coated SiNWs, iii) SiNWs coated with conducting polymers and iv) SiNWs coated with transition metal oxides such as MnO<sub>2</sub>. All of those electrodes led to excellent results. Figure 1 shows a summary of the manufacturing and record electrochemical performance of the device based on MnO<sub>2</sub> coated SiNWs electrodes which has been patented.

Conducting polymers such as PEDOT, PPy and PANi were also used as pseudo-capacitive materials in order to improve specific capacitance, power and energy densities. Uniform, homogeneous and adherent organic coatings were deposited onto SiNWs using electrochemical methods (Figure 2, left). This led to enhanced capacitances 3 orders of magnitude larger than for SiNWs (12 mF cm<sup>-2</sup>) with outstanding electrochemical stability. This approach was thus applied to other micro-supercapacitor electrodes based on diamond-coated SiNWs (Figure 2, right), whose results are still under study. Presently, in its final stretch, our NEST project is advancing towards final prototypes, under the technical lead of Elzbieta Frackowiak (PUT) and the coordination of Gerard Bidan (CEA).





### ECPs-coated SiNWs



### ECP-coated Diamond/SiNWs

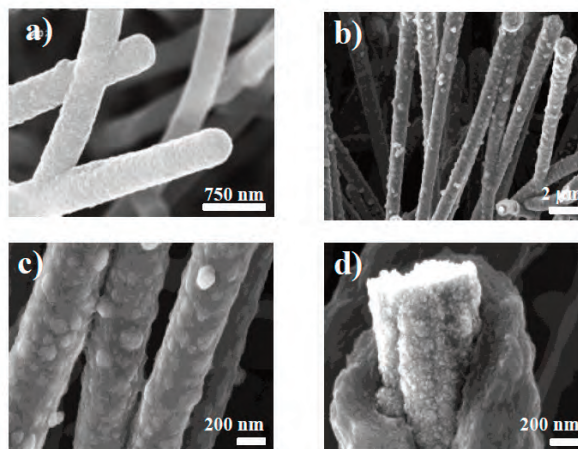


Figure 2: (Left) SEM images of a) SiNWs grown by CVD on silicon substrates. b) PEDOT-coated SiNWs, c) PPy coated SiNWs and d) PANi coated SiNWs. Insets shows magnified SEM images of ECPs-coated SiNWs. Scale bar: 100 nm (RSC Advances. 2014, 4(50), 26462.) (Right) SEM images of a) Diamond-coated SiNWs. b) and c) Low and high magnification SEM images of PPy-coated Diamond/SiNWs d) Cross-section view of PPy-coated Diamond/SiNWs




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# BFS blue Enterprises technology. The solution “Converting CO<sub>2</sub>”

Because of the human cycles of production and consumption, our food, energy and environment are intricately linked. According to the projected growth of the world population (9.1 billion people by 2050) and consistent global development, it is increasingly difficult to satisfy our world with sufficient food and energy. BFS blue technology presents a realistic proposal to address those 3 pressing issues with a feasible business model that can be applied starting today.

## Healthy planet

Meeting the food and energy demand has a direct impact on the environment, especially through the emission of greenhouse gases, particularly atmospheric CO<sub>2</sub>, which is currently at an unprecedentedly high concentration of nearly 400 ppm (September 2013).

According to the global scientific and environmental community (UN, NASA, IPCC, EPA, etc), if current emission rates continue, we will soon reach a point of no return with irreparable damage resulting in a lack of potable water, changes in food production conditions and increased mortality rates from natural disasters such as floods, storms, and droughts. Climate change is not merely an environmental issue, it has deep economic and social implications. Though many of these natural phenomena have already been documented, energy from fossil fuels has allowed for most of society's modern comforts, making it difficult to implement changes in behaviour.

According to the International Energy Agency, \$1trillion is roughly the

amount of investment needed worldwide each year for the next 36 years to stave off the worst effects of global warming and keep the Earth habitable.

BFS technology presents a unique technology (3rd Cycle of CO<sub>2</sub>) to accelerate CO<sub>2</sub> reduction based on Carbon Capture Conversion and Neutralization (C<sup>3</sup>N). C<sup>3</sup>N is an alternative, or in some cases complementary, to the CCS technology. In BFS technology CO<sub>2</sub> is captured, but instead of being buried, this is used to feed marine phytoplankton (the building blocks of life) that capture the CO<sub>2</sub> via photosynthesis and transform it into valuable bioproducts.

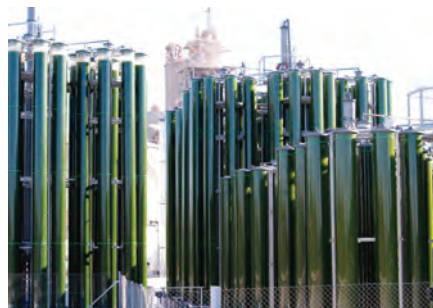


Figure 1. BFS' tested and certified (SGS) Industrial plant that absorbs CO<sub>2</sub> emitted from an adjacent cement factory.

Plant Tour:  
<https://www.youtube.com/watch?v=-v33kNULivs>

## A clean renewable source of energy

Fossil fuels are non-renewable, and it is estimated that by 2025 the demand will be 120 million barrels a day. With this projection we will see the oil reserves gradually decrease, and in the not too distant future, we will have supply problems. The increase in prices will affect the global economy, and if we add the environmental

damage involving combustion, the search for clean renewable energy as an energy source is clear to see.

The current green energy solutions don't have the capacity of sequestering or neutralizing CO<sub>2</sub>. Additionally, they do not account for more than 10% of our global energy demand. As they will not significantly reduce the global level of fossil emissions, the risk of surpassing the 400 ppm of CO<sub>2</sub> accumulation in the atmosphere will continue.

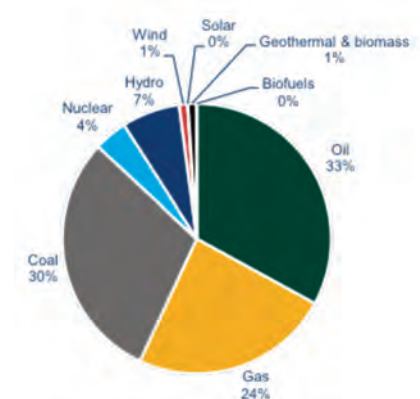


Figure 2. Origin of the energy produced

The growth of agricultural products to produce bioethanol and biodiesel have two big problems:

- Huge extensions of arable land are necessary. This technology competes with food and water, and to substitute the crude oil with this technology is not feasible (the land and water required is bigger than the real availability).
- These systems have the ability to recycle CO<sub>2</sub> but not to permanently sequester or neutralize it.

In contrast, BFS blue technology has the ability to produce a clean renewable

source of energy. To produce 1 BBL of crude oil, BFS technology permanently neutralizes 1 ton of CO<sub>2</sub>. Given the average combustion emissions of one barrel of oil being 390kg of CO<sub>2</sub>, BFS completely offsets 2.5 barrels for every barrel of blue petroleum, ensuring net emissions of 0 from the combustion of the 3.5 total barrels.



In this way, we can maintain our current energy model without changing our current lifestyle or infrastructure, even after the end of fossil energy.

In essence, 3.7 Million of BBL per day of BFS blue oil will neutralize the CO<sub>2</sub> emissions of the EU from the crude oil (EU crude oil consumption is 12.7 MMBL/day).

To reach this production of 3.7 MMBL per day of BFS blue Petroleum would require a much lower investment than \$1Tn/year (According to the International Energy Agency, \$1Tn is the amount of investment needed worldwide each year for the next 36 years to stave off the worst effects of global warming and keep the Earth habitable). In fact, the investment in total,

from 2015 to 2050 would be €1.4Tn; €38.3Bn/year, around 0.4% of the GDP every year up to 2050; from this point on, no additional investment would be needed anymore and the plants would generate a revenue of €544Bn per year.

**Nutrition for a growing world**

According to the projected growth of the world population (more than 9.1 billion people in 2050) it is estimated that food production will be double by 2050. This implies that nutritional problems in the world will worsen.

An increased demand for food, implies a greater demand for water and arable land. All in a time when the natural resource base for agriculture is degrading, large areas of land is being used for purposes other than agricultural production (biofuels), and climate change threatens to further reduce the amount of land suitable for cultivation.

BFS technology can be a source of proteins, energy and micronutrients; malnutrition is characterised by an inadequate intake of those proteins, micronutrients and calories. Figure 4 shows an example of a product with a really good ratio of proteins (high quality according to the aminoacid score).

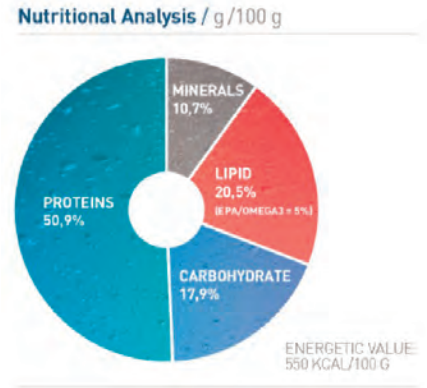


Figure 4. Nutritional Analysis and Energetic value

**Conclusions - Reflexion**

The BFS business model gives the opportunity to produce high value products, blue Petroleum (fully competitive with fossil oil) or a combination of both depending on the market demand (see below example for 10 ha plant. The technology is also feasible in small plants), but always reducing CO<sub>2</sub> from Industrial emissions:

	Case 1	Case 2	Case 3	Case 4	Case 5
H. Value P.	20%	40%	60%	80%	100%
Petroleum	80%	60%	40%	20%	0%
Payback period	6	4	4	3	3
EBITDA (M€)	19	29	32	40	45

Table 1. Different business oportunities for different strategies based on the % of crude oil to produce in a plant

Authors: Eloy Chapuli and Bernard A. J. Stroôazzo-Mougín

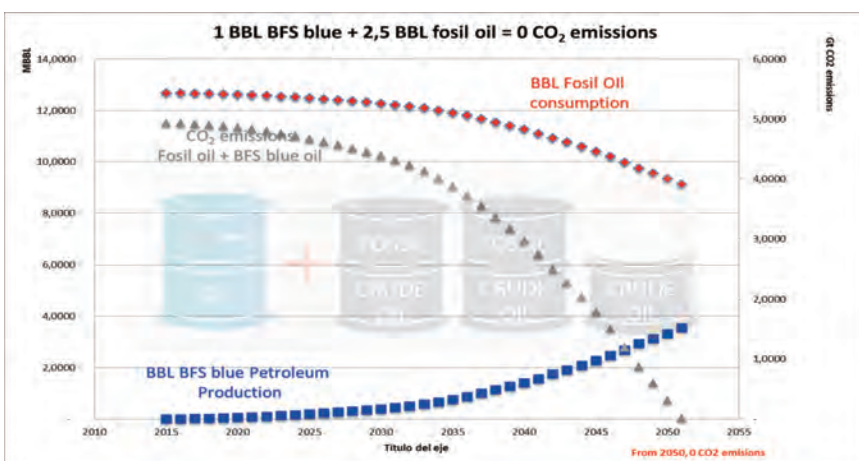


Figure 3. BFS crude oil production to get 0 CO<sub>2</sub> emissions



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# E3-Modelling research finds first-mover advantage for the European Union as frontrunner in climate action

In Paris, delegates from the 196 UN parties will meet in December 2015 to negotiate a global climate agreement. Countries accounting for roughly a quarter of global emissions met the March deadline to provide targets for curbing Greenhouse Gas Emissions (GHG) while at the same time some of the leading economies have missed the deadline, including Canada, Australia and notably China, lowering expectations for a universal climate agreement by December. However China signed an agreement with the USA on coordinating climate mitigation strategy. In contrast, the EU submitted ambitious emission reduction goals for 2030 well within a decarbonisation pathway.

The stakes are high, as the world is at present on a path to possible above 4°C global warming by 2100. Hitherto preventive action – including efforts to build a carbon market or to subsidise renewables – has been confined to the developed world and is largely insufficient. The European Union is clearly a frontrunner but many question the macroeconomic and industrial adverse effects of unilateral action.

E3-Modelling, based on modelling services to clients such as European Commission, Governments and business stakeholders, published research showing that in contrast with skepticism the EU's economic and industrial benefits can be effectively reaped from pioneering climate action.

## Abatement of GHG emissions & carbon leakage

As stated on numerous occasions by the President of E3-Modelling Prof. P. Capros, “the basis for the deep decarbonisation of the global economy rests in efficient and equitable effort sharing. Lack of consensus on an international agreement for reducing Greenhouse Gas Emissions eventually leads to asymmetric climate policies which not only increase the cost of reducing emissions, but also dent the effectiveness of climate policy, through carbon leakage<sup>1</sup>.” In particular, studies performed by E3-Modelling staff conclude that an international concerted action to reduce GHG emissions at safe levels by 2050, would require 1.5% of global GDP. In the case where only OECD countries embark in GHG mitigation, the carbon leakage rate is estimated to be close to 25%. If China participates to the abatement effort of OECD countries then carbon leakage rate can be reduced to 3%, underlying the importance of allying developed and emerging economies in pursuing GHG emission reduction policies.

## EU as a first mover

Europe has long been a leader in pursuing a global climate deal, and has early outlined – with support from our economic and energy modelling research (PRIMES and GEM-E3 models) – a robust set of targets for drastically curbing the region's emissions by 2030. Indeed, the

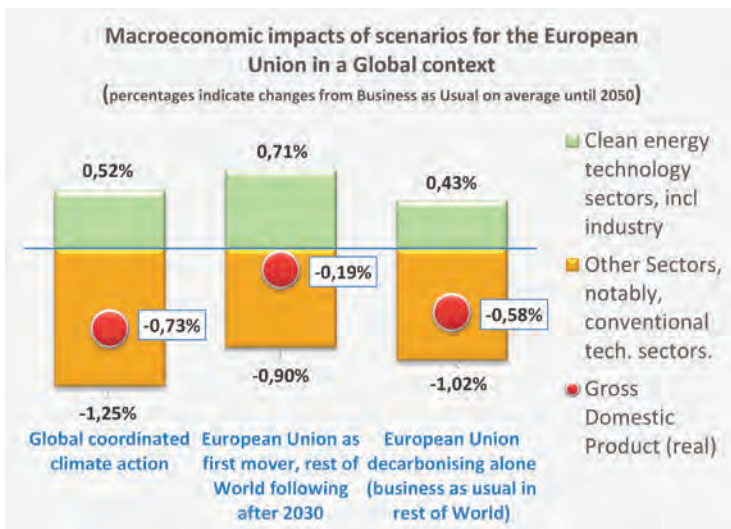
Conference of Parties (COP21) submission of EU countries' targets has formally put forward a binding, economy-wide target of cutting the region's GHG emissions by at least 40% below 1990 levels by 2030. The EU COP21 submission has been largely based on modelling work undertaken by E3-Modelling staff, with the use of two highly sophisticated and well established in the European context models: the PRIMES energy market model and the GEM-E3 computable General Equilibrium Model.

The EU can be considered as a first mover in global GHG mitigation. The net impact on EU economy is uncertain as early movers incur costs, but may also benefit from gaining a cost comparative advantage on producing low carbon technologies; the costs depend on the loss in competitiveness that leads to a decrease of their shares in global markets. A recent study performed by E3-Modelling shows that the net potential gain to EU from undertaking a first mover action can be up to 0.54% of its GDP.

## Modelling tools operated by E3-Modelling

The main energy-environmental-economic modelling work of E3-Modelling rests upon a series of highly sophisticated in-house models:

PRIMES, a workhorse energy market model developed and maintained for



all individual European countries and the internal electricity and gas markets is a sophisticated market-oriented engineering-economic model with modular structure by sector, with high sectorial resolution including for transport sector. The model has been extensively used in assessing the 20-20-20 energy and climate policy package, the EU's decarbonisation Roadmaps and the recent climate and energy policies for 2030.

In contrast with optimisation models, PRIMES is an agent and market oriented model aiming at representing the reality of actors' behaviors and their interplay in markets, for energy commodities and for the emission allowances (EU ETS). PRIMES is rich in engineering information and includes detailed representation of energy and transport infrastructure. Its sub-models cover power market operation in high resolution, investment and design, gas market strategic analysis, energy efficiency in houses and buildings, industrial energy use and cogeneration, district heating, biomass/waste sector and new technologies including bio-energy, renewables, smart grids, power-to-gas, power-to-liquid and synthetic fuels, as well as storage. The Energy Roadmap publications and the Eurelectric Power Choices scenarios, carried out using PRIMES illustrate the capabilities

of the model in simulating deep restructuring of energy systems in demand and supply sectors, the dynamics of investment and equipment turnover in all sectors, while projecting impacts on markets (incl. EU ETS), commodity prices and costs by agent.

The GEM-E3 general equilibrium macroeconomic model is a sophisticated multi-sector and multi-country model used for economic impact assessment and macroeconomic studies. GEM-E3 fully linked with the energy model PRIMES analyse closed-loop energy-economy-environment assessments. The world energy projections, with focus on hydrocarbon world markets, is handled by E3-Modelling using the PROMETHEUS stochastic world energy model. GEM-E3 has been the model of choice for numerous country-specific macro-economic studies for a variety of cases, including Romania, Switzerland, North Africa countries, and others.

### Modelling of Energy Economy and Environment

The researchers of E3-Modelling have provided scientific support and policy advice for the European Commission on many occasions including most recently the 2030 Energy and Climate Communication (January 2014), but have also provided support to the

German Ministry of Economic Affairs and Energy in the run-up to the agreement. They also regularly provide support to the Belgian Government, as well as to numerous non-governmental groups such as Eurelectric, AEGPL, EUROGAS. E3-Modelling participates in international cooperative projects such as the EMF and partners with renowned world institutes such as MIT, IIASA, PIK, FEEM, etc. in order to validate and enhance its modelling tools and regularly publishes its findings in international peer-reviewed journals.

At E3-Modelling, our aim is to communicate to policy makers and stakeholders around the world the quality output of leading scientific research in the areas of energy and the environment, helping them take informed decisions when formulating their optimal pathways towards a low carbon economy.

E3-Modelling is a spin-off company based on research activities performed at the National Technical University of Athens.

More information about E3-Modelling can be found at [www.e3modelling.gr](http://www.e3modelling.gr)

<sup>1</sup> The part of emissions reductions in abating countries that may be offset by an increase of the emissions in non-abating countries



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# Distributed renewable power

An interview with the two founding partners of Kliux Energies: Brothers Inaki Eguizabal (CEO) and Juan Jose Eguizabal (CTO)...

“After five years of intensive investment in R&D and commercial recognition we are now looking for partners to join us in this successful technology/industrial project, 100% Made in Spain, which has grown with internationalisation in its DNA since inception.”

**“We’re seeing a paradigm shift in the energy market worldwide.”**

We uncover this company, Kliux Energies, and their energy solutions in distributed power generation. Kliux is a Spanish company with proprietary and patented technology worldwide, capable of producing clean sustainable energy that provides substantial savings, increased efficiency, and environmental benefits. At this time they are in the throes of international expansion, for which they are looking to raise additional funding through strategic, industrial and financial investors who may want to bet on a successful project with a great global projection.

Kliux Energies is a company which specialises in providing solutions in distributed power generation.

**For those who do not know this technology, what is distributed energy and what are the benefits of its implementation?**

Power generation in general consists in transforming some kind of energy

(kinetic, thermal, light or chemical, etc.) into electrical energy. In the case of distributed power it consists of harnessing the renewable energy resource available locally in order to produce electricity at the point of use or near where consumption will take place. This process can be done on a much smaller scale, both in terms of size and the electricity supply needed. These are just some of its advantages: avoiding losses that occur in traditional energy transport; no fossil fuels are used and CO<sub>2</sub> emissions are reduced and (which is essential nowadays) having a great deal of impact in savings for any enterprise and improving quality of life for our society. In short: distributed renewable energy is energy efficient, environmentally respectful and with important economic savings.

**How do you put this solution into practice?**

Through the implementation of our Kliux Zebra, a small and simple to

install vertical axis wind turbine, which can easily be managed by end-users. Additionally, since the two most abundant sources of distributed energy around the world are solar and wind, we integrate complete solar and wind-solar hybrid systems for self power generation installations. This guarantees reliability of the system and optimises each available source of energy in order to satisfy demand at a lower Levelised Cost Of Energy (LCOE). These types of distributed energy solutions can be installed in different combinations in order to be implemented anywhere in the world both in grid connected and off-grid locations and applications. In fact our technology is an international reference point.

**What products are currently on the market?**

We own several proprietary patents and currently we market various products to provide distributed







energy solutions; a disruptive vertical axis wind turbine (Kliux Zebra) and Hybrid Solutions using the combination of this VAWT and Solar Photovoltaic panels, including energy storage through the use of batteries or any other innovative or disruptive solution that improves cost and efficiency. Our Kliux Zebra is safe for public transit areas, silent and easy to install in urban and residential environments. Both products can be installed for grid connected solutions or in isolated off-grid locations, with multiple renewable and sustainable applications for residential, industrial, municipal, agricultural or communications power needs.

**There is talk of the 3rd Industrial Revolution and of empowering individuals to be in control of their own energy generation...**

The 3rd Industrial Revolution will be the energy revolution and Kliux intends to become a direct participant in and contributor to this new concept of sustainable energy generation and

consumption. There is a global paradigm shift towards renewable energy, even though there is still much that remains to be done in this field; we are at the tip of the iceberg.

**“...we are now looking for partners to join us in this successful technology/industrial project, 100% Made in Spain, which has grown with internationalisation in its DNA since inception.”**

**What is the fundamental basis of this change of model?**

The change goes through a decentralisation of power generation, making it independent from the grid and bringing it closer to the real needs of consumer's energy demand, therefore allowing final users to be in control of their energy costs.

In 2015/16 there will be a strong growth in distributed energy markets. Our international project continues to follow that trend by seeking to establish links with investing partners and

to develop strategic alliances with industrial and financial groups in order to help us bring our company the next level of global commercial growth. But our first step towards this goal will require us to first close our current capital round of 5M-10M euros during Q3 and Q4 of 2015.



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# UK climate matters

**Adjacent Government highlights the government's commitment to tackling climate change, with a speech by Secretary of State for Energy and Climate Change Amber Rudd at the Aviva conference, 'Climate Change the Financial Implications'...**

Climate change is a major challenge, wherever in the world you are. In July, Amber Rudd, Secretary of State for Energy and Climate Change, spoke to business leaders in London about the UK government's commitment to tackling the problem. She outlined how they intend to deliver clean growth, as well as keeping energy bills down in order to deliver lasting economic security for hardworking families.

"We are committed to taking action on climate change and we are clear that our long-term economic plan goes hand in hand with a long-term plan for climate action," said Rudd.

"Climate action is about security, plain and simple – economic security. If we don't act, it will become increasingly hard to maintain our prosperity, protect our people and conserve our countryside.

"The economic impact of unchecked climate change would be profound."

In December 2015 world leaders will meet in Paris to discuss a new International Climate Change Agreement. The new Agreement will be adopted in December and implemented from 2020. The European Commission has set out the EU's vision for a new Agreement that will, through collective commitments, put the world on track to reduce global emissions by at least 60% below 2010 levels by 2050.

So what is the UK government's approach?

"We are committed to climate change action; committed to economic security; and committed to decarbonising at the least cost," said Rudd.

Image: © Department for Energy and Climate Change



**Amber Rudd,  
Secretary of State  
for Energy and  
Climate Change**

"The UK is lined up with the progressive countries of the world on this. We want strong, ambitious, rules-based agreement that makes the shift to a clean global economy irreversible.

"Why? Because that is the best way to convince the private sector and investors we mean business. Without the commitment, energy and innovation of private enterprise – across the world – we will not succeed in making the transformation to the global low-carbon economy we need."

Rudd went on to say that she was not getting into old arguments about whether climate change is happening or not. She believes that leaders must come together, unite and act.

She said: "It cannot be left to one part of the political spectrum to dictate the solution and some of the loudest voices have approached climate action from a left-wing perspective.

"So I can understand the suspicion of those who see climate action as some sort of cover for anti-growth,

anti-capitalism, and proto-socialism. But it was Margaret Thatcher who first put climate change on the international agenda.

