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Spring 2014

Includes editorial contributions from:

Dominique Ristori
Director-General for Energy, European Commission

Gesine Meissner
Member of the European Parliament

Robert-Jan Smits
Director-General, DG Research & Innovation, European Commission

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Foreword

2014 is but a few months old, and it has already ushered in many new issues to beset Europe and her peoples. Perhaps the situation in the Crimea looms largest: as I write, its Russian population appears to wish to secede from Ukraine, its seemingly Kremlin-inspired, eastward-looking gesture no doubt a response to Kyiv's determination to look west towards a European future. With more than half of Europe's energy consumption coming from imported sources (for which, read 'Russia'), the implications for Europe's energy security are readily apparent. Nevertheless, the combination of mild European spring weather and high gas stocks appears to be strengthening Europe's hand. For the time being.

We are delighted to feature a first article from Dominique Ristori, newly-appointed Director General at DG ENER; in so doing, we extend to his predecessor Philip Lowe our heartfelt thanks and best wishes for his new endeavours. Our readers will know Philip as a regular and much respected contributor. M. Ristori sets out his philosophy behind 'Innovation through Regulation', calling for greater efforts with renewable energy, energy efficiency and low-carbon technology to increase Europe's competitiveness, sustainability and energy security - a timely thought in view of events to the East. He identifies Europe's energy-related legislation as the framework for innovation; legislation backed up in the European Structural and Investment Funds with €23 billion worth of potential investment, and his views are reflected in two further articles from the Commission. Robert-Jan Smits, Director-General at DG Research & Innovation, examines how Horizon 2020 can turn Europe's energy challenges into opportunities. Echoing M.Ristori, he calls for an integrated policy framework to ensure regulatory certainty for investors. He outlines how H2020's budget of almost €80 billions will put innovation at the heart of the energy transition, bridging the gap between research and the marketplace and helping make Europe a world leader in clean energy. Elsewhere, Zoran Stančič, Deputy Director-General at DG CONNECT, writes thoughtfully about making European energy supplies smarter and more sustainable. He explains how the research programme will explore how best to use ICT to increase energy efficiency. Smart Grids form an important element of this strategy and Mr. Stančič suggests that using existing digital infrastructure and existing network standards indicate how Horizon 2020 extends beyond 'scientists in white coats' to real world implementation.

In our shipping feature, Gesine Meissner MEP reviews recent developments in the maritime sector, from greenhouse emissions, through NOx and sulphur to LNG, European and IMO legislation. But perhaps most striking is her discussion of the possibility of a zero-emission ship, based on liquid hydrogen propulsion and using on-board wind turbines, solar panels and innovative hull and propeller designs. This technology is already available, so her question: Too good to be true? Might realistically be answered with No!

And so we hope that, even as you keep one eye on developments in the Crimea, you find much more to read inside…

Michael Edmund
Editor

EU's energy efficiency: innovation through regulation

By Dominique Ristori, Director-General for Energy, European Commission.

Energy is one of the biggest challenges facing Europe in the coming decade. Our dependence on imports, in particular on oil and gas, is a matter of great concern. It is set to grow to more than 80% by 2035, and this against a backdrop of increasing global competition for energy resources. Despite having become one of the least energy-intensive economies in the world, more investments are needed to increase our competitiveness. More renewable energy, more energy efficiency and more low-carbon technology will help make Europe more competitive, more sustainable and enhance our energy supplies.

The European Union has been a motor of the development of a highly-advanced policy framework for Energy Efficiency: the *Energy Efficiency Directive*, the *Ecodesign* and *Energy Labelling Directives*, and the *Energy Performance of Buildings Directive* are the four pillars boosting innovation in the field.

The *Energy Efficiency Directive*, adopted in October 2012, provides the framework to achieve the 20% energy efficiency target in 2020, tapping energy savings potential in all phases of the energy chain, from generation to consumption.

As regards products, the *Ecodesign* and *Energy Labelling*

Directives set minimum efficiency requirements, in order to remove the worst performing products from the market, and label the energy performance of products with a view to raise consumers' awareness of highly energy-consuming products.

As for buildings, the revised *Energy Performance of Buildings Directive* sets the target for all new buildings to be 'nearly zero-energy' by 2021, allowing the European Union to decrease energy consumption, greenhouse gases emissions and energy bills considerably.

Despite having been relatively recently adopted, the regulatory framework in energy efficiency has generated very concrete impact in terms of innovation – with positive results in terms of energy prices and costs.

The regulatory measures on phasing-out old, highly energy-consuming appliances and promoting new, energy efficient appliances had a direct stimulating effect on product development and innovation, improving the competitiveness of the European industry. For example in 2009, almost 90% of refrigerators, washing machines and dishwasher's sales corresponded to an efficiency class equal or above 'A' class. On average, about 30% of new refrigerators sold in 2009 were in the highest efficiency class (labels 'A+' or 'A++') compared to less than 10% in 2005.

As for buildings, the introduction of energy efficient measures in buildings (e.g. better insulation) contributed to a significant decrease of the average energy consumption per dwelling: 11% for Ireland, 16% for Sweden, 27% for Denmark, around 35% for France and Netherlands, and even around 50% for Germany and Slovakia between 1990 and 2009.

Besides regulation, innovation also needs effective financial instruments. To speed-up the energy transition towards a low-carbon, efficient, affordable and sustainable energy system, the EU has stepped-up its efforts through the new EU 2014-2020 Financial Framework. 23 billion Euros are now ring-fenced for low-carbon investments under the *European Structural and Investment Funds*. A relevant part of this funding should boost the market uptake of both new and mature energy efficient technologies. A large part of the funding is expected to be channelled through innovative financial instruments, combining public and private finance. Further, more than 1 billion Euros is available for energy efficiency research and innovation under the *Horizon 2020 Program*.

As financing is one of the key challenges for energy efficiency investments, new business models and financing products are needed to attract private capital. Therefore, specific attention is given to supporting innovation in this area. Following the *Communication on Energy Technologies and Innovation*, adopted in 2013, an EU Integrated Roadmap is currently under development by the Commission services and stakeholders. The Roadmap will address the whole energy system and ensure better coordination of available funds at EU and national level.

Evidence shows that innovation in energy efficiency can bring forth growth, a renewed and dynamic industrial competition, and job creation. It brings savings for consumers and promotes less dependence on energy. Innovation in energy efficiency is without any doubt the way to make Europe a world leader in energy.

Process optimisation
Top energy efficiency solutions in waste energy

By Johan van der Kamp & Hans van Essen.

INTRODUCTION

The Afval Energie Bedrijf (AEB) in Amsterdam (Netherlands) has been processing waste for almost a century. The company aims for maximum environmental efficiency, in the sense that waste does not simply remain waste, but is converted into energy and basic materials. The waste is incinerated and the energy released is used to generate electricity, while the remainder of the energy released becomes usable heat. As many valuable materials as possible are reclaimed from the ash residue.

To produce electricity from the available combustion energy, the well-known cycle of steam boiler, steam turbine (connected to the generator), condenser and feed water pump is used. It is also commonly known that the higher the pressure and temperature of the steam supplied to the turbine and/or the lower the pressure and temperature of the steam leaving the turbine, the higher the conversion efficiency is of fuel into electricity. In a steam turbine not only the pressure of the steam decreases, , the temperature also drops increasingly, creating 'wet' steam; an increasing amount of condensate forms in the steam. If the water content in the steam becomes too high, it will damage the turbine. As a result, the condensate in the steam ultimately determines the achievable outlet pressure, and thus to a large extent, the shaft power.

When the steam entering the turbine is superheated steam (dry steam), the moment that condensate formation starts is delayed, and the steam pressure at the outlet of the turbine may be reduced. The result is a higher shaft power. The design goal is that not the moisture content of the exhaust steam determines the pressure at the turbine outlet, but the temperature of the condenser cooling medium, usually the ambient or cooling water.

There is sufficient cooling water

Figure 1: Waste Energy Company Amsterdam (24-02-2014)

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at AEB, so in principle a very deep vacuum could be achieved at the outlet of the turbine. But then extreme superheating of the boiler steam would be required. However, the many corrosive constituents in the boiler's combustion gases limit this temperature, since the already very expensive materials would corrode too quickly.

To break this circle of limited conversion rate, AEB opted for a two-stage turbine, with reheating the steam between the two stages. The steam – moderately superheated – flows through the first (high-pressure) stage of the steam turbine, up to a location where, approximately, condensation would start. Here, a connection has been created in the turbine housing for the steam to exit. This steam is then extremely superheated in a re-heater and will enter the second (low-pressure) stage of the steam turbine as superheated steam. A very deep vacuum can now be achieved in this second stage. Using a two-stage turbine with reheating increases the efficiency of the system by more than 30%, which means additional electricity production of over 30% from the same amount of fuel!

THE REHEATER

The high-pressure steam from the boiler (1) has a pressure of 130 bars. This means an evaporation temperature of 330˚C. The steam flowing to the high-pressure stage (2) of the turbine is superheated by more than 100˚C. After this high-pressure stage, the steam has a pressure of 14 bars, at the corresponding temperature of more than 190˚C. The steam first flows to the separators. Here any water droplets formed in the turbine are collected and discharged. Then the dry steam goes to the superheater (position 6 in Fig 2.), where the temperature is increased by approximately 130˚C, from 190˚C to 320˚C. A portion of the high-pressure steam is used as a heating medium. The superheated low-pressure steam flows through the red pipes to the low-pressure stage of the turbine (4). In addition to the separator and the reheater, both reheater units consist of a condensate vessel for the high-pressure condensate formed. These vessels are necessary for controlling the units. The low pressure steam from the turbine is liquified in the condenser (5). The high-pressure stage of the turbine and the low-pressure stage transfer their mechanical energy to the generator (3), where it is converted into electrical energy.

The reheater units were so crucial to realising a properly-working, highly-efficient installation, that AEB decided to purchase the installations themselves directly. When Bronswerk received the request for the reheaters, it proposed supplying the complete units, including separator, condensate vessel and the connecting piping. The proper operation of the separator is crucial to the proper operation of the reheater . To prevent having the warranty spread over two suppliers, it was wise to keep everything in one hand. AEB gave Bronswerk the opportunity to supply the complete installations.

The proposal by Bronswerk Heat Transfer contained a surprising combination of techniques that

Figure 2: Process overview

together result in a compact and robust unit. The High Pressure Compact Header, which had just been developed by Bronswerk, was provided for the high-pressure steam. To avoid vibrations due to high flow rates of the low-pressure steam in the condenser , a 'no-tubes-in-windows' type was used, while low-finned tubes provide good heat transfer to the low-pressure steam.

For a company aspiring to be a market leader, it is necessary to introduce a breakthrough development to the market every now and then. The High Pressure Compact Header referred to here is just such a Bronswerk development. It is also essential to know the discipline to the finest detail. This makes it possible to use the right combination of existing and new technologies. This project shows that Bronswerk also masters these aspects.

AEB was so pleased with the design of the reheater unit that it also awarded Bronswerk the dump condenser. Ultimately, AEB now has an incinerator with uniquely high efficiency.

Energy & innovation

By Bruno Lechevin, President, French Environment and Energy Management Agency

Innovation in the energy sector has greatl y been stimulated by our will to diversify the energy mix and by the development of renewable energies to fight climate change. Therefore new energy generation technologies and R&D projects improving process efficiency have been developed. But beyond technological innovations, organizational or societal innovations are also crucial: this is the case, for instance, for smart electricity grids or car-sharing services. Often, only the combination of different innovations allows real progress. Self-consumption of renewable electricity, management of renewable energies at urban blocks scale, curtailment of electricity and tomorrow storage or adjustment… as many innovative techniques being deployed which need smart grids so that everyone can play a role in the production and consumption of its own energy. This also implies innovation in governance so that local authorities are better associated with the management of energy, while maintaining solidarity between territories. At the same time, new communication technologies, allowing immediate linking of supply and demand, contribute to innovations in "collaborative economy" and so on in energy savings.

Based on these evolutions, ADEME has undertaken a forecasting exercise which set out proactive energy and climate scenarios for 2030 and 2050. It shows that "Factor 4" (i.e. French objective of cutting greenhouse gas emissions by three-quarters by 2050) can be achieved thanks to the deployment of renewable energies but also by halving our energy consumption.

On a larger scale, innovation also requires enhanced cooperation between States. Europe's action is in line with this approach. Launched in late 2013, the new Horizon 2020 program that supports Research, Development and Innovation (RDI), puts forward the "secure, clean and efficient energy" theme with a dedicated budget of 5.9 billion €. ADEME contributes to the implementation of this program, through a mission of "National Contact Point" for environment and energy.

Horizon 2020 places particular emphasis on innovation compared to the previous programs, which were more focused on R&D. Indeed, bridging the gap from R&D to market is needed to make those projects industrial references. In particular, transition from the innovation stage to an industrial phase represents a particularly risk-taking period for companies from a technological and financial point of view. To address this issue we have launched since 2008 in France, a comprehensive program for funding demonstration projects. The *Investments for the Future* program is administrated by ADEME for the French government over the period 2010-2014.

This program emphasis on energy issues, with three programs dedicated to renewable energies and low-carbon energy, smart grids and vehicles for the future. Over 135 demonstration projects have already been launched for a financial assistance of over one billion €, and more than 2 billion € mobilized from the private sector. For example, in the area of smart grids, 16 projects are underway at the territorial level. All these technologies have a strong development potential at European and global level.

In Europe, ADEME has held the EnR (European Energy Network) Presidency in 2013. EnR is a voluntary network of 24 European energy agencies which aims in particular at strengthening exchanges on innovative public policy and on European legislation negotiations (for example in the frame of the review of the Ecodesign and Ecolabel Directives, or on the discussions on the new framework for climate and energy by 2030).

Beyond Europe, important work is being implemented to support innovative approaches in the energy sector, with for example, projects on energy efficiency in buildings in the Mediterranean under the MEDENER network, on sustainable cities in the major emerging countries, or also on energy access in Africa.

Boosting Energy Research and Innovation in Europe

By Maria da Graça Carvalho, MEP

The European Union has set ambitious goals regarding Energy and Climate Change policies. It intends to reduce greenhouse gas emissions by 20% below 1990 levels by 2020, with a further reduction to 80-95 % by 2050. In addition, renewables should cover 20% of final energy consumption in 2020 coupled with a 20% energy efficiency target.

These targets will contribute to the transition to a reliable, affordable, publicly accepted, sustainable and competitive energy system. The aim is to reduce fossil fuel dependency in the face of increasingly scarce resources, increasing energy needs and climate change.

In achieving these objectives, Research and Innovation play a central role. Advances in science and innovation are crucial to achieve clean, affordable and accessible energy for all.

We cannot attain these improvements in Europe without a properly weighted budget that promotes the real advantages of research and innovation at European level. Horizon 2020 – the European Research and Innovation programme that will run from 2014 to 2020 with a budget of €77 billion – is a cornerstone of European policy in this field. The €77 billion investment will be distributed between three fundamental pillars: "excellence in science", "industrial leadership" and "societal challenges".

However, Horizon 2020 is much more than a funding programme: it will be a key instrument in structuring research and innovation in Europe over the years to come. In particular, it was designed to be as simple as possible; to be effectively and adequately funded; to include a comprehensive approach to the passage from research to market and, finally, it will overcome fragmentation and encourage collaboration across Europe and beyond.

The European Parliament has actively contributed to strengthening Societal Challenge 3 "Secure, clean and efficient energy". The Parliament secured a budget of nearly €6 billion for this challenge, from which nearly €900 million will fund projects under the Market uptake of energy innovation, the former successful Intelligent Energy Europe programme. Moreover, the Energy challenge has now a broader and more ambitious scope covering all energy technologies.

In this regard, the following seven areas, in addition to the Market uptake of energy innovation as this builds on Intelligent Energy Europe will be given specific support. These are: Reducing energy consumption and the carbon footprint by smart and sustainable use; Low-cost, low carbon electricity supply; Alternative fuels and mobile energy sources; A single, smart European electricity grid; New knowledge and technologies;

and Robust decision making and public engagement.

Achieving the ambitious objectives of the European energy and climate change policy will require an overhaul of the energy system combining low carbon profile and the development of alternatives to fossil fuels, energy security and affordability. The European Commission has a strong commitment in pursuing these goals and has invested a considerable amount of resources. Nevertheless this effort alone is not enough. It is essential that all the different stakeholders, including the private sector and the Member States, contribute to these priorities.

Turning energy challenges into opportunities: Horizon 2020

By Robert-Jan Smits, Director-General, DG Research & Innovation, European Commission.

The need to ensure a competitive, secure, affordable and sustainable energy system is without a doubt one of the greatest challenges of the 21st century. It is a fundamental issue for Europe, its citizens and its economic well-being.

On 22 January last, the European Commission presented its '2030 climate and energy goals for a competitive, secure and low-carbon EU economy'. While the European Union is making good progress towards meeting its climate and energy targets for 2020, an integrated policy framework for the period up to 2030 is needed to ensure regulatory certainty for investors and a coordinated approach among Member States. The Commission has put forward ambitious yet achievable objectives - a 40% greenhouse reduction target for 2030 and a 27% target for renewables. The Commission is convinced that this framework represents the most cost-effective milestone in our path towards a low-carbon economy; it gives stability to investments, it will boost green jobs and supports our security of supply.

The 2030 framework recognises the continuous evolution of technology and the crucial role that research and innovation must play if we are to achieve our targets. We know that countries that do not invest in R&D fall behind, and those that do not innovate risk stagnating. Without investment in science and research, we are at risk of stifling the advances in technology and the entrepreneurship needed for the energy solutions of tomorrow.

HORIZON 2020: TURNING THE ENERGY CHALLENGE INTO A PATH TO PROSPERITY

The European Union has just launched Horizon 2020, its biggest research and innovation programme to date. With almost €80 billion to invest over the next seven years, Horizon 2020 is one of the few areas of the EU's new budget that sees a major increase in resources. Striking the right balance between supporting excellent science, boosting the competitiveness of our industries, and tackling societal challenges, Horizon 2020 will make almost €5.8 billion available for (non-nuclear) energy research and innovation. It is clear that the current energy system, which is based largely on fossil fuels, will require a complete overhaul. Horizon 2020 aims to redress the balance by making new, cleaner, low-carbon, energy-efficient sources commercially attractive.

In a break with the past, the calls for proposals are less prescriptive. Rules are simplified, which will stimulate participation, encourage competition and deliver impact. Activities will cover the full cycle from ideas to market, with a new focus on innovation-related activities. The participation of SMEs is specifically targeted through a dedicated 'fit for purpose' instrument and will receive more than €8 billion during the seven-year programme.

The Energy theme of Horizon 2020 has been designed taking into account the following key goals:

To unlock the full potential of energy efficiency. Europe is still the largest market in the world for energy-efficient products

and services. But only a small part of our economic potential is exploited. In buildings for example, up to half of energy currently used could be cut by the use of intelligent and energy-saving technologies. Energy-intensive industries and SMEs need more affordable energy-efficient technologies to reduce their costs and become more competitive.

To exploit the potential of further indigenous resources in Europe. In this respect, increased attention should be paid to renewable energy and other clean conventional options. This will in turn bring the cost of low carbon technologies down, while at the same time it will promote coordinated and efficient European industrial value chains, from the supply of materials to the assembling of the final product.

To develop an integrated energy system. The internal energy market must be strengthened through smarter and more integrated EU energy grids. More attention must be paid to the incorporation of technologies into the energy system for more sustainable, cost-efficient solutions, economies of scale and to address increasing energy prices.

To reach out and engage. This requires cooperation with our international partners where there is clear added value. There is also a need to integrate the social science and humanities dimension into energy research. We must empower and engage further with the citizen by raising awareness about the need to develop innovative solutions.

The role that nuclear energy plays in Europe's overall energy mix should not be overlooked. Since nuclear energy remains an important technology of choice for many Member States, the Commission will maintain and develop research into this area. With a budget of over €1.6 billion, the five-year Euratom Programme will support nuclear research and training activities particularly for improving nuclear safety, security and radiation protection. It will, therefore, contribute to the long-term decarbonisation of the energy system in a safe, efficient and secure way.

HORIZON 2020: A POWERFUL INSTRUMENT TO LEVERAGE INVESTMENTS IN RESEARCH AND INNOVATION AND TO COORDINATE EFFORTS WITHIN THE MEMBER STATES

New possibilities have been created so that Horizon 2020 funding can be combined with private and national funds, and with support from other European programmes such as the Structural Funds. In particular, Horizon 2020 will help mobilise private investment by making access to risk finance easier. This will leverage substantial investment in key research and innovation sectors, such as energy, which are strategic for reinforcing Europe's international competitiveness.

Over the next seven years, it is expected that more than €1 billion will be invested in the public-private partnership on 'Fuel Cells and Hydrogen'. This partnership with industry will accelerate the market introduction of carbon-lean energy systems based around fuel cells and hydrogen technologies, with significant potential applications in many sectors, including transport and power generation.

The central pillar for the coordination of research and innovation actions between Member States and the EU programmes is the Strategic Energy Technology Plan (SET Plan). It triggered investment in low-carbon technologies across the EU from €3.2 billion in 2007 to €5.4 billion in 2010. This investment is expected to substantially increase under Horizon 2020 with the development of a single integrated roadmap and action plan for coordinated investments for: energy efficiency; competitive low-carbon energy; and smart cities and communities. This roadmap and action plan will take account of each Member State's preferred energy mix, and will provide greater support for first-of-a-kind, large-scale investments in technologies that have been successfully demonstrated at small scale but which are not yet commercially mature.

CONCLUSION

Horizon 2020 provides a means to accelerate innovation in cutting-edge, low-carbon technologies, to support the energy transition and help secure Europe's competitiveness by creating growth and jobs. We are convinced that by putting innovation at the heart of the energy transition the EU can bridge the gap between research and the market and take its place as a world leader in clean energy technologies and services.

Improving urban environment using innovative photocatalytic infrastructures

By Kristina Villar and Ignacio del Val, Advanced Materials Group. ACCIONA Infrastructures.

There is an increasingly public concern regarding pollution in the crowded cities. NO_x and VOCs emissions from cars, buildings and industries are the main source of pollution in urban areas[1].

These compounds have negative impact on the environment. For this reason, the European Commission developed several directives that tried to put limits to the concentration of several harmful compounds (2008/50/EC, 2001/81/EC). Moreover, the EC is applying penalties to infringements of the provisions of these directives in order to ensure that they are implemented.

As a consequence, regional and local authorities must reduce the pollution level, especially if they are close to the directives limits. A passive, not restrictive and coercive way to reduce the pollution is the implementation of photocatalytic technology to building materials.

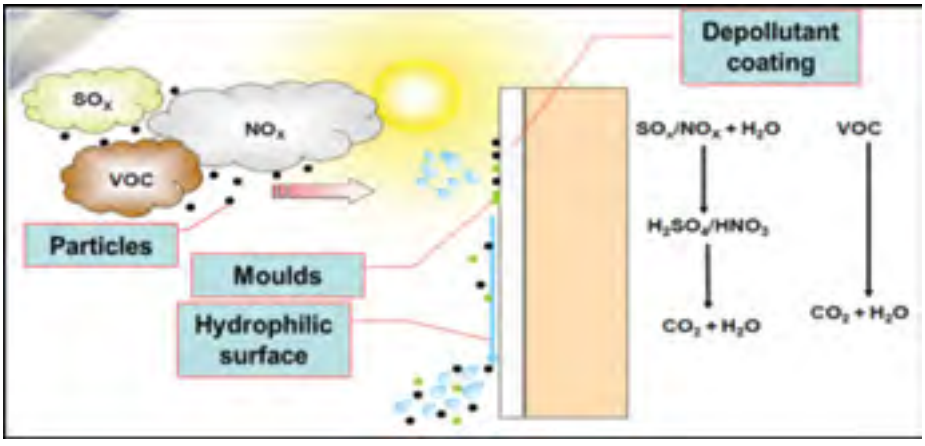
It is well known that pollutant compounds in the presence of humidity and UV light are descomposed by photocatalitic oxidation allowed by photocatalysts as titanium dioxide (hereafter TiO_2). This process creates hydroxyl radicals and super-oxide ions, which are highly reactive. These compounds aggressively react with other elements in the air, such as NO_x and VOCs, and effectively "oxidize" the pollutants. This breaks the pollutants down into harmless carbon dioxide and water molecules in the case of VOCs and nitrates in safe low concentration in case of NO_x.

Furthermore, the TiO_2 turns the surface superhydrophilic, so the condensation of water damp and rain drops form uniform films, which flatten out washing down the nitrates and the dirty on the surface of facades.

ACCIONA Infraestructures R&D, leader company in the development of advanced solutions in the field of construction, has been working along the years to develope technologies to improve the smart building concept and to achieve an eco-efficience performance of cities. For this reason since 2007 ACCIONA works in the development of a commercial photocatalytic additive with a high decontamination function at a competitive cost.

ACCIONA first contact with photocatalytic applications started from the hand of a National Project (DOMINO Project 2007-2011), which ultimate objective was the development of advanced nanostructured materials with improved properties for assorted industrial markets. The development of innovative products with differential properties is essential to improve the competitiveness of Spanish and European partners in their traditional markets, ensuring their survival. After some

Figure 1. The photocatalytic effect



1 NO_x is the generic name for the nitrogen oxides NO and NO_2 and VOC is an acronym for Volatile Organic Compounds

research in collaboration with the Spanish company TOLSA S.A., a new photocatalytic additive was finally developed (patent number: WO2013020972). Its performance has been proved following the self-cleaning and depollution standards for photocatalytic materials (ASTM G7-97 and ISO 22197-1:20122025).

Due to its properties, this photocatalyst is more homogeneously dispersed onto the matrix, allowing its incorporation in different materials for multiple applications.

The additive is incorporated to the matrix in two general patterns: embedded in coatings (sol-gel coating, slurry, asphalt pavement) and added in mass to different constructive elements (paving stone, monolayer mortar, concrete slabs).

All the applications were improved by their dosage optimization in laboratories in order to fit to each case. Then, ACCIONA was able to start with real application cases in urban zones. First applications were possible due to the gentle collaboration of different city councils, which are betting on this sort of technologies as a way to reduce high NO_x and VOCs levels in air, mainly in big capitals such as Madrid and its region.

Among these interventions, the following ones done between 2010 and 2013 can be highlighted due to its relevance:

- Two streets in Madrid city center (Spain) were treated with a slurry coating (Figure 2), with a total surface area around 3000 m²
- The same application was done in a new Eco-neighborhood in Madrid surroundings (1900 m²)
- 1500 m² of concrete slab were installed at Ávila coach station
- 1500 m² of façade tiles were set at one of the main universities of Madrid (Spain) (Figure 3)

The broad know-how acquired during the last years has made it possible for ACCIONA to be part of three different national and European funded projects focused on cutting-edge photocatalytic applications in infrastructures

NANOPIGMY (FP7, 2012) aims at promoting different multifunctional pigments provided with photocatalytic-based self-cleaning properties for the incorporation in paints and plasters.

ACCIONA presence is also important in other R&D projects, as the Spanish TECNOCAI (CENIT, 2009) and the European LIMPID (FP7, 2013), still on going. The main target this time is the chemical characterization of outdoor and indoor air quality in terms of NOx under already mentioned international standards and VOCs degradation using ad-hoc simulation chamber developed within the projects framework.

The next natural step after participating in the materials development phase of several avant-garde projects is to make a qualitative leap towards a more holistic approach of the decontamination phenomenon, in which classical infrastructures as roads, pavings and buildings, traditionally seen as a pollutant

Figure 2. Slurry application in Madrid city center (2012)

Figure 3. Façade tiles (in white) at University building (2013)

source, will turn into active decontamination elements thanks to their photocatalytic properties. Nowadays ACCIONA participates as consultant in several ambitious projects, dealing with monitoring strategies to evaluate and control NOx removal efficiency of photocatalytic materials, trying to achieve a smart grid for urban air quality management.

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Technical and operational measures to improve the energy efficiency of international shipping

By Edmund Hughes, Technical Officer, Marine Environment Division, IMO

A significant rise in international trade arising from globalization has led to increases in CO_2 emissions from maritime transport. IMO's Second GHG Study, published in 2009, identified that CO_2 emissions from international shipping accounted for approximately 2.7% of total anthropogenic CO_2 emissions in 2007 (this emissions estimate is currently being updated and is expected to be finalized later this year).

If no regulatory measures were developed, CO_2 emissions were projected to grow between 200% and 300% by 2050, despite significant market-driven efficiency improvements.

Against this background, in 2011 IMO adopted a suite of technical and operational measures comprising an energy-efficiency framework for ships, which entered into force on 1 January 2013 under Annex VI of the International Convention for the Prevention of Pollution from Ships (MARPOL). Estimates suggest that successful implementation of this energy-efficiency framework by 2050 could reduce shipping GHG emissions between 1.0 to 1.5 gigatonnes per year CO_2 against the business-as-usual scenario. (To put this in context, global energy-related CO_2 emissions reached 31.6 gigatonnes in 2012, according to the International Energy Agency, in its World Energy Outlook Special Report (OECD/IEA, 2013) http://bit.ly/1a5L7AH).

The package of technical and operational requirements, that apply to ships over 400 gross tonnage, requires new ships to be constructed to a mandatory design index, the Energy Efficiency Design Index (EEDI), which sets a minimum energy-efficiency level for the work undertaken (i.e. CO_2 emissions per tonne-mile) for different ship types and sizes.

The EEDI requirement will increase the energy efficiency of new ships over time. It is a non-prescriptive mechanism that leaves the choice of which technologies to use in a ship design to the stakeholders, as long as the required energy-efficiency level is attained, enabling the most cost-efficient solutions to be used. It is therefore intended to stimulate innovation in, and continued development of, the technical elements influencing the energy efficiency of a ship.

Reduction factors are set until 2025 when an improvement in energy efficiency of up to 30% over the average energy efficiency for ships built between 1999 and 2009 will be required.

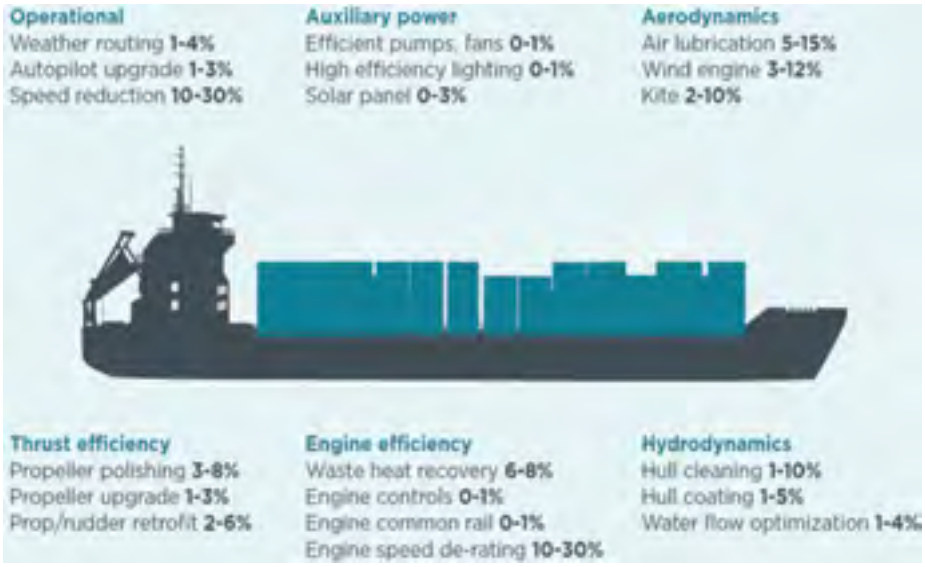

Figure 1: Potential fuel use and CO2 reductions from various efficiency approaches for ships (International Council on Clean Transportation (ICCT, July 2013). Long-term potential for increased shipping efficiency through the adoption of industry-leading practices) ***http://bit.ly/17NasAT***

The EEDI has been developed for the largest and most energy-intensive segments of the world merchant fleet and, with the recent inclusion of additional ship types, will embrace approximately 85% of emissions from new ships.

The new regulations also make mandatory the Ship Energy Efficiency Management Plan (SEEMP) for all ships over 400 gross tonnage. The SEEMP is an operational measure that establishes a mechanism to improve the energy efficiency of a ship against business-as-usual, in a cost-effective manner and also provides an approach for monitoring ship and fleet efficiency performance over time, using, for example, the Energy Efficiency Operational Indicator (EEOI) as a monitoring and/or benchmarking tool.

Studies by IMO indicate that uptake of SEEMP measures will have significant effect in the short to medium term, while EEDI measures should have a greater impact in the longer term, as fleet renewal takes place and new technologies are adopted.

Some examples of technology innovations expected to be adopted through effective EEDI and SEEMP implementation include speed reduction, weather routing, use of auxiliary power optimization and a focus on aerodynamics and hydrodynamics.

A variety of commercially viable emission-reduction solutions for sustainable shipping exist, as illustrated in Figure 1, with energy savings being far greater than the upfront capital costs. For example, propeller polishing (4.0% potential gain), water flow optimization (2.8%), and hull cleaning (4.8%) each offer energy savings that potentially far outweigh their upfront costs.

The package of technical (EEDI) and operational (EEOI) measures represent the first ever global and legally binding CO_2 reduction regime for an international industry sector or transport mode and will significantly reduce the amount of CO_2 emissions from international shipping.

In addition IMO, as the global regulator of international shipping, will continue its endeavours to reduce environmental impacts from international maritime transport, a vital industry to world trade and sustainable development.

Working together on a sustainable Port

By Maurits Prinssen, Project Manager Sustainable Development and Victor Schoenmakers, Director European & International Affairs, Port of Rotterdam

Ports are the indispensible key hubs in the global supply chain that enable the uninterrupted flow of world trade providing economic activities and jobs. However ports also have responsibilities in maintaining a clean and healthy environment in the port area, as does the port of Rotterdam.

With the expected future growth of cargo, new port areas and increased transport, the port continues to develop. It is necessary to do so in a sustainable way, in order to accommodate this growth and from considerations of societal responsibility.

Clean and efficient land based operations in the port of Rotterdam are part of its responsibility but the port of Rotterdam also aims to improve the performance of visiting ships by encouraging them to reduce air emissions as much as possible. In order to do so, the port of Rotterdam is participating in different incentive programs and invests in infrastructure for clean fuels.

ENVIRONMENTAL SHIP INDEX

Seagoing vessels that voluntarily join the Environmental Ship Index (ESI) and which have an ESI score over 31 points receive a 10% discount on the Gross Tonnage part of the port dues. The average discount was €1,100 per call last year and over 4% of all calling vessels received such a discount. The global ESI database is filled with more than 2,200 vessels and over 30 ports in the world are participating in this incentive program.

BARGES AND GREEN AWARD

Also barges can receive discounts in their port dues. Barges using abatement technologies like soot filter combined with Selective Catalysts Reduction or running on LNG may receive a 30% discount on the port dues. For barges with a Green Award certificate a 15% reduction is applicable.

With the incentive programs the port of Rotterdam let the ship operators decide how they'd like to reduce the emissions of their vessels. Whether abatement technology or clean fuels are used, as long the emissions are lowered to a sufficient level, they can participate in incentive programs.

ONSHORE POWER SUPPLY

In some port areas extra projects may have a high beneficial impact on the air quality. Onshore power supply for inland barges is already available at every public berth and one ferry operator is using a high voltage Onshore Power system. Infrastructure in new port areas is already prepared for these facilities, once onshore power is requested by the calling vessels. However, investments for shore facilities and vessels are high before they can actually plug in. The difference in pricing of bunkers and electricity is a significant parameter for a business case for shore power.

CLEAN FUELS

Clean fuels are warmly welcomed in the port of Rotterdam. LNG is the most well-known at this moment and already has been bunkered in the port of Rotterdam using trucks. In 2015 a bunkerpontoon for inland barges and bunker barges are planned to fulfill expected demand. The port of Rotterdam LNG ambition for 2015 is to encourage it further by incentive programs, make sure LNG infrastructure is available and that all regulations and Port Bye Laws are completed for all bunker activities in July 2014. The Port of Rotterdam Authority is setting a good example by already using low sulphur fuel in all company vessels and soot filters and catalytic converters on new company vessels.

SUPPORTING INTERNATIONAL AND EUROPEAN LEGISLATION

Finally the port of Rotterdam supports international and European legislation concerning the reduction of air emissions. For example the introduction of the agreed stricter sulphur standards in the North Sea and Baltic Sea from 1-1-2015 onwards. More recently the port of Rotterdam supported the stricter nitrogen standards at the earliest possibilty, which still has to be decided upon within the International Maritime Organisation.