“She told the World Climate Conference in 1990 that, ‘The danger of global warming is real enough for us to make changes and sacrifices, so that we do not live at the expense of future generations,’ and I agree,” said Rudd.

The Secretary of State detailed how she feels that the burden of the Levy Control Framework is shouldered by the public through energy bills. She would like to see household and business energy bills kept low, and carbon emissions reduced in a way that works for everyone.

“We have a duty to protect consumers and keep bills as low as possible while we reduce emissions,” said Rudd.

“To work for everyone – and to maintain support for climate action – decarbonisation has to be sensitive to the impact it has on people’s pockets, and wider economic circumstances.

“That means we have to control public subsidies – taking rough decisions on what schemes and projects are supported. That is why we have announced proposals to control costs including, closing the Renewables Obligation early for small scale solar farms in the same way we have for offshore wind.

“We still need renewable energy to continue growing and I understand that the industry need certainty so that they can continue to invest in the UK, supporting jobs and growth.

“That is why existing investment has been protected,” she added.

Rudd detailed that reaching a deal in Paris is one of her priorities this year. However, even though she believes a deal is in reach, she doesn’t think there is room for complacency.

“Key for me will be to ensure 3 things,” she said. “First – that the deal must keep the global 2 degrees goal

within reach, because that is what the science tells us will avoid the worst effects of climate change – and so must remain our ambition.

“Second – the deal must include a set of legally binding rules that give us confidence that countries will deliver on their commitments.

“Third – that we agree a process of regular 5-yearly reviews where we can increase our global ambition, taking account of what the science says is required and taking advantage of the increasingly lower costs of renewables and advances in technology.

“And as a whole, the deal needs to send a clear signal that the future is low carbon,” She added.

The new Secretary of State concluded her speech by saying that climate finance will form an important part of any deal. She added that the UK plays a lead role in supporting private sector involvement in less economically developed countries, to help with climate change impacts.

“The conference in Paris is crucial,” says Rudd. “But, it will not be the end of the process, nor the end of the story. I have no doubt further action will be needed beyond Paris to maintain the ambition we have set ourselves.

“That is why getting the right rules in place, and agreeing to ratchet up ambition as conditions allow will be so important. We need to continue to speak up for a global deal, to continue to invest, to innovate, and to drive the clean economy forward.” ■

Comments for the article were taken from a speech, which can be found in full on the Department for Energy and Climate Change’s (DECC) website – <https://www.gov.uk/government/speeches/secretary-of-state-speech-on-climate-change>

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# Hope for climate change action

The last few months have revealed several world leaders dedicated to establishing effective actions to combat spiraling global warming. Two examples.

First, Angela Merkel. The German Chancellor has stated that climate change is the most challenging issue of her political career. Hailed as one of the most outspoken leaders on the need to control CO<sub>2</sub> emissions, in June she raised her game by hosting a G7 summit (Germany, France, Italy, United Kingdom, Japan, USA, and Canada) to discuss and get consensus on commitments to CO<sub>2</sub> emission cuts ahead of the global summit in Paris in December, 2015. It is widely believed that the Paris summit will be the last chance the world has to establish meaningful emission reductions. We are rapidly approaching the point at which the window of opportunity to limit global warming to +2°C, compared to the average global temperature prior to the industrial revolution, will close. After that window closes, Earth will inevitably heat up to temperatures that will cause horrendous consequences for human society and all flora and fauna.

The target of limiting warming to +2°C has existed since the mid-1980s. At that time CO<sub>2</sub> levels were about 350 parts per million (ppm), which was about 75 ppm higher than 250 years ago (pre-industrial revolution) when atmospheric CO<sub>2</sub> varied narrowly

around 275 ppm. However, due to little positive action to limit emissions in the intervening 30 years, CO<sub>2</sub> has increased to its current level of over 400 ppm. Even more alarmingly, it has steadily increased its rate of increase. This fact means we have little time left to bring our contribution to the CO<sub>2</sub> load under control.

**“...Earth will inevitably heat up to temperatures that will cause horrendous consequences for human society and all flora and fauna.”**

A target of +2°C warming is extremely ambitious and corresponds, according to scientifically modeling, to a CO<sub>2</sub> level of 450 ppm. Figuring on an average of 2.5 ppm/year increase, it will take the world only 20 years to reach 450 ppm. That's 2035. Even if the world were to agree to substantial cuts in emissions, it is very doubtful that we will be able to stop CO<sub>2</sub> at 450 ppm. A much more realistic target, but still impressively ambitious, would be to aim at maximising CO<sub>2</sub> at 550 ppm, which is a doubling over the level 250 years ago. To achieve this revised target would require the world's CO<sub>2</sub> emissions to maximise at 40 billion metric tons of CO<sub>2</sub> per year. In 2014 the world was already at 36.3 billion metric tons/year. This means that we will reach our maximum annual limit for this scenario in 5 years. After reaching this maximum, our job is

only beginning, because we will have to aggressively decrease CO<sub>2</sub> emissions to about 25 billion metric tons of CO<sub>2</sub>/year by 2100. Obviously, the entire global society will have to transition to different and renewable sources of energy.

Germany is showing the world this can be done. Under Merkel's leadership, Germany now produces about 75% of its total energy requirements from wind and solar sources. And they have done it while continuing to enjoy a healthy economy. For some countries, however, this transition will be difficult. At the recent G7 summit, Japan and Canada displayed their unease with a rapid transition. Japan's problem is that they had been devoted to nuclear power up until a few years ago, but in the wake of the Fukushima meltdown, Japan decided to shut down all their nuclear reactors and to reset their future energy needs to fossil fuels. Any change in that decision is going to cause Japan serious public and political challenges. Canada is in a different situation. The Conservative government in power over the last 10 years has steadfastly based its model of economic growth on the development of Canada's tar sands deposits in Alberta. This can be seen as a commitment to continue to grow CO<sub>2</sub> emissions from oil produced from such resources. Accepting emission cuts means that Canada will have to invent a different strategy to have the economic growth it desires.



The G7 summit hosted by Merkel put special pressure on Japan and Canada. With strong support from French President Hollande and U.S. President Obama, Merkel was able to get a G7 consensus to reduce greenhouse gas emissions by 40 to 70% by 2050, compared to emissions in 2010. Japan's opening position had been a reduction target of 26% by 2030 based on 2013 levels; Canada had proposed a reduction target of 30% below 2005 emissions. The consensus achieved by Merkel will be the position taken by these countries in Paris in December. It is a major step forward.

The second example of leadership is Pope Francis. In June he released his first papal encyclical entitled "On Care For Our Common Home", which is a sensitive and intelligent comment on the current direction of most human endeavors. Francis is critical of the

current model of continuous economic growth and profligate material consumption at the cost of social justice and environmental sustainability. Climate change, he believes, is a direct outcome of our consumption of energy from dirty fuels. Importantly, he sees this as a moral issue. That is why, as a religious and spiritual person, and as an advocate for billions of people in economically depressed developing countries, he feels compelled to speak out. He has done this in advance of the Paris conference in the hope that his views will be brought into the decisions that must be made there.

Prior to their political and spiritual careers, both Merkel and Pope Francis were educated as chemists. They understand the science and they know it is compelling. Both want Earth to be able to sustain dignified human lives far into the future. In order to make

that happen, both know that the need for action on global warming is urgent because billions of people will be horrifically affected if it is allowed to continue unchecked. Both look toward Paris as the time for 200 nations to reach agreement on what must be done and what must be put in place to ensure that it is indeed done with the speed and quantity needed.

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# Investing in climate change resilience

**Daniel Johns, Head of Adaptation at the Committee on Climate Change explains how effective planning and investment can help the UK prepare for the impacts of climate change...**

This is an important year for climate change action. In Paris, in November, leaders from around the world will try to agree a way to limit the increase in global average temperatures to no more than 2°C. Since the industrial revolution, temperatures have already risen by about 1°C as a result of the 2.2 trillion tonnes of carbon dioxide that human activity has released into the atmosphere. Whilst “no more than 2°C” is the goal, even this level of climate change could still have profound implications.

In the UK, climate change is likely to mean hotter, drier summers and warmer, wetter winters. But this summary masks what the weather is likely to be day to day, or year to year. The science shows that the UK will still experience cold winters and wet summers but that these are likely to become less common. Instead, what we currently consider to be a heatwave may be a normal summer by the 2040s, and the risk of both winter and summer floods is set to increase. Overall we are likely to see a greater range of temperatures in future.

Such details are critically important when it comes to preparing the UK for the expected impacts of climate change, and to determine when and where future investment is needed.

Take the UK's infrastructure. Railway engineers need to know how temperatures are likely to fluctuate so they can allow for rails to shrink and expand without buckling. Train signalling would fail more often if temperatures and humidity were to rise and fall more rapidly. When it comes to electricity, high temperatures and dry ground conditions can reduce the efficiency of overhead power lines, while cold temperatures and ice can affect electricity sub-stations. Increases in heavy rainfall can cause subsidence, affecting underground telephone and other cables.

These examples show that the UK's transport, energy and communications networks need to be finely tuned for the future climate if we are to avoid unnecessary and costly failures. That takes planning, and it takes investment.

In our recent assessment of the UK's National Adaptation Programme, we show that whilst progress has been made to prepare the UK for climate change, there are a number of urgent issues that require attention.

Flood defence is one. Even the best case scenarios suggest continuing sea level rise, with tides rising by about 50-100 centimetres by the end of the century. The tidal surge in December 2013 was Britain's highest in 60 years, inundating many communities and affecting port operations along England's east coast.

National infrastructure is another. A warmer atmosphere holds more moisture, creating potentially stronger, more damaging storms and increasingly extreme weather events. Our research shows that more needs to be done to assess, and reduce, the chance of critical national infrastructure failing during severe weather.

Climate change poses particular challenges for policy-makers in central and local government. How high should flood defences be built to protect our coastal towns and cities from sea level rise? The chance of a severe summer heatwave has already doubled, but how much should be spent to adapt hospitals and care homes to avoid future impacts on patients and the elderly?

There are some common sense answers. Where there is uncertainty about the scale of future impacts, decision-makers should focus first on ‘low regret’





activity – things that deliver strong and early benefits in any event. Examples include improving flood defences, passive cooling measures in buildings (such as solar shading and improving ventilation), and adopting natural approaches to surface drainage such as increasing the area of urban greenspace.

Many actions have multiple benefits. Increasing the size of parks and open spaces also improves biodiversity, and air quality, and helps to counter the urban heat island effect, where inner city temperatures are higher than the surrounding countryside. The area of urban greenspace in England has fallen by 7% since 2001. We recommend that government adopts and delivers a goal to increase urban greenspace to help manage a range of climate change risks, while improving health and well-being.

Where significant investment may be required at some stage, but uncertainty about the impacts of climate change remains, it makes sense to think about the level of climate change that would make such investment necessary, and then monitoring the situation to see if ‘trigger points’ are broken.

For example, the Thames Barrier was designed to be closed up to 50 times per year. During the winter floods of 2013/14, the Barrier was indeed closed 50 times. If this number of closures per year becomes routine, it would trigger a review and perhaps new investment in longer-term flood defence options for London.

In this way, policy-makers can be confident that they have considered a range of scenarios, and that money, when it is needed, can be invested with care.

The Committee on Climate Change advises the Government on reducing UK emissions and preparing for climate change. To find out more, visit [www.theccc.org.uk](http://www.theccc.org.uk). ■

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**Daniel Johns**

**Head of Adaptation**

Committee on Climate Change

[www.theccc.org.uk](http://www.theccc.org.uk)

[www.twitter.com/theCCCuk](https://www.twitter.com/theCCCuk)

# Effective competition to improve quality

Driving change in the electrical distribution network...

Ofgem's recent findings in its review into the electricity connections market<sup>1</sup> published on 21st January 2015, recognised that "Effective competition will help improve the quality of service that customers receive and reduce the cost of connection. Competition can also encourage innovation in the type of services on offer. A well-functioning market for connections to the distribution network should benefit us all – connections that are timely and cost effective help the economy to grow and help to decarbonise the energy we use."

One of the key drivers for change within the UK will be the delivery of a fully open and competitive market place for provision of electrical connections to distribution networks owned and operated by the incumbent Distribution Network Owners (DNO's).

Whilst it is accepted some progress has been achieved, there is still a long way to go. There are many outstanding issues, such as streamlined processes targeting at minimising times not working to maximum durations accessing DNO records systems to enable self-service and self-approval processes. With these arrangements in place, it would provide an open competitive market place aimed at meeting the end customers' needs in a time frame they desire.

From Power On's position, there is a

need to swiftly manage transition of the ability to service our customers' needs with the minimum of DNO engagement.

The proposed national Code of Practice (COP) which is currently being discussed between Ofgem, and the DNO's with consultation with ICP's and IDNO's, if successfully adopted and implemented, will support a truly open and competitive marketplace where quality of service and cost efficiencies can be derived.

The COP will hopefully provide a standard methodology across the UK for enabling connections to be undertaken with minimal involvement or intervention of the DNO. It is hoped that the COP will cover each of the following areas:

- The Customer Awareness of Competitive Alternatives
- Emergency Service for IDNO networks
- Unmetered supply inventories
- ICP to be in control of delivery of the connection
- Contestability of Disconnections on Brown Field Sites, Diversions and Service Alterations
- Construction, Adoption and Connection Agreements
- Land rights process and performance

- Competition in Part Funded Schemes
- Governance

**"...Power On Connections customers have access to specialist expertise and decades of industry experience in traditional and next generation utility infrastructure including gas, electricity, water, superfast fibre and community-based district energy."**

As the UK's No 1 Independent Connections Provider, we have the accredited capabilities and competencies as required by the DNO's to operate and subject to independent audit undertaken by Lloyd's through the National Electricity Registration Scheme. However, despite this routine demonstration of competence, we are still subject to further DNO approval, site audit and review.

Every Power On employee interfaces on a daily basis with the bureaucratic processes which have evolved from the DNO's from enquiry through to the adoption of the assets. Fortunately, throughout the past ten years of engagement, we have developed the knowledge and capability to successfully get through these barriers, but are still at times disadvantaged by the draconian application of maximum times for responses and endless gates of approval and double checking.





Naturally, we are the leading advocates of change and we have leadership roles on all the national debating platforms for Competition in Connections. We are strongly supported by our Sister company, GTC, who are the largest Independent Distribution Network Owner and Operator in the UK to try to drive this requirement forward, which we all believe will deliver improved customer service, shorter delivery times and a more cost effective solution for electrical connections.

Through our sister company, See the Light have developed a relationship with Sky to offer their services across our 300Mb fibre optic network, providing our customers with unrivalled quality service and speed. As well as clean and foul water service connections through our Water business, further complementing our unique utility service provision are our Sustainable energy experts, Metropolitan,

who offer a range of district heating and energy schemes.

We all operate under the same group Brookfield Utilities UK, the leading independent provider of last-mile networks with over 30,000 discrete networks serving over 1.5 million utility connections throughout mainland UK. This means that Power On Connections customers have access to specialist expertise and decades of industry experience in traditional and next generation utility infrastructure including gas, electricity, water, superfast fibre and community-based district energy.

Whilst Power On Connections' core business centers on delivering complex electricity solutions, the company has the power behind it to provide multi-utility infrastructure to every development and being part of a big family in Brookfield Utilities UK has many advantages for our customers. We are able to offer all the traditional

as well as next-generation utility infrastructure solutions through just one partner which gives the best possible customer experience. Utilities are time critical in every development project and that kind of continuity and delivery can and does make a vital difference.

<sup>1</sup> [www.ofgem.gov.uk/ofgem-publications/92527/connections-competitionreviewfindings-pdf](http://www.ofgem.gov.uk/ofgem-publications/92527/connections-competitionreviewfindings-pdf)



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## Evaluating sustainable energy

**Elena Nekhaev, Programmes Director at the World Energy Council, details how energy analysis is important in order to achieve future energy sustainability...**

According to the World Energy Council's Scenarios, the total primary energy supply (TPES) will increase by 27-61% by 2050 and despite the continuing strong growth of renewables, fossil fuels will remain the dominant source of energy, accounting for 59-77% of the primary energy mix. How can we ensure that this demand will be met and in a sustainable manner? The range of available options is narrowing as time passes by.

The World Energy Council in its series of reports about the World Energy Trilemma has identified 3 factors which are vital for achieving future energy sustainability, energy security, energy equity and environmental sustainability.

The simplified image of the energy Trilemma hides a multitude of links between public and private entities, governments and regulators, constantly changing economic and social factors, availability and diversity of national natural resources, environmental concerns, individual behavior, interdependencies between different stakeholders and many more.

Energy projects have long lead times and require long-term policies and regulatory stability. A long-term view is a key to achieving sustainability in the energy sector.

**“Heavy corporate investment in renewable energy technologies is evidence of the potential competitiveness of alternative fuels in the near future.”**

### The Choice of Technologies

The current global energy mix is heavily dominated by fossil fuels: coal, oil and natural gas. However, with the increasing concerns about climate change, renewable energy is widely believed to be much cleaner than fossil fuels and it is increasingly becoming more attractive economically. The World Energy Council in its scenarios indicates that renewable energy is poised to gain significant market share over the next few years. Although renewables are still more expensive than conventional energy, production costs have dropped significantly over the past 2 decades and the gap between the cost of conventional and renewable energy is narrowing. Given the growing pressures to

## Balancing the 'Energy Trilemma'

### Energy Security

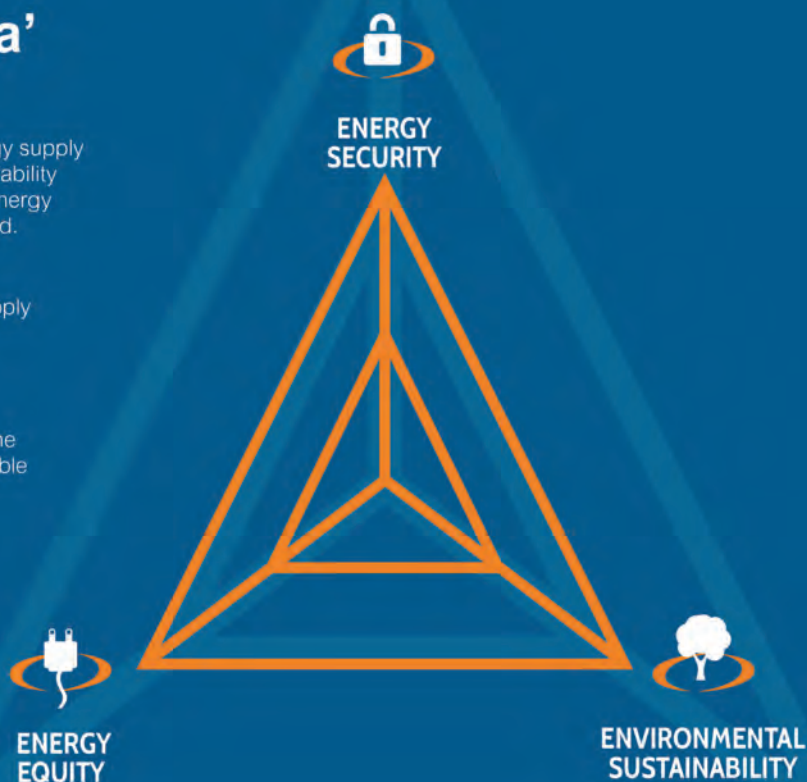
The effective management of primary energy supply from domestic and external sources, the reliability of energy infrastructure, and the ability of energy providers to meet current and future demand.

### Energy Equity

Accessibility and affordability of energy supply across the population.

### Environmental Sustainability

Encompasses the achievement of supply and demand-side energy efficiencies and the development of energy supply from renewable and other low-carbon sources.



reduce greenhouse gas emissions, new policies might be introduced which will make fossil fuels more expensive than renewable energy. Increased regulatory costs can lead to renewables becoming the lowest-cost fuel on the market.

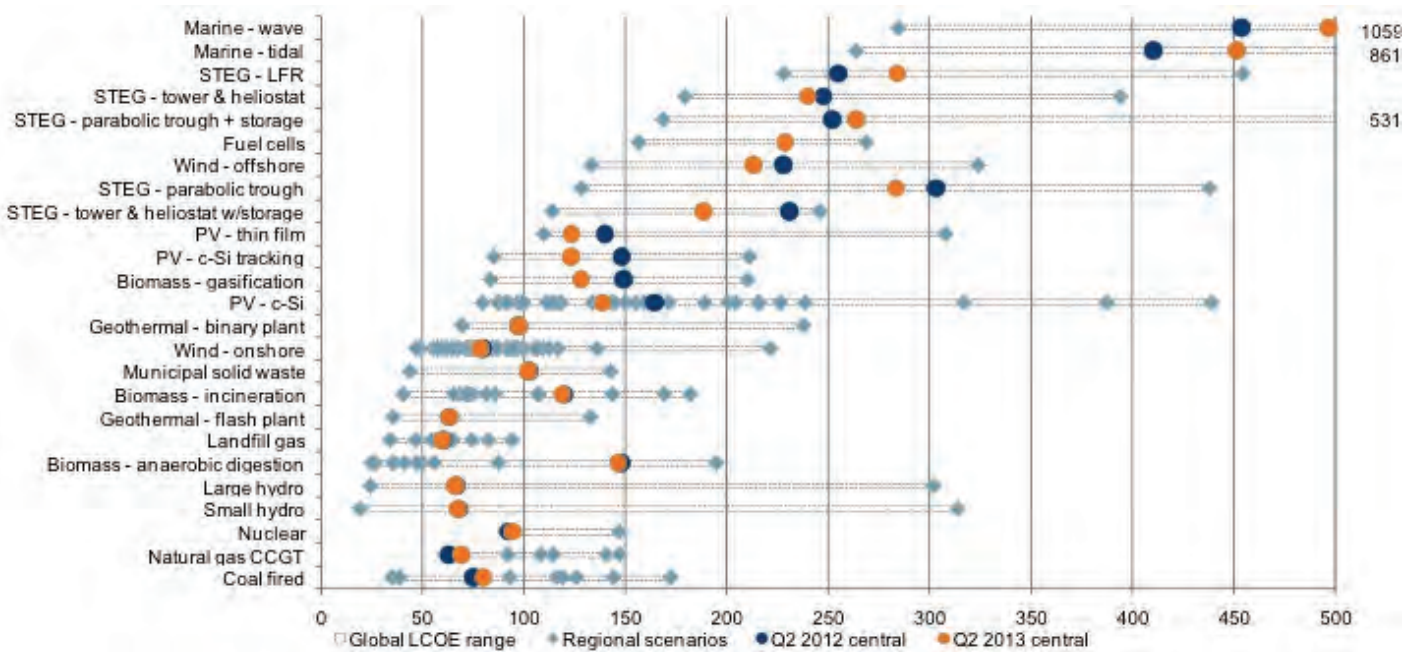
### The Economies of Renewable Energy

Although renewable energy is often considered to be a "new" industry sector involved in an unfair struggle against "Dirty Coal and Oil Suppliers", many large utilities are making renewable energy markets a reality. Practically all major energy companies are pursuing aggressive renewable energy R&D and development projects. Heavy corporate investment in renewable energy technologies is evidence of the potential competitiveness of alternative fuels in the near future.

The levelised cost of electricity data, however, is distorted by numerous government subsidies and preferences. It is important to note that the levelised

costs shown above do not include the costs of transmission because those costs are site-specific and hard to estimate.

The cost of transmitting electricity produced by renewable energy, however, can be very high for several reasons. First, the best renewable energy sites are far from urban areas. Second, this problem is compounded by the fact that large amounts of agricultural land would be displaced if used to harvest such diluted fuels as biomass, for example. Production costs of renewable energy vary tremendously by location. It should be reiterated that site-specific conditions are critical to the economic feasibility of renewable electric generating plants. However, the number of ideal sites is limited. Moreover, ideal sites, given that they hold the greatest profit potential, will inevitably be developed before higher-costs sites. This makes projections of future global market share for renewable energy alternatives uncertain.



The environmental case made for renewable energy often ignores the very real and serious environmental costs. While those costs are not yet widely recognised by the public, mainly due to the fact that renewable energy facilities are still so few and far between that the environmental damages have so far been relatively minor. Further major increases in renewable energy market share, however, will surely bring up these concerns.