This is how the port of Rotterdam is working together on a sustainable port!

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Energy Efficient Shipping: things are changing

By Gesine Meissner, Member of the European Parliament

Shipping is a growing source of greenhouse gas emissions accounting for 3% of the greenhouse gas emissions worldwide. The burning of heavy fuel oil also produces important amounts of NOx and SOx emissions.

During this parliamentary term there have been some achievements on European as well as on international level tackling the problem of shipping emissions. First we had to align European legislation to the stricter requirements of the International Maritime Organization (IMO) concerning sulphur emissions of ships. The main change was the introduction of Sulphur Emission Control Areas (SECAs) namely the North Sea, the English Channel and the Baltic Sea. The maximum sulphur content of fuels used by ships operating in these areas was limited to 1.5% starting from 2010 and will further be reduced to 0,10 % from 2015.

Ship owners warned that there won't be enough alternatives to heavy fuel oil available to comply with the coming 2015 sulphur limits. Since then in the Parliament we intensively discussed Liquid Natural Gas (LNG) as a cleaner fuel for shipping. I very much welcomed in the beginning of last year the Commission's proposal on the deployment of alternative fuels infrastructure which was accompanied by an LNG action plan. This legislation is crucial to break the current chicken and egg situation. Ship-owners don't invest in LNG-ships because there are only few ports with LNG bunkering facilities. Ports don't invest in LNG infrastructure as there is only little customer demand.

Although negotiations with Council are quite tough I am confident that we will find an agreement which will allow circulation of LNG-fueled ships throughout the TEN-T Core

Network within the next decade. We should have a flexible and market-driven approach also taking into account mobile supply solutions by LNG-trucks. Not every port must build its proper infrastructure. We should consider actual market needs and existing bunkering points to build up the LNG network.

Clean shipping regulation on EU-level continued with last year's Commission proposal on Monitoring, reporting and verification of CO_2 emissions from large ships using EU ports which is still in the legislative process. At international level IMO adopted two measures in 2011. The Energy Efficiency Design Index (EEDI) sets compulsory energy efficiency standards for new ships. The CO_2 reduction level for the first phase is set to 10% and will be tightened every five years to keep pace with technological development. The Ship Energy Efficiency Management Plan (SEEMP) is a management tool for ship owners to improve energy efficiency during operation of the ship.

I also saw some creative initiatives for energy efficient shipping these last years. Beluga Shipping, one of the shipping companies of my constituency, attracted some attention by operating the world's first commercial container cargo ship co-powered by wind energy. MS Beluga Skysails was partially powered by a 160-square-metre, computer-controlled kite. It was launched in 2007 with a first passage from the northern German port of Bremerhaven to Guanta in Venezuela. While the kite was in use, the ship saved an estimated 10-15% of fuel.

The kite did not become widely accepted and Beluga Shipping went bankrupt a few years later. But we need to think out of the box for innovation in shipping. Ship owners are still suffering from the economic crisis, as amounts of cargo transported around the world remain lower than before 2008. Therefor they are less likely to invest into alternative propulsion systems.

Nevertheless Scandlines, a ferry company operating in the Baltic Sea, is thinking about a Zero-Emission Ship. It has been designed by FutureShip, a subsidiary of the German-Norwegian classification company DNV-GL. The Zero-Emission Ship could be deployed by 2017 on the ferry service linking Puttgarden (Germany) and Rødby (Denmark). This service transports passengers, cars and trains on a 19km long passage over the Fehmarn Belt with departures every 30 minutes.

The propulsion of the Zero-Emission ferry is based on liquid hydrogen. On-board wind turbines can also contribute to propulsion when possible. Solar panels on the roof feed additional electricity into the electrical board system. Excess on-board electricity is stored in batteries for peak demand. Total energy needs are reduced by optimizing hull lines, propeller shape, ship weight and procedures in port. This ship would produce neither CO_2 nor NOx and SOx emissions. Maybe too good to be true?

GESINE MEISSNER

Member of the European Parliament
In 2009, Gesine Meissner became a member of the European Parliament. She is currently the coordinator of the ALDE Group on the Committee on Transport and Tourism and a substitute member in the Development Committee as well as in the Committee on Fisheries. Mrs Meissner is also a member of the EU-Mexico and Euro-Latin America Delegations.

She is a member of the council of the ALDE party and the federal executive board of the German Free Democratic party (FDP). In November 2013, she was elected as Vice President of the ALDE Party Gender Equality Network.

Before joining the European Parliament, Gesine Meissner was a member of the regional Parliament of Lower Saxony where she was chairing the Committee on Health and Social Affairs from 2003 to 2009.

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ZERO EMISSIONS PORT CALL

Green House Gas (GHG) emissions from sea going vessels are mainly released away from the coast, but the impact of GHGs is global since it affects the entire atmosphere regardless of where the gases are released.

The shipping community, led by the UN agency with responsibility for the safety and security of shipping and the prevention of marine pollution by ships – IMO, has recently implemented measures to significantly reduce the amount of CO_2 produced by ships. IMO has also introduced regulations to reduce Sulfur Oxides (SOX), Nitrogen Oxides (NOX) and Particulate Matter (PM). The latter, along with black carbon, are very small airborne particles that tend to concentrate close to where they are emitted; they are linked to premature deaths because the particles are small enough to get into the lungs and into the blood.

Despite the fact that maritime transport is by far the most environmentally friendly of all transport modes – in terms of CO_2 produced by unit of cargo transported per unit of distance – there are certainly improvements that can be made to reduce emissions from ships further.

Over the last 40 years the number of (non-naval) ships in operation with electrical propulsion has grown from 54 units to 1,694 units. This impressive growth has been driven mainly by the flexibility offered by electrical propulsion and, in certain cases, led to reductions in fuel consumption. Although electrical propulsion is emission free, shipboard electricity is generated by internal combustion engines – unless the power source is nuclear – which in turn release GHGs.

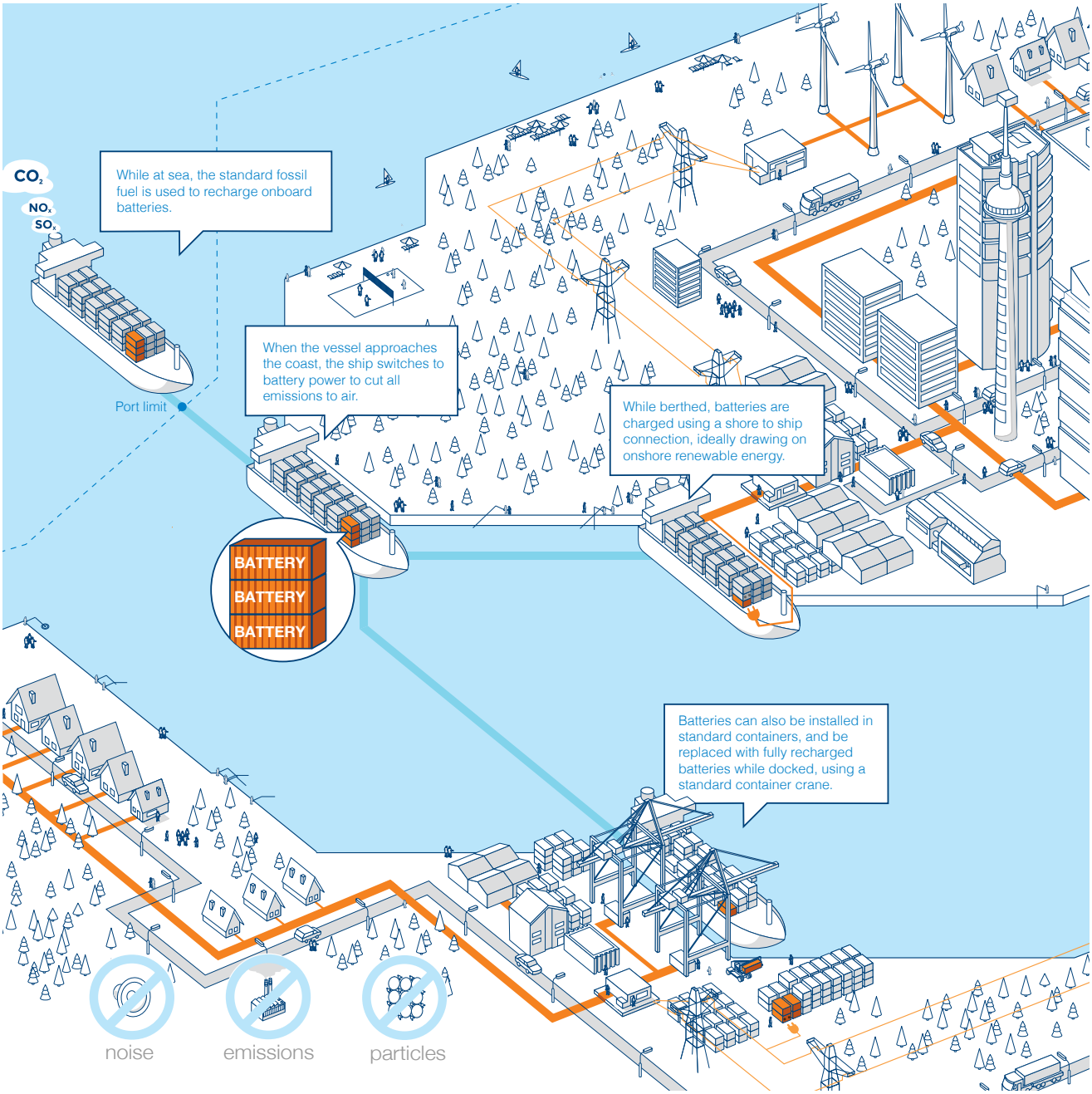
We are possibly on the verge of a breakthrough in marine propulsion, mainly driven by recent developments of battery technology. Today, it is already possible to install battery packs on board ship with enough capacity to run the ship on batteries alone for a few hours. This is not only technically feasible, but in some cases economically appealing. ABB Marine has recently developed solutions based on hybrid propulsion, i.e. electrical propulsion facilitated by a combination of electrical generators and batteries. The fuel savings attained by such a combination generates positive cash flow within a few years, despite the fact that the cost of batteries remains high.

There are other drivers that work in favor of including batteries in the ship power mix. ABB technology that is available today makes it possible to build a ship that switches off the main engine a few miles before entering the port and sails exclusively on batteries from that point to the dock. Once alongside the dock the ship would connect to the shore grid and charge the battery packs.

Alternatively, battery packs can be made interchangeable so that drained packs are swapped with charged ones during port-side cargo operations. The empty batteries can then be re-charged at the terminal, taking advantage of electricity from sources available via the grid – gas, solar, coal, fuel, wind, nuclear, hydro, waves. Electricity from the grid is greener and cheaper than that generated under ship's own power. In addition, batteries can be charged from the grid during off-peak periods when prices are lower.

Ships that operate within harbor areas are definitely the first candidates for battery propulsion technology. Typically, these are small ferries, river vessels and tugs. Tugs, for example, could benefit from the approach because they mostly operate at very low loads - while installed power is high, full power is not often required. River ferries could run solely on batteries, with charging points at each end. The battery option also offers significant potential for container carriers operating in harbor areas and city ports to reduce emissions; these vessels feature high installed power, but rather inefficiently use only a small part of that power when navigating within harbor areas.

Such a solution would allow a ship to produce no emissions whenever sailing very close to urban centres. That is to say, the ZERO EMISSIONS PORT CALL is possible, practical, and available today.



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Energy Efficient Shipping and Impact on Shipbuilding Evolution

By Luciano Manzon, Chairman, SEA RDI

Today shipping faces strategic challenges: escalating energy costs and impact on climate change. The common denominator of these challenges is the industry's reliance on fossil fuels. The fuel cost represents the most significant cost item when operating a vessel (46% of the operating cost – standard Panamax containership).

Shipping will increasingly be obliged to be included in regional and worldwide regulatory regimes to reduce greenhouse gas emissions. Therefore the investments in energy efficiency, resulting in increased cost efficient products, and the transition to new fuels to reduce the sector's environmental footprint both represent a challenge and a distinct evolution needed for the waterborne industry.

The compelling case to take action to mitigate the impacts of climate change by reducing emissions is reflected by the present regulatory framework both globally and regionally through strategic maritime policy goals.

The IMO has been setting a global emission reduction agenda:

- The introduction of the Energy Efficiency Design Index (EEDI) that mandates vessels to have a 30% CO_2 reduction by 2025.
- Annex VI of MARPOL including a cap on the Sulphur content in fuel oil as a measure to reduce SOx.
- NOx emission limits are being set for diesel engines.
- Stringent requirements regarding the emission of particulate matter is also expected.
- Overall increase in ship efficiency will be realised through the creation of the Ship Energy Efficiency Management Plan (SEEMP).

The European Commission's WHITE PAPER ON TRANSPORT has given high priority to tackle the environmental impact of transport. A challenging target of CO_2 emissions from maritime transport of 40% by 2050 compared to 2005 levels has been set. The global fleet is expected to double and therefore the real reduction in CO_2 emissions of each sailing vessel should be at least 70% on average, compared to 2005.

The maritime industry needs to utilise R&D in order to re-think the energy production and absorption chain of vessels, finding different cost-efficient solutions to be implemented from today until 2050. A strategic overview of the different "combinations of key technologies" (and their possible evolution) to be focussed on, in that period, is essential to meet the challenge.

The European maritime industry is doing just that through its network represented by the European Waterborne Technology Platform.

Room for improvement in the overall vessel efficiency appears to exist, considering if 100 is the fuel energy going into the main engines, around 50 is transmitted to the shaft and going from the shaft to the propeller, about 34 is the "working" propulsion power covering the hull friction, the wave generation and other resistances to the motion. There are many losses in the power chain!

The research of better efficiency measures will concern all areas of energy loss. Breakthrough solutions are needed in hull, propulsion and auxiliary domains whilst not forgetting the important areas of overall ship operation and energy management.

Two important aspects should need to be taken into consideration:

- Efficiency measures differ according to the type and the operational profile of the vessel;
- Measures for increasing efficiency are generally not cumulative.

This highlights the important role of a ship designer who has to choose and integrates different possible technological solutions for the best overall performance of a ship.

Promising areas of the research that can assist to meet the strategic goals could address:

Hull: Developments of Computer Fluo-Dynamics tools for eco-efficient design in order to innovate and optimise hull forms for multi-mission operational profiles; new molecules for hull treatment reducing resistance and combining antifouling properties; viscous resistance reduction identifying new laminar hulls concepts; wave-ship motion optimisation; advanced hull designs for inland / shallow water navigation; and next generation propulsors.

Materials: Breakthroughs are expected regarding the use of lightweight / higher strength composite materials (e.g. metal foamed sandwich) and the relevant joining techniques.

Engine: Combustion optimisation of marine engines (injection timing, compression ratio, fuel spray geometry, etc.); alternative fuels (LNG, methanol, ethanol, DME, biodiesel and biogas); renewable energy propulsion (wind, sea and solar power); fuel cells running on hydrogen as auxiliary propulsion power; and in a longer term vision a diverse fuel mix adoption, with LNG, biogas, batteries and hydrogen produced from renewable sources.

Overall ship operation and energy management: innovative solutions are expected for the monitoring, control and automation suitable to optimise the energy use on board permitting cost efficient operations in different vessel conditions.

All these research issues are currently under consideration by the maritime technology industry and is reflected in the strategy of the Waterborne TP. The sector has engaged to finalise a large research program – "Vessels for the Future". It is proposed that a Private Public Partnership with the EC can tackle the challenges related to energy efficient shipping and safety, thereby, encouraging a change in perception of shipping and fundamentally altering the state of operation, when compared with today.

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Green Retrofitting through Improved Propulsion (GRIP)

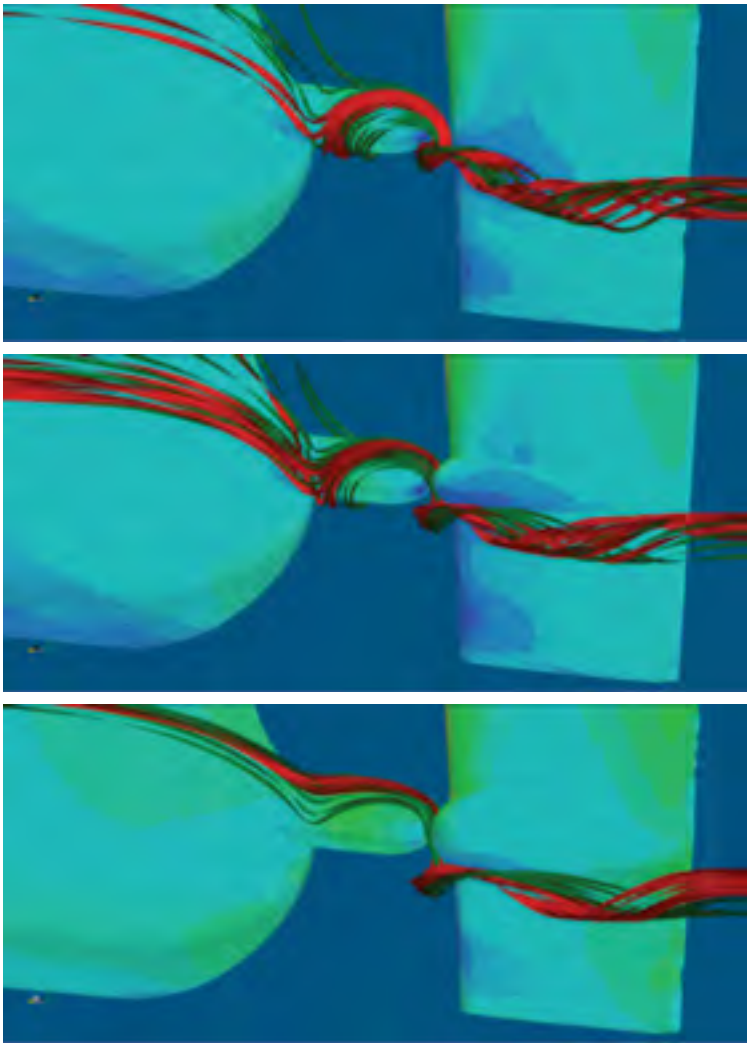
Energy Saving Devices (ESDs) are designed to prevent the inevitable energy losses in the ship propulsion system or to recover some of these losses. The idea of an ESD is not new, during energy crises and other periods, where ship owners have an urge to reduce the operational costs, a great deal of attention is paid to the development of such devices. ESDs have been tested in model basins and have shown great potential at model scale. Although, in some cases that correlation with full scale performance cannot always be found.