Most renewables produce diluted energy, requiring large areas of land. This magnifies both the environmental damages to sensitive ecosystems mankind's "footprint" on the land. For example, the size of land required to produce enough biomass fuel to replace all fossil fuelled generation capacity is twice as large as the entire land area of the Earth. In the United States alone, it would require 46% of the total land area. Solar power facilities also need a large area, but wind power facilities are not quite as land intensive, although they still require between 1.5 and 2+ acres of land per windmill. This is still about 85 times more land per kWh than gas-fired power plants, and wind power has its own drawbacks such as visual pollution and bird mortality.

Solar energy also faces certain issues. Manufacturing of photovoltaic cells produces highly toxic waste and

solvents that require special technology for safe disposal. A 1GW solar facility, for instance, would generate 6,850 tonnes of hazardous waste. Moreover, a solar energy system which could replace fossil fuels would require at least 20% of the world's known iron resources and require over a century to build.

While the environmental problems of renewable energy are not necessarily significant enough to discard renewable energy, the environmental costs must be considered as part of the cost/benefit analysis when comparing renewable energy with conventional energy options. Unfortunately, this is not the case at present.

Small changes in oil supply or demand have very large effects on prices. Accordingly, oil prices can be highly volatile and episodic price spikes can impose tremendous costs on the economy. Greater reliance on renewable energy could minimise the impact of such spikes.

Renewable energy subsidies are introduced as a method for reducing the use of imported oil, which, in turn, reduces vulnerability to the effects of oil shocks. The idea that reducing oil imports will reduce the potential harm caused by OPEC production decisions, however, is not serious. Changes in oil supplies



anywhere in the world affect oil prices everywhere in the world, as long as oil is freely traded in markets. Moreover, oil shocks also spill over into domestic coal and natural gas markets.

Renewable energy cannot realistically substitute fossil-based generation in the foreseeable future, not least because renewable energy is primarily used to generate electricity. Given how far electric vehicle technologies have to go before they can compete with the internal combustion engine, increasing renewable energy power generation will have no major impact on oil consumption in the short term.

**“Although renewables are still more expensive than conventional energy, production costs have dropped significantly over the past 2 decades and the gap between the cost of conventional and renewable energy is narrowing.”**

#### **The Italian electricity sector offers a telling case study**

Policymakers often underestimate the cost of renewable energy subsidies and the strain they place on national economies. As an example, the cumulative cost of Italy's FIT (Feed-in-Tariff) programme between 2000 and 2014 is estimated at €200bn. In 2015 alone, a further €14bn is expected to be spent on subsidies for renewable energy, the amount equivalent to almost one third of Italy's education budget.

Perhaps the strongest argument for renewable energy is the argument for fuel diversity. While renewables cost more than conventional alternatives on a stand-alone basis, they are typically “passive” sources of energy in that they have no state of “on” or “off”. Because they are devoid of systematic (as opposed to random) risk, they may well decrease the risk inherent in any given portfolio of energy sources and in turn reduce the overall cost of electricity.

Will the threat of climate change be the policy ‘wild card’ that leads nation-states to provide the massive dose of taxes and subsidies necessary for renewable energy to supplant conventional energy sources in the 21st Century?

Actually stabilising greenhouse gas concentrations at present levels would require a 60-80% cut in present greenhouse gas emissions. This would essentially mean the complete, or near complete elimination of fossil fuel consumption, given that fossil fuels comprise about 80% of total greenhouse gas emissions. Such an undertaking is simply not conceivable given the economic and environmental costs of renewable energy.

#### **Conclusion: The Nature of Prognosis**

Will a technological breakthrough make some renewable energy sources suddenly competitive with conventional energy? Will catastrophic global climate change compel nations to adopt strict policies to end our reliance on fossil fuels? Will advances in conventional energy technologies suddenly ground to a halt? Will conventional energy reserves suddenly run dry? Such events are unlikely, but of course, they are theoretically possible. ■



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# Managing the transition to a sustainable energy future

There are five major challenges in transitioning to a sustainable energy future. First, scale; the energy system must supply adequate energy to meet the needs of the expected global population growth over the next century. Second, availability; our current energy system is largely dependent on finite, non-renewable energy resources that are being rapidly depleted (coal, oil, gas and to a lesser extent uranium). Third, accessibility; there are geographical and social (e.g. geo-political) constraints on the access to primary resources, which may impact both security and cost of supply. Fourth, affordability; the energy system must deliver energy to society without itself requiring too large a proportion of society's resources, either physical or financial. Fifth, impact; the energy system has large environmental impacts, the most discussed being climate change, but also impacts related to critical resources (e.g. neodymium), water withdrawal/consumption, land use and emissions other than greenhouse gases (e.g. mercury). Additionally, the biosphere's capacity for assimilating these impacts is itself being undermined by human activity. All of these interconnected issues must be addressed in a holistic manner, using a systems approach (see figure).

As already mentioned, a primary focus for sustainable energy has become the issue of climate change which is driving a transition to a

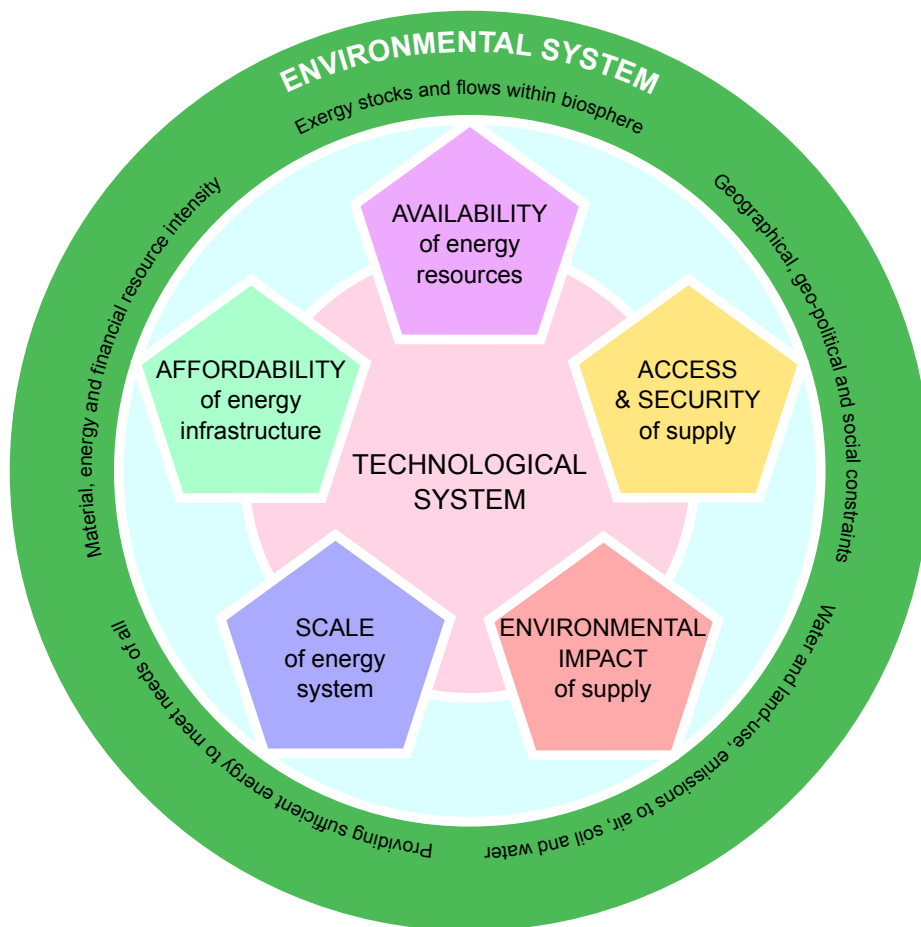


low-carbon economy. With too narrow a focus however, it is possible to undertake seemingly positive actions that may actually undermine whole-system, sustainable energy goals. Alternative liquid fuels for transport may reduce greenhouse gas emissions, but increase other environmental impacts. Electrification of transportation avoids end-use emissions but puts further strain on the need for low-carbon electricity resources. Carbon capture and storage addresses the climate impact of fossil fuels, but actually accelerates their depletion, arguably making use of the resource more unsustainable. Equally, focusing solely on technological solutions may cause us to overlook more effective solutions in the political and social realms.

Ultimately, energy planning policy must be undertaken in the context of one simple question; “can a renewable,

accessible, affordable, clean energy system sustainably supply our current level of energy demand?” The energy system must be environmentally and technologically feasible. It should also not use too many of society's resources and seek to minimise environmental impact. This question is of the highest priority, since it sets the boundary for all other considerations. If it should be found that the sustainable supply is lower than current energy demand levels, then clearly the goal of energy policy should be to (perhaps dramatically) reduce energy demand.

Finding the answer to this question demands greater appreciation of the physical structure of our economies. We need to better understand how physical resources (materials and energy) enter, flow through, accumulate and leave our economies, since these physical resource constraints



**Aspects of energy policy planning**

set hard limits (social, political, and financial constraints are more flexible, though not necessarily easy to change). This means developing a complementary set of databases of physical quantities to supplement financial systems of national accounts. A number of organisations currently collect this information at the economy-wide level, however much more work needs to be done to develop these databases at the sectoral level. A large array of data, tools and methodological frameworks are available in this effort, developed primarily by researchers in fields such as net energy analysis, material flow analysis, life cycle assessment, industrial ecology, ecological economics, and biophysical economics.

Other benefits that stem from supplementing financial analyses with energy and material flow analysis include:

- Better appraisal of early-stage technologies (low technology readiness levels) often having highly uncertain financial characteristics, but that are still subject to fundamental physical laws which can help identify potential costs and barriers to technology development;
- Identification of alternate metrics for valuation of energy and other natural resources and their production pathways, by comparing our ability to transform resources into societal benefits; and

- Calculation of alternative metrics for comparing the environmental impact of individual goods and services, or even entire industries or economies, such as freshwater consumption, global warming potential, or primary energy demand.

Given the large changes required in coming decades to supply energy in a more sustainable fashion, it is clear that a vast transition of our current energy system is required. A piecemeal approach focused solely on technological solutions is not enough. We must take a whole systems approach. To manage the transition in the coming age of resource constraints requires making smarter decisions based on a richer understanding of the physical basis of our economies.



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# Reimagining what's possible for clean energy

**David Mooney, Director of the Strategic Energy Analysis Center, at the US Department of Energy's National Renewable Energy Laboratory, explains how understanding energy is important to the success of clean energy technologies...**

**M**oving from today's energy system to a clean energy system will require a profound transformation. While today's energy system is largely carbon-based and not very efficient, there is great potential for a future energy system to harness the wind and sun and other sustainable energy sources. It could make energy supplies more accessible, affordable, carbon neutral, and secure, while powering economic development.

For a range of renewable and energy efficiency technologies, costs are dropping and adoption is increasing sharply. Energy system transformation is indeed already underway.

## **Transformation requires imagination**

The US Department of Energy's National Renewable Energy Laboratory (NREL) is well positioned to assess and understand the potential for a clean energy future. An objective, credible, and robust analysis capability has been part and parcel of NREL's mission from our inception as the Solar Energy Research Institute in 1977. Starting with techno-economic analysis, our early researchers understood the vital role of providing technology-neutral analysis to ensure that innovations developed in the lab fit the needs of energy consumers. Today, NREL continues to develop tools that increase our understanding of energy technologies, resources, infrastructure, markets, and, policies along with their connections to economic, environmental, and security priorities.

Groundbreaking analyses conducted by NREL, other US national labs, and our many domestic and international partners have helped redefine what's possible for renewable energy. For example, in one project NREL and its partners have worked to create a computer model of one of the most complex systems

ever built. This system, the eastern part of the North American power grid, is likely to host an increasing percentage of renewable energy in years to come. Understanding how this system can be reliably and affordably operated under a variety of scenarios is important to the success of clean energy technologies. Through innovations in capacity expansion and production cost modeling, we are engaging in detailed assessments of the challenges utility operators may face in scenarios of high penetrations of variable generation sources such as wind and solar. Critical to an energy systems transformation is the coupling of these scenario analyses with comprehensive sustainability analysis to compare the life-cycle impacts of renewable and conventional technologies on the environment including impacts on land, water, and air.

We also know that our future is likely to include many energy technologies – not just renewables. It is therefore critical that scenario analyses include a variety of combinations of renewables, fossil, and nuclear energy sources, which require a detailed understanding of the operational characteristics of all conventional and renewable generators. Of particular note is NREL's growing body of work on the nexus of natural gas and renewable energy, which offers insights on multiple pathways to lower carbon energy systems.

Collectively, our body of analysis work illuminates what is feasible for renewable energy today, and where changes to today's system could lead to enhanced prospects for cleaner, more secure energy systems over time.

## **Transformation requires information**

NREL aligns its core energy analysis, technology development, and deployment capabilities and teams so that insights gained at all scales inform the next set



David Mooney, Director, Strategic Energy Analysis Center

of research priorities. Through numerous projects to support renewable technology deployment at scales from campus to community to continent, we collect operational insights on what is practical and what is possible. By doing so, our energy analysis efforts support and complement our science and technology work. Our analyses create a feedback loop between ideas and implementation and allow NREL to continually ask: What’s needed next and how do we achieve it?

**Transformation requires collaboration**

NREL’s analytical work doesn’t stop at our lab’s boundary or even our nation’s borders. NREL works with a wide variety of domestic and international partners to provide tools, insights, and assistance to help policymakers, investors, federal agencies, utilities, state and local government, technical institutions, and governments around the world make informed

energy choices in the context of environmental, security, and economic priorities. We collaborate with partners to build global networks that support low-emission economic development. Within these networks, developing countries can partner with subject matter experts to gain insights into, and assistance with, the incorporation of renewable energy into national power systems.

At home and around the world, NREL analysis informs policy and investment decisions as energy-efficient and renewable energy technologies advance from concept to commercial application to market penetration. We continue to make progress toward transforming our energy systems to be cleaner, more reliable, and more secure, and we embrace the opportunities ahead. Every day, NREL and its partners are reimagining what’s possible and leading the way to a clean energy future. ■

NREL develops clean energy and energy efficiency technologies and practices, advances related science and engineering, and provides knowledge and innovations to integrate energy systems at all scales. Learn more at <http://www.nrel.gov/analysis/> and <https://youtu.be/XtV574kBEbU>.



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# Taking action to improve efficiency & reduce costs

**Alexandra Latham, Communications Officer at the European Geothermal Energy Council details how RHC technologies including Geothermal go hand in hand for a sustainable energy supply with stable prices...**

**T**he need to ensure stable and affordable energy prices for consumers thereby elevating fuel poverty and enabling growth, and the need for this energy use to be sustainable, is obvious. But how can this be reconciled with increasing population growth and economic activity? And how can it fit in our current energy system?

The market, the legislation, and technological challenges make a silver bullet impossible, but there are solutions. In the heating and cooling sector-which currently accounts for half of the energy use in Europe-implementing energy efficiency measures and switching fuels to renewables will go a long way to ensure a secure future.

The situation today is far from ideal. The EU, the world's largest energy importer, spends more than €1bn every day on imported fuels. Most of these imports are used in the heat sector, which relies mainly on heavy polluters like oil, gas, and coal. Compare this with the readily available local sources of heating, cooling, and domestic hot water available to us and the knowledge that by 2020 the €21.8bn could be saved annually just by covering 25% of heat demands with renewables.

Geothermal heating technology is already widely used in countries such as Germany and Sweden, but could be much more widely exploited. The technology is highly efficient; geothermal heat pumps are amongst the few to achieve the highest category A+++ in the new energy labelling system and Seasonal Performance Factor (calculated as the ratio of the heat delivered to the total electrical energy supplied over the year), is today well above 4. This means that for each kW of electricity consumed, geothermal heat pumps generate 4kW of thermal energy. And, with continued

improvements, average values in the order of 5 can be achieved.

The figures may be shocking, but it is not difficult to understand why we persist with this model which leaves us vulnerable to price hikes and locked into a carbon intensive future: Fossil fuels remain subsidised, prices and costs of energy, particularly heating and cooling, are not transparent, and structural problems with the energy system need to be tackled.

Figures on the subsidisation of fossil fuels are known; the recent EC study 'Subsidies and costs of EU energy' found that subsidies for natural gas amounted to €6.5bn, whilst support for geothermal was only €70m in 2012. Geothermal heating and cooling delivers affordable energy at stable prices and is available across Europe, yet we continue to give more support to an expensive energy source which leaves consumers vulnerable.

As heating and cooling has largely been neglected in public policy, information on the cost of heating and cooling is not readily available, and the available statistics are not always reliable or comparable. Further, externalities such as the impact on fossil fuels are often overlooked, and there are information gaps with consumers not able to understand the information available. Policy makers are also unsure of the most effective policy options and the decision making factors of consumers.

The FROnT project (Fair RHC Options and Trade), supported by the EC, is currently working on these issues on multiple fronts. Studying the various factors which determine the costs of heat will allow for an assessment of the levelised cost of heating and cooling; by studying and measuring the success factors of





A picture of a geothermal district heating plant in Veresegyhaz, Hungary

Image: © EGEC

support schemes. It will produce valuable information on how future schemes should be developed, by understanding the decision making factors of consumers, and it will improve the dialogue between stakeholders and the common understanding of the heating and cooling sector.

Today, consumers are already taking action in reducing the amount of energy they use; improving the efficiency of homes and businesses is essential in both new builds and particularly in existing building stock, there are huge savings to be made. Energy efficiency alone is, however, not enough. An important point that is often overlooked: reducing energy consumption is not the same as reducing fuel dependency. After energy efficiency measures, a building still needs fuel, even if the demand is lower; whilst this energy comes from fossil fuels it is still victim to unstable supplies and prices.

Only by coupling energy efficiency with a fuel switch to renewables will we reap the full benefits of both. Both sectors face similar barriers, such as public awareness and acceptance, and upfront financing. These barriers are best removed together. For example, with increased understanding of the costs of heat and

options available to consumers, more people will take action. Economies can be made by integrating renewable heating and cooling systems whilst energy efficiency measures are implemented- building work does not need to happen twice.

Our energy system is not only expensive today, but will get more expensive in the future, as the price of fossil fuels and electricity go up. It sends GDP outside our borders. Long term, sustainable solutions are available but a holistic approach, structural reforms and political courage are needed to make a systemic switch. ■

For more information on Geothermal Heat pumps visit [www.heatunderyourfeet](http://www.heatunderyourfeet) and follow @heatunderfeet.

For more information about the FRONt project visit [www.front-rhc.eu](http://www.front-rhc.eu).

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**Alexandra Latham**  
**Communications Officer**

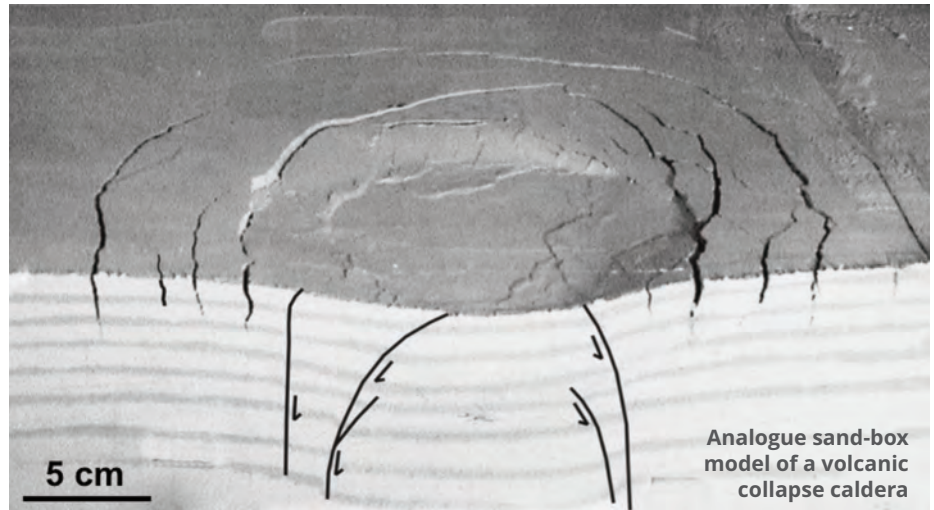
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# Volcanoes and geothermal and mineral resources

## Analogue and numerical modelling

Volcanoes are one of main geological systems hosting economic and energetic reservoirs; i.e. geothermal energy. As soon as magma (i.e. molten rock generated at the Earth interior) enters the crust, for example, as a shallow intrusion beneath a volcano, the normal geothermal gradient of about 25°C per km of depth is locally perturbed as temperature rises around the intrusion. The extent and duration of such a thermal anomaly depend mostly on the temperature and volume of the intruded melt. The presence of hot magmas below the surface of active volcanic regions offers the prospect of harnessing a huge amount of geothermal energy. The latter is a renewal resource, as it exploits the abundant Earth's interior heat and water, which once used and cooled, is then piped back to the reservoir.

As in many others geological disciplines, modelling is essential to understand volcanic processes. During the last decades, analogue and numerical modelling techniques have become fundamental tools to study geological processes, especially in those cases where direct observation of the phenomena (i.e. subsurface or long-term processes) is not possible. On the one hand, analogue models try to reproduce in the lab, using specific materials, the processes occurring in nature with a factor of scale regarding physical properties. Analogue experiments



are indispensable to explore new phenomena, observe processes, determine the values of key parameters, test hypotheses and theoretical models and validate computational models.

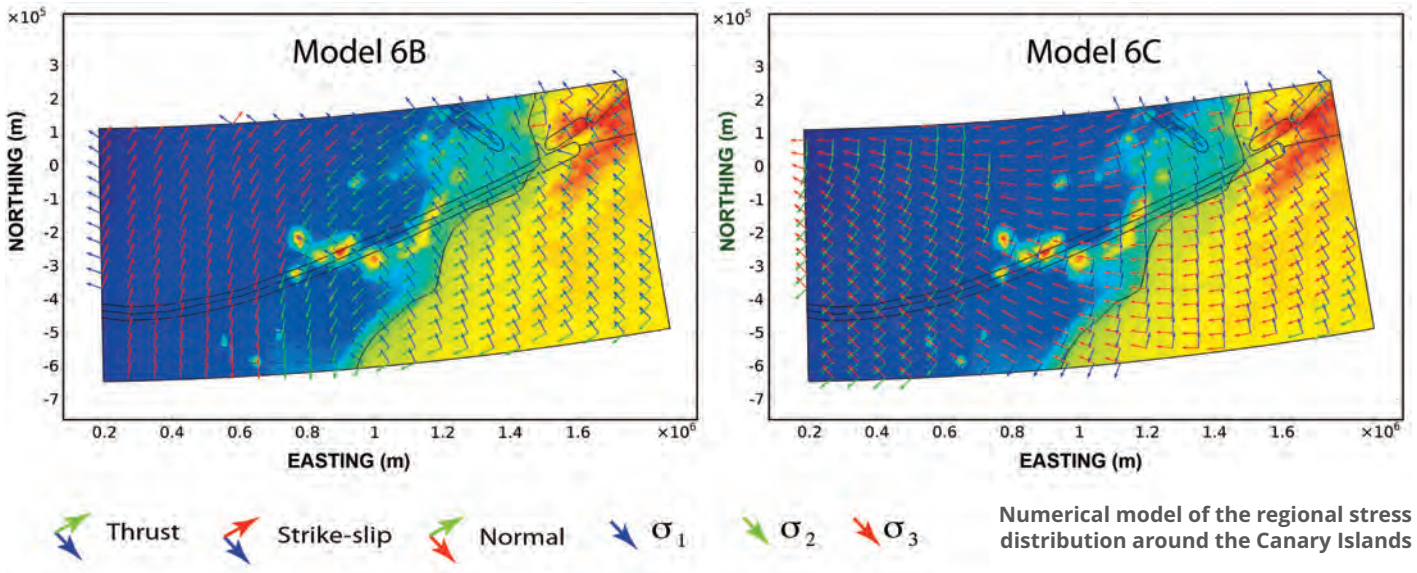
On the other, numerical models can be described as a simplified abstraction of a certain natural phenomena, characterised by a set of equations called govern equations, which describe the physical problem in a mathematical way. The use of theoretical/mathematical models based on thermodynamics, rock and fluid mechanics principles has become more and more important since they are a fast, cheap and accurate method to simulate and predict volcanic processes. In most cases, the complexity of the mathematical expressions makes unworkable the analytical solution of the problem and it is required the application numerical methods such as

differential and/or integral calculus run on (super-)computers.

Thus, the combination of mathematical and analogue models together with field studies, is by now the best way to understand the whole sequence of processes involved in the formation and evolution of geothermal reservoirs.

At the Institute of Earth Sciences Jaume Almera, CSIC, of Barcelona, Spain, the group of Volcanology (GVB-CSIC) lead by Prof. Joan Martí, carry out analogue and numerical models aimed to understand different processes related to volcanic systems. The group includes experts on analogue and numerical modelling of volcanic systems, as well as a broad expertise on Geographical Information Systems (GIS), and development of specific software for hazard assessment and risk management. The laboratory used for the analogue models is equipped with a hydraulic

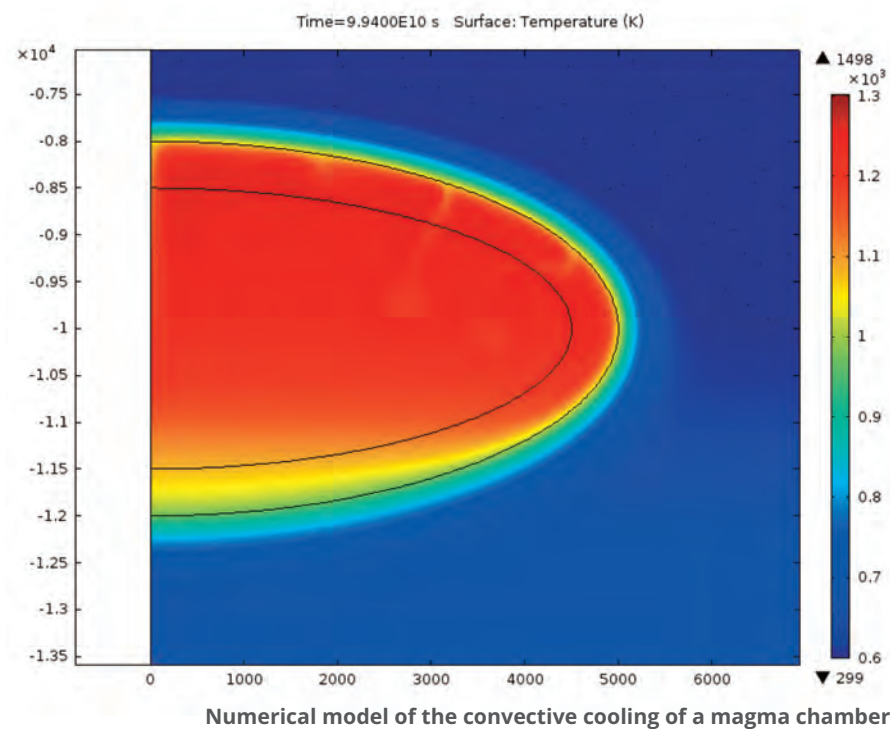




experimental channel, a experimental petrology laboratory for the study of the thermodynamics of shallow magma chambers, an a magma chamber simulator. Several GIS commercial and free packages are available (e.g. ArcGIS, QGIS), as well as software for digital image processing, numerical modelling using the finite element method (COMSOL. 5.1) and geological modelling and 3D visualisation (3D Geomodeller and RockWorks 16). The GVB aims to promote the application of experimental and mathematical

modelling to the study of geological processes and especially of those which pose a risk to people and the environment or those that are associated with energy and economic resources, following one of the main lines of scientific research in the European Union. Research on energy and mineral deposits related to active and past volcanic systems, require to understand its origin, evolution and current dynamics. A better understanding of these fundamental aspects that characterise volcanic

systems is fundamental to identify their geothermal and mineral resources potential. Their study through mathematical and experimental modelling help to correlate and constrain existing data from surface geology and geophysical exploration, and allow to combine all the available information in order to obtain reliable 3D simulation and visualisation models that help to improve the efficiency of exploration and exploitation strategies significantly reducing their costs.



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# Energy efficiency and housing: what next for local authorities?

Ian Hutchcroft, Head of Local Delivery at the Energy Saving Trust explains how local authorities can retrofit for energy efficiency and deliver benefits for carbon reduction, health, jobs and growth...

There is no doubt that the drivers for local authority action on housing energy efficiency are strong, and getting stronger.

With 22,500 excess winter deaths per year and many more avoidable winter hospitalisations, the economic and social costs of cold homes are significant and on the increase. One in 5 of us live in fuel poverty, and burdened with the oldest, least efficient housing stock in Europe, the single greatest driver for local authority action is health improvement.

**“To develop and deliver effective strategies for housing, health, economy and carbon, councils need to know which measures are required in which houses, the costs, impacts on bills and carbon, funding available and the investment business case.”**

There is a strong economic case to make for retrofitting because it creates real, local jobs and growth. A striking example of this is Energy Saving Trust’s ‘Ready for Retrofit’ programme in the South West which created 274 additional jobs and £50m for the economy, as well as many warmer and easier to heat homes. This is work that is done locally by skilled businesses and there is a lot of work to be done. Indeed, the programme has just begun a new energy efficiency retrofit initiative in Devon, with a £725k investment.

But underpinning all of this is a legally binding commitment to meet the targets in the Climate Change Act: a zero carbon housing stock by 2050, now less than 35 years away. Achieving this will overcome many of the health problems associated with cold homes and create thousands of long term, skilled jobs.

Ward	Solid Walls	
Bickenhill	1137	22%
Blythe	550	10%
Castle Bromwich	936	20%
Chelmsley Wood	420	8%
Dorridge and Hockley Heath	668	15%
Elmdon	825	16%
Kingshurst and Fordbridge	432	8%
Knowle	740	18%
Lyndon	2276	42%
Meriden	986	21%
Olton	1385	27%
Shirley East	1484	33%
Shirley South	1100	22%
Shirley West	1664	33%
Silhill	1697	34%
Smith's Wood	412	8%
St Alphege	844	17%
<b>Solihull Total</b>	<b>17556</b>	<b>21%</b>

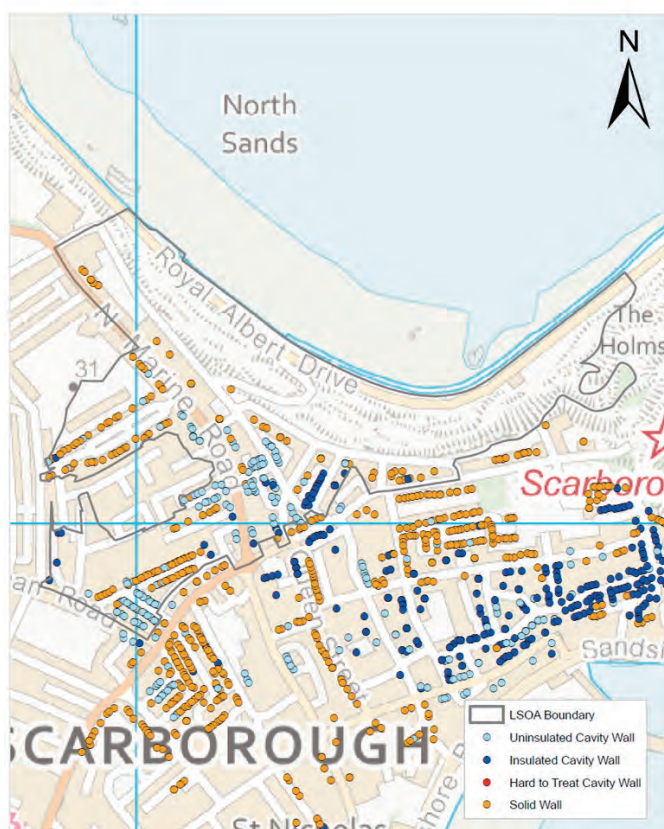
Data analysis can identify areas to target eg in Solihull

With the role of local authorities increasing as we approach the General Election, delivery has so far been difficult. Budget cuts and staff resource constraints coupled with the ever changing policy and funding environment has not helped. However, there are examples of local authorities taking the lead, forging ahead and delivering results for their communities.

Bristol is this year’s European Green Capital, an accolade that is underpinned by an ambitious housing retrofit programme backed by the Mayor. Further south, the Plymouth Energy Community has a large social housing retrofit programme, with Green Deal Communities funding filling in the privately owned

Scarborough Borough Council  
E01027847

energy  
saving  
trust



Home analytics data can be used to produce address level spatial analysis

gaps, and a Community PV programme funding provision of advice to householders through a new cooperative. Just next door in rural Devon, 10 local authorities are working on the Cosy Devon programme.

In the capital, the Re:new programme has moved from doorstep advice and referrals to insulation schemes, into a European Investment Bank funded programme to help landlords invest hundreds of millions of pounds in retrofitting their stock. The UK's

other major cities are all active, with Leeds and Newcastle both working with their neighbours in large regional programmes.

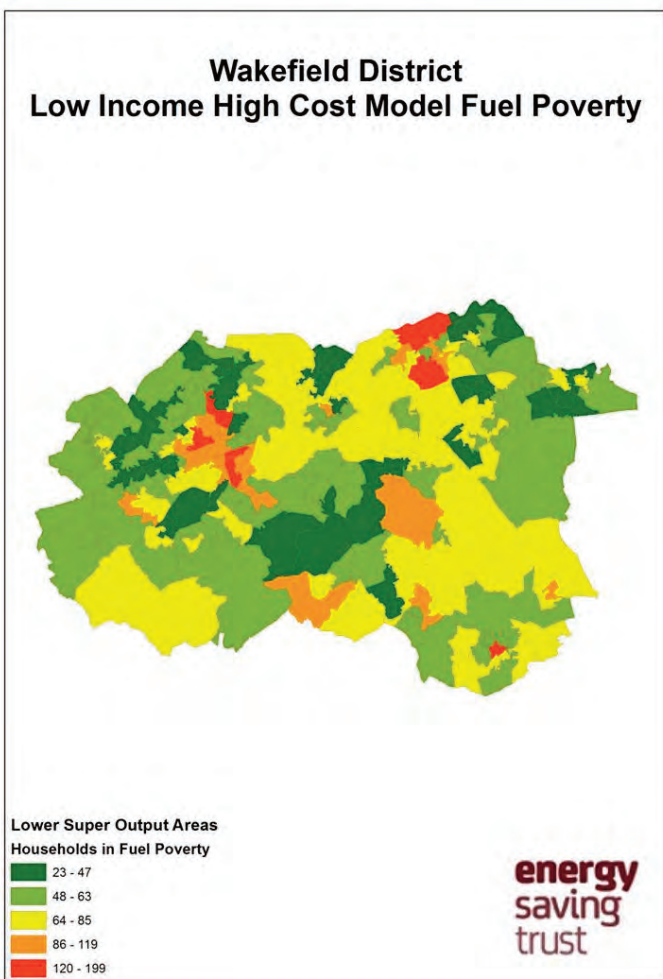
### So, what next for local authorities?

#### 1. The big challenge needs big data.

To develop and deliver effective strategies for housing, health, economy and carbon, councils need to know which measures are required in which houses, the costs, impacts on bills and carbon, funding available and the investment business case. We have been collecting housing data for over 20 years and developing our Home Analytics database for all of the 27 million addresses in Great Britain, and this is available to every local authority. Our recent research has shown that access to clear, comprehensive data and analysis is one of council officer's biggest barriers. Many officers joined our recent [webinar](#) where we showed how to access and analyse the many sources of available data.

#### 2. Do everything, in the same place, at the same time, for a consistent period of time.

Many local projects have suffered from being just a partial solution, looking at one part of the problem: grants, supply chain or community engagement, and often constrained by very tight spending and delivery timescales. No sooner have they got up a head of steam, then their funding runs out. Our Ready for Retrofit programme, referred to earlier, has shown the benefits of working on demand stimulation through grant aid, together with supply chain development and local business support, market development by supporting community groups and Open Homes events, and helping local authorities access longer term finance. Doing all of those things in the same place over 3 years has delivered real results and we believe should be the template for local programmes in the future.



Targeting fuel poverty

**3. We need catalysts to increase scale and reduce costs.**

Could social landlords play a greater role in making trusted, well managed, good value retrofit schemes available to privately owned homes in their areas as well? Could the next big idea in housing retrofit have been developed in the Netherlands, called Energiesprong (Energy Leap)? This net zero energy retrofit is built off-site to reduce costs and time on-site to 10 days, with guaranteed energy performance and

maintenance, and funded by replacing energy bills with monthly service charges. Dutch housing associations have now come together and let a contract to Energiesprong to retrofit 100,000 properties, which enables the supply chain to move from prototypes to industrialised methods and significantly reduce costs.

Local authorities increasingly recognise that focusing on improving housing energy efficiency is one of the most effective ways to improve health prospects, create local jobs, reduce energy bills and cut carbon emissions. There will be many willing partners for the next government to work with. ■



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[www.energysavingtrust.org.uk](http://www.energysavingtrust.org.uk)  
[www.twitter.com/EnergySvgTrust](https://www.twitter.com/EnergySvgTrust)  
[www.twitter.com/IanHutchcroft](https://www.twitter.com/IanHutchcroft)



# Energy efficiency – It's now the law

**Liz Ainslie MSc AIEMA, Environmental Consultant for Hosking Associates Ltd outlines the new legislation for energy efficiency in both the domestic and non-domestic private rental market...**

**R**ecently, new legislation has been passed that makes it easier for tenants to rent more energy efficient properties.

Called the Energy Efficiency (Private Rented Property) (England and Wales) Regulations 2015, the regulation introduces measures to improve the energy efficiency of rented properties in England and Wales. Both domestic and non-domestic private rented property is included in this legislation.

The regulations are the first instruments to be made using the powers conferred by the Energy Act 2011. The Act places a statutory duty on the Secretary of State to make regulations implementing the tenants' energy efficiency improvements provisions by 1st April 2016.

The property industry will need to review the legislation carefully and take the regulations into account now, with start and enforcement dates beginning in the autumn of next year. The dates are phased in stages.

## **What are the regulations?**

The new regulation states that from 1 October 2016, all private rented properties must have a minimum energy performance certificate of band 'E'. Landlords will not be able to take on new tenancies after this date without making energy improvements. Then, after 1 October 2018, for any domestic property below an E rating, these regulations will apply to all existing tenancies. This date is 1 October 2023 for non-domestic properties.

By making the regulations clear well ahead of their application date, and by phasing in requirements over time, all participants will have time to take voluntary

action, reduce their costs of complying, and decrease the need for enforcement of the legislation.

## **Who must comply?**

All buildings requiring an EPC will be part of the legislation. Therefore, buildings due to be demolished, used as a place of worship, listed buildings, or other exemptions do not have to comply. However, these are the minor exceptions to the rule.

Currently, around 20% of non-domestic property with an EPC is rated 'F' or 'G'. Those landlords in possession of such buildings will need to take into account financial and reputational loss when their non-compliant property is valued. Lenders will most likely have greater focus on the energy rating of a building when the legislation is implemented, and they may require borrowers to bring properties up to standards before any money is released.

## **What happens if I don't?**

It makes sense to begin upgrading your property now if you fall into the 'F' or 'G' ratings. You will save money in energy bills in the long term, thereby making your property more attractive to lease. There are many Green Deal options out there to help your business become more energy efficient without costing you a fortune up front.

Local authorities will enforce the regulations for domestic properties, while non-domestic properties will most likely be enforced by Trading Standards. The penalties for a breach of compliance are civil, not criminal. There could be a financial penalty, a publication penalty, or both. Penalties will range from £1,000 for giving false or misleading information on a domestic property, up to 20% of the value of a non-domestic property for failure to comply.



Liz Ainslie MSc AEMA, Environmental Consultant for Hosking Associates Ltd

**Domestic tenants will benefit too**

This legislation will be a boon for domestic tenants who are so often overlooked by legislation. From 1 April 2016, domestic tenants will have the power to request the landlord’s consent to energy efficiency improvements which require no up-front or net cost to the landlord. It even places a duty on the landlord not to unreasonably withhold consent.

This is great news for all tenants, in that poorly performing buildings won’t put such a strain on tenant’s energy bills going forward. It is especially good for the domestic market. Tenants often have very little choice around their energy usage in older or less-well-maintained properties, and landlords have been slow to respond to the voluntary approaches to energy savings in the past.

However, in practice this means that landlords can still wait for another 3 years before making any improvements. Also, while an ‘E’ rating is acceptable, the legislation doesn’t go far enough in ensuring that buildings are as energy efficient as possible. The UK has commitments under the Climate Change Act 2008

to reduce greenhouse gas emissions. Domestic and non-domestic buildings account for around 37% of the UK’s total carbon emissions (as at 2009 figures) – landlords could play a huge part in this reduction. ■

To read the full text of the legislation, visit the Gov.UK legislation pages on <http://www.legislation.gov.uk/uksi/2015/962/contents/made> .



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# Understanding thermal energy storage

**Lindsay Wright, Policy Engagement Manager at the UK Energy Research Centre (UKERC), outlines the potential for thermal energy storage in the UK...**

**T**hermal energy storage uses different technologies to collect heat for future use, whether that's hours, days, or even months later. This can happen at building, district, town or regional scale, depending on the technology used.

Recent research for the UK Energy Research Centre (UKERC), led by Philip Eames at the University of Loughborough, has helped us to better understand how we use heat in the UK, which technologies are available for thermal energy storage and where they might be deployed and distributed, and the potential for thermal energy storage to balance peak grid load.

Heat networks currently supply less than 2% of the UK's space heating, compared to approximately 16% in Germany. Just under half (45-47%) of UK energy consumption is for heating purposes, and of the total national heat demand, space and water heating account for 63% and 14% respectively. Domestic heating makes up 57% of total heat use, but around 80% of the UK's heat is currently generated by fossil fuels. If we are to achieve our greenhouse gas emission reduction targets, then it's vital we develop low emission heating approaches.

Until the UK's building stock is transformed to be more thermally efficient, or replaced with energy efficient new build, the greatest use of heat in the UK will continue to be for space heating. To assess the feasibility and potential of a range of thermal storage approaches, the UKERC research team undertook 2 case studies using data for a house in Derby, and for the Pimlico district heating scheme in London.

In the Derby case study, daily winter heat requirements and daily peak heat requirements were determined for a large family house and scaled, based on the

predicted performance if the house was compliant with the Building Regulations of 1980, 1990 and 2010. Thermal stores were sized to meet the maximum space heat load for a 3 hour period to allow heat pump operation at periods of low electrical grid load.

For a water-based sensible heat store, the storage volumes needed were found to range from 2.6m<sup>3</sup> for the house constructed to 1980s Building Regulations, to 0.56m<sup>3</sup> for construction to 2010 Building Regulations. A 'theoretical' phase change material (PCM)-based store was found to reduce these volumes by two thirds. Given that PCM storage is likely to become a viable technology in the next few years, the researchers found that combining it with an electric air-source heat pump as part of a retrofit could be technically possible. If an appropriate demand side management strategy was also in place, demand could be reduced, and supply challenges for electricity utilities minimised.

In the second case study, the researchers analysed the Pimlico District Heating Undertaking which includes a 2500m<sup>3</sup> thermal store built in the 1950s, providing a balancing function to match variable supply and demand as well as an emergency buffer to ensure seamless supply in the event of planned or unexpected maintenance. The thermal store allows better control and plant efficiency; without it, the system would need to vary in operation to meet the changing demand, and so run inefficiently.

The team investigated the potential additional national electrical generation and peak grid load resulting from the deployment of different numbers of air source heat pumps with different performance characteristics, and calculated the potential storage in GWh of heat and electric equivalent that could be achieved with distributed thermal storage. They





found that 2 million air source heat pumps with a winter COP of 2, each meeting a 12kW thermal load, would require an extra 12GW of electrical generation (compared to a current winter peak load of just under 60GW). If each dwelling equipped with a heat pump system had 3 hours of thermal storage, then the equivalent electrical storage would be 36GWh. This would enable improved capacity factors of generation plant to be realised and reduce the amount of additional power generation capacity needed to meet this additional load.

The expansion of heat networks in the UK is possible in areas of high heat demand, although installation costs are high at present. If the electricity supply is decarbonised, CHP will no longer be the lowest carbon option and large MW-scale heat pumps may prove preferential.

The wide-scale adoption of air source heat pumps for space heating will also require significant investments due to the seasonal variation and magnitude of peak winter loads. Strengthening of the low voltage electrical network and significant additional generation

capacity will be needed in addition to major building refurbishment to reduce heat loads.

Distributed thermal energy storage can provide a significant diurnal load shifting capability. However, without the development of effective latent or thermochemical heat storage systems, the storage volumes required will be large and difficult to integrate into existing domestic dwellings. ■

This article is based on the findings of the 2014 UKERC Research Report:

Eames, P., Loveday, D., Haines, V. and Romanos, P. (2014)

The Future Role of Thermal Energy Storage in the UK Energy System: An Assessment of the Technical Feasibility and Factors Influencing Adoption

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# Thermal Energy Storage at the University of Lleida

In 1999, the research group GREA at the University of Lleida already saw the importance of thermal energy storage (known as TES) in today's energy systems. The main advantages of TES are a reduction of energy costs, a reduction of energy consumption, an increased flexibility of operation, a reduction of initial and maintenance costs, and an improvement of indoor air quality in buildings. Although energy storage is already acknowledged for its potential by policy makers, TES is still disregarded. Thermal storage may be stored by elevating the temperature of a substance, by changing the phase of a substance (such as melting ice at 0°C), or with the use of the energy involved in chemical reactions.

TES, therefore can be applied in the grid, in the industry, in buildings, and in our cities. At the University of Lleida, several applications have been demonstrated, and are shown here. One of them is the use in buildings to reduce their energy demand, demonstrating that TES is one of the tools to be used, together with the use of renewable energies and consumer



Pilot plant available at the University of Lleida to test TES up to 400°C

behaviour. GREA has a unique demonstration pilot plant, where cubicles of adequate size have been monitored over 10 years.

Another key installation is the one where industry applications are developed, such as use of TES in solar power plants, recovery of waste heat from the industry by implementing TES, or the use of industrial by-products as storage materials.



Pilot plant available at the University of Lleida, where TES is tested together with other energy efficiency technologies (good insulation, solar energy, heat pumps, etc.)



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# Accessible and affordable transport for all

## Adjacent Government outlines the key priorities of the European Commissioner for Transport, Violeta Bulc...

Transport is fundamental throughout Europe, providing mobility for millions of people as well as being a key factor in trade. Ensuring that transport throughout Europe remains sustainable is a concept the European Commission is committed to. Developing innovative solutions to reduce carbon emissions through transport is high on the agenda.

One of the key priorities for the European Commission as set out by President Juncker is creating jobs and boosting growth throughout Europe. In order to deliver further on this commitment, the Commission revealed in June a record €13.1bn investment plan in 276 transport projects. These projects were selected under the Connecting Europe Facility (CEF) – a multi-annual funding programme set up to finance improvements in Europe’s transport, energy and digital networks.<sup>1</sup>

The investment will not only improve transport infrastructure, but will also promote sustainable and innovative mobility solutions. The European Commissioner for Transport, Violeta Bulc was delighted to announce the funding: “I am very pleased to propose the largest investment plan ever made by the EU in the transport area.

“The projects we selected will serve citizens and businesses alike, by upgrading infrastructure and removing existing bottlenecks. They will promote sustainable and innovative mobility solutions. This unprecedented investment represents a major contribution to the Commission’s agenda of growth and job creations.”

Commissioner Bulc outlines her priorities and commitments for transport for the coming months in a short video - ‘Commissioner Bulc’s vision for EU Transport’<sup>2</sup>. In the video she explains how vital transport is, with an average European covering 12,000km per year and an

average family spending 13% of their household income on transport – the same amount as food.

“My goal is to create European transport systems that are seamless by removing all administrative and technical barriers,” explains Bulc. “In the long run, I would like to create an opportunity for a single transport area across all the modes.”