It is the objective of the FP7 project GRIP (Green Retrofitting through Improved Propulsion) to obtain an insight into the working principles of ESDs and validating the potential by full scale trials. GRIP furthermore focuses on the (retro-) fitting process including the costs which to provide ship owners with a decision making tool on the payback period of ESDs.

EARLY ASSESSMENT TOOL

The field of application of an ESD is often not made clear by the manufacturer, which makes it difficult for a ship owner which makes it difficult for a ship owner to select to select the best ESD for a specific vessel. Next to that, reliable performance data of these devices is not readily available. Therefore, the GRIP project will deliver an Early Assessment Tool (EAT) for ship owners to characterise the potential energy and emission reductions and associated costs in case of retrofitting.

The EAT will be released as a web based tool for public use and an extended version for GRIP project members. Target users are the technical staff of ship owners, consultants etc. The tool is a means to give guidance in preliminary selection of ESD's. The EAT will determine the viability of various ESD's based on a limited amount of general input data such as vessel type, main engine power, vessel speed and propeller diameter. Three types of ESD's where chosen to be part of the EAT: pre-swirl stators, upstream ducts and propeller hub loss recovery devices (e.g.



Streamlines passing through the propeller hub of the FORMPRO bulk carrier for cases without bulb (left) and with the baseline (right) and the optimised (bottom) rudder bulb using only the bulb thickness as a single design parameter (optimisation done by HSVA)

hub cap, rudder bulb and small rudder stator fins). A cost model competes the EAT and makes it possible to judge the economic viability of various ESD's. The cost estimate is based on the actual component and installation costs. The benefit is based on a suitable measure, such like a return on investment.

CFD BASED DESIGN PROCEDURE

One of the reasons for the reluctance of ship owners to invest in ESDs is the uncertainty in the performance gains at full scale. The newest CFD techniques, presently available, are utilised by the GRIP project to set up a design procedure including the analysis of the hull – propeller – ESD interaction. Current CFD tools are capable of capturing small deviations in the flow caused by the presence of the ESD for both model and full scale.

A parametric variation has been done for a rudder bulb installed to a bulk carrier of which the results are shown in the figure to the left. Similar optimisation are done for the three ESD types also included in the Early Assessment Tool for a container vessel, a bulk carrier, a RoRo vessel and a reefer ship. The analysis will study an optimised design as well as scale effects on the ESDs.

STRUCTURAL ASSESSMENT

Today the ESD structure is not reviewed, only its attachment to the hull is considered. Estimating the loads on the ESD is challenging and regulations give no guidance to validate the ESD design. The GRIP project tackles this challenge by developing a methodology to assess the strength and to approve the ESD design considering static and dynamic loads, fatigue life and vibrations.

The main challenge is to evaluate the dynamic loads applied to the structure in sailing conditions. In order to consider the dynamic loads, Bureau Veritas has developed a methodology to define the maximum forces applied to an ESD in the design wave condition. This methodology is based on the local flow incidence variation and the estimation of the inertia loads on the ESD.

Further focus of the structural work group is on vibrations of the ESD caused by fluid-structure interaction. Vibration induced by fluid flow can be classified by the nature of the fluid-structure interaction.

RETROFITTING PROCESS

A perhaps unexpected uncertainty in retrofitting vessels with ESDs is the actual shape of the hull. Unfortunately, detailed information on the geometry of the hull is often not available for the ship owners. Ships change owner quite often, diffusing existing information. Methods are developed within GRIP to determine the exact geometry of the ship.

Another obstacle for retrofitting ships is the costs of investment. More efficient retrofitting processes are needed without endangering the accuracy of the retrofitted device. A business process model and a retrofitting technical process model were created in GRIP to represent the requirements of a retrofitting process in a shipyard.

VALIDATION

Validation of the actual fuel saving effects of an ESD is an important aspect of a retrofit process. Validation will be done on a new built vessel where trials are done without the ESD followed by dedicated trials after installation of the ESD. Apart from the validation of the fuel saving effect of the ESD, the flow improving properties of the ESD will be validated. This will be done by full scale flow measurements. For this purpose, a flow measurements system will be developed and tested based on Laser Doppler Velocimetry. Trials are scheduled for early summer 2014.

OUTLOOK

At time of publication, the GRIP consortium is working on validation tests for a pre-swirl stator installed on a bulk carrier. Dedicated speed tests and flow field measurements before and after installation of the ESD will validate the developed design techniques.

GRIP is likely to have the final dissemination event presenting the project results at the Green Shipping Technology Conference 2015. A dedicated session on GRIP will give attendants to GST 2015 the opportunity to learn about the results obtained.

This research project has received funding from the European Union Seventh Framework Programme

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Energy Efficient shipping with WE Tech Solutions Oy

WE Tech Solutions Oy (WE Tech) is a leading energy efficiency provider for the global shipping industry. The company develops, sells and delivers energy efficient solutions and services for both retrofitting of existing ships and new builds. With the primary focus on creating savings, WE Tech strives for bringing the next level in energy efficient shipping.

The solutions delivered by WE Tech focus on utilizing Variable Frequency Drive Shaft Generator systems for electrical power generation on board ships. The main advantage of utilizing Shaft Generators is that electrical power is generated by the Main Engine which is driving the ships propulsion machinery. The Main Engine(s) are significantly more energy efficient in comparison with Auxiliary Engines which otherwise are driving the electrical power generators on board. Electrical power generation via the Shaft Generator means also that the Auxiliary Generators are stopped when the vessel is at sea. By utilizing variable frequency drive technologies in the shaft generator systems the main propulsion machinery can be operated with highest possible efficiency at all times with the Shaft Generator online.

WE Tech's WE Drive™ is a grid converter that takes in variable frequency and voltage of the Shaft Generator and gives out nominal frequency and voltage for the ships electrical network at all times. Thus the main propulsion machinery can be operated in combinator mode (a combination of variable speed and propeller pitch) enabling increased energy efficiency by up to 20 % and savings per vessel ranging between €300 000 and €800 000 per year.

The WE Drive™ is also utilized for electrical motor drive i.e. to run the Shaft Generator as a motor. Driving the Shaft Generator as a motor provides Boost mode and Take Me Home modes to vessels operations and many ship types have great benefits in terms of safety and energy efficiency from this type of hybrid propulsion features.

WE DRIVE™ SHORE POWER CONNECTION

WE Tech also supports vessels to achieve greater energy efficiency by utilizing shore power. When vessels are berthed at harbour the WE Drive™ installed on board is converting electrical voltage between the ship's electrical network and shore power, thus facilitating the connection of shore power to the ship. Consequently, as the ship's electrical network is supplied from shore, the Auxiliary Generators are stopped when in harbour. This creates savings by reducing the fuel consumption, and improves the environmental condition by cutting emissions, such as CO2, NOx, SOx.

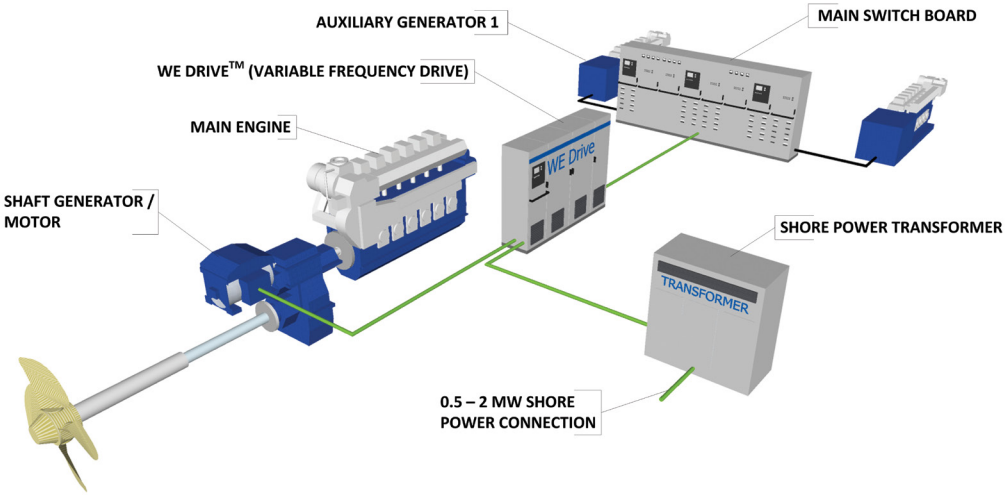

Figure 1 Propulsion machinery with WE Drive™ and Shore power connection

About WE Tech

WE Tech Solutions Oy is a Finnish clean-tech company and an energy efficiency solution provider for the shipping industry. WE Tech develops, sells and delivers energy efficient solutions for the global shipping industry. WE Tech has developed a new type of variable frequency shaft generator system providing many benefits for the shipowner. The energy efficient solutions of WE Tech are suitable for retrofitting on existing ships as well as for newbuildings. WE Tech's services and technology creates savings and brings the energy efficient shipping to the next level. The company is headquartered in Vaasa, Finland and has an office in Shanghai, China.

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From the Muelle de las Mulas to Stockholm: Emission-free shipping comes of age

By Mike Edmund

The pessimist complains about the wind;
the optimist expects it to change;
the realist adjusts the sails.

–William Arthur Ward

Muelle de las Mulas, Seville: 10th August 1519. Despite the heat, there was no doubt something of a crowd gathered at the dock on the river Guadalquivir. Under the command of Fernão de Magalhães five ships had assembled there before moving downriver to Sanlúcar de Barrameda, and then on to circumnavigate the world; the first expedition to do so. Only one of those ships eventually returned: the Victoria, under Juan Sebastián Elcano. The man many know today as Ferdinand Magellan sadly did not live to acknowledge the accolades due him from the enterprise; nor did he reap its doubtless considerable financial rewards.

Elsewhere in this issue of European Energy Innovation, an excellent article by Edmund Hughes reviews the IMO's legislative and technical response to the environmental effects of maritime shipping. He points out how the growth in international trade meant that shipping accounted for almost 3% of anthropogenic CO_2 in 2009, a figure projected to triple or quadruple by 2050 if nothing is done. The IMO has now framed the first ever global and legally-binding legislation to concern emissions and energy efficiency: a framework that could substantially reduce the former and while significantly increasing the latter. Considerable investment will no doubt be necessary, but Mr. Hughes points out rather interestingly that simple measures such as hull cleaning and

propeller polishing can confer energy savings far outweighing their initial costs.

Both commercial and legislative forces are already shaping the reaction of the shipbuilding industry, and Marine Insight magazine recently reviewed several zero emission shipping concepts. One vessel already in service, it reports, is the Emerald Ace, constructed by Mitsubishi. She represents a stepping stone along the path towards zero-emission shipping by virtue of the solar panel and battery storage systems that power her in port: she emits nothing while berthed.

More futuristically, the E/S Orcelle is a car-carrying concept ship from Stockholm-based conglomerate Wallenius. She integrates electrical systems, wind and wave power and fuel cells into her propulsion systems and, although Wallenius does not currently believe the E/S Orcelle will ever be built, the company nevertheless believes that elements of her design will feature in its future vessels. More significantly, Wallenius has a roadmap for the eventual production of a zero- emission ship by 2040. Slightly closer to today, the Super Eco Ship from NYK is scheduled to become operational by 2030. Her design features particular attention to streamlining to reduce drag, and solar and LNG propulsion systems which together anticipate reducing CO_2 emissions by 69%. Still on the drawing board is GL's Container Feeder Vessel ZERO, which features hydrogen fuel cell propulsion, and is expected to produce no CO_2, NO_x and SO_x emissions. Meanwhile, Futureship's Zero-Emission Ferry Concept for the shipping company Scandlines incorporates photovoltaic systems, fuel cells and Flettner rotors. Designed to have space for 1,500 passengers and 2,200 lane meters for vehicles, the concept is mentioned by Gesine Meissner MEP in her article in this issue; it intrigues her so much that she even asks if she is too good to be true.

The use of wind energy in shipping has of course been very much a reality for a very long time: and so we return to Ferdinand Magellan's expedition of 1519. The ship's log on the Victoria confirmed that a whole day had been lost during the time at sea: this prompted great excitement and a special delegation was even sent to the Pope to explain the phenomenon to him. One eventual result was the creation of the International Date Line. Proof, if you will, that the right technology can change how we look at the planet. Why, it can even change the measurement of time itself.

DAPhNE – Development of adaptive ProductioN systems for Eco-efficient firing processes

"…Sustainable Development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs…"

This is how UN explains the concept of Sustainable Development. In a world where manufacturing has become the driving force behind Nations' economy, more and more effort should be put in steering technology towards sustainability and eco-efficiency.

It is a well-known aspect that global energy demand has grown widely during the last decade. Now, it is no longer a surprise that the largest slice of the "primary energy cake" is used for heating. Heat and electricity dominate the total end use and represent approximate 55% of the total energy use (57.3 EJ). Even though the use of natural gas and electricity for heating (accounting for 66%) is common to several sectors (e.g. residential, service, etc.), the industrial sector still represents the most-energy demanding.

In this context **DAPhNE**, *a FP7 EU-co-funded project within the framework of the Intelligent Manufacturing System (IMS) program*, aims at introducing a completely new, flexible, modular, re-configurable, smart and digital factory concept in three energy-intensive manufacturing sectors as ceramics, cement and glass, which do represent key sectors for the European manufacturing economy. As proved by Eurostat data (Jan 2009), in 2006 cement, glass and ceramics represented, respectively, 44.3%, 20.9% and 19.5% of the value added of the other non-metallic mineral products manufacturing sector (EUR 79.8 billion, corresponding to 1.4 % of the EU-27's value added in the non-financial business economy).

These three sectors have already implemented technologies, control systems and measures to reduce primary energy consumption and plant emissions. However, several improvements could still be done in order to achieve eco-efficiency, especially for what concerns the most energy intensive parts of the production chain: the firing processes. DAPhNE's Consortium is seeking common solutions based on the introduction of **microwave (MW) heating technology** as a full-scale industrial process and on the exploitation of **innovative monitoring and control systems** at factory level for providing real time information about the energy consumption and the product quality by the evaluation of specifically developed Key Performance Indicators.

Solutions outputted by the DAPhNE project are expected to provide benefits to the world of mass commodities manufacturing industry in terms of **energy efficiency** (the target is to reach an overall energy demand reduction of more than 40%), **sustainability** (decrease of CO_2 emission up to 85%), economy (higher production rate coupled to modularity of the production chain coupled to reduced costs).

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Making European energy supplies smarter and more sustainable

By Zoran Stančič, Deputy Director-General, DG CONNECT, European Commission

In December last year, the European Commission launched Horizon 2020. With almost 80 billion euros of funding over the next 7 years[1], this is the biggest and most ambitious EU research and innovation funding programme so far. The range of research and scientific fields covered by the programme is large and varied. Let me outline our ambitions for the 2014/2015 part of the research programme specifically on how best to use ICT to increase energy efficiency, allow for higher integration of renewables and reduce greenhouse gas emissions.

Europe needs to do much more to meet our longer term energy targets. Current policies, whilst making progress, cannot achieve the demanding targets that we have set ourselves for 2020, 2030 and 2050. More and better use of ICT can help us to get there. Large scale deployment of smart grid technology will help to reduce demand and make more intelligent use of renewable and distributed energy sources and smart meters in households will allow consumers to make informed decisions about their power use. But smart grids are expensive – a study in 2011 concluded that some 56 billion euros needs to be invested in smart grid technology by 2020[2].


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So one of the things we hope to achieve under the research and innovation programme is to identify ways of reducing that cost. If there are cheaper ways of building and deploying smart grids then the return on investment will be higher and the money will be more easily found. Market forces will then naturally drive a faster deployment of smart grids, saving energy and improving efficiencies in the supply industry.

One way of reducing costs would be for smart grids to make as much use as possible of existing digital infrastructure and existing network standards, the standard telecommunication system and the universal internet protocols, rather than creating duplication or additional complexity. Greater interoperability will also lead to

lower implementation costs and foster a more open market with low entry barriers and solutions that are adaptable enough to capitalise on new breakthroughs. We also need to identify which of the data produced (e.g. by smart meters) can be usefully made available to third parties and in which formats – while respecting and protecting consumers privacy. These data will be the basis for new smart applications that will inform consumers and help produce the reduction in demand that we need. It is also important that ICT reduces its own environmental footprint, and that the work continues to adopt common standards for measuring and comparing this.

So, although the term "research" usually conjures up images of scientists in white laboratory coats, this part of Horizon 2020 is aimed very much at practical applied research and experimental, real world innovation and implementation.

For maximum effectiveness, we would like to see research proposals by partnerships that include public utilities such as energy companies or telecom providers working together with researchers, ICT and technology companies.

We are looking to support projects that develop and validate real integration of ICT and energy supplies, interacting with real end users to demonstrate genuine energy saving benefits. The purpose is to develop the practical implementation of systems that can intelligently and efficiently manage demand and integrate energy supplies (and energy types – electricity, heat) from a number of sources, allowing small scale renewables and locally integrated CHP (combined heat and power) plants to make a fuller contribution.

Projects will also need to properly assess the energy and resource consumption of their ICT solutions to ensure that they would not create more CO_2 than they "save".

On the demand side, we are looking for projects that can identify how best to enable and motivate domestic consumers, the general public to be more in control of their energy consumption and their energy bills, with easier to understand (and cheaper) "smart metering" , moving from expensive smart meters with complex interfaces to simpler and more effective apps on PCs or smartphones.

For Horizon 2020, there are also general eligibility requirements for projects that are broadly similar to the previous EU Research funding programmes. There must be at least three different partners, drawn from at least three different EU Member States or Associated countries[3].

More details about the "call for proposals" for Energy efficiency and ICT can be found on the Horizon 2020 website.

There are two calls for submitting a proposal in this area. The deadlines are 7th May (for call for competitive low-carbon energy - Distribution grid and retail market, LCE-07-2014) and 5th June 2014 (Energy Efficiency Research & Innovation - New ICT-based solutions for energy efficiency - EE-11-2014).