She went on to confirm how the European Union recognises the importance of potential innovation in transport. She highlighted that 24% of private research and development expenditure is dedicated to that area, with the European Commission, allocating €6.4bn into innovative transport solutions.

She said: “Transport accounts for 32% of energy use in Europe, at the same time it generates 24% of greenhouse gas emissions (GHG).

“That’s why I support the move towards the least polluting and most efficient transport solutions; those that are friendly to the environment and have a sustainable nature. In my mandate I will focus on digitalisation, alternative fuels, electrification based on alternative fuels and internationalisation of European transport solutions.”

The Commissioner is aware of the ambitious goals that she has set, but feels they are justified by the huge opportunities they will bring. ■

1 [http://europa.eu/rapid/press-release\\_IP-15-5269\\_en.htm](http://europa.eu/rapid/press-release_IP-15-5269_en.htm)

2 <http://ec.europa.eu/avservices/video/player.cfm?ref=I102073>

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# Energycaps: High power and high energy lithium ion capacitor

A research project in the frame of Industry-Academia Partnerships and Pathways (IAPP) – Marie Curie Actions...

The management of the electricity supply interruptions that can occur unexpectedly is vital for hospitals, telecommunication centers, airports, supermarkets, banks, tunnels or critical production plants. About 20 seconds are needed to start an additional electric generator of several megawatts (e.g., a diesel generator). To ensure the uninterrupted power supply (UPS), an intermediate device capable of delivering such a high power within a fraction of a second and keeping it up to about 20 seconds is needed.

Lead-acid battery has been meeting the demand of uninterrupted power supplies (UPS) at a megawatt scale for many decades. Its power to weight ratio is, however, very low and appears as major inconvenience.

Lithium-ion capacitors have recently emerged as an interesting alternative. Their competitive advantage over lead-acid battery is an important reduction of the device size. Compared to Li-ion batteries, Li-ion capacitors offer a better compromise between power and energy for this application.

This technology was identified as a new opportunity for SOLVAY to promote the products typically sold on the lithium-ion battery market. Li-ion capacitor could also be used to improve the fuel saving and reduce the CO<sub>2</sub> emission in hybrid vehicles.

A SOLVAY researcher sought for part-

**Electric bus in Nice (FR) powered without any fossil fuel and without cable. The bus gets the energy at each bus station within 20 seconds. This energy is currently stored in classical supercapacitor (also called ultracapacitors) and allows about 1km range (see: [www.pvi.fr](http://www.pvi.fr))**



Image: © PVI company

ners to the forefront in this field of research in 2010. Two academic teams (Poznan University of Technology, Kiev National University of Technologies and Design) and two small companies (YUNASKO from Ukraine and RECUPYL from France) were selected. They joined SOLVAY in the collaborative project "Energy Caps", sponsored by the European Marie Curie funding program "IAPP" (Industry-Academia Partnerships and Pathways) with more than 2 million Euros.

The objective of the project is to demonstrate market perspectives of this emerging technology (Li-ion capacitors).

The project started at the end of 2011. It has a mixture of secondments (26 researchers, 143 months) and recruitments.

Academic partners are involved in electrodes, electrolytes, separator and current collector development/optimisation.

RECUPYL is currently developing a recycling process and assessing the environmental impacts.

YUNASKO develops a prototype of Lithium-ion capacitor. The device provides an energy density similar to that of lead-acid battery, a charging time as low as 1 minute, and a number of cycles and power capability improved at least by a factor of 100.

Solvay products have been used in the electrodes, the separator and the electrolyte mixture. According to YUNASKO, LiTFSI, produced by SOLVAY is the preferred lithium salt for Li-ion capacitor.



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# Maximising the impact of green road transport

**Lucie Beaumel, Head of Office at the European Green Vehicles Initiative Association (EGVIA) outlines the importance of maximising the output of green transport...**

In order to achieve a more sustainable transport system and reduce the greenhouse gas emissions generated by road transport – which represents a quarter of EU greenhouse gas emission – European policy-makers and the industry agreed that efforts have to be made to promote the deployment of green vehicles across the European Union.

As the successor of the European Green Cars Initiative (EGCI – 2009-2013) implemented in FP7, the launch of the European Green Vehicles Initiative (EGVI – 2014-2020) in the framework of Horizon 2020 programme, constitutes a new opportunity for the clean vehicles sector.

Established on the basis of a contractual arrangement, the EGVI takes the form of a public-private partnership involving the industry, research and associate members of the European Green Vehicles Initiative Association (EGVIA) and the various Directorates General of the European Commission. It is coordinated by the Directorate General for Research and Innovation, providing financial support for the implementation of the Initiative.

Dedicated to delivering green vehicles and mobility system solutions which match the major societal, environmental and economic challenges ahead, this new initiative aims at accelerating research, development and demonstration of technologies allowing the efficient use of clean energies in road transport.

The scope of the EGVI slightly differs from its predecessor's: the focus is placed on the energy efficiency of vehicles using alternative powertrains. Thus, also including additional forms of alternative energies and covers broad types of road transport vehicles – from passenger cars to vans, trucks, buses, and new vehicle



concepts. The new initiative addresses innovation challenges and strategic topics, such as the electrification and hybridisation of powertrains, with a view to accelerating the transition towards a more energy-efficient and sustainable transport system. It will also boost the innovative strength and competitiveness of the European industry, thus contributing to address one of the major Grand Societal Challenges identified in Horizon 2020: the development of a Smart, Green and Integrated Transport system. Built on a cross-sectoral approach, the EGVI involves the automotive, smart systems and smart grids industries, with the objective to positively impact on the innovative strength and global competitiveness of the European economy.

In order to maximise its impact on greening road transport, the EGVI PPP develops an integrated approach, with the objective to cover the entire process chain from resource application to demonstration and creation of services, and to extend research and development to innovation. All products layers are addressed by the initiative, from modules to systems and vehicles, as well as the integration of resources and the integration into infrastructure. The projects



funded under the EGVI PPP will deliver innovative technologies that will contribute to reach the EU's target of reducing CO<sub>2</sub> emissions in transport by 60% by 2050. Thanks to the deployment of electric and plug in hybrids vehicles on European roads.

**“Dedicated to delivering green vehicles and mobility system solutions which match the major societal, environmental and economic challenges ahead, this new initiative aims at accelerating research, development and demonstration of technologies allowing the efficient use of clean energies in road transport.”**

Among the several topics covered by the EGVI PPP, several strategic research areas have been defined for the programme 2016-2017: topics on the hybridisation of road vehicles, next generation of electric drivetrains, or the new interior design of electric vehicles, will all look at the optimisation of energy efficiency – also considering cost or comfort aspects. Research on batteries will be put forward in order to cover, on one

hand their physical integration at pack level and on the other hand, the development of post lithium-ion systems supporting fast charging. For heavy duty vehicles, the focus will be put on electrification of medium duty trucks and buses, and the development of aerodynamic and flexible trucks. Additional topics will consider opportunities for weight reduction of vehicles and components, modelling and testing methods for electric vehicles, vehicle integration with fast charging infrastructure, or the integration of electrified L-category vehicles in the transport system. ■



**EGVI**  
European Green  
Vehicles Initiative

.....  
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**Head of Office**

European Green Vehicles Initiative Association (EGVIA)  
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# Cost effective solutions in difficult times

Speedar Limited is committed to providing cost effective solutions for the measurement of speed in campaigns to increase road and site safety

Speedar Limited was formed out of Ottery Electronics in 2004, encapsulating the wealth of experience gained by Ottery Electronics staff over a period of 30 years. A designer and manufacturer of speed measurement systems for Evaluation, Education and Enforcement in traffic applications, its core business has historically been in the field of hand held and tripod mounted radar units and Vascar systems. Speedar Limited are the only United Kingdom manufacturer of hand held radar equipment and hold United Kingdom Home Office approval for our Speedar range of equipment.

Speedar products have an enviable reputation worldwide and have been exported to over thirty countries in Europe, USA, Australia, Middle East and the Far East.

Speedar products have been sold to a high number of U.K. Police Forces, and Local Authorities in the United Kingdom as well as NATO forces. It has an increasing presence in the industrial market and can count some of the major corporations among its customers. In addition a recalibration and repair service as provided.

With the commitment by U.K. Government and Local Authorities to make the UK roads safer and reduce the incidents of death and injury, they have funded the provision of equipment to create community



speed watch groups. These groups provide a valuable contribution by monitoring motorists' speed through the villages.

Speedar Limited have supplied hand held radar units and associated training to several speed watch groups. The Speedar range has the advantage of being very robust, easy to use and considerably cheaper than Laser units. This makes it a cost effective choice for Speed watch groups.

A small but flexible company it has some notable achievements:

- **first** to use direction sensing Doppler radar.
- **first** to produce a cordless hand held radar.

- **first** UK designer of the VASCAR system.
- **first** standalone Laser Jammer Detector.

Speedar has a policy of continued product development and continually looks for new products in the fight to make roads safer.

## Construction and Industry

Recognising the increasing Health and Safety requirements on Industrial and Construction sites Speedar Limited has developed its highly successful SpeedVision range. The new SpeedVision SV3R is a standalone unattended unit that can be tripod, post or wall mounted and battery or mains powered. This enables the effective monitoring and recording



of speed violations whilst not endangering operatives standing roadside to operate the equipment. Recording of violations is to a CF card from which photographs with overlaid data can be produced using dedicated software. This has completed tests and literature will be available shortly.

For larger site applications, Speedar Limited is now developing a network version with speed cameras relaying data back to a central control room.

**Police 'In Car' system**

Speedar has also produced a new range of Vascar systems.

Vascar is a tried and tested method of speed measurement, computing distance and time to measure the average speed over a minimum distance.

This has the advantage of measuring the average speed rather than the 'spot' speed as measured by radar or laser. It also has the advantages of not being able to be detected or jammed.

Now, in line with the modern demand for Video evidence, the new Speedar range of Vascar includes video recording and display, with the Vascar information superimposed on the video.

Integrated with any in-car existing computer system they have the facility to enable the screen to be used as a normal pc display for ANPR and/or Sat. Nav. programs.

The hand held controller is equipped with positive 'feel' switches and audible indication that the switch has

been activated. These systems are designed for easy retrofit into existing vehicles, expanding the functionality and extending the life of existing equipment, thus eliminating the need to change whole systems. Furthermore the Vascar system can easily be removed and transferred when the vehicle is replaced.

Some clever design features and sourcing of quality components ensure that this unit meets the stringent requirements of the UK Home Office HOSDB/CAST specification. These systems have now completed U.K. Police trials, test house testing and have been submitted to the Home Office CAST department for final approval.

The objective of the new Vascar systems is not only to provide a means of speed measurement but also to provide a cost effective solution.

**SPEEDAR**  
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## BIM the HS2 way

In an interview with Jon Kerbey, Director of BIM at HS2, he explains to Editor Lisa Carnwell, how BIM will be utilised on the UK's first high speed rail endeavour...

**H**S2 has not been met with universal glee from everyone in the UK and still has its critics with many believing there is no real business case for it. Whatever your stance, the now Conservative-led government have always maintained its importance for the UK economy and will strive to ensure its implementation. They believe that HS2 is all about the future of building and strengthening the economy and the importance of recognising the growth of cities and the need to link them efficiently.

The first phase of HS2 between London and Birmingham was voted for in the House of Commons last year with a staggering majority of 452 to 41. The Hybrid Bill is now going through the parliamentary scrutiny process at Select Committee stage, where they are examining the route with a fine tooth-comb. It is hoped that the Bill will receive Royal Assent sometime in 2016.

Construction of the first stage will begin in 2017 with enabling works, utility diversions and demolition. Major tunnelling and civil engineering work will start

in 2018. Once complete, the new line will connect with the existing network north of Birmingham to allow services to travel onward to places like Liverpool, North Wales, Stoke-on-Trent, Glasgow and Edinburgh.

It is estimated that around 26,000 people will work on delivering HS2 with more than £10bn of civil engineering contracts due out for tender later this year. A project of this scale demands an approach that can handle the complexities of large-scale infrastructure – BIM of course was the natural choice for delivery. Jon Kerbey outlines the fact that:

“Nothing as yet has been built, all our value lies in our data about the railway. Using BIM as the methodology and the mechanism for capturing all that data and turning it into useful information and knowledge is the backbone of the project's success”.

### Standards

Using the standards involved in working to BIM Level 2 ensures that HS2 can use them in contracts to specify to the supply chain. Kerbey explains:





Image: © HS2 Ltd

recommendations resulting from it. One is to develop an up-skilling portal – as described by Kerbey as like “a web-based environment for interested parties to visit and learn about guidance, what we are doing, and what processes we will have, and what it means to meet the requirements of BIM in HS2.” The portal is due to be released in the next couple of months.

“It will be open to everyone and we will continue to develop it as our requirements become clearer and we get closer to procurement and contract awards,” Kerbey says.

“The content will be continually developed to make sure it is useful to everyone – not just our supply chain. We want it to be as helpful as possible to the wider construction industry, picking up the baton from Crossrail in terms of what they have done for industry, by learning their lessons and hopefully moving industry on.

“It is part of our duty as a major infrastructure project to help, but without catalysts like HS2 and Crossrail, it can be difficult to get momentum. The government has done a great job in promoting awareness of Level 2 and - at the end of the day - there’s nothing like the lure of big contracts to motivate firms.”

It is widely recognised that the UK has a shortage of the required construction skills, especially for HS2, or indeed any large rail project. At the moment, we have many capable of basic construction skills up to level 2, but HS2 need at least 50% of the workforce to be above that level. They are addressing this shortage through assisting the Department for Business, Innovation and Skills to establish the new [National College for High Speed Rail](#), which will help to develop the next level of skills needed by the time of peak construction. HS2 will be able to act as a catalyst for the industry - giving it a shove on BIM, but also a shove on basic level skills too.

It is hoped that by initiatives such as the new college, the image of engineering can be changed. No longer should the sector be seen as just manual work – with the advent of BIM, there are whole new careers available with technology at the heart. Only 1 in 7 engineering graduates are women. There is no real reason for this low figure – it just needs a little encouragement for them to take up the new roles.

“We have examined some of the standards to see how we can implement them most effectively and efficiently throughout all the supply chain. Because some standards are more accepted than others in terms of the supply chain capability level, we ran a supply chain upskilling study last year which was published back in October [available here](#).

“It clearly showed that Tier 1 companies are confident in meeting the standards as they are already doing BIM, or are well on the way to doing it. However, the study showed that if HS2 doesn’t intervene with Tier 2 organisations and below, there may be some issues with them meeting the requirements. HS2 are working on that at the moment – how we can best engage with them, and what that engagement looks like.”

### Education and skills

Being engaged with the supply chain also means that HS2 are quite visible in conferences and events – explaining what they are doing, what they want to do, and what their vision is. As part of the up-skilling study, they are starting to implement some of the

Industry is changing quickly, but people's perceptions are lagging behind.

### Challenges

Any project of this scale will create many challenges, but foremost on Kerbey's 'worry list' at the moment is that of procurement. He discussed the issue of specification stating it was vital that:

"We are specifying in enough detail for our supply chain – making sure we have the right information and BIM standards within the contracts, and making sure we have the right incentives in place to ensure we can deliver on our requirements".

He went on to say that:

"It's hard to specify really early in a project – which is what BIM requires for it to be successful – so you need an intelligent client. It's difficult to maintain the balance between under specifying so that you have complete flexibility in the supply chain, and over specifying so you almost stifle innovation. There aren't many user cases to go against, but working closely with Crossrail has enabled us to understand how they would do things differently this time".

### The software

Kerbey outlined that it was important to remain agnostic in their approach to the software used in the BIM process. They have listened to what the supply chain want and are trying to take technology out of the equation by concentrating on the information required. He explains:

"The reason we want to remain agnostic about software use is because if we were to dictate a software platform or design package that all of our supply chain had to use, it might mean that it may not be relevant to all of the disciplines that require different software packages.

"Also, we would be putting a massive reliance on some of our smaller suppliers to upskill in a package they may never use again on another project. This would be a big investment for them, not just from a training perspective, but also a software licensing perspective. The suppliers are comfortable with the packages they already use and they know how to get the best out of them in the most efficient way. We want to take advantage of that. If we as the client can accept data from any software package, then that will help the supply chain."

This software agnostic approach should also enable a simple approach to COBie detailing. The ability to use the data schema as the data exchange protocol doesn't change the approach as to whether HS2 used a single, or a multi-vendor route. Using a standard format to validate and to check asset information against it is vital. As Kerbey explains:

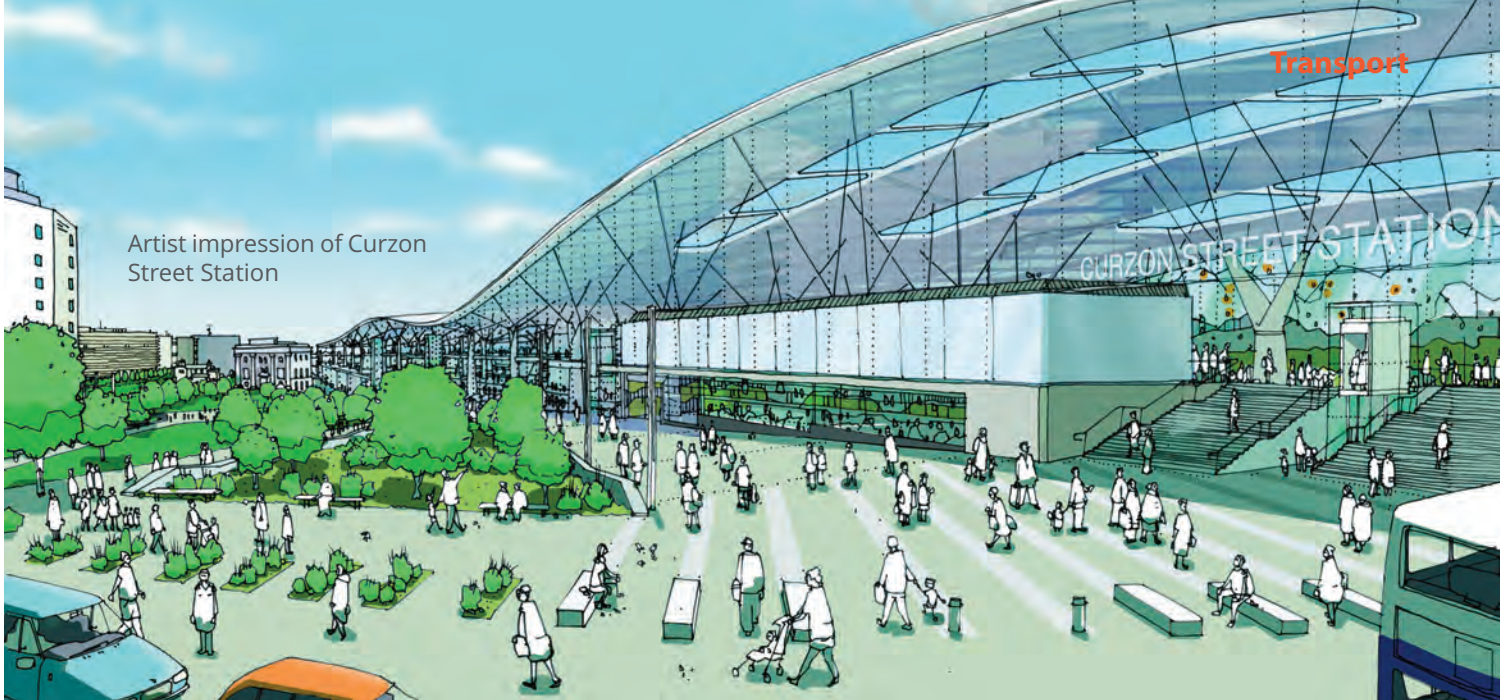
"If we can standardise data throughout the entire supply chain, then we've got a relatively easy job of joining everything together. However, the amount of data is really a different matter. This is one of the areas that we are testing at the moment – just to ensure that it is effective and efficient and we can do something with it."

### A successful BIM project

So what does a successful BIM project look like? What first steps are the most important? For Kerbey, the key is standardisation. This was the first aspect made clear in the project – making sure that everyone had standards to work to that achieved standardised data deliveries, and that there was a standard common







Artist impression of Curzon Street Station

Image: © HS2 Ltd

data environment that people actually worked in. This for Kerbey ensured they could improve the validation and assurance processes and streamline some of the delivery, and therefore, examine what efficiencies could be achieved.

One of the biggest benefits of BIM is that by working in a virtual world, the project can be tested and certainties realised very early on. As Kerbey described:

“When you do finally get onsite, you know what’s going to happen, when it’s going to happen, what will go where, and where people will be – the whole process is about mitigating risk. We are doing this earlier than anyone has before which has meant a change of working. BIM is very much about a cultural change and about people making decisions early on in the project. It has certainly presented more opportunities than it has frustrations, and provided a big learning curve for both the client and the supply chain.”

HS2 is reaping the lessons learned from Crossrail, which is perhaps Europe’s largest construction project to date. In an [interview](#) in an earlier edition of PBC Today, their Head of Technical Information Malcolm Taylor, said that the Crossrail project would be “exploiting, exploring and developing technologies that will be copied and built upon in future projects”. He wasn’t wrong. Kerbey acknowledged that one of the lessons learned means that:

“We actually understand a lot about our assets already. Even though we haven’t built anything, we have virtual assets and we know where they are down to a certain level of detail. We are capturing information

about them now and that will continue to mature as we go through construction, moving to as-built asset information. The big benefit is having a really efficient hand-over of information from HS2 construction, to operations and maintenance. By working in a data driven environment now, and to a standardised approach, we will be able to hand over data easily.”

### Meeting the 2016 deadline

The question of whether industry will meet the 2016 deadline is usually met with a similar response to that of Kerbey, who said he hoped they would. It seems pretty clear that those who are already engaging in BIM are seeing the benefits and will continue to develop their processes, but there is still some work to do. The HS2 supply chain BIM upskilling study showed that with certain tiers of the supply chain, some progress is still required and for Kerbey, he believes that:

“We need to make BIM fit for purpose, particularly for the lower levels in the supply chain – making sure they understand what they have to do, and that BIM is not a big unwieldy beast that maybe Tier 1 organisations have to cope with. It’s important to make it relevant to the people and organisations that are doing it.” ■

.....  
**Jon Kerbey**  
**Director of BIM**

HS2 Ltd  
[www.gov.uk/government/organisations/high-speed-two-limited](http://www.gov.uk/government/organisations/high-speed-two-limited)  
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# Advanced security for countering terrorism

**Simon Adcock, Chairman of the British Security Industry Association's CCTV Section, offered his insights for the most effective ways of securing the UK border at a commercial level...**

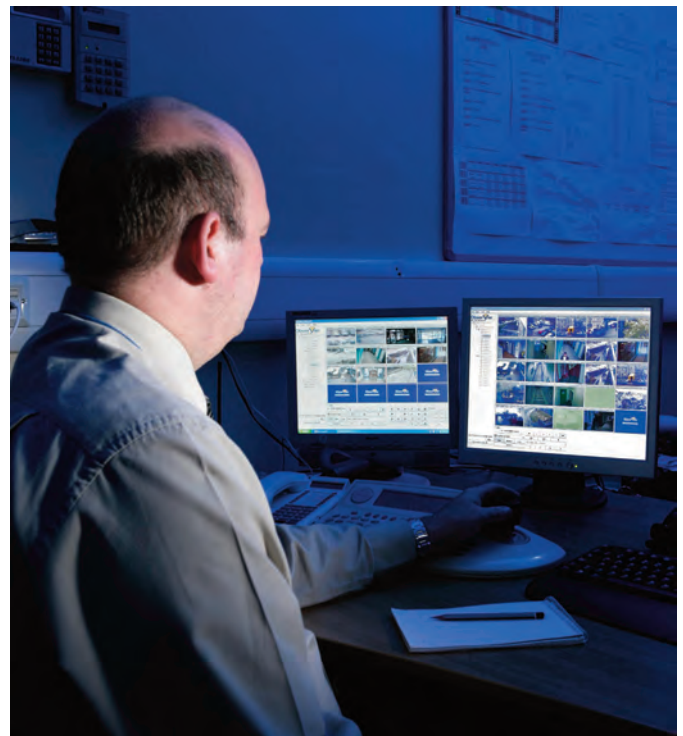
**W**ith thousands of migrants rioting in the French town of Calais while attempting to cross the channel, the British Government has begun to reassess their security strategies to better police the areas they are responsible for.

A robust strategy should be employed by the border force and contracted security firms in order to combat the influx of migrants trying to cling to heavy goods vehicles (HGV's) and trains, to prevent human trafficking and most importantly to stop potential terrorist activity that currently threatens the United Kingdom. Currently, the UK border is protected by a variety of security measures taken to address these issues. However, the most difficult areas to police are often the busiest.

Border crossings to be secured might be part of a larger publicly available site such as an airport or port. Careful planning and consideration should be given to these areas to ensure the smooth operation of commercial businesses and travelling civilians.

As Theresa May recently outlined, perimeters to staging areas in ports should be secured with 2 hardened fence lines to create a sterile catchment zone<sup>1</sup>. All persons found within the catchment area should be treated as suspicious. Advanced access control points should be placed at limited intervals throughout the fence line to allow access to security services.

Furthermore, to better secure the sterile area, the deployment of thermal imaging cameras at regular intervals along the fence line would provide a superior system to legacy CCTV to alert security personnel to potential threats. Thermal cameras are able to monitor large areas of land with great efficiency.



Threat assessment reports should be conducted for all potential penetration points in order to have an overall awareness of where the perimeter around important facilities is weak. Gates should be opened and closed rapidly and under vehicle scanning can also be conducted as HGV's pass through security checkpoints.

With the increased threat level that terrorism presents to the UK, security is paramount at every border crossing to be secured. Video Content Analysis (VCA), also known as Video Analytics and Smart CCTV, is the technology within video surveillance that analyses and detects temporal and spatial events. This can and should be deployed at ports or other border crossings to recognise repeat offenders and those on 'wanted lists'.



With heightened alert levels in most of the western world, a robust physical security presence should be deployed in order to reassure the public that all is being done to counter illegal and terrorist activity. Security officers should never allow themselves to lose focus or relax a vigilant attitude from the task at hand of protecting a nation.

It is not easy to plan security for borders, where open and multifaceted spaces characterise the area in question, but the key is to have in place a number of security measures that can complement each other. Combining CCTV with access control and physical security measures such as fencing, bollards, doors and locks, backed up with security patrols can provide an overall security solution that is effective and intimidating to would-be criminals.

The deployment of advanced security measures should not only be implemented to stop criminals and terrorists, but also for the sake of commercial efficiency. Personal injury claims can have a large detriment to a business or organisation if individuals continue to attempt to gain access by high risk means. Employees, especially HGV drivers in Calais, are also

being affected. The stress could impact their work but worse, their health or judgement while they are driving. Increased and advanced security protocols will give peace of mind to the transport industry.

The British Security Industry Association is the trade association covering all aspects of the professional security industry in the UK. Its members provide over 70% of UK security products and services and adhere to strict quality standards. To find out more about the products and services offered by BSIA members, visit our website at [www.bsia.co.uk](http://www.bsia.co.uk). ■

1 <http://www.theguardian.com/world/2015/jul/14/calais-secure-zone-theresa-may-lorries>

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# The power of surprise

**Antoon Burgers, Program Manager for Holmatro Special Tactics Equipment details the advantages of using hydraulic tools for police operations...**

Every day, police forces all over the world are faced with suspects who may be hiding in houses or business premises. In many cases these suspects are armed, on the run from the police or carrying out illegal acts when the team enters the building. For many decades, police forces have used various breaching tools in order to gain rapid access to houses and business premises. Let us examine a scenario:

A team of detectives gather at a police station in the middle of the night, in the heart of the city. This team is specialised in detecting houses that are being used as drug dealing premises. Evidence against a suspected hard drug dealer has been gathered for several months. This dealer sells the drugs from his home and has been arrested by the police for the possession of drugs on a number of occasions. Observation has revealed that a large number of people visit the house of the suspected drug dealer in the evening, and 2 people have been arrested for the possession of drugs after visiting the house. After consultation with the public prosecutor the decision was made to raid the house tonight. The goal is to arrest the suspect and to find drugs in the house if possible. These could subsequently be used as evidence in the legal proceedings. It is therefore very important for the team to surprise the suspect when the house is raided. This will enable the team to prevent the suspect from quickly getting rid of drugs and other evidence. The police has no indication that the suspect will resist arrest. There is also no indication that the suspect is in possession of a firearm.

The moment that the team had observed that all of the lights in the house had been switched off and that the suspect had probably gone to sleep, they gathered in order to prepare for the raid. The detectives started

with an exhaustive briefing in which all of the facts relating to the suspect house were discussed. The decision was made to break the front door of the house with a 'storm ram' – a long iron pipe with a weight of 20 kilograms. As soon as the house was open the detectives would enter as quickly as possible in order to arrest the suspect.

**“One of the detectives who was using the storm ram fell to the ground shouting he was wounded. The team saw that there were 2 small holes in the door of the house and that their colleague had a bleeding wound in his shoulder. This raid had suddenly taken a completely different turn...”**

The team put on bullet-proof vests, collected the required breaking equipment and travelled to the house. When they arrived, the detectives parked their vehicle at the end of the street, and walked the final distance to the house in order to keep noise to a minimum. The team hoped that this would ensure that the suspect did not wake up before the front door was broken. Once they arrived at the house, the team moved into position and 2 detectives stood in front of the door. They were responsible for breaking the door and together held the storm ram. When the complete team was in position, the 2 men stepped forward and shoved the storm ram in the direction of the door. Soon they noticed that this first impact was insufficient and that the door was still locked. After a second attempt again the door stayed closed. They decided to try once more. But at that moment a loud bang was heard from inside the house followed by a second and third bang. One of the detectives who was using the storm ram fell to the ground shouting he was wounded. The team saw that there were 2 small holes in the door of the house and that their





colleague had a bleeding wound in his shoulder. This raid had suddenly taken a completely different turn.

When the suspect was finally arrested, it was revealed that he had used a firearm to shoot through the front door of the house 3 times. The suspect stated that he had been threatened by another drug dealer for several months. This dealer wanted to take over his 'business' and had threatened to murder the suspect if he continued to sell drugs from his house. When the suspect was shocked awake by the noise of the front door being broken, he thought that this other

dealer had come to his house to kill him. The suspect then took a firearm and shot at his front door in order to scare him away. The suspect stated that he had never heard that it was the police standing in front of his door. No drugs were found in the house after the arrest.

### Keeping distance

A significant risk for the police officers in this scenario is that they had to position themselves in front of the access door in order to be able to breach it. This can lead to extremely dangerous situations when you do not know what is happening behind the closed door. While they concentrate on breaching the access door, it is impossible to completely focus on the potential dangers to themselves and their colleagues. This puts police officers in an extremely vulnerable position.

**“Another great advantage of these hydraulic breaching tools is that they can be operated in complete silence, making the surprise for the suspects even greater. This gives the police officers more opportunity to overpower the suspects and/or secure evidence faster. The hydraulic door openers have such power that even the strongest locks and hinges can be broken.”**

Countless practical examples have shown that in cases of breaching a door, suspects feel trapped which leads to them using a firearm to shoot at the door. Most of the time, the stress and the noise of the breaching means that these people are not aware of the fact that a police officer is on the other side of the door.

Practice has now shown that the safety of police agents is increased when they are only positioned in front of the access door for as short a period as possible. It is even better if the officer is not in front of the door at all when it is breached. We must also consider the possibility of 'booby traps', which are regularly placed behind doors in order to prevent undesired access.



**Hydraulic breaching tools: increased safety and silent operation**

Fortunately, a great deal of hard work has been devoted to the development of hydraulic breaching tools that can be operated remotely. These tools are developed in consultation with specialist police units. The manufacturers have listened closely to the wishes of these units and translated them in their equipment. The many years of practical experience gained by these police units, combined with the manufacturer's knowledge of hydraulic equipment, are used in these

special tactics tools and now give police forces all over the world a new possibility to enter houses or business premises with increased safety. The hydraulic breaching tools are frequently derived from rescue tools developed for the fire and rescue market. These tools are already well-established and are an essential part of the equipment of rescuers around the world.

Another great advantage of these hydraulic breaching tools is that they can be operated in complete silence, making the surprise for the suspects even greater. This gives the police officers more opportunity to overpower the suspects and/or secure evidence faster. The hydraulic door openers have such power that even the strongest locks and hinges can be broken.

**“Most of the time, the stress and the noise of the breaching means that these people are not aware of the fact that a police officer is on the other side of the door.”**

Specialised police units in many countries make daily use of these hydraulic breaching tools and are also introduced to other special operations and military forces. These teams are becoming increasingly aware of the risks and realise that a safe distance and silent operation, when breaching doors, create a better overview and increases their capacity to respond to potentially dangerous situations. ■



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**Antoon Burgers**  
**Program Manager**

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Watch the video:





# Investing in learning & development

Ruth Stuart, Research Adviser at CIPD speaks to Editor Laura Evans about learning and development and why it's an important investment for organisations...

Organisations are increasingly tapping into talent already employed within their business. This can have great benefits including reducing costs, and protecting skills you may need in the future. In the CIPD 2015 Learning and Development survey many organisations reported a lack of confidence in using technology, and yet also predict growth in areas such as e-learning, virtual classrooms and social learning.<sup>1</sup>

The report also highlighted that many organisations and businesses are still struggling to evaluate the impact of L&D activity on the business. Ruth Stuart, Research Adviser at CIPD explains about the main benefits of L&D.

"Learning and development can comprise of a lot of different activities", explains Stuart.

"But overall it's really about developing employees, so they can contribute to organisational performance. Within a lot of organisations it's also about encouraging change across the entire organisation, and using L&D as a way to develop the culture of the organisation, and in turn develop the business. It's no longer just about training in its traditional form."

As businesses evolve at a rapid pace, L&D is integral to help this progression. At a time when budget cuts are significant throughout the whole of the public sector, organisations are encouraged to develop long-term sustainable growth. Learning and development can help with this progression and transform businesses, as Stuart outlines.

"If we look at capability within organisations, if we can develop employee and organisational capability, that can be a key driver towards developing businesses or transforming an organisation.



"If there is a situation where they need to make a radical change to a business model, making sure that you have got employees with the right skills in the right place is essential to that process.

"For learning and development initiatives to really have a powerful impact they need to be aligned to business needs," she continues.

"There has to be a critical component of an L&D programme, and the actual strategy, that is really aligned to business needs. Otherwise, you might end up investing in something that won't have an impact on the overall performance of the organisation."

There can be many different methods of learning and development, and the CIPD 2015 report identified the most used and most effective ones. Different organisations will benefit from different methods, depending on their goals and business needs. In the report, on-the-job training, in-house development programmes, and coaching by line managers or peers came out as the most commonly used and most effective development methods, in line with findings from previous years.

Ensuring the learning initiatives are worth the investment can be part of the process of deciding on the right method. Stuart believes that there has to be a really robust evaluation process as a starting point.

“If you have a robust evaluation process at the start and align that with your business needs, that allows you to see if the initiatives that you introduce are the right ones,” she says.

“It’s important to have the ability to measure and understand the goals of the initiative and the impact it’s designed to have. Looking at the overall impact, whether they are learning new skills on a training course, or coaching or mentoring on an online programme, how are those employees really transferring the skills to the workplace, and what is the ultimate bearing on their performance and therefore the organisations performance.”

Before introducing training initiatives into the organisation and to employees, Stuart believes that consideration is needed to the business strategy first and foremost, and what the training could bring to that strategy.

“There are many different ways of looking at that,” she explains. “It could be that you have the strategy around business growth, so it’s therefore looking at what are the capabilities you might need for the future, and the changing the business environment, and putting the steps in place to develop the right initiatives – to develop the skills you need for the future.

“For the employees, learning and development can have a really important role in regards to developing an individual’s long term career. I think if you look at all the ways an individual can develop, whether that be technical skills, or more leadership or behavioural skills – investing the time in developing yourself can impact your individual performance, but also set you on a course for different or larger roles in the future.”

In regards to growth and the organisation moving forward, I asked Stuart what role continuous improvement can play in learning and development strategies, and whether the two go hand in hand.

She explains: “Continuous development and improvement has a really important part to play. I don’t think learning and development should be viewed as a one off initiative, it should be viewed as part of your day to day life.

“You might have a meeting and a situation where you learn something new, and to me that’s learning and development. If you have the time to reflect on what you’ve learnt every day then that’s part of continuing to develop your skills and capabilities.”

She also explained that it’s important as an organisation to send the right messages to your employees in regards to developing as a business and themselves.

“It’s about setting a culture of continuous improvement, she says. “It’s about everyone in the organisation, from leader’s right down to every employee, making it a real expectation that everybody focuses on continually developing themselves.

“Having role models in the organisation who can really highlight that and make it really apparent that continuous improvement is important to them no matter how senior they are. That’s a really important message to send”, she concluded. ■

1 [http://www.cipd.co.uk/binaries/learning-development\\_2015.pdf](http://www.cipd.co.uk/binaries/learning-development_2015.pdf)

.....  
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# Winning Support for Continuous Improvement Projects

Your quick step-by-step guide

**G**aining support to implement and sustain a continuous improvement program is an oft-voiced concern within organisations. These concerns reflect frustration in both senses of the term – feeling frustrated personally and encountering attitudes that frustrate the effectiveness of the program.

Three sets of skills and methods have shown success in gaining buy-in. They are:

- Using a proven step-by-step process for leading change.
- Recognising and overcoming resistance to change.
- Applying influence principles to engage resistant stakeholders.

## Step-by-Step Process for Leading Change

### Step 1: Establish a Sense of Urgency – Confronting Reality

People tend to feel comfortable with their current situation and naturally resist change – unless there is a good reason for change. The outcome of Step 1 is, in effect, a compelling business case for change. Why is this change necessary? Articulating that compelling reason – the issues with the current reality that drive an individual, a group or a company to drive others – is a critical first step.

For an individual project, the project charter – approved and supported by key stakeholders – can provide this compelling reason, this urgency. For a

broader initiative, such as implementing an entire Lean Six Sigma (LSS) program, substantial effort might be required to identify major issues holding the organisation back, and thus provide compelling motivation for change.

### Step 2: Form a Guiding Coalition – Early Stakeholder Engagement

Implementing change by yourself is not only lonely and frustrating – it is also ineffective. It may be appropriate to combine Steps 1 and 2 to form a guiding coalition that shares your sense of urgency and then brainstorm ways to clearly articulate the “burning platform.”

For an individual project, the team is the obvious coalition – with the addition of a management sponsor or Champion committed to the success of the project. For a LSS program, key stakeholders such as management sponsors or Champions would make a good guiding coalition – especially if the LSS program can be shown to align with achieving their own goals, the organisation’s “must-do’s” going forward. In that sense, the LSS program provides the how for achieving the goals.

### Step 3: Define the Vision

Defining the vision for improving a process or developing a new product can be a team-building activity that leads to a vital deliverable: for a smaller-scope project, a compelling



business case for the project; for a larger-scope program, the compelling vision that the stakeholders (the guiding coalition) would share with the larger organisation for how the LSS program aligns with achieving the goals of the organisation.

Team building with the guiding coalition is part of the desired outcome, and the development of the vision should involve the stakeholders so that they feel ownership of that defined vision. The vision could include such concepts as doing things right the first time, dramatically reducing new product development time or ensuring that the voice of the customer (VOC) is heard and heeded.

For a smaller-scope project, the vision can initiate and establish the project charter. For a larger-scope project, an effective set of steps for defining the vision could be:

- The senior manager/executive clearly articulates the burning platform. The stakeholders then brainstorm the issues, starting with the issues from Step 1.



- The stakeholders brainstorm keywords, phrases and terms that seem to capture the direction they would like to take.
- Either the team begins to construct a first-pass vision statement, or a stakeholder or a pair of stakeholders volunteer to work on a first draft of the vision statement for the team to review, amend or replace.
- The team reviews, edits, modifies and finalizes the vision. The vision should be easily remembered, brief, clear and compelling – powerful!

**Step 4: Communicate the Vision**

If the vision has been polished so that it is brief, clear, compelling and easily remembered, then it has fulfilled the first part of the equation:

$$\text{Quality} \times \text{acceptance} = \text{effectiveness}$$

This equation explains that the effectiveness of a proposed change within an organisation depends not only on the quality of the change and the preparation for the change, but also on the receptiveness of the organisation to accepting and even embracing the change.

Some key elements required for communicating a vision well include the following1:

- Simplicity
- Analogies and examples
- A variety of media: meetings, memos, lunches, emails and newsletters. Some of these allow for a two-way communication, which is more powerful than simply talking “at” people and allows messengers to address questions and concerns.
- Repetition
- Leadership by example. Nothing

undercuts a vision like having leaders undercut the message by inconsistent behaviors or snide or counter-message remarks. Even expressions of lukewarm or contingent support undermine the credibility of the message, and subsequently its acceptance. Communicating the vision is a time to show leadership, not hesitancy.

- Addressing of seeming inconsistencies, which otherwise might also undermine the credibility of said vision.

**Step 5: Empower Others to Act on the Vision**

The term frustration is unusual in that it defines both the symptom and the cause. If people begin to feel frustrated and discouraged, it probably means that something seemingly or actually beyond their control is preventing them – frustrating them – from accomplishing the goals.

The Champion’s role is to help individual project leaders and Lean Six Sigma ‘Belts’ remove roadblocks in their projects.

**Step 6: Generate Short-term Wins**

Short-term wins help a team in a multitude of ways. They:

- Provide evidence that supports and provides justification for the project or program.
- Deliver a sense of accomplishment.
- Convey helpful feedback for the leadership team.
- Undermine cynics and critics.
- Strengthen support from the managers.
- Help build momentum.

DMAIC (Define, Measure, Analyse, Improve, Control) Lean Six Sigma proj-

ects lend themselves to low-hanging fruit. They find opportunities for quick wins in the Define and Measure phases through process mapping and the identification of non-value-added activities. Beyond that, team-building activities such as brainstorming and fishbone diagramming can achieve visible, if small-scale, success. From small acorns grow...

**Steps 7 and 8: Consolidate Gains and Anchor the New Approach in the Culture**

People rise to challenges if they trust that:

- Leaders care about the project.
- The team will be supported.
- Individual successes and the full team’s success will be recognized.

People also feel recognised when they are encouraged to share their successes, through presentations to management and elsewhere within their organisations as well as through presentations to other organisations. Media such as staff meetings, newsletters, bulletin boards, posters and banners can be used to recognize people and teams and celebrate success.



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# Why train staff in Lean Six Sigma?

**Dr Andy Slaney, Principal Consultant and Lean Six Sigma Master Black Belt, BSI explains the benefits to organisations of using the training initiative Lean Six Sigma...**

**W**ith its roots in manufacturing, Lean Six Sigma is now being applied across numerous diverse industries, in both the public and private sectors. Irrespective of whether the organisation involved deals predominantly with products, information or people – or a combination of all 3.

Lean Six Sigma is about improving organisational performance and sustainability. It does this through the development of a precise understanding of customer needs, and how to meet those needs in the most effective and efficient way.

When utilised correctly, Lean Six Sigma can provide the organisational structure, project methodology, toolkit, philosophy and motivation to understand and seriously challenge poorly performing processes. That is irrespective of institutional objectives.

## **Lean vs Six Sigma**

In order to understand the benefits of Lean Six Sigma training it is necessary to understand a little more about Lean Six Sigma itself.

Firstly, the techniques and philosophies of Lean place a great focus on ensuring that processes are designed and operated to fulfil the needs of the customer and that all activities can be regarded as value adding. Lean also stresses the need for processes to have unhindered 'flow' and not waste effort, time, materials, information, equipment, or assets.

Lean when combined with Six Sigma's aggressive drive to consistently meet customer needs, reduce variation and promote process stabilisation, provides a powerful means by which organisations can improve.

Most individuals coming to Lean Six Sigma for the first time actually leave the training with a very changed and fresh perspective on ideas such as, what it means to be customer focused, how much waste occurs every day in organisations and how they can contribute to making the organisation successful.

## **Organisational Structure**

What is the organisational structure used when deploying a Lean Six Sigma based improvement programme? Initiated by Motorola, who first developed and codified Six Sigma methodologies in the 1980s, and based on the martial arts, you will often find the term 'belts' being used.

Although Lean Six Sigma programmes are fine-tuned to the organisation, typically a number of belt types exist in any major deployment. The belts receive an appropriate level of training for the role they are expected to perform. Some examples of common belt 'levels' are given below:

- White Belt – One day training in the concepts involved with Lean Six Sigma. Will participate in problem solving or continuous improvement teams;
- Yellow Belt – Two days training in basic problem solving and facilitation skills. Will drive local problem solving initiatives and be an active participant in larger improvement projects;
- Green Belt – 10 days training in advanced problem solving and continuous improvement tools, as well as a selection of leadership and project management techniques. Will drive and lead longer term continuous improvement projects in their local area;

- Black Belt – 20 days training covering a wide array of practical, graphical, statistical and leadership tools used in Lean Six Sigma. These individuals are the most advanced improvement experts and change agents and are expected to drive difficult and challenging projects;
- Project Sponsor or Champion – Two days training that promotes management involvement in all stages of a continuous improvement project's lifecycle.

**Project Methodology**

Many project based methodologies and templates are associated with problem solving and continuous improvement. Lean Six Sigma teaches the scientific method, as well as a pragmatic and common sense approach to problem solving.

Trainees are taught the DMAIC methodology, helping them to understand that improvement projects should follow some important phases, namely:

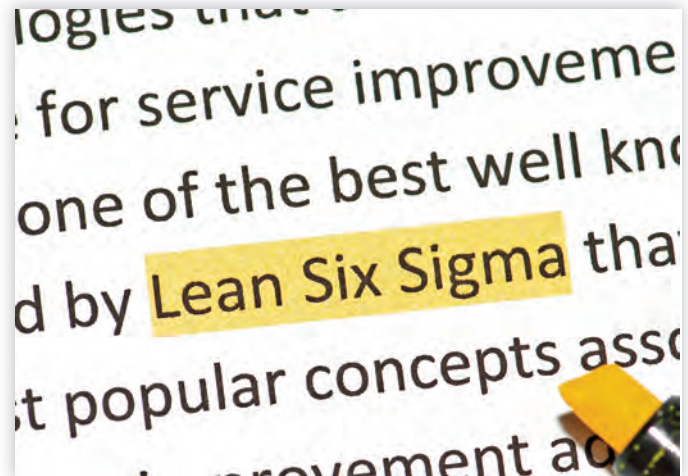
- Define the problem or opportunity;
- Measure the current state; data is key;
- Analyse to understand root causes;
- Improve and address process issues; validate improvements;
- Control the process long term to maintain the gains.

Those who have been Lean Six Sigma trained are less likely to engage in short term fire fighting, will understand the importance of using objective data and will be in the best position to enact long term business solutions.

**Philosophy and Motivation**

Anyone associated with Lean Six Sigma, understands that engaged people are the most important asset to any organisation.

Lean Six Sigma is inclusive, promotes ownership of issues and encourages everyone to be involved at some level, whether as a team member, team leader



or as a project sponsor. A focus on process can eventually be used throughout, encouraging people to solve problems, continually seek improvements and never to blame others for organisational shortfalls.

**“Lean when combined with Six Sigma’s aggressive drive to consistently meet customer needs, reduce variation and promote process stabilisation, provides a powerful means by which organisations can improve.”**

In order to obtain the benefits of Lean Six Sigma, any institution embarking on the journey will need to train and coach its people well. Without adequate support, attempts at introducing a culture of continuous improvement, which Lean Six Sigma demands, will fall by the wayside.

Instead, the application of the ‘correct tools for the job’ and the ‘engagement of the right people’ to obtain your belt can help your organisation to start fighting and become the best in class. ■

.....  
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# Productivity: What part can employee engagement play?

David MacLeod OBE and Nita Clarke OBE, investigate why the UK has a productivity deficit, and looks at some of the factors that might address the problem...