1 http://ec.europa.eu/research/participants/data/ref/h2020/legal_basis/fp/h2020-eu-establact_en.pdf - the Regulation establishing Horison 2020

2 http://www.navigantresearch.com/research/smart-grids-in-europe

3 http://ec.europa.eu/research/participants/data/ref/h2020/legal_basis/rules_participation/h2020-rules-participation_en.pdf - the rules for participation in Horizon 2020

This paper expresses the personal views of the author and in no way constitutes a formal/official position of the European Commission

Charting green, digital success in cities

By Daniël Termont, Mayor of Ghent and chair of the EUROCITIES knowledge society forum

Cities offer the most energy efficient form of human settlement. High density buildings and population require less energy per person, while journeys are shorter for both people and goods. There is therefore good cause to believe that the bulk of the 20% reduction in energy use the EU is targeting by 2020 will take place in cities.

Currently urban areas account for three quarters of the EU's population and 80% of its energy use. As mayors we have a variety of options at our disposal to make our cities consume less energy. We can offer better public transport, more and wider cycling lanes, and encourage the use of more building insulation and more efficient appliances. We can also work with citizens to raise awareness about energy efficiency measures and the need to fight climate change.

And new possibilities are constantly emerging. The digital age and the explosion in use of Information and Communication Technologies (ICT) give us the opportunity to rethink how we live and work together. ICT can help improve energy efficiency by more efficiently managing urban transport or energy supply and demand. The downside is that ICTs themselves consume energy, and there is a risk that the savings they achieve are overshadowed by those they generate.

42 cities have signed the Green Digital Charter

The Green Digital Charter (GDC) is an attempt by city authorities to make sure that doesn't happen. It represents a commitment by our city governments to improve energy efficiency through the use of ICT. By signing, cities pledge to work together to deploy five large-scale ICT for energy efficiency pilot projects within five years, and to decrease our ICT carbon footprint by 30% within ten years. Implementation of the charter is being supported by the European Commission through the NiCE project, coordinated by EUROCITIES.

So far, 42 major European cities have signed the charter, including 11 capital cities. We have developed ways of comparing performance on ICT

and energy efficiency. We have shared our experiences and learned from one another. And, crucially, we have gained access to an expanding database of successfully tested projects, tools and ideas.

Bristol was an early signatory of the GDC and the Bristol Green AddICT website was one of the first platforms for businesses to share expertise and best practice on green ICT. It includes carbon calculators and a comprehensive solutions database for designing tailored action plans.

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The charter also encourages our city administrations to make better use of existing infrastructure. The IT department of the city of Linkoping used one of the GDC tools to show how upgrading its equipment with new, more energy-efficient hardware could give a faster than expected return on investment, thanks to substantial savings in electricity costs.

As GDC signatory cities, we take part in three distinct types of activities, all of which support the fulfilment of our commitments. Study tours, which are peer learning activities between cities, offer the possibility to interact with project managers in the host city and really understand how a project works. This helps us assess whether a similar project is worth implementing back home. Secondly, there are technical trainings, which help cities tackle the barriers and challenges we face in delivering on our commitments. Finally, we organise roadshows, which are networking events that allow the creation of partnerships between cities and other stakeholders to develop new projects.

All these activities help our city authorities trial new technologies like smart meters. These devices enable citizens monitor their own energy consumption. Crucially, they could also one day facilitate the creation of smart grids that would help balance peaks and troughs in electricity supply and demand. One of Nuremberg's projects is to equip its municipal buildings with smart meters. As well as adopting strict passive building standards, smart meters will help Nuremberg more efficiently monitor and control its energy use.

Ghent has created a central print management solution for all city departments which has halved the number of printers used and cut the number of pages printed by 54%. Employees now use the same badge to activate a print job as they do to access their office building. This has led to substantial energy savings and a reduction in ink usage by the city government. The city council's decision-making process has also been fully digitized so that all documents are now handled electronically rather than on paper, including signing. This has allowed the city of Ghent to save a pile of papers stretching as high as the Eiffel Tower (300m) on a yearly basis.

European cities have both traditional and new solutions at their disposal to become more energy efficient. Digital technologies are among the latter, offering us great potential for reducing energy consumption and for better managing our city infrastructure. We need to make the most of this as cities, by sharing our experiences through EUROCITIES and projects like NiCE. The Green Digital Charter is the kind of initiative that can chart that green, digital success.

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Environmental product declarations for all systems

Lamilux, manufacturer of high quality daylighting systems and equipment for natural smoke and heat extraction has taken another big step towards demonstrating the environmental sustainability of its products and their resource-conscious production. The company from Upper Franconia, Germany, is the first developer of rooflighting systems to have introduced Environmental Product Declarations (EPDs), which are now available for all rooflight domes, continuous rooflights and large-area glazed roof constructions. The daylight specialist thus provides comprehensive information on the environmental impacts of its products, allowing their contribution to the sustainability performance of a building to be assessed. These analyses, which consider the entire product life cycle, are of great relevance in particular to planners and architects aiming for Green Building certification of their buildings - as issued, for example, by Deutsche Gesellschaft für nachhaltiges Bauen (DGNB - the German Society for Sustainable Building) - or for certification in line with the international BREAM or LEED standards.

The EPDs (Environmental Product Declarations) are issued subject to the specifications the European DIN EN 15804 standard and are an internationally recognised and accepted product eco-label. After all: they allow valid conclusions on the environmental impact of a product to be drawn - from its production and the raw materials used therein, through the consumption of resources throughout the product's service life, up to its removal and disposal, that is, from the cradle to the grave.

EPDS ALREADY PART OF MANY BUILDING CERTIFICATION SYSTEMS

Due to the many utilisable values and details in practical facility planning, EPDs are already recognised by numerous international building certification systems, such as DGNB, BREAM or LEED. They thus follow a recommendation of the Building Products Ordinance, the European framework for sustainability assessment of products according to DIN EN 21930: "To allow assessment of the sustainable use of resources and to evaluate the impact of buildings on the environment, Environmental Product Declarations (EPDs) should be referenced, where available."

"BUILDING PRODUCTS DETERMINE A BUILDING'S SUSTAINABILITY"

En route to EPD certification - with ift Rosenheim as the program operator, Lamilux was supported by brands & values GmbH. The Bremen-based company specialises in advising organisations and companies that seek and intend to practically

implement sustainable corporate governance. For sustainability consultant Martin Blumberg, Lamilux has clearly demonstrated - in attaining these EPDs - that its products play a positive role in the holistic sustainability consideration of buildings. "Whether or not a building is sustainable, is largely determined by the materials used," he stresses.

VALUABLE PRODUCT DETAILS FOR SUSTAINABILITY PLANNING

In Blumberg's opinion, the Lamilux products have a positive effect on a building's climate and environmental footprint; for example, due to the excellent recovery quota, and the high proportion of recyclable components. Added to this, is the impact on functional and economic qualities thanks to good thermal insulation and air and driving rain tightness of the daylight elements and their low maintenance and repair costs in the building's life cycle.

Martin Blumberg: "All of these aspects have now been exhaustively examined and quantified in the EPDs." The individual results for the Lamilux products can be retrieved directly from a database (Ökobau.dat/ Information portal for sustainable construction) and included in the draft designs of sustainable building. "This makes the work of planners and architects much easier, as they now easily access the values,and can include them in their sustainability planning," was the conclusion drawn.

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About LAMILUX Heinrich Strunz GmbH

For almost 60 years, **LAMILUX** has produced high-quality daylighting systems made of plastics, glass and aluminum. Architects, construction engineers, planners and roofers use **LAMILUX CI Systems** when building industrial facilities, administration buildings and industrial shed complexes as well as private residences. The purpose of these structures primarily consists in optimising the use of natural light and guiding it into building interiors. Fitted with controllable flap systems, they also serve as smoke and heat exhaust ventilation systems (SHEVS) and energy-efficient building systems providing natural ventilation. The unique **LAMILUX CI Systems** range includes a wide variety of different structures – from rooflight domes and continuous rooflights through to glass roof constructions in aesthetically pleasing shapes. The company also offers considerable expertise in developing and manufacturing facility control systems for activating and automating both smoke and heat exhaust vent systems and ventilation and solar protection installations. With 630 employees, LAMILUX generated a turnover of 175 million euros in its two business divisions - **LAMILUX Daylight Systems and LAMILUX Fibre-Reinforced Plastics** - in 2013.

www.lamilux.com

Whether large glazed roofing structures for aesthetic and representative building or functional continuous rooflights and rooflight domes for natural light in industrial, sports and exhibition halls, Lamilux now has Environmental Product Declarations (EPDs) for all products and systems.

Rationales for Innovation towards Energy-efficient Buildings (EeB)

By Luc Bourdeau, E2BA Secretary General

With a yearly turnover around €1.2 trillion, the European construction sector, including its extended value chain (e.g. materials and equipment manufacturers, construction and service companies), is the largest European single activity (10% of GDP) and the biggest industrial employer (14.6 million direct jobs). Furthermore, the built environment affects the quality of life and work of all citizens (European citizens spend more than 90% of their life indoor). This sector is therefore of paramount importance for Europe and its citizens.

More particularly, the construction sector is crucial to EU environment and energy policies, as buildings use 40% of total EU energy consumption and generate 36% of greenhouse gases in Europe. While the replacement rate of the existing stock is very small (1-2% per year) the construction sector is today on its critical path to help decarbonise the European economy by 2050, by reducing its CO_2 emission by at least 80% and its energy consumption by as much as 50%.

Considering this major challenge, the European Commission and industry, represented by Emmanuel Forest, as President of the Energy Efficient Buildings Association (E2BA) signed, on December 17, a contractual Public-Private Partnership (PPP) on Energy-efficient Buildings (EeB) to continue in Horizon 2020 the joint efforts launched in 2008 in FP7 towards developing affordable breakthrough technologies and solutions at building and district scales. A global public funding of €600 million is foreseen in Horizon 2020 for this PPP.

The ambition of the EeB PPP is to develop a high-tech building industry, which turns energy efficiency into a sustainable business.

The EeB PPP has so far selected 105 projects within FP7 for a total amount of €546 million of public funding. These projects reflect the variety of innovations required to achieve high levels of energy efficiency in Europe's built environment. The focus was on topics as diverse as new materials for EeB components, nanotechnology-based approaches, retrofitting solutions and near zero-energy building renovation for cities and districts, as well as ICT for EeB and energy positive neighbourhoods. The projects demonstrated scientific and technological excellence across all levels from early stage conception through to demonstration of the potential for commercialisation. Within the portfolio of 76 projects firstly funded from 2010 to 2013, E2BA identified over 242 demonstrator projects located in 24 countries. Over 70% of demonstrators were in EU states with Spain, Italy and Germany recording the highest numbers. The total renovated area was calculated to be over 780,000m^2, including district

based projects, whereas the total area in new buildings reached more than 680,000m^2. The average energy saving per project was 39% whilst the average annual carbon saving claimed per project was 4 Mt CO_2. 70,000 citizens were engaged for a total of 15,300 dwellings. Other structures which were demonstrated were 22 schools or universities, 2 sport facilities, 2 airports and 1 subway station. Last but not least, 4.9 million individuals were estimated to have been reached in dissemination activities and 8,900 individuals trained. The impact of these projects is remarkable considering the €429 million of private investment they attracted and the high participation of SMEs in the programme (30% of the partners). The EeB PPP was therefore a "pioneer" as projects were often at high Technology Readiness Levels (TRL) at demonstration stage.

The implementation of Horizon 2020 will provide continuity with the on-going FP7 projects, some of which will run until 2017. The first topics proposed for 2014-2015 cover priority areas such as sustainable materials for the building envelope, adaptable envelopes, quality insurance, manufacturing of prefabricated modules, deep renovation of historic buildings, thermal storage integrated solutions, performance assessment and monitoring, and integrated design.

Indeed these topics come from a multiannual EeB roadmap prepared by E2BA and containing the research and innovation priorities of the private sector, which are essential inputs for the design of the research work programmes by the European Commission.

The major challenges addressed by EeB in Horizon 2020 will be to:

- Develop technologies and solutions enabling to speed up the reduction in energy use and GHG emissions in line with European goals, e.g. through a higher renovation rate of the building stock at lower cost;
- Develop energy-efficient solutions in order to turn the building industry into a knowledge-driven sustainable business with higher productivity and higher-skilled employees;
- Develop innovative and smart systemic approaches for green buildings and districts, helping to improve the competitiveness of EU building industry by delivering cost effective, user-friendly, healthy and safe products for smart cities.

The EeB PPP will promote high standards of energy efficiency in line with wider employment, competitiveness and environmental objectives – and all Europeans potentially stand to benefit from its achievements.

www.e2b-ei.eu

High Performance Insulating Render for Historical Buildings

INTRODUCTION

Historical buildings account for about 20% of the existing building stock. Many of them are not protected buildings but they are largely defining the identity and history of European cities. They are an essential part of our cultural heritage. Those dealing with renovation of such historical buildings are frequently faced with the challenge of how to improve the thermal insulation levels of old structures in an effective yet elegant way. Since 2013 there exists a new method for solving this problem without noticeably changing the appearance of the historic building. Researchers from Empa's Building Technologies Laboratory in cooperation with Fixit AG, a leading manufacturer of building materials, have developed an aerogel-based high performance insulating render "Fixit 222". The product being mineral-based, this new render is very similar to originally used "historic" building materials, both by appearance and in its application, which makes it ideal for internal and external applications in old buildings.

PRODUCT DESCRIPTION

The energetic retrofitting of historical buildings requires adapted solutions which do not affect the lively character of existing façades. Many of these buildings are massively built and traditionally plastered with mineral renders. Empa and Fixit researchers have developed a high performance rendering with a thermal insulation value that is three-times better than that of conventional insulating renders. The new material offers an elegant method for renovating historic buildings, saving energy without altering their appearances. Before, the choice was limited to a thin layer of artificial looking compact insulation and a badly insulating but natural looking render layer. The aerogel render now offers both – natural look and high-performance insulation. The rendering system can be applied in layers of 30 to 80 mm thickness on façades and additionally as internal insulation. The application can be done by hand, similar to traditional renderings or for larger areas by machine spraying. This purely mineral render is a water vapour open material, allowing fast drying of the product itself and residual moisture in walls. (Figure 1)

Figure 1: A historical demonstration building from the 15th century with a 6 cm of exterior aerogel render insulation

PRODUCT PERFORMANCE

The «secret» behind the novel insulating render is the so-called aerogel filler. This silicate based material which is known as "frozen smoke" because of its appearance, consists of around 5% silica – the rest is air. The size of the air voids are in the range of tens of nanometers.

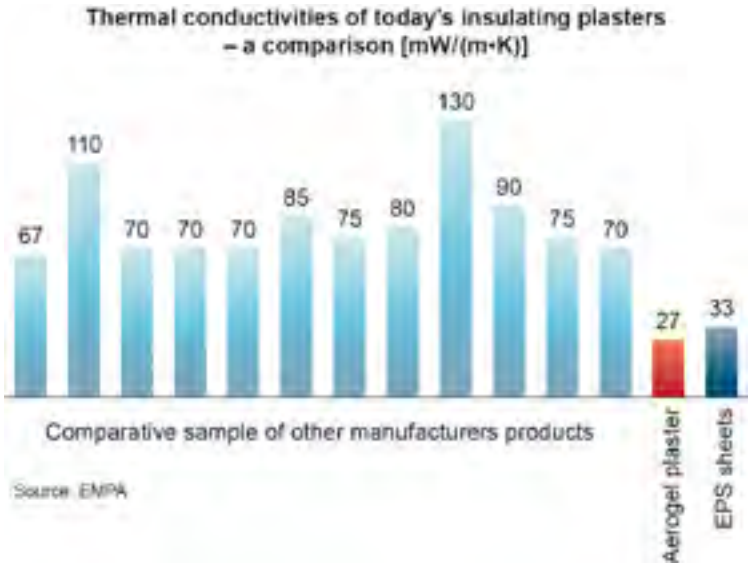

Figure 2: Comparison of the thermal conductivity of conventional insulating renders with the Empa/Fixit Aerogel render

Figure 3: Application test with a commercial spraying plaster machine

These air voids make aerogels an excellent thermal insulator material. The aerogel itself reaches a thermal conductivity as low as 0,014 W/(m·K). When mixed with mineral binders the aerogel render is created, still offering a thermal conductivity value around 0,028 W/(m·K). This is about three times lower than that of insulation renderings with expanded polystyrene beads and considerably better than standard insulation (polymer foams or mineral wool). (Figure 2)

APPLICATIONS

The product development included several series of testing – from palm-sized laboratory test specimens to weathering tests over several months. In a next step, test buildings were decorated with the new high performance material in spring 2012. Since then, Empa has been monitoring thermohygric performance in these buildings with temperature and humidity sensors. Since its market introduction in spring 2013, more than 5000 m2 of building façade area were outfitted with the Fixit 222 high performance insulating render in Switzerland so far.

CONCLUSION

Historical buildings do not have to become zero energy buildings, but they should be reasonably energy efficient to be operated and maintained in the future. The aerogel render offers a solution with good thermal insulation while maintaining the historical appearance of such buildings.

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Energy-efficiency in Austria: the European Investment Bank supports climate-friendly housing in Austria

Austria has embarked upon an ambitious programme for improving the energy performance of buildings, which covers both rehabilitation and new construction projects. Comprehensive promotional programmes at national and regional level are now being co-financed by the European Investment Bank (EIB) under a EUR 150m framework loan. The contract for an initial EUR 50m tranche was signed in January between the EIB and Bausparkasse der Österreichischen Sparkassen AG ("Erste BAU"), which will make the funds available to borrowers.

Through these promotional programmes launched by its national and regional governments, Austria is aiming to improve the quality of its housing. The EIB loan will be used to co-finance refurbishment schemes that will enhance the energy efficiency of residential and public buildings and also new housing with an energy efficiency performance substantially above the required minimum level in Austria.

In this way, the country is seeking to increase the proportion of buildings that consume almost no energy and are supplied from renewable energy sources. These buildings are also referred to as "nearly zero energy buildings" (NZEB). Austria will thus comply with the EU directive requiring that all new buildings in the EU meet NZEB standards by 2021. For public buildings, this requirement already comes into effect in 2019.

The EIB loan will be available for projects leading to documented energy savings and or increased use of renewable energies. These may include, for example, improvements to building shells or heating systems. Projects that use renewable energies for heating and electricity are also eligible. Both private and public sector projects may benefit from the funds.