**W**hy has productivity stalled? Our view is that what actually happens on a day to day basis in our workplaces, public and private, may provide a compelling insight. Put simply, too many employees find their abilities and skills underutilised at work; they may be working extremely hard, but ineffective business organisation and processes means much of this effort is wasted. Ineffective or positively dysfunctional managers add to the problem; and organisations that fail to explain their purpose find it unsurprisingly hard to motivate staff. Resistance to change is endemic across organisations, and most employees characterise their organisations as low trust. Very few organisations really listen to their employees and consequently have little idea about life on the ground, and fail to invite or follow up on employees' ideas about product or process improvement.

A recent survey of thousands of employees across 20 countries found the UK had the third lowest levels of engagement, 10% behind the global average. What a waste of people's potential, what a loss of productivity and what a cost to the nation.

So better employee engagement may offer part of the answer and part of the solution. Employee engagement, according to the Institute of Employment Studies, is 'a positive attitude held by the employee towards the organisation and its values. An engaged employee is aware of the business context, and works with colleagues to improve performance within the job for the benefit of the organisation.'

There is increasing evidence of the link between engagement and productivity – on an individual and an organisational level. There is a strong relationship between engagement and both employee advocacy and customer satisfaction and loyalty. In a massive



survey of over 23,000 business units, Gallup found that those with engagement scores in the highest quartile were 18% more productive than those in the lowest quartile.

How are we to explain this link? Innovation may be central to this. Engaged employees are more innovative; they seek to continuously improve processes, look for new ways of adding value to their work and are more likely to suggest and follow through on new ideas. In 2007 Gallup found that 59% of the more engaged employees said that work brings out their most creative ideas, compared to just 3% of the less engaged.

So what are we to do? It may be worth looking back at the 4 enablers of engagement – a strategic narrative, engaging managers, employee voice and integrity – identified in our report *Engaging for Success* (2009).

## Strategic Narrative

The strategic narrative is about having 'a strong, transparent and explicit organisational culture which gives employees a line of sight between their job and the vision and aims of their organisation.' Employees need to find meaning and purpose in their work. They need to see how their individual graft and toil

contributes to something greater, something that they can buy in to and believe in. Otherwise work becomes merely contractual and transactional – you come to work and do what you’re told just because you have to.

Looking at the Workplace Employee Relations Study (WERS) – a large survey of the UK workforce – there seems to be some way to go here. Two in three employees (65%) agree or strongly agree that they share the same values as their organisation. But just 16% strongly agree, indicating some room for improvement.

**Engaging Managers**

Line managers are absolutely crucial to employee engagement. We identified the importance of having engaging managers who ‘offer clarity, appreciation of employees’ effort and contribution, who treat their people as individuals and who ensure that work is organised efficiently and effectively so that employees feel they are valued, and equipped and supported to do their job.

Again, while the headline figure from WERS is reassuring – with two third (64%) saying that relationships with managers are good/very good – just one in 5 (21%) believe they are very good.

**Employee Voice**

Voice is central to employee engagement. We defined voice as having a situation whereby “Employees’ views are sought out; they are listened to and see that their opinions count and make a difference. They speak out and challenge when appropriate. A strong sense of listening and responsiveness permeates the organisation, enabled by effective communication.’

There is evidence of a voice deficit. ETUI rate the UK as second bottom of the league in the EU in terms of employee participation – beaten into last place only by Lithuania. Evidence from WERS shows that just one employee in 2 (52%) says that managers are good or very good at seeking their views. Fewer still – just one in 3 (32%) – say that managers are good or very good at allowing employees to influence decision making.

This is a significant cause for concern. If employers are to benefit from the expertise and experience, the

ideas and innovation of their employees, they need to allow and indeed encourage them to speak up.

Many of our most productive industries tend to buck the trend of low voice and low involvement. Take the automotive industry or the aerospace sector, where high levels of union membership, and high levels of employee involvement go alongside incredibly high levels of productivity.

**Integrity**

The final enabler of engagement is integrity. This is defined as ‘a belief among employees that the organisation lives its values, and that espoused behavioural norms are adhered to, resulting in trust and a sense of integrity.’

Again, there is evidence of some work to do here. WERS shows that just one in 2 employees (50%) agree/strongly agree that managers keep their promises. Only slightly more (58%) agree/strongly agree that managers deal with employees honestly.

The UK faces a productivity puzzle. Employment relations could in part be the missing piece. If employers in the UK were better able to engage with their employees, we could both improve the quality of work for people, and drive up productivity for the benefit of all. ■

This article was originally published by ACAS in their recent publication Building Productivity in the UK. The report and other useful material is available here [www.acas.org.uk/productivity](http://www.acas.org.uk/productivity).

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# Change management

Why is it difficult to make it part of business as usual?

Change Management is not well understood amongst business leaders plus the skills to perform it do not occur in many businesses as a norm. Sometimes people expect IT solutions to provide the silver bullet to cure this but it does not and ends up transferring the problem from the business to IT.

In many cases resistance to change is under estimated, for example key performance indicators built into the existing systems can be counter-productive to change; businesses do not identify the benefits associated with change and do not monitor whether the change has been implemented and is sustainable.

**So how can we change this?**

**Why should we change this?**

Change is a way of life and the two quotes that underline this:

J F Kennedy said:

*“Change is the law of life and that those that look only at the past or the present will miss the future.”*

Whilst Winston Churchill said:

*“To improve is to change, to be perfect is to change often.”*

**So what do we mean by Change Management and who is involved?**

This is the transformation of a way a company does business and facilitates



the removal of waste and poor practice. It needs a change of behaviour at all levels from Senior Executives and Departmental Managers, to front line staff.

**Why is it so hard?**

First of all any change requires a goal and a vision and staff in a business need to be able to see their own benefits as well as the corporate ones to participate in any change that is required. Change is the movement from the known to the unknown with the resultant fear of it. Change will

require clarity and consistency in a person’s role, how they will be measured, and decision making skills that they will need. This will identify the gap between their present skills and those required to make the change a success.

**So what are the key elements that are required to be understood to make change successful?**

The first of these is the development of a vision. There are a number of tools to help companies do this, such





as Target Operating Models that enable senior managers to articulate the vision. Done well these define the future state in terms of processes, business rules and job roles; leading to a change agenda covering organisation, roles and processes.

If we get this right then change is not guaranteed to be successful, but it certainly lays the groundwork for it to be..

**What are the benefits and what follows on behind a change programme?**

A better ability to measure and manage processes, embedding of change skills and the mind-set can ensure that continuous improvement is buried and becomes a part of business as usual. This avoids the problem that change has not been tackled for such a long time irrespective of many changes in technology, mergers and acquisitions or growth,

requiring huge jumps making change painful and quite scary.

A number of quantifiable benefits such as increased business performance; bottom line performance growth and better agility within the market place can be achieved. Increasing the staff contribution by getting them to be enthusiastic about embracing change and moving the business forward. Improving measurements can enable staff to contribute effectively to business performance, they can also potentially reduce external support costs, avoiding handing the change programme to external agencies.

At H3 Partners what we do is we provide both the facilitation and mentoring of internal change teams and management teams as well as leaving our customers with the tools, techniques and the confidence to sustain change going forward. Successful

change programmes are fun to be engaged in and leave many of the participants with a real array of new skills and able to make a better contribution to the business.



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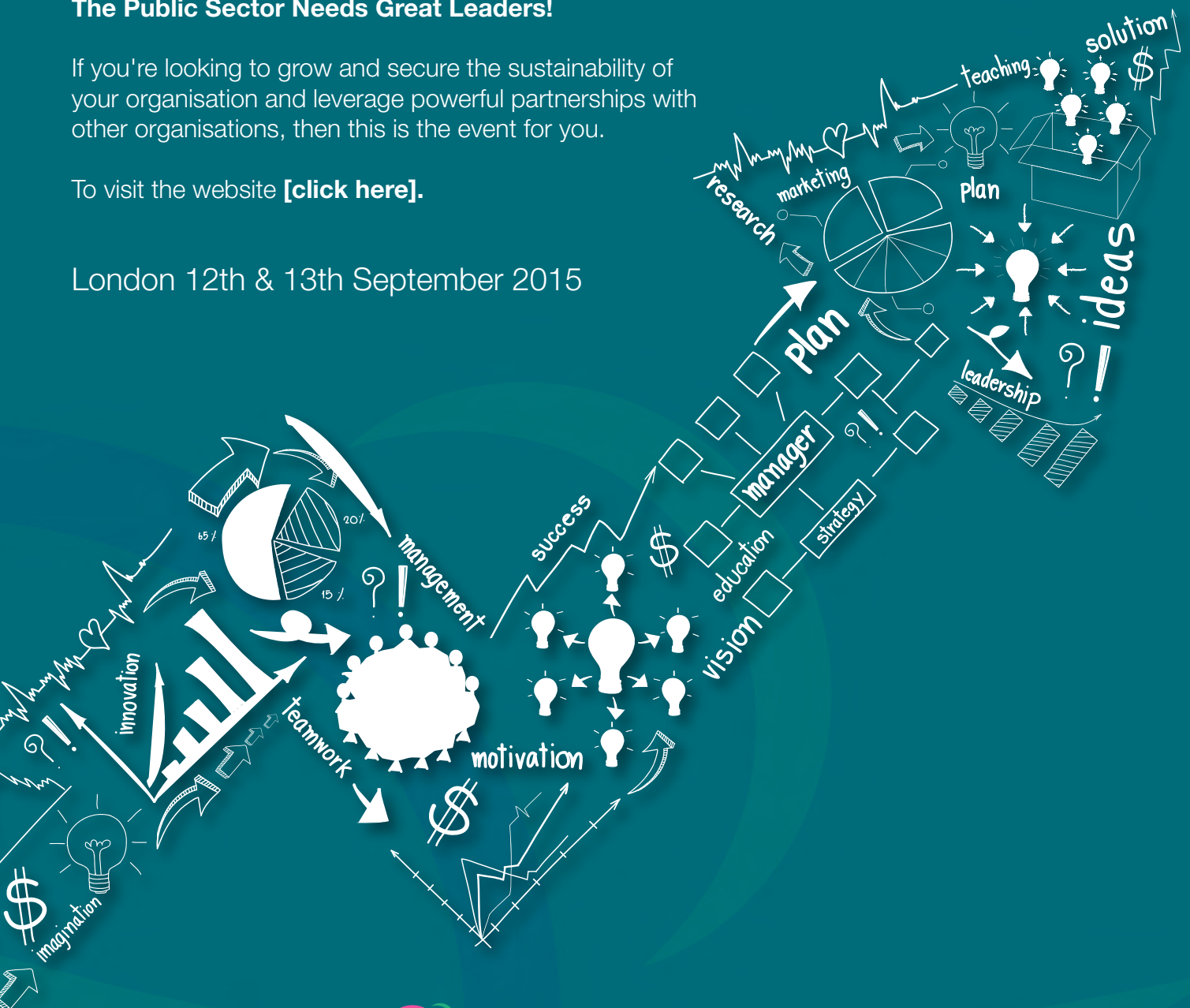
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# How standards benefit the UK economy

**Daniel Mansfield Head of Policy Engagement at BSI discusses how standards contribute to the UK economy, and focuses on the stand-out sectors...**

Independent research by Cebr (Centre for Economics and Business Research), commissioned by BSI, the UK's National Standards Body and funded by the Department for Business, Innovation & Skills, uses macroeconomic data for the period 1921–2013 to analyse the impact of standards on the UK economy as a whole. It also uses microeconomic data (from a survey of 527 UK firms, plus a number of in-depth interviews) to understand the effects of standards in companies.

## **Key findings**

The research finds that standards contribute towards 37.4% of UK labour productivity growth and towards 28.4% of annual UK GDP growth. They add around £6.1bn every year to UK exports. These findings come from the macroeconomic study.

The microeconomic study focuses on companies surveyed across 7 sectors (automotive, aerospace/defence, life sciences, food/drink manufacturing, ICT, energy and construction).

At the sector level, reported impacts on annual turnover range from 1.7% (aerospace and defence) to 5.3% (food and drink manufacturing), (this closely mirrors findings from a series of ISO company case studies which found impacts ranging from 0.15% to 5% of annual turnover).

This translates into substantial financial benefits for the 7 sectors surveyed, amounting to annual impacts on turnover totalling £33.3bn (2014 prices) and £6.9bn in GVA terms (2014 prices).

Food and drink manufacturing reported the largest revenue impact (£10.2bn per year) while the ICT sector had the largest impact in GVA terms (£2.1bn per year).

The report concludes that standards are likely to have played a role in sustaining productivity in high-growth sectors during the recession and that if businesses used standards more widely, average productivity in the whole economy could rise.

### About the methodology

Standards, of course, do not work in isolation from other factors: companies that use them also use a number of other processes and procedures, quality controls, tests, measurements, etc.; the research seeks to disentangle their effects from those of other complementary factors that drive productivity.

The macroeconomic-level research of the new study follows the methodology previously used by the government in research published in 2005 by the DTI, *The Empirical Economics of Standards*. The methodology is comparable also to other studies conducted around the world. An innovation in the new report is the incorporation of company-level data: this was not covered in earlier reports.

The DTI study from 2005 reviewed evidence from 1948 to 2003 and found that standards contributed to 13% labour productivity growth, or an 11% contribution to GDP (equivalent to £2.5bn at the time).

### Sector focus

While standards have been beneficial to many of the sectors surveyed, it can be seen that the most productive sectors use standards the most:

#### Aerospace and Defence

Aerospace and defence increased productivity by 20.1% between 2005 and 2014, while UK average was 4.9%. Reported impacts on annual turnover was 1.7%.

The aerospace and defence sector is comprised of civilian and military aircraft manufacturing, military equipment manufacturing, naval shipbuilding as well as civilian aviation services.

The sector in the UK employs 126,000 people and had an annual turnover of £32bn in 2013, making it one of the largest in Europe.

The requirement for R&D and innovation in the aerospace and defence sector is high – with the sector ranking in the top 5 for UK R&D spend in 2012.

#### Food and Drink Manufacturing

Food and drink manufacturing reported the largest revenue impact (£10.2bn per year).

UK's largest manufacturing industry, generating £95.3bn of turnover in 2013 and employing 412,000 staff.

The sector covers a significant section of the food chain, from ingredient manufacturers such as meat processors to manufacturers of final products such as soft drinks.

#### Information and Communications Technologies (ICT)

The ICT sector had the largest impact in GVA terms (£2.1bn per year).

The sector is composed of 3 broad sub-sectors; communications (wired and wireless networks), computer hardware and computer services (including software development, IT consultancy and web services).

Innovation levels are high in the sector; ranking second in terms of annual R&D spend (£3.7bn, 21% of UK total) with the majority of this expenditure (51%) in software development and information services.

The UK ICT sector ranks third in the EU after Germany and France<sup>1</sup> in terms of annual value added generated and is one of the largest sectors in the UK. In 2013, ICT value added represented 8.2% of the UK non-financial business economy in 2013 making it slightly larger than the whole of the manufacturing sector<sup>2</sup>.

Annual turnover in the sector was £159.1bn in 2013, dominated by telecommunications (39% of total) and computer services (55% of total).

<sup>1</sup> European Commission Digital Agenda Scoreboard 2014

<sup>2</sup> ONS Annual Business Survey 2013

.....  
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# A brighter future for our towns and cities

**Keith Burge, Director at the Institute of Economic Development outlines the recommendations made to help under-performing towns and cities overcome their challenges...**

The Institute of Economic Development (IED), Association of Town and City Management, Royal Institution of Chartered Surveyors and Royal Town Planning Institute came together to explore the notion of developing a practitioner-led approach to the challenges faced by our under-performing towns and cities.

Launched in May 2015, the 'Brighter Futures for our Towns and Cities' report sets out 16 recommendations which are designed to apply to all towns and cities above 100,000 population and with above national average levels of unemployment for each of the past 3 years. It should be noted that these recommendations have emerged from the work of the Commission (principally practitioner workshops), and do not necessarily represent the official views or policy of each of the partner organisations.

## The Recommendations

Relevant towns and cities should each produce a development plan (and be given the resources to do so). This would set out what kind of place each town/city wants to be and how this vision would be achieved, including a list of priority projects/initiatives. Clear links would need to be established between activities outlined in each plan and the most pressing issues faced in that particular town/city.

Where physical developments are proposed, these ought to be bold and innovative, capable of attracting people to live, work, study, shop and play. In-fill schemes and superficial improvements to existing buildings and public spaces may not be sufficient to grab the attention of all target audiences.

Where achievement of the vision requires devolution of powers/responsibilities, this should be detailed in

specific terms i.e. what powers/responsibilities, why they are best devolved and what added value this will achieve.

Economic development should be made a statutory function within each local authority and resourced accordingly.

In spite of repeated overhauls, the system of providing education and developing skills is failing both young people and employers. All Local Enterprise Partnerships (LEPs) should be given full responsibility for funding skills development in their area, informed by the work of Education Business Partnerships and complemented by independent and appropriately resourced careers support services (supporting both young people and adults).

Regardless of what happens with HS2, other transport infrastructure and ICT infrastructure projects ought to be explored that have the prospect of bringing benefits to under-performing towns and cities. Better connections between these places and with more successful local economies will help businesses seeking new markets and people seeking jobs.

The system of Business Rates needs to be overhauled in the interests of both fairness and efficiency. In doing so, there is the potential for under-performing town and city centres to be more competitive and retain/attract more business activity (and associated jobs).

The issue of poor leadership needs to be tackled head on through the creation of full time elected posts (the word 'Mayor' is still regarded as toxic in some quarters). Job descriptions should focus on economic development, regeneration, housing, commercial property, planning and transport.





These leaders should head new partnerships of the private, public and third sector that will help to ensure the appropriateness, deliverability and effectiveness of development plans.

Higher education provision in these towns and cities should be supported locally and nationally, whilst recognising that universities are independent organisations. Mechanisms to incentivise students to study there (e.g. tuition fees support) and the bending of national funding (both direct and through research grants) could support universities in under-performing towns and cities. Universities themselves must play an active role in addressing local performance issues, and see their success as partly dependent upon it.

All higher education provision in under-performing towns/cities should be resourced to provide start-up business accommodation and customised business support for graduates, staff and local communities.

The siting of new hospitals and other large scale healthcare provision should consider economic impacts and how they can be maximised for under-performing towns and cities.

All London-based government departments should be made to justify why they (or component parts)

cannot be relocated outside the capital, as part of an independent review of civil service activities in London.

LEPs ought to be better resourced and demonstrate the best of practice amongst their peers (e.g. in respect of board structure and appointments). Within their current Investment Plans they should be required to set out specific proposals for under-performing towns and cities as their contribution to town/city development plans.

The above should be overseen by a beefed up LEP Network which should also have a co-ordinating role to ensure that LEP decisions make sense across LEP boundaries and not just within them.

Area-based regeneration has its role to play but needs to focus on long term solutions not short term fixes and be appropriately resourced. There should be a particular focus on linking people to opportunities as a sustainable pathway out of deprivation. ■

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# Putting theory into practice – Exeter’s success story

In the May edition, Richard Ball from Exeter City Council wrote about the importance of ‘place’ in economic development. He argued that the most important component in the transformation towards a knowledge-based economy is a much greater reliance on intellectual capital and its application. This is inevitably based on significant advances in communication and other technologies and the management of data.

It is also important to consider the work/life balance that the environment offers in order to attract and retain talented highly-skilled people. Talented people are no different to other people in liking places with active communities that have social, leisure, creative and cultural opportunities. The difference is that key workers in smart specialisms such as climate change mitigation, health, water, science and agri-tech, are better able to dictate their terms choosing the geographical package that not only pays well but fulfils their lifestyle needs.



Butts Ferry Quayside



Image: © Tony Cobley

## Exeter University Medical School

Millions of pounds are being invested in and around Exeter to create an environment where business and industry can thrive. Whilst much development has happened recently, the seeds of change began some years ago. With the benefit of hindsight, it is obvious that the arrival of the Met Office to the Exeter Business Park in 2003 and early developments at the Russell Group University of Exeter 5-10 years ago were significant catalysts for further developments. Each of these organisations has, in its own way, put Exeter on the global map.

The agreed Met Office’s £97m investment in high performance computing will bring benefits worth £2bn to the UK economy between 2016 and 2020

in the fields of climate research, renewables, aviation, flood prevention, food security and winter resilience.

Seeking to tackle some of the big issues of our time, the University of Exeter has invested in excess of £230m into Research and Development into next generation science. Working with its business partners, the University is encouraging innovation and has helped to introduce new technological start-up businesses that are bringing new jobs to the area. Luke Lang from Exeter-based Crowdcube (the very first crowd-funding company in the world) says that he has no problem recruiting highly-skilled graduates. In fact he recently enticed an employee from Silicon Valley, California to relocate to the Exe Valley, Exeter!



Phase 1 – Exeter Science Park



Image: © Guy Newman

The £30m investment into the 24 hectare Exeter Science Park is now bearing fruit too with the recent opening of phase one of the Exeter Science Park Centre. This is soon to be followed by the Met Office High Performance Computer and Global Environmental Futures Collaboration Centre which will be a new base for serious investment and innovative business.

Skypark Business Park, located close to Exeter International Airport, will be a £210m sustainable business park with the potential to create 6,500 jobs. Meanwhile in Exeter’s city centre, plans for a £20m redevelopment that is focused on the bus and coach station are progressing which will feature leisure facilities including a new swimming pool. £12m is currently being spent remodelling the Guildhall Shopping Centre in the centre of the city.

The introduction of new hotels, better access roads and new housing has been important in the Exeter area. When finished, the new town of

Cranbrook to the east of Exeter will be a community of up to 6,500 homes with a low carbon district heating network. Additional new construction within and to the west of Exeter is adding over an additional 10,000 homes.

Exeter offers an excellent work/life balance. Exeter’s historic quayside offers many leisure activities including walking, cycling, kayaking and climbing or just chilling out. You can visit one of Exeter’s four theatres, 3 cinemas or hear great live music in the city. Exeter is getting ready for Rugby World Cup 2015 which is predicted to put £39m into the local economy. Some readers may have tickets for one or more of the three matches taking place at Sandy Park.

With all this change taking place it is not surprising that Exeter has been named as the second most productive city in the UK. With a successful economy and a wide range of premises and new business space, Exeter offers the golden opportunity for those looking to grow, expand or diversify.

To see how Exeter is pursuing its growth agenda, watch our video by clicking on the link: <http://bit.ly/1TpIL67> or the QR code below:

[www.investinexeter.co.uk](http://www.investinexeter.co.uk)



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# How to run a smart cities demonstrator

Tom Saunders, Senior Researcher and Peter Baeck, Principle Researcher at Nesta detail how The Internet of Things has great potential to transform cities...

The Internet of Things and its more abstract cousin the smart city has great potential to transform how cities are run. Yet despite the huge sums invested in smart bins, smart streetlights and city-wide sensing pilots worldwide, there is little evidence these technologies have helped city governments address issues that they or their citizens face. Innovate UK's recently launched £10m Internet of Things cities demonstrator<sup>1</sup> competition could go a long way towards helping to generate this evidence. With its goal of creating a model for the future development of smart cities in the UK and internationally, what should the pilot focus on?

Over the last 2 decades the label 'smart city' has been applied to a family of technologies that can speed up the flow of things around the city and reduce the physical frustrations of urban life – free flowing traffic instead of jams; smart flows of energy and less waste; public services better targeted where they are most needed. Advocates of this top down approach to the smart city have often faced criticism: for being too concerned with hardware rather than with people; too focused on finding uses for new technologies rather than finding technologies that can solve pressing problems; and for emphasising marketing and promotion at the expense of hard evidence and testing solutions out in the real world.

In Nesta's recent report, 'rethinking smart cities from the ground up'<sup>2</sup>, we argue that successful smart cities of the future will combine the best aspects of technology infrastructure while making the most of the growing potential of 'collaborative technologies', technologies that enable greater collaboration between urban communities and between citizens and city governments. Based on our report, we offer cities that want to run Internet of Things pilots the following



5 recommendations on how to make this happen:

## Set up a 'smart citizen centre' to drive innovation in collaborative technologies

Alongside investment in hardware projects, pilots should explore the potential of the Internet of Things to enable greater collaboration with citizens. To do this, the pilot should set up a 'smart citizen centre.' One of the primary goals of the centre should be investing in and testing 'collaborative technologies', with a focus on 4 emerging methods that are helping city governments engage and enable citizens: the collaborative economy, crowdsourcing data, collective intelligence and crowdfunding. The centre should be used to generate and share evidence with other cities for the most effective ways to engage citizens.

The Seoul Innovation Bureau, and the Boston Mayor's Office of New Urban Mechanics (MONUM) are 2 examples of how the centre could work.

## Use open data and open platforms to mobilise collective knowledge

Internet of Things pilots around the world are evolving from a closed, proprietary model, for example

Santander's sensing pilot <sup>3</sup>, to one based around modular platforms and open specifications, such as Chicago's Array of Things <sup>4</sup> project. This can potentially make Internet of Things pilots much cheaper as well as include a more diverse set of ideas from a range of organisations. To achieve this cities should:

Ensure that all hardware and software generated throughout the pilot is open source and open specification, so that other cities can learn from and build on the results of this pilot. Where possible, the pilot should build on existing open source projects, such as the planning software built by OpenPlans, rather than developing proprietary tools from scratch.

Open up problem solving to citizens, using online tools that let people debate ideas and decide which of them get implemented. Better Reykjavik is an example of how to do this. Challenge prizes are another way to gather ideas from citizens about the issues that are most important to them. They offer a powerful incentive for meeting a specific challenge, and can help stimulate new ideas for some of the most difficult challenges that cities face.

Make all data from sensors open to the public to help generate innovative solutions to urban challenges. Once the data is released, pay attention to finding productive uses for the data. For example, the Open Data Challenge series, a project by Nesta and the Open Data Institute brings businesses, community groups and city governments together to develop new ways of using city data.

### **Take human behaviour as seriously as technology**

The smart city vision often fails to recognise the role that behaviour and culture play in the way cities work. Yet unsustainable patterns of living – such as the heavy use of resources or private transport – undermine data and technology-led efforts to make cities more sustainable. City governments should explore how the Internet of Things could be used to promote what is known as the collaborative economy, where people can access the things they need, but only occasionally use, from cars to power tools and gardening equipment. City governments should look to the example of Seoul, which has supported a range of collaborative economy initiatives.

### **Invest in smart people, not just smart technology**

Without the ability to interpret data and understand how and why it is collected, there is a serious risk that it will be misinterpreted or ignored by city government employees. City governments should invest in training to give all staff a baseline understanding of data handling as well as hiring data specialists with advanced skills. Internet of Things pilots should also invest in digital skills for citizens. Successful programmes include: CoderDojo, a global movement of community-based programming clubs for young people, and 'hackathons' organised by the Singapore Government, which teach people how to use open data.

### **Spread the potential of the Internet of Things to all parts of society**

Smart cities and the Internet of Things are often most beneficial to connected citizens. However not everyone uses a smartphone, has internet access or the time to engage with their city governments. Communities that are underserved by digital technologies are usually the elderly, the young, the sick and the poor. When piloting Internet of Things technologies, cities should explore ways to expand their potential to these communities. Working with intermediaries including community groups, charities and NGOs could be one way to do this.

- 1 <https://interact.innovateuk.org/-/internet-of-things-cities-demonstrator>
- 2 <http://www.nesta.org.uk/publications/rethinking-smart-cities-ground>
- 3 <http://www.sciencedirect.com/science/article/pii/S1389128613004337>
- 4 <https://arrayofthings.github.io/>

Download Nesta's report Rethinking Smart Cities from the Ground Up for free at [www.nesta.org.uk](http://www.nesta.org.uk)

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# Europe's investment in digital talents and digital innovation!

**Willem Jonker, CEO of EIT Digital outlines how the organisation plays a crucial role in driving innovations to market...**

In the past the entrepreneurial spirit brought Europe into a leadership position, however staying at the top requires continuous effort. In Europe we need to step up, especially when it comes to digital innovation.

EIT Digital is a leading European open innovation organisation driving digital technology innovation, and developing entrepreneurial talent for economic growth and quality of life in Europe. Since the start in 2010 and supported by the European Union via the European Institute of Innovation and Technology (EIT), EIT Digital has consistently been mobilising talents, ideas, technologies, investments and business across Europe, and beyond to stimulate disruptive digital innovation.

We invest in strategic areas to accelerate the market uptake of research-based digital technologies and to bring entrepreneurial talent and leadership to Europe.

Digital technology plays a crucial role in society and fundamentally changes industries and business models. EIT Digital is focusing on areas that are strategic for leadership such, as for example, Internet of Things, smart industries, or health and wellbeing. These are all areas where the digitisation creates so-called cyber-physical-systems, combining hard and software via networked data collection sensors, actuators and big data analytics. These systems are the basis for the data economy where intelligent data management will enhance capabilities of production facilities, preventive healthcare systems, urban life and mobility, cars, etc.

As a pan-European organisation, EIT Digital brings together entrepreneurs from a partnership of over 130 top European corporations, SMEs, start-ups, universities and research institutes. The headquarter is in

Brussels with co-location centres in Berlin, Eindhoven, London, Helsinki, Paris, Stockholm, Trento, as well as in Budapest and Madrid. Here students, researchers, engineers, business developers and entrepreneurs come together to drive the digitalisation of society.

The organisation invests human and financial resources in key high-potential thematic activities for the development of ICT business and talent in Europe. The activities have been strategically chosen and focus on specific domains like smart energy, smart cities, security, clouds, network infrastructures, health etc. We select the most promising research results, disruptive technologies and business strategies from our ecosystem and beyond. Our ambition is to drive these innovations to succeed in world markets and become European success stories.

We have a team of business developers fully committed to bringing these innovations that we invest in to the market. If you have technology that you want to bring to the market, or you are a startup looking for customers for your product or service, or funds to fuel your growth, we help by leveraging our pan-European network.

The organisation also has the ambition to stimulate regional growth in EU countries where EIT Digital is not present. The objective with the program, called Arise Europe, is to connect local and regional incubators, accelerators, regional clusters with EIT Digital and its partners; e.g. joint support to boost technology projects and startups at the European level; improved mentoring, market access & fundraising opportunities and enhancement of the quality of local digital professionals.

Various education programmes are provided where students develop cutting-edge ICT knowledge merged





with innovation and entrepreneurship skills – in a blended setting of physical and virtual classrooms. The Master School breeds a new generation of European entrepreneurs, the Doctoral School delivers Europe's digital leaders of tomorrow, and the Professional School keeps European's digital technology professionals ahead of the ever-changing industry needs.

**“Digital technology plays a crucial role in society and fundamentally changes industries and business models. EIT Digital is focusing on areas that are strategic for Europe leadership such as for example Internet of Things, Smart Industries, or Health and Wellbeing.”**

EIT Digital is unique in many aspects such as its tight integration of research, education and business development, its unique best-in-class partnership, its pan-European business accelerator, its schools in

digital entrepreneurship. Although a young organisation, EIT Digital is showing its impact on the European digital economy via the delivery of concrete results, both in terms of digital entrepreneurial talents delivered by our schools, as well as, digital innovations and start-ups delivered from our innovation activities. For details on our organisation, our results and our impact visit us at [www.eitdigital.eu](http://www.eitdigital.eu).

.....  
**Willem Jonker**

**CEO**

EIT Digital

[www.eitdigital.eu](http://www.eitdigital.eu)

# Advanced Knowledge Management in Smart Cities

New ways to deal with complexity and dynamics of change in our cities...

Ongoing urbanisation makes cities focal points for economies and societies. As its share of resource consumption and emissions grows, economies become knowledge intensive. City life accelerates, its complexity grows exponentially along with various instabilities, challenges, uncertainties and risks. Urban areas become more like complex biological organisms with all their internal relations and interactions between multifold processes. Key players such as cities' inhabitants, organisations, industries, regions and governments have different political and economic interests, views on priorities, events and causes. All these result in difficulty understanding holistic knowledge of city life.

In addition, local urban environments face increasing impacts of global issues like climate change, emergency events and disasters, such as storms, hot and cold weather, and abnormal amount of rainfall or snow, drought and floods. All of these lead to resource scarcity and issues with biological diversity, interruptions of regular life processes and losses of lives, considerable extra costs, recovery time and delays in achieving planned objectives. Hopes that such impacts may decrease in the long run melt away with every passing year.

Integrated vision of city life with its ecosystem services, capacity for quick and easy detail and adding necessary

resource optimisation models for decision making and actions when necessary, become increasingly important to meet growing challenges.

These issues had been explicitly addressed by the Association for Sustainable Innovative Development in Economics, Environment and Society (ASIDEES), NGO, Austria by developing a Knowledge Management Framework for Smart Governance "Smart City Monitor" (<https://win2biz.com>).

**"...ASIDEES aims at providing best solutions for viable future cities and their successful smart governance."**

It integrates knowledge about ongoing processes based on real data in real time, makes understanding of trends, policy roadmaps and response options easy. At the same time it assists city stakeholders in the implementation of concepts of sustainability, low carbon, low resource consumption and resilience, making them transparent and measurable.

Some attempts to solve the issue have already been done. For example, ISO standard 37120:2014 aims to provide some methodology and establish a common ground for cities around the world while being unique and different.

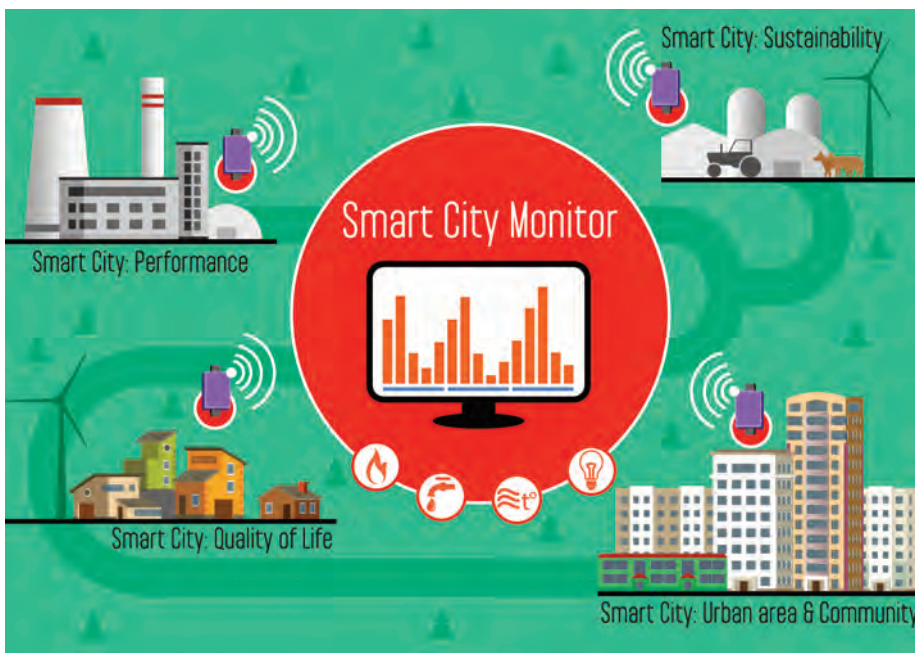
Each city is a unique composition of its citizens' life patterns, culture,

architecture, geo-location, industries, energy consumption, city water management, wastewater and sewage treatment, economics, environment and transportation. Where large numbers of people live, move, work, learn and have fun, which is all generating a diverse flow of events.

Which in turn influences questions like:

- What is current state of our city or particular district or that public service now?
- What's happens to water consumption and quality in that location or street?
- What do our local businesses offer now (or tomorrow, etc), where and which service quality can be expected (free places, waiting time, etc) under quality requirements to actual information about operations and status's set by the city council?
- What information is available in other categories, e.g. air quality, environment, carbon, waste collection and processing, etc presented on city maps updated each hour?
- Does our city achieve planning targets?

With real time information about large number of diverse ongoing processes and high processing power Smart City Monitor helps to answer such questions and provides practical and easy



accessible answers to all stakeholders in simple, easy and quick mode.

Compared to static content of major city web services this knowledge management platform allows collection of real time data from all necessary city information sources, processing it accordingly to city models of quality of life, planning and growths, ecological considerations. Presenting resulting information along with necessary details. It includes status and quantitative results, such as air quality, noise and crime levels, transportation density, energy consumption, water management, state of the natural capital, situation with the health system even what innovation approaches were undertaken by the city council.

Smart City model can be initially based on latest the international and national standards like ISO 37120:2014. It is open for further advancement by adding unique city content and functions, optimising overall city performance, use of resources as well as citizen's lives and local business. The outcomes of the comprehensive information-rich model at any necessary level e.g. city, district, concrete

street and geo-location help in identifying policy roadmaps to facilitate a transition to local urban areas, characterised by low carbon emissions, low resource consumption and robust economic growth.

Smart City Monitor emphasises technologically oriented concept's and provides unified view to the development of urban areas. This directly helps minimising the use of energy and natural resources, measured in short time periods, providing job and new business opportunities, enrich city's life and increase its quality.

The knowledge management framework integrates the innovative methodology and various advanced IT components and data standards for cities (e.g. IFCs, CityGML, LandXML), based on common and widely available technologies such as open source software, Linux server clusters, mobile devices, Wi-Fi and cable communications, as well as remote sensors based on Internet of Things (IoT) or Machine-to-Machine (M2M) devices. In addition its open system architecture allows integration with existing information sources and already running city

systems, resulting in a significant decrease of implementation and maintenance costs. The robust and cost-effective city system empowers all stakeholders to enrich the quality of life, its content, monitor, analyse, benchmark, report, verify changes, risks in urban areas and maintains its ecosystems providing new commercial, social, spatial, physical and digital dimensions.

Implementation of the innovative solution through real life experience makes possible influencing EU policies that have an impact on the local area, open and effective in providing access to local services, resources and business opportunities for citizens and companies. The challenges facing the cities require new approaches and proactive solutions. In return it leads to raising a city's profile as smart, attracting more investments and business service providers.

Technology and innovative solutions are only part of the bigger picture. Cities are about people and their expectations, experiences and already accumulated knowledge. In this regard, ASIDEES aims to provide best solutions for viable future cities and their successful smart governance.



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## High noon for Europe's data protection reform

David Martin Ruiz, Senior Legal Officer at the European Consumer Organisation explains the importance of transparency and control for data protection...

Over the next 4 months, the legislative machinery of the European Union will be in full swing to seal an agreement on the much-needed reform of Europe's data protection regime. Nearly 4 years of complex negotiations and finally one of the biggest and most important lobbying battles that Brussels has seen in recent times will reach its climax.

From a consumer perspective, what should be centre stage can be easily summarised in 2 simple words: transparency and control.

First, transparency, and in particular transparency over business practices when it comes to the use of consumers' personal data. What data do companies

collect and process when consumers are online, when, how, and for what purposes? Consumers have been living in a digital 'black box' for too long, oblivious as to how companies are tracking their every move, mining and trading their personal data and making huge profits from it.

Second, control – consumers own their personal data. From accessing the data held by a particular company to objecting to the collection and use of the data in the first place, whatever might happen with a consumer's personal data should be nobody's choice but his or her own.

It must be clear for every consumer that 'free of charge' does not equal 'for free'. We are paying a high



the Snowden revelations, Europe has a real opportunity to capitalise on its higher data protection standards and become a trust hub in the world. It is a clear example that data protection and economic growth are not contradictory and that robust privacy protection will not kill innovation. In a hyper connected world, privacy must be seen as a must and as key element in the overall quality of any given product or service.

**“From a consumer perspective, what should be centre stage can be easily summarised in 2 simple words: transparency and control.”**

The stakes are high and the Data Protection reform has been through a long and intense journey. Now it is more important than ever not to lose sight of the original objective of this reform: building a modern, robust and coherent data protection framework which strengthens individuals’ rights and fosters the development of the EU Digital Single Market. Consumers must be able to enjoy the benefits of the digital revolution without completely sacrificing their privacy.

Above all, let’s not forget that privacy is not an obsolete concept that some idealists are fighting for. It is a long standing fundamental right and how we treat it will define the kind of society we live in. ■

.....

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price in exchange for online services and our personal data is the currency. But it is actually more than that. Data has become a commodity in the digital age and its value is only likely to rise. It is high time that all consumers know the rules of the game and that there is a legal framework in place which effectively ensures that their rights are respected. No more hidden tracking. No more unrestricted collection and use of consumers’ personal data. No more trap-filled privacy policies. There has been enough of all that and things need to change. Our fundamental rights and the future development of the digital economy are on the line.

The Data Protection reform is key for the success of the Digital Single Market, and for Europe’s economic growth. Without consumer trust, the Digital Single Market will not reach its full potential. And, without the necessary legal safeguards and consumer protection measures, that trust will never be built.

Moreover, there is without a doubt an unexploited market potential for privacy friendly products and services. The rise of applications such as Ghostery, Ad-block Plus and Disconnect.me demonstrates it. Leading IT companies such as Apple are using their (recently discovered) respect for privacy as a competitive differentiator and a valuable selling point. Following

# Personal data: why ethical management matters?

Communication in general and marketing in particular went through colossal changes along deep and fast technological evolutions which have completely reshaped our world. Those waves have changed the way we communicate but also the way we consume. The consumer wants to play an active role, he wants to ask questions, to get answers, to give opinions. The digital world has forced communication to become interactive. Consume is not synonym to have anymore, consume is now be-have.

Through the millions on digital and social media, it's also true that the consumer wants to be perceived as unique. Brands have decided to put him in the centre of their strategy and to provide him with two important elements: personalised communication and real-time experience, both enhancing the relation consumer can have with brand. And this can only be based on data.

The added value of data is confirmed by the work done by the European Commission. "We need a digital European market which allows new business models to flourish, start-ups to grow and industry to innovate and compete on a global scale" stated Vice President Ansip for the digital single market. The Digital Single Market will only reached its full potential if based on a strong but balanced Data Protection Regulation.

Data protection must act as a water filter, catching harmful particles with-

out blocking the flow in order to deliver purified water to the individual.

The text is getting closer to an adoption, however, many voices have raised concerns that the discussions have derailed from protecting individual from misuse of data, to a solution which limits usage of data altogether. Such an approach seems hardly compatible with the promises of the digital single market. The future rules must remain principle based, technology neutral and be complemented by effective self-regulation developed by European trade organisation. Industry self-regulation is the right tool to use, flexible and adapted to the industry. Already supported by the European Commission, codes of conduct will bridge general and legalistic principles with the real daily life of data processing, providing full set of rules and guidance adapted to each specific sector and situation.

Going even further than mere compliance to the future rules, organisations, nowadays, have learned the hard way that customer trust is key to economic development. We've all seen in the press the potential of damages mismanagement of data and lack of respect of consumer's privacy can do. Ethical personal data management becomes a key competitive advantage in a world where everyone is processing personal data.

Willing to address both challenges, legal compliance and ethical management, at the same time, FEDMA, with



its unique experience of having a code of conduct approved by data protection regulators, has developed a Charter on Ethical Personal Data Management. This Charter will be the corner stone of the new self-regulation programme. With the necessary engagement of the industry and the renewed support of the regulators, the solution found with and for the entire European industry will unleash the potential of data while maintaining individual's trust.



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# ETHICAL PERSONAL DATA MANAGEMENT CHARTER



We are  
Data-Driven  
Marketing !



This Charter provides five key principles for ethical management of personal data for the data-driven marketing industry. These principles originate from legislation and from the FEDMA codes of conduct. Details and exact provisions of the FEDMA codes of conduct are available on the FEDMA website.

Data-Driven Marketing is an industry which uses data to effectively match customers and prospect's needs with relevant brand offers. Data-Driven Marketing industry main objective is to establish and maintain a personalised and interactive relationship between organisations and customers and prospects.

**With this Charter, the industry's objective is to ensure customers and prospects interests are respected by organisations:**

- Customers and prospects are expected to have a positive and engaging marketing relationship with an organisation.
- Customers and prospects are expected to feel valued, respected and receive commercial communication that the organisation considers as relevant to them.
- Customers and prospects, when participating in a dialogue with organisations, are expected to be able to express their preferences in receiving commercial communication through different communication channels used by the organisation.
- Organisations are expected to provide customers and prospects with understandable information. Special care is expected to be given when commercial communications are aimed at children.

## PRINCIPLES:

### **1 BE HONEST AND FAIR**

- > Organisations are expected to be honest and fair and offer a clear customer journey.
- > Organisations are expected to be clear with customers and prospects about why they collect data and how they intend to use it for marketing purposes.

### **2 RESPECT INDIVIDUALS**

- > Organisations must act in accordance with all legal requirements relevant to the processing of personal data

applicable to marketing activities; the processing must be based on a legal ground and provide the individuals with the rights they are legally entitled to, such as the right to object.

- > Organisations are expected to avoid irresponsible commercial communication.

### **3 BE DILIGENT WITH PERSONAL DATA**

- > Organisations are expected to always treat customer and prospect data with the utmost care and respect.
- > Organisations are expected to take reasonable steps (such as by validation when necessary) to ensure that customer and prospect data are accurate and kept up to date.

### **4 EMPOWER THE CUSTOMER WITH CHOICE**

- > Customers and prospects should have access to organisations' privacy policies providing an explanation relating to the processing of personal data for marketing purposes and their contact details enabling customers and prospects to interact with the organisation.
- > Organisations are expected, where possible, to give customers and prospects the possibility to express their preferences in receiving commercial communication through the different communication channels used by the organisation, and respect these. This can be done through the use of preference services lists (such as Robinson lists) where available.

### **5 BE ACCOUNTABLE**

- > Organisations must ensure that they employ appropriate security measures when processing customer and prospect data, taking into consideration the sensitivity of the data and technological state of the art.
- > Organisations must take responsibility for the processing of customer and prospect data in-house. When the data processing is partly or fully outsourced to a data processor, both the controller and the data processor should be responsible for ensuring that all the applicable legal provisions relating to such processing are complied with unless a legal provision is explicitly assigned to either the controller or the processor.

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**Featured eBook**



# FATTY LIVER DISEASE

## AND THE CONSEQUENCES FOR EUROPE

Alterations in our diet over the last decades, combined with a sedentary lifestyle have contributed to the worldwide incidence of overweight and metabolic syndrome, characterised by abdominal obesity, insulin resistance and Type-2 diabetes, hypertonia and dyslipidemia.

This trend is not only observed in industrialised countries in the US and Europe but also gradually now in developed as well as developing countries.

Currently it is believed that approximately 90 million Americans and 40 million Europeans suffer from a fatty liver (also called Non-alcoholic fatty liver disease (NAFLD)).



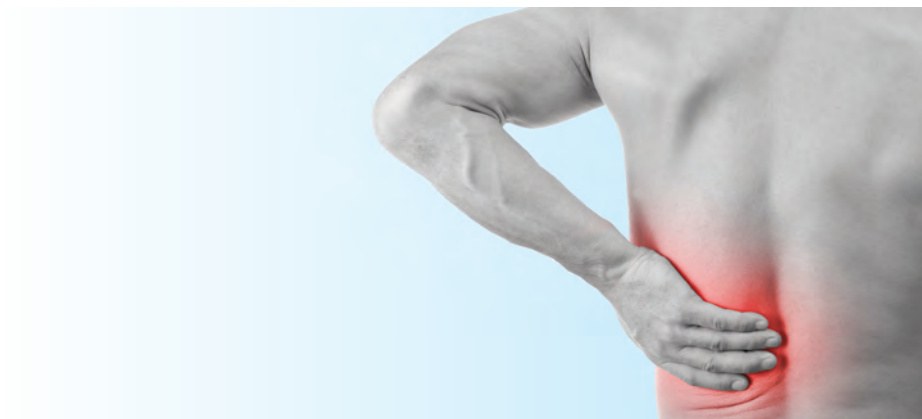
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The clinic's expertise in nursing and its wide range of therapies are complemented by social and psychological support services, legal services, professional integration measures, trial accommodation opportunities and a number of other services.

The **Balgrist**

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# DURABILITY AND CORROSION

The chair for Durability and Corrosion at ETH Zurich belongs to the Institute of Building Materials of the Department of Civil, Environmental and Geomatic Engineering. The main mission of the institute consists in teaching and research on construction materials. The chair for Durability and Corrosion focuses on the durability of RC structures and corrosion of metallic materials.

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