EIB Vice-President Wilhelm Molterer commented when signing the loan contract, "Austria is addressing the energy efficiency issue with great commitment at all levels. This will not only have a positive effect on housing quality and the energy balance, but will also be of considerable benefit to the country's construction industry, as significant know-how must be developed and applied to ensure the right solutions. "

European Investment Bank The EU bank

WIENER WOHNEN: IMPROVING THERMAL ENERGY EFFICIENCY IN MUNICIPAL HOUSING

Earlier last year, the EIB signed another operation in the field of energy efficiency in Austria. A loan totalling EUR 270m was made available to the Viennese firm Stadt Wien - Wiener Wohnen to improve the thermal energy efficiency of municipal housing. The funds come from the 2011-2014 investment programme and are divided into two tranches, the second having been signed in September last year.

With the funds the urban housing stock will be modernised and upgraded, the aim being to significantly reduce the energy consumption of rented accommodation. One of the things that make the EIB loan attractive for Wiener Wohnen is its long-term nature (25 years). Added to that there is the positive signalling effect with regard to other potential sources of finance.

INCREASING ENERGY EFFICIENCY BY 20 PER CENT BY 2020

Energy efficiency plays a key role in helping to meet the Europe-wide "20-20-20 targets", which include improving energy efficiency by 20 per cent in the EU by 2020 and thereby lowering energy consumption. The other two targets are to reduce CO2 emissions by 20 per cent and to increase the proportion of electricity produced from renewable energy, which is also due to amount to 20 per cent by 2020.

Energy efficiency measures and the area of resource efficiency in general are one of the EIB's key concerns. In the past year alone, the Bank has provided loans totalling more than EUR 1.1bn for energy efficiency projects. Over the past five years, the Bank has made more than EUR 70bn available for long-term energy projects in connection with the EU's energy and climate protection policy and the Member States' energy strategies.

The European Investment Bank is the long-term lending institution of the European Union owned by its Member States. It makes long-term finance available for sound investment in order to contribute towards EU policy goals. In 2013, the Bank provided loans totalling EUR 71.7bn for projects in Europe and beyond. This is an increase of 40 percent compared to the previous year. The EIB focused its priorities on research, development and innovation, strategic infrastructure, climate action and resource efficiency as well as on small and medium-sized companies.

For more information: www.eib.org

REVIEW DOMOTEX FAIR 2014
Flooring Industry commits itself to sustainable building

Manufacturers of the flooring industry commit themselves to sustainable building on the leading international trade fair for carpets and floor coverings DOMOTEX. Their contribution: Environmental Product Declarations, EPDs.

More than any other sector the flooring industry promotes more sustainability in the construction industry. 45.000 professional trade visitors could convince themselves at this year's DOMOTEX, 11 to 14 January in Hanover, that higher product transparency is the key for sustainable, ecological and healthy building. The exhibiting companies – regardless their industrial background (textile, resilient or hard floor coverings) - agreed: sustainable building requires verified and comparable data in view of the many different environmental impacts of products throughout their life-cycle. All these information are provided in Environmental Product Declarations (EPDs), which in Germany are issued by "Institute Construction and Environment e.V. (IBU), a branch-independent program operator for EPDs. During the exhibition IBU's Managing Director Dr.-Ing. Burkhart Lehmann handed over EPD's to numerous companies and manufacturers from the flooring industry.

As a start nine Branch Average EPDs ("Generic EPDs") for linoleum-, elastomer-, polyvinyl- and cork-floor covering were handed over to the Managing Director of European Resilient Flooring Manufacturers' Institute, ERFMI, Ton Pluijmertand and also to representatives of different companies who had been involved in the creation of those EPDs.

"The market more and more demands sustainable building. IBU's member companies and associations have realized that long ago. The flooring industry is in the lead", according to Lehmann. Since the beginning of IBU-Programs in 2004 altogether around 650 EPDs have been issued, one seventh can be allocated to the flooring industry. Pioneers regarding sustainability are ERFMI (European Resilient Flooring Manufacturers' Institute), EPLF (Association of European Producers of Laminate Flooring), and the two carpet manufacturer groups ECRA (European Carpet and Rug Association) and GUT (Association of Environmentally Friendly Carpets). ERFMI, as well as, EPLF and GUT have their own Sector-EPDs that are currently being adjusted to the CEN Standard EN 15804 which was introduced Europe-wide in spring 2012. Additionally, GUT helps their members with supporting services when they are creating specific Company-EDPs. More and more manufacturers are using EPDs to stand out from average values in the branch." Usually an added to creating EPDs is a further optimization of the environmental performance of products", says IBU's Managing Director.

EPDs are used as a base for assessing the life cycle of buildings and are therefore significant prerequisites for sustainability-certification of buildings. Whether or not a building can be assessed as sustainable depends on a number of criteria, according to Lehmann. An essential contribution is provided by the different construction products in components and structures. However, an objective assessment can only be performed looking at an individual building and a given installation situation. "You have to consider production stage, installation and use phases including maintenance as well as end-of-life".

There are life cycle assessment based key performance indicators for different

environmental impacts – such as global warming or acidification – raw material and energy use, waste production and material and energetic recycling that are included in a complete EPD of Institute Construction and Environment for floor coverings; furthermore information about product application and use classes, service life and the influence of the product to the interior air quality are included.

"EPDs do not assess whether a product is good or bad ", explains Burkhart Lehmann. "In fact, they show the environmental impacts of products in a transparent, independent and comprehensible way". EPDs contain verified and comparable information, verified by independent third parties. Due to these declarations planners, architects and building owners, of either of private or public buildings, can decide exactly how sustainable their building should finally be. You can refer to the respective EPD to allocate the percentage of individual products or product groups to the complete environmental impact of the building.

IBU is the only organization in Germany to operate a cross-industry EPD-Program for construction products according to ISO- und CEN-standard. European standard EN 15804 was released in April 2012 and is the basis for Europewide recognized EPDs. IBU was the first European program operator to implement the relevant standards.

Further information:
www.construction-environment.com

Handing over EPDs at DOMOTEX 2014

ERFMI: *Awarding EPDs to European Resilient Flooring Manufacturer's Institute (ERFMI) at the special exhibition area innovations@ DOMOTEX. From left to right: Bob Smith, James Halstead; Feliks Bezati, Tarkett; Ortwin Top, itec; Ton Pluijmert, ERFMI; Dr. Mario Kröger, nora systems; Fred Seifert, Forbo; Dr. Burkhart Lehmann, IBU; Harro Hoseus, Amorim, Steve Mulholland, James Halstead.*

Fletco: Benny (left) and Brian Jensen (right) from the Danish family-owned business Fletco Carpets A/S receive two EPDs for woven carpets and carpet tiles from IBU's Managing Director Dr.-Ing. Burkhart Lehmann.

Upofloor: Kyösti Puurunen, Category Manager, is pleased to be awarded the EPD for resilient flooring of the product series "LifeLine" at DOMOTEX 2014 from IBU's Managing Director Dr.-Ing. Burkhart Lehmann.

THE ENERGY INFOCENTER

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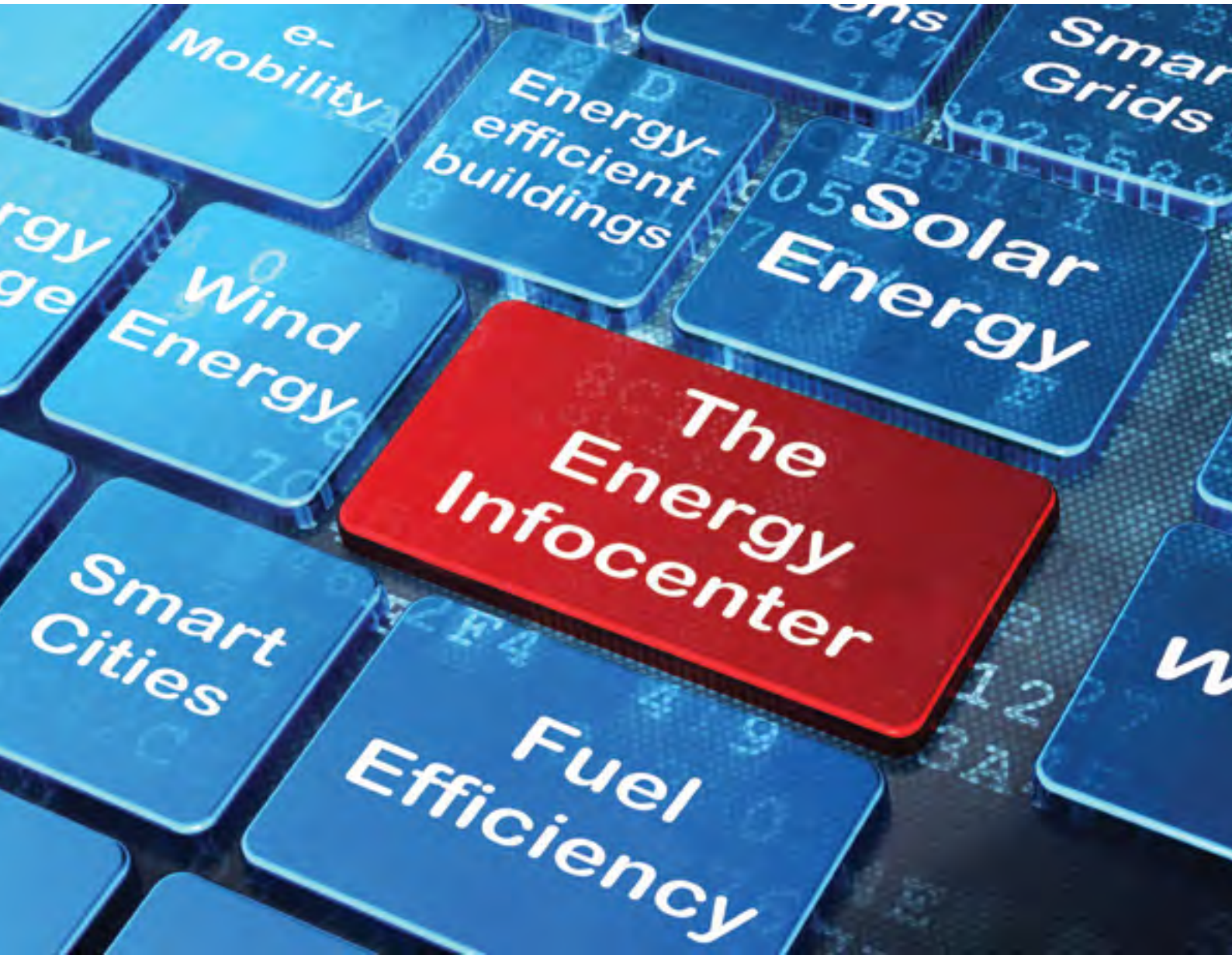

European Energy Intelligence has developed an new online service that taps into the information streams coming out of the key European Institutions. It analyses them, organises and then presents them in a way that allows subscribers to access them.

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StorePET: PCM-enhanced fiber insulation for lightweight building solutions

By Mónica García (Acciona Infraestructuras R&D, Spain), Omar Maschi (Centrocot SpA, Italy) and Cristina Navarra (Centrocot SpA, Italy).

Buildings account for around 40% of total energy consumption and 36% emissions in Europe. Specifically, Heating, Ventilation and Air Conditioning systems represent almost 33% of the energy use in commercial facilities. Poor insulation in old constructions contributes to this overspent of energy, as well as the lack of thermal mass observed in novel lightweight buildings.

During the STOREPET project, the Consortium has worked in increasing the thermal mass of traditional insulation materials by the inclusion of Phase Change Materials (PCM) in blankets composed by recycled polyester fibers. This smart material can store heat during the day and release it when the temperature goes down, maintaining the environment within a stable thermal range.

Different methodologies for the integration of PCM have been studied to get the best scalable-up and cost-effective solution. As next step, the STOREPET panels have been manufactured thanks to the contribution of an Italian company specialized in nonwoven manufacture. For the STOREPET production, it has been used recycled material treated with PCM to reach the required thermal properties. The treatment was performed by industrial machinery commonly used in textile finishing, showing the scalability of this innovative STOREPET production.

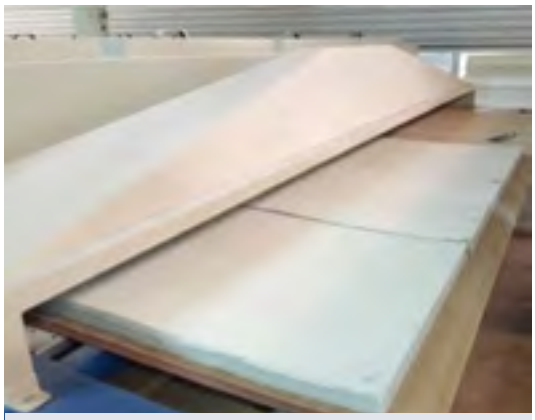
Before installation, treated panels were characterized by the Project Partners IPN (Portugal) and Centrocot SpA (Italy) in order to assess their thermal and physical properties and consequently evaluate the changes due to the deposition of PCM.

In the Storepet Project, Acciona has installed the materials developed in the project to extract its behavior in comparison to traditional panels. Two demo-buildings are separately insulated with StorePET and traditional panels to be monitored during one year, considering temperatures, energy consumption and heat fluxes.

The demonstration is carried out within the NanoE2B Cluster initiative, a continual co-operation between several FP7 projects aiming the development of innovative materials and systems for energy efficient buildings.

As first results during this phase, it has been extracted that this novel material can be produced at industrial scale showing promising thermal properties. Moreover, the installation has followed the same procedure than traditional panels and it completely fulfills the construction standards.

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 28673



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Project Partners

SME Associations

SMEs

RTDs

Switzerland: Human nature collides with science?

By Mike Edmund

During 58 B.C., a tribe of Celts attempted to migrate from their Alpine heartlands towards the west coast of the country that is known today as France. At a place called Bibracte, near modern-day Chalon sur Saône, they met in battle six Roman legions, led by none other than Julius Caesar; they fought determinedly but were defeated and returned eastwards. Caesar and his successors went on to unite much of Europe under Roman rule, while the descendants of those Celts today form an important element of the Swiss nation: they were known as the Helvetii.

Today, in the byzantine world that is the domain name system of the Internet, the top-level domain for Switzerland is .ch, letters that are also used on the country's vehicle licence plates. They come from the Latin Confoederatio Helvetica and refer as much to that ancient Celtic tribe as to the Rütlischwur, the legendary Rütli Oath of the Old Swiss Confederacy.

Ask anyone to play word association with the name "Switzerland" and the chances are that you will hear at least one mention of (in no particular order) The Red Cross, The Alps, Emmental (or its holes), Yodelling, Watchmaking, Punctuality, Clean Streets, Banking and Roger Federer. It can surely be no accident that the Swiss are renowned for producing masterpieces of precision timekeeping, and that there is a national approach to punctuality that borders upon obsession. Indeed, the Swiss Railway system might well be held up as the embodiment of both qualities, while many of those phenomena (I think it is fair to describe Mr. Federer as a tennis phenomenon) may well have some bearing upon the Swiss national character; or they are perhaps a result of it. However, it is perhaps the country's near-unique geography, dominated by Jungfrau, Monte Rosa and Matterhorn, that exerts the most commanding presence. And so it is with Swiss renewable energy: according to the Swiss Federal Office of

Energy (SFOE), the combination of topography and abundant annual precipitation make ideal conditions for the generation of hydroelectricity. So much so that hydropower accounted for almost 90% of domestic electricity production at the beginning of the 1970s. Today, the SFOE says, a total of 556 hydropower plants, each with a capacity of at least 300 kilowatts produce an average of around 35,830 gigawatt hours (GWh) per annum, almost half from run-of-river power plants, and half from storage power plants.

A glance at the 2012 figures from Berne's Bundesamt für Energie (BFE) will reveal that just over just over 53% of the country's final energy consumption of 882,280 TJ was derived from oil, and just under 47% from renewable resources, of which over half was in the form of electricity. According to the BFE, the less important renewable energy sources showed growth during 2012: final energy consumption energy from wood increased 10.6%, that from heat pumps by 16.0%, photovoltaic by 11.4%, biogas by 4.8% and biofuels by 15.6%.

Switzerland is home to 12 Universities and no fewer than 29 Research Institutes; it has accumulated considerable expertise in nuclear physics since CERN based itself there. Swiss technology is therefore important on the global stage, which is why news earlier this year was particularly disappointing; and perhaps not a little ironic. Swiss-based researchers will no longer be able to apply for European Research Council grants under Europe's Horizon 2020 programme, while Swiss students are to be excluded from the Erasmus+ student exchange programme. These moves follow the Swiss referendum on restricting immigration from other EU member states. The issue of European migration was not solved, it seems, at Bibracte.

Plus ça change… ●

The SRB solar thermal collector

By C. Benvenuti, SRB Energy

The company SRB Energy was created in 2005 with the aim of the industrial production of a flat panel solar thermal collector developed at CERN and patented in 2003.

The distinctive feature of this collector is its high efficiency at high temperatures achieved thanks to vacuum and to selective black absorbers (i.e. black in the visible range but low emitting in the infra-red).

In its standard configuration the collector is equipped with cylindrical mirrors, which reflect equally well on the back side of the collector both the direct and the diffuse light. This feature is very important for regions such as in Central Europe, where the diffuse fraction of the solar light may exceed 50%.

In this way temperatures as high as 400°C could be obtained without the help of focusing mirrors.

The collector, shown with its mirrors in Fig.1, consists of a metal frame closed on both sides by glass windows. The resulting box contains blackened copper absorbers which transform the solar light into heat. The absorbers are laser welded to stainless steel pipes which allow the heat to be extracted by circulating a cooling fluid. These features are common to many others flat solar thermal collectors: the distinctive feature is that the SRB collector operates under vacuum. Vacuum helps reducing the thermal losses

Fig 1.

resulting from the molecular heat conduction between the hot absorbers and the glass window.

A vacuum tight connection between large glass windows and a metal structure represents an (almost) insurmountable difficulty. The SRB solution to this problem consists in plasma spraying a metal coating onto the glass perimeter, on which a metal joint may then be soft soldered. Vacuum brings about another problem: atmospheric pressure applies a force of 1kg per square centimetre to the outside of the panel windows, resulting in many tons for a medium size panel. This force would provoke panel implosion if not properly supported. The chosen supporting structure provides mechanical stability up to an external pressure of 2.5 atmospheres. The absorbers are coated with a low emissivity selective coating.

To maintain the vacuum throughout the panel life of 30 years, a getter pump is used. Gas molecules impinging on the getter surface are captured to form stable chemical compounds. By doing so, the surface is progressively covered until finally, at complete saturation, its pumping action is lost. To avoid this event to happen, the getter pump is exposed to sun, and heating helps to diffuse the trapped gas molecules to below the getter surface, which becomes active again. In this way the vacuum may be maintained inside the collector for at least 30 years.

Getters were used for the first time to provide the large and linear pumping required for accelerators in the Large Electron Positron collider (LEP) at CERN. To cope with the requirements of the following CERN accelerator, the Large Hadron Collider (LHC), getter thin film coatings were developed, a technology covered by CERN patents and since widely used in many other projects.

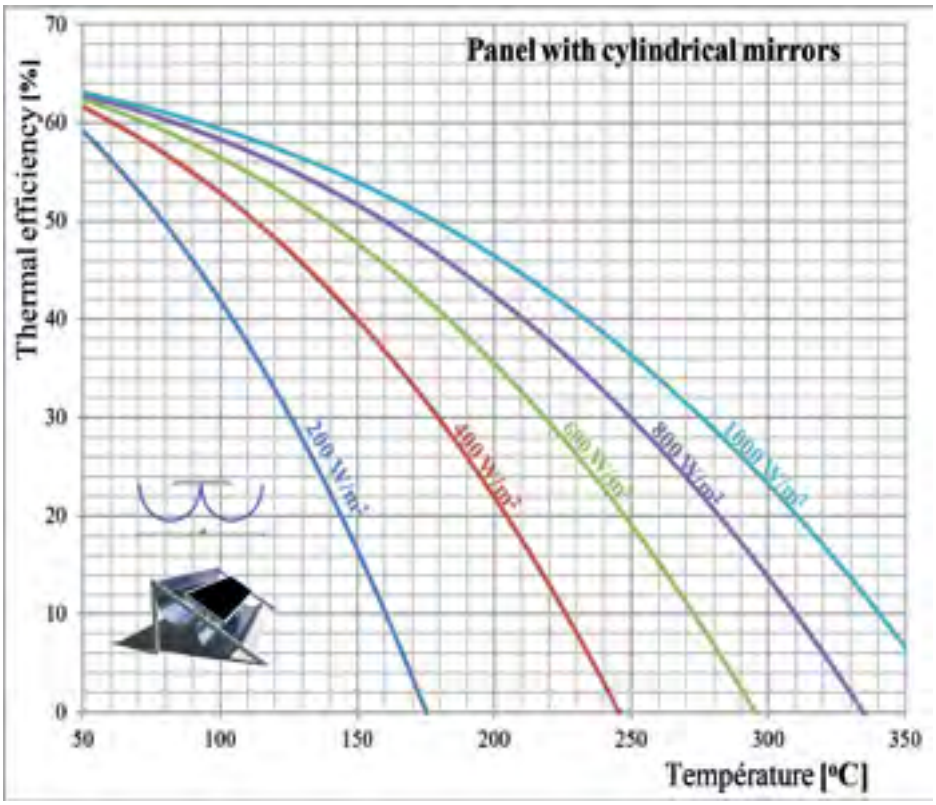

Fig 2.

The thermal efficiency of the SRB collector equipped with cylindrical mirrors is shown in Fig.2. The efficiency depends on both the incident solar power and the temperature of operation. For instance, it reaches 45% at 200°C in ideal sun conditions, and about 40% at 100°C for a solar power of only 200 W/m^2.

The SRB collector is very versatile. It may be used to produce industrial process heat up to 200°C, but also for cooling by means of a cooling cycle machine. Equipped with Fresnel mirrors it could also produce electricity.

So far it has been used for production cooling by a pharmaceutical company in Spain, to keep bitumen at 180°C in Switzerland and to provide heating and air conditioning for Geneva Airport. This last project, featuring a solar field of about 1200 m^2, is described in details on WEB.

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Counting on clean technologies – the Swiss approach

There is now broad consensus within the scientific community – on both sides of the Atlantic – regarding the negative impacts of human activity on the environment, and thus on flora and fauna, as well as on human beings themselves. In its 2007 report, the findings of which were endorsed by more than 40 scientific bodies throughout the world, the IPCC[1] affirmed that climate warming is almost certainly attributable to the increase in greenhouse gases resulting from human activity. And since we human beings are gifted with intelligence, we have resolved to take steps to attempt to turn the tide.

All over the world, significant efforts are now being made to overcome this enormous challenge. In Switzerland's energy sector, the main focus of these efforts is on the reduction of greenhouse gases and the withdrawal from nuclear energy. In order to achieve these two objectives simultaneously, within an acceptable timeframe and without an excessive loss of comfort (and here I say again, mankind is gifted with intelligence), we need to bring about a change in attitudes and behaviour, and thus pave the way for an "energy turnaround". To accomplish this, Switzerland has decided to take action in two stages, commencing with incentives in the form of subsidies, then moving on to clearly defined legislation.

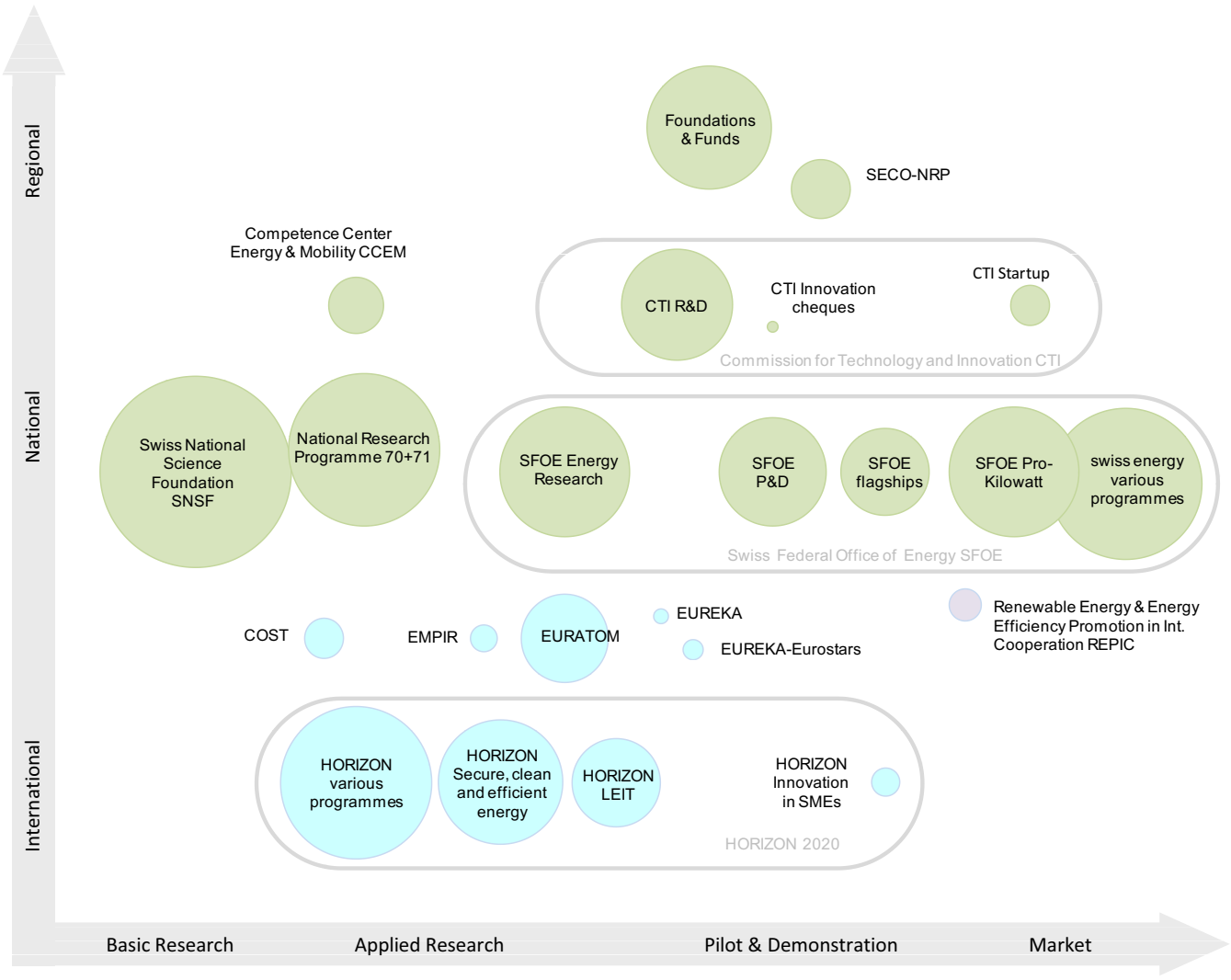
Switzerland is fully aware of the significant role that will be played in this process by innovation and new technologies, and has therefore decided to focus its attention on supporting what are now widely referred to as "clean technologies" (or cleantech for short) so that these will have a better chance of being discovered, developed, optimised, commercialised and accepted by both the population and the market. Switzerland's support extends along the entire value chain of research, innovation and market maturity. At the beginning of this chain it is providing instruments that facilitate a bottom-up approach, in which neither the administration nor the economy intervene in the ideas and efforts of researchers and inventors. Then as we move further along the chain, the various instruments focus on products that meet the needs of the economy, communities and the population on the one hand, and on the other hand are in line with the strategy and regulations that have been introduced.

The range of available instruments is enormous (see illustration) and comprises programmes adapted to the various technologies, the size of the various projects and the involved institutions (in particular, universities, large companies, etc.), as well as to the corresponding segment of the value chain. In order to bring a given technology to market maturity it is necessary to successfully pass through each individual stage, from research and development through to the production of prototypes and the performance of practical trials, and on to industrialisation or commercialisation. And of course this process also includes appropriate education and sensitisation in order to ensure that the technology concerned can be introduced, utilised and maintained in an efficient and effective manner.

The public promotion of cleantech in Switzerland is characterised by its high degree of density and diversity. This is an approach which has proved to be successful to date, despite the relative lack of transparency for small and medium-sized companies. It is also one of the factors behind our country's major capacity for innovation, which is frequently recognised at the international level in various categories[2].

1 Intergovernmental Panel on Climate Change, which was established by the UN in 1988 for the purpose of assessing available scientific, technological and socioeconomic data relating to climate change in an impartial and systematic, clear and objective manner. Its 5th Assessment Report (AR 5) is due to be completed in 2014.

2 1st place in the rankings of the World Intellectual Property Organisation (WIPO) as of July 2103.



Programmes supporting energy innovations of companies and research institutes in Switzerland

The size of the bubbles is proportional to the annual budget of the programme that is allocated to energy innovations. Further information available on www.bfe.admin.ch/cleantech.

The accompanying illustration gives an impression of the diversity and magnitude of the various public support programmes for clean energy technologies along the value chain from research through to market introduction.

Switzerland participates successfully in the European research programs through bilateral agreements since 2002. Only in September 2013, the Parliament voted in favour of a credit of CHF 4.3 billion for the participation of Switzerland in "Horizon 2020" and association negotiations are currently held. The Mission of Switzerland to the European Union in Brussels follows closely the developments of cleantech both in Switzerland and in the EU.

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A long way to go to a 'renewable Switzerland'

By Katia Schaer, Communication Manager of the Swiss Energy Foundation, an NGO based in Zurich.

Shortly after the Fukushima nuclear disaster, the federal council of Switzerland declared its intent for a gradual nuclear phase out. Subsequently, the government developed a long-term energy policy ("Energy Strategy 2050"), which will secure the country's energy supply while boosting energy efficiency and renewable sources. A new era – the energiewende – has begun – but there is still a long way to go.

Eventually, the prospects for a „renewable Switzerland" are bright: 60 % of the electric energy that is produced in Switzerland is hydro-electric, there is a huge potential for solar power and there are no power plants in Switzerland that use fossil energy. By 2035, an estimated 25 % of the electricity could be produced in the congested midlands, only considering already existing infrastructure for setting up solar panels. Wind, biomass and geothermal energy will add to a completely renewable electricity production.

Politically, the energiewende has gained a wide support throughout the political parties. Except by the national-conservatists, the energiewende as an idea is generally accepted. But the more crucial step has yet to be done. As a proposition for the modus operandi of the energiewende, the federal council has submitted a package of measures to the parliament. It covers such disparate topics as a construction ban for new nuclear power plants, but not for the nuclear technology itself, targets for consumption of electricity and the production of renewable energies, programs for energy-focused building refurbishment, or feed-in remuneration at cost.

The preceding consultation procedure, in which political parties, governmental institutions as well as civil society organisations participated, already showed clearly the different and sometimes incongruous notions of the energiewende. Even the ecologists and the socialists, usually agreeing on green subjects, do not have no consistent, unequivocally communicated concept, but become antagonists in matter such as bird conservationists, fisher, advocates of wind power or on the contrary of hydropower. These different agendas will manifest even heavier during the debates in the parliament. Each change to legislation will be discussed and voted individually, and there are strong tendencies to even split the whole package into separate proposals submitted to the vote.

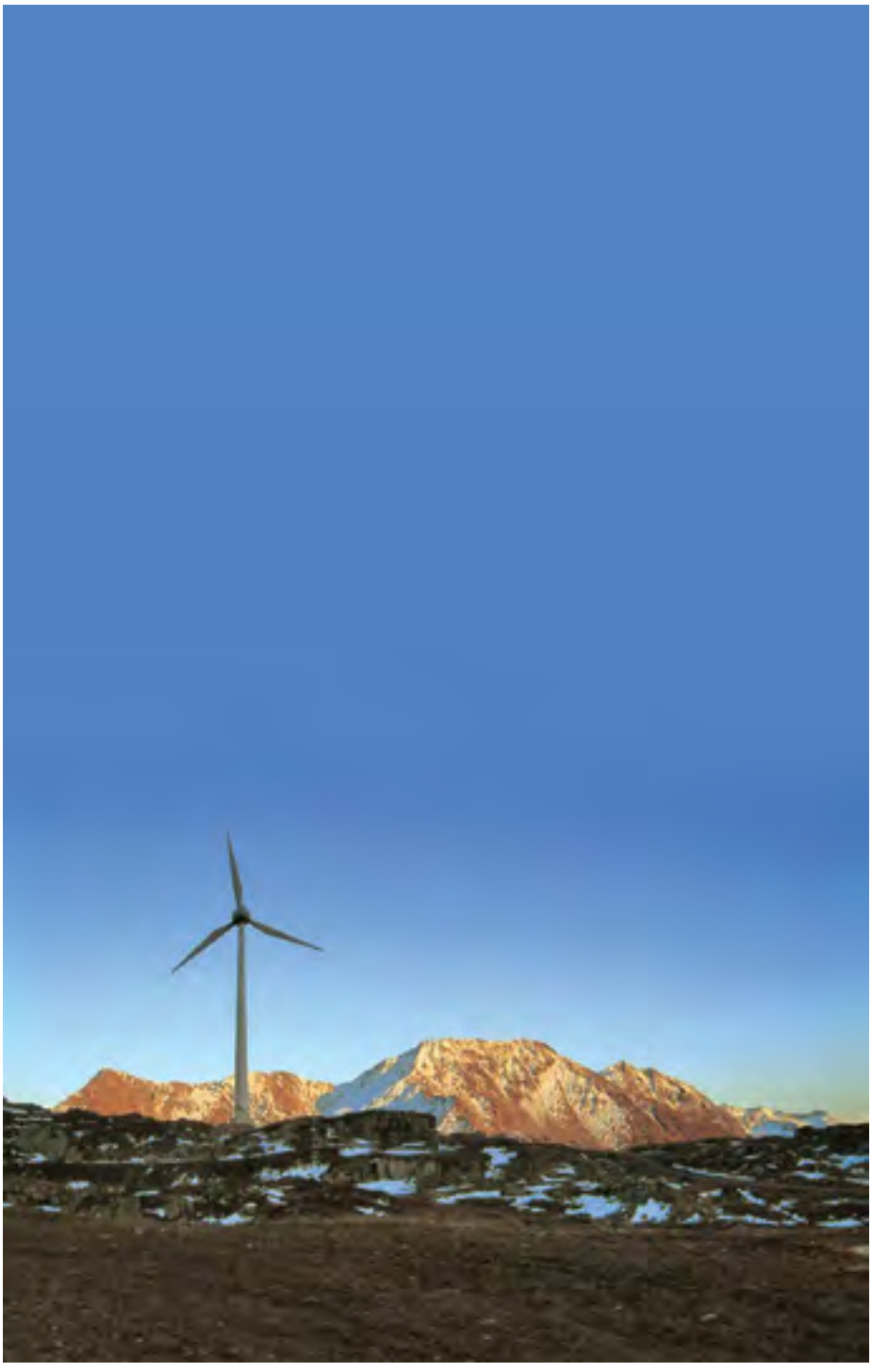
The biggest shortcoming of the government's proposed strategy is the complete lack of a precise date for shutting down nuclear power plants or a limitation of the time span. The nuclear power plants in Switzerland are among the oldest worldwide. The decision for the phase out and the ensuing construction ban did not result in shutting down the existing ones, but only prompted the operating companies to let them run as long as possible. Aspects of security are largely ignored, as an old nuclear power plant can only be patched, but will never achieve the standard of safety required today. Especially damages resulting from ageing create an uncontrollable hazard. The danger of a nuclear accident

is growing day by day – and the government seems to be willing to take that risk.

As long as huge amounts of money are spent for repairing the old power plants, financial resources for the promotion of renewable energies are lacking. Simultaneously by investing in old power plants the operating companies are struggling against the possible shut down of their plants from one day to the next. The feed-in remuneration at cost is the ideal instrument for quickly increasing the quantity and capacity of renewable power plants. In recent years, the production of solar power had a growth rate of 70 % annually, but still hardly exceeding the 1% mark of the total electricity production. The system is too slow: Effective since 2009, the feed-in remuneration at cost had not the effect of creating numerous new power plants, but of a waiting list of 30'000 photovoltaic projects waiting to be granted. Only 6000 projects could be realised.

Critical for the success of the energiewende are also economic interests. Although the electricity market is split into almost a thousand smaller and larger producers, only six regional or national companies deal 80 % of the production. The most important amongst them still rely heavily on conventional energies and invest strongly in lobbying for safeguarding their interests. They are fuelling people's vague fears about massively increasing electricity costs or – since lately very popular in Switzerland – the dependency from foreign markets.

In the long term, the energiewende will come – due to the limits of conventional resources. It is the only sustainable concept for Switzerland's energy future. But in the short term, the energiewende could be doomed to failure by too many particular interests. ●



Transparent photovoltaic solar cells in building facades towards zero emission buildings

Many people are familiar with blue or black solar photovoltaic panels on rooftops, but technologies are being developed for transparent solar cells to be integrated into facade buildings. In Brussels where I walk every day to get to the office, I notice many buildings have a glass facade, wouldn't it be great to add to the decorative aspect the possibility to harvest energy and convert it into electricity? On 10 February I had the opportunity to interview Prof. Jordi Martorell, Group Leader at ICFO - The Institute of Photonic Sciences located in Barcelona, Spain.

HOW DOES THIS TECHNOLOGY WORK?

Light is made up of electromagnetic radiation spanning a spectrum of wavelengths and each contains energy that can potentially be harvested by a solar cell. The human eye can detect only part of that spectrum, what we call the visible light. With the right materials and technologies, we can develop technologies that allow light that we can see pass through the solar cell, and the rest would be absorbed by the solar cell.

WHAT IS A MAJOR ADVANTAGE OF THIS TECHNOLOGY FOR AIMING AT ZERO EMISSION BUILDINGS?

The technology is less efficient than the current photovoltaic technologies available on the market, but the advantage is that it could be used on the facade rather than just on the rooftop. We did the analysis on a skyscraper, the rooftop surface was 1.000 sqm but the facade surface was 21.000 sqm. If we aim at an efficiency of these solar cells 3 times less but the available surface is 21 times more, you can do the math and understand how it would greatly contribute to generate electricity that could be used on-site, and the excess that is not used sent back to the electricity network.

WOULD THIS NEW TECHNOLOGY BE APPLICABLE ONLY IN NEW BUILDINGS?

It would be easier of course to implement in new constructions but the overall environmental impact would be limited, therefore we do work on solutions and consider cases allowing retrofit into existing buildings. We currently work on this via SOLPROCEL, a European funded project we coordinate.

IN TRADITIONAL PHOTOVOLTAIC THE FEED-IN-TARIFF REGULATION HELPED TO BOOST THE MARKET, HOW CAN PUBLIC AUTHORITIES SUPPORT THE TAKE-UP OF THIS NEW TECHNOLOGY?

The overall objective of zero emission buildings is requiring a combination of technologies of which transparent solar cells could be part of the mix, and the use of public procurement

in an initial phase to start large volume production would lead to economies of scale and reduced cost.

WHEN DO YOU EXPECT TRANSPARENT PHOTOVOLTAIC TO BE WIDELY IN USE?

Maybe in 5 years, at some point it's not a technology question anymore but implementation, capabilities to industrialize, educate the installers and designers, … Together with the Knowledge and Technology Transfer team at ICFO we are working with industrial companies such as Comsa_Emte for the commercial and development aspects of this technology.

DOES TRANSPARENT PHOTOVOLTAIC HAVE ALSO APPLICATIONS IN CONSUMER PRODUCTS?

Currently we achieve 30% transparency which doesn't make it entirely transparent but good enough for some building facade applications. Future developments could lead to 90% transparency and allow incorporation in consumer applications like your phone or tablet since the technology can also work in-doors. Combined with technologies that enable devices to consume less energy, you would have to recharge less often. ●

Prof. Jordi Martorell discusses the benefits of transparent photovoltaic solar cells with Carlos Lee, Director General at EPIC, the European Photonics Industry Consortium.
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LED lighting
Avoiding the CFL backlash

By Nils Borg

I remember meeting with a senior municipal manager in Stockholm in July 1998, when the city had nearly completed replacing all their traffic signals with LED modules. With a smug look on his face, he said "Yes, there is a lot we need to do with traffic signal controls, but I cannot see how LED lighting could be developed any further now".

Over the last 15 years, further investments in LED research and development have proven him wrong. LED technology has revolutionised the lighting business. In 1998, we had just seen the first harbingers of revolution – coloured applications like traffic signals, exit signs and brake lights on cars. Today, a 60W incandescent lamp can be replaced by fully dimmable, quality 10W LED products that retail around €15 (cheaper, products of lower quality are also available). Indeed, only five years ago, the first 60W LED replacement lamps would cost around €50 and were only offered. by a small handful of manufacturers. The US Department of Energy forecasts that LED lamps will become on average about 10% more efficient and 11% less expensive each year from now to 2020.

A market survey report issued by the Danish Energy Agency in March 2014 concluded that in the current EU market, "LED replacement lamps which are fully compatible, including e.g. dimmability, are available for 76 percent of the stock of non-directional halogen lamps." Who would have thought this 15 years ago?

LED lighting manufacturers are innovative and keep pushing the boundaries – but everything is not rosy. The traditional lighting industry has been dominated by a few major, global players for decades. That changed when Compact Fluorescent Lamps (CFLS) entered the market – hundreds of manufacturers cropped up and markets around the world were flooded with CFLs of questionable quality. This caused a consumer backlash against CFLs.

We risk the same backlash with LED lighting. Again, thousands of new businesses are entering the lighting market – some are very techy companies filled with brilliant engineers who know about electronics and LEDs but not lighting. Others are simply cutting corners and cheating people. In this dynamic market, quality manufacturers that invest

heavily in R&D are at risk of not being able to capitalise on their investments.

A number of governments around the world have come together and formed an international collaboration to address these issues. The SSL Annex was established in 2009 under the framework of the International Energy Agency's Energy Efficient End-use Equipment (4E) Implementing Agreement equipment to provide advice to its ten member countries seeking to implement quality assurance programmes for LED lighting. This international collaboration brings together the governments of Australia, China, Denmark, France, Japan, The Netherlands, Republic of Korea, Sweden, United Kingdom and United States of America.

One focus area of the SSL Annex has been the development of so-called performance tiers to provide simple model specifications to governments and programme managers (for instance technology deployment programmes in developing countries). Instead of reinventing the wheel, the SSL Annex's member governments have pooled their resources to develop unified quality specifications with a few tiers from basic to advanced that can be used around the world. But good specifications are just one part of the puzzle. How can we trust the declared performance of products that are on offer?

Testing can be a major bottleneck for manufacturers and governments alike. Lab capacity around the world is scarce and not evenly distributed. And, LED products are difficult to test and don't necessarily behave in the lab as traditional lighting technologies. In order to understand this, the SSL Annex launched a global Interlaboratory Comparison (IC 2013) and assessed the proficiency of labs to test SSL products around the world. In total, more than 100 laboratories have been compared.

In order to achieve this, the SSL Annex developed an interim test method based on a compilation of the most stringent requirements from several LED lamp test methods around the world. The SSL Annex test method was created only for the comparison of labs in the IC 2013. Based on this stringent test method, it is hoped that the same proficiency test can be used by a lab when applying for accreditation in different parts of the world. The Annex is now working to help participant laboratories in their applications for accreditation.

This work is a one-time market intervention with the aim to establish global laboratory accreditation based on a single proficiency test as the norm.

In July 2014, the SSL Annex will launch its second five-year term. In the coming years, the Annex will focus on market monitoring, verification and enforcement (MV&E). Governments have a responsibility to police the market and remove bad products, but it is expensive. Together, participating countries will look to develop and deploy cheaper and simpler MV&E methods. The Annex will also venture into other tasks, such as an additional laboratory comparison using a goniophotometer, and investigating how new features such a built-in wireless control could affect LED SSL product energy use could affect LED product energy use.

Nils Borg
Operating Agent for the IEA 4E SSL Annex

Please visit webpage for more information
http://ssl.iea-4e.org/

Emerging Trends in Road and Street Lighting

By Koen Van Winkel – Marketing Manager Europe, Schréder sa

LEDs are rapidly taking over the leadership position of discharge lamps in outdoor lighting. Is this just another lamp source or are there other consequences related to this switch in technology?

ENERGY REDUCTION IS THE MISSION, LED TECHNOLOGY IS JUST THE TOOL TO ACHIEVE THIS GOAL

Public lighting accounts for an important share of the overall energy consumption of a municipality or public authority. A large percentage of installed lighting schemes have reached the end of their life time. Depending on the country, we still see a lot of luminaires that provide poor and inadequate light levels and are equipped with lamps containing hazardous substances like mercury.

LED technology in combination with electronic drivers, integrated in a luminaire with optimised thermal and photometrical performances and equipped with dimming features for adaptive light schemes, can enable municipalities to reduce their energy consumption by 50 to 80%.

"WHITE" LIGHT FOR IMPROVED VISUAL PERFORMANCE

The white light of LEDs is typically offered in three binning categories (warm - neutral - cold). Neutral (4000K) and Warm (3000K) are used the most. The gap in performance between warm and neutral white is getting smaller, resulting in a light source combining technical performances with warm comfortable light. The typical spectrum of LED light, together with a much higher colour rendering capacity, provide undeniable improved visual performance compared with the more yellow light of sodium discharge lamps. This will enable the standardisation bodies to reduce the proposed light levels for a given application.

INCREASED LIGHT OUTPUT WHILE CONSTANTLY REDUCING COSTS

LEDs are semi-conductors following the Haitz law. This implies an exponential increase in light output (lm) per decade, combined with an exponential decrease in cost ($/lm) per decade. Such an evolution was unknown for conventional light sources, so far. This positive evolution of the light unit cost, enables a large scale introduction of LED luminaires in all kinds of public lighting applications, both for new and existing installations. Not just traditional street lighting, but also applications like tunnels, illumination, sports, industry, etc. are equipped or replaced at rapid speed. In some European countries, penetration rates of 50-70% for new installations have already been achieved, which is much earlier than anticipated in the most optimistic forecasts to date.

TRADE OFF BETWEEN INITIAL COST, ENERGY EFFICIENCY AND LIFE TIME (LUMEN MAINTENANCE)

LEDs can be driven at different drive currents. The resulting light output is not linear to the increase in drive current and as a consequence the wattage consumed. Higher drive currents may lead to a more pronounced aging process i.e. shorter life time or stronger decrease in luminous flux. The end-customer must make the tradeoff between the afore-mentioned variables. This extra degree of freedom was also unknown in the case of discharge lamps.

IN THE DIGITAL WORLD OF LEDS, 'CONTROLS' TAKE THE LEAD

LED sources are driven by electronic gears or drivers. These units no longer just provide the appropriate drive current to the LEDs, but are equipped with additional features to adapt the light levels according to the origin and density of the traffic, period of the night, weather conditions etc. As a result, they provide an additional significant reduction in energy consumption. The use of sensors and cameras can further reduce energy consumption whilst increasing the level of comfort and safety.

Public lighting schemes no longer need to be uncontrolled stand-alone installations. Remote (wireless) management systems enable real-time status visualisation and reporting, the flexible set-up of lighting schemes, accurate energy metering, optimised maintenance programmes as well as integration in high level control software. It is a first and utmost important step in the direction of a Smart City concept.

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Photonics for Europe

Text of a speech by Neelie Kroes to the Photonics 21 Conference.

I am delighted to be with your Community once again. From lighting to laser manufacturing, from communications to cancer detection; photonics matters to our society, our economy, and our people.

It's not just a key enabling technology: it's one where Europe's industry is strong. And I intend to keep it that way.

I first proposed an ambitious public-private partnership in photonics a couple of years ago. And since then there's been very good progress.

Now we have before us a clear proposal: a roadmap to reinforce leadership in research and innovation.

I know over 60 photonics companies and research institutes are already fully committed; I hope that in due course all of you will sign up. So thank you to Michael Mertin and all those taking part.

This proposal is ambitious and strategic. Not a plan to subsidise an industry, but to strengthen Europe's innovation potential.

Because in fact, under these proposals, each euro of public money would leverage 4 euros of photonics investment. And this has a wider economic impact too: remember that this is an industry directly employing 290,000 people – but with an impact on 10% of all jobs in Europe.

Here are five ingredients for success.

First, the need to commit. I am doing so on behalf of the Commission; I hope you can do so too.

Second, we must pay more attention to innovative small and medium sized enterprises. With 5000 of them active in photonics, let's involve them more in the value chain, and better meet their needs.

Third, let's not work in silos. Photonics can help solve our societal challenges, like healthcare or climate change, so we need to engage more closely with those communities too.

Fourth, on funding. The legislators are still discussing Horizon 2020. And it's clear that the overall result will be lower than the Commission proposal. But I am confident that

the photonics budget in Horizon 2020 will still see a significant increase on the current programme, FP7. Yet Horizon 2020 alone won't meet all your investment needs. We need other complementary sources of financing, especially when closer to the market. We are working with the European Investment Bank on this; and I hope you can persuade regional authorities to unlock the new cohesion funds for photonics too.

Fifth, I know your most important resource is people: human capital. Yet not enough people are studying to become scientists, engineers or entrepreneurs. That's bad for our competitiveness, and bad for our employment.

I know that the skills gap is already affecting and constraining the photonics industry. And I hope you will be able to provide the solution too. I've already seen great initiatives from you - like bringing the Photonics Explorer to classrooms. Our Grand Coalition for Digital Jobs is a new way of working together to solve that problem; I hope the photonics community will be able to make a pledge for that Coalition too. It's in your interest and mine.

Now you will soon be ready with your PPP proposal. I expect that you will be able to formally submit it to us within the next few weeks, and we can look forward to a Photonics PPP right from the beginning of Horizon 2020.

Ladies and Gentlemen, this PPP will be a huge step forward, and our preparations are nearly complete. It can be a cornerstone of Horizon 2020; a lasting partnership between sectors; and a stimulant to European innovation. Our economy needs it; our society needs it; so let's take that step forward. Thank you.

Editorial Comment

When delivering this speech at the most recent Photonics 21 conference, Commissioner Neelie Kroes spoke of five "ingredients for success" relating to the strengthening of Europe's position. She was clearly anticipating significant progress in this industry.

One of these ingredients was funding, and much has happened since that conference: in particular, the launch of Europe's flagship Horizon 2020 programme with its colossal funding budget of almost €80 billions and announcements regarding the photonics public-private partnership (PPP). A recent news article commented that this amounted to a "52% boost for EC investment compared to FP7, as photonics and organic electronics projects move center stage". Specific programmes include ICT 26, worth €47m and covering biophotonics and solid-state lighting; and ICT 29, worth €18m, which covers novel materials and systems for OLED lighting. Looking forward to 2015, there will be further photonics-related calls, including ICT 27, worth €44m (laser-based manufacturing and photonics based integrated circuits); ICT 28, worth €56m (OLEDs on flexible substrates)

Commissioner Kroes' observation that each euro of public money might leverage as much as 4 euros of private photonics investment suggests the truly impressive sums of money potentially involved in the photonics PPP

Moreover, in this issue of European Energy Innovation, no fewer than three senior members of the Commission write on related matters, offering a timely opportunity to reflect upon the significant steps being made towards realising Commissioner Kroes' ambitious plans.

In his article, Dominique Ristori from DG ENER sets out the regulatory principles upon which successful innovation may be based, adding that there is substantial funding available (albeit from the European Structural and Investment Funds, perhaps further emphasising the role of public financing). Zoran Stančič at DG CONNECT examines the role ICT in energy efficiency, commenting upon the importance of existing digital infrastructure in cost-containment. Meanwhile, Robert-Jan Smits from DG RTD explores the role of Horizon 2020 in a little more detail, calling for an integrated policy framework to ensure regulatory certainty for investors. These comments together go a very long way to bridging the so-called "valley of death" referred to by Martin Goetzeler of Photonics 21 when discussing how innovation can fall down between successful science and pilot scale industrial deployment.

In essence, then, events already appear to bear out Commissioner Kroes' optimism for this business sector.

Disclaimer: This editorial comment reflects the views of European Energy Innovation, and should not be interpreted as expressing EU policy.

LED
Simply a new dressing gown?

Innovation in the lighting industry has always been driven by the development of new light sources. So it might be interesting to look back in history to gain some insights about the technology adaptation.

When Mr. Edison developed the first incandescent bulb, it took years if not decades to change the luminaire design; the first luminaires to house an incandescent lamp looked exactly the same like the old gas-mantle lanterns.

Later, with the development of the fluorescent tube, the luminaire designs had to change; the tube was the first longitudinal lamp which needed another form factor. In the later phase of the fluorescent lamp other shapes were developed: the compact fluorescent lamp, the energy saving lamp with integrated ballast and round versions in different diameters.

So the new light source LED now meets a variety of existing luminaire archetypes in different shapes – and guess what happens: LEDs are – once again – integrated in old design luminaires.

Even retrofit LED lamps are offered – both for incandescent and fluorescent lamps, in round and tubular shapes.

This does not come as a surprise – the lighting industry is used to treat the lamp as a consumable wear part which has a much shorter lifetime than the luminaire itself. The lamp always had to be easily replaceable; lamp replacement is part of the lifecycle maintenance of each and every lighting installation.

In the old days this even made sense from an economic point of view: The expensive luminaire stayed in place, the cheap light source was replaced.

BUT NOW THINGS ARE CHANGING:

Imagine a typical residential luminaire, maybe with a lamp shade made out of tissue paper, to house a simple Edison socket originally designed for an incandescent bulb. In a "modern" installation this lamp might be dimmed by means of a simple dimmer on the wall. The production / material costs of the luminaire are significantly below an Euro, it already stayed in place for a couple of years.

Now the incandescent lamp brakes, the sale of incandescent bulbs is banned, and the people integrate an LED retrofit bulb into this old luminaire. New high-tech for umpteen Euros in old low-tech for a few cents. Suddenly the wall dimmer does no longer work because the electrical load is much to small and the customer gets angry about the huge investment he was forced to take which in the end does not work properly. He will try to get his old incandescent lamp again. Lighting is not always a very rational business.

Unfortunately lighting is not fashionable, is not trendy, is not in. Otherwise you would expect something to happen like Denis Diderot described it in his 1769 essay "Regrets on parting with my old dressing gown":

Starting with the first LED retrofit bulb, the user starts to exchange everything: All other light sources, the old wall switches and dimmers, the old luminaires. And he will end up with a new, modern lighting system, with wireless control, nicely designed luminaires which not only gives his home a new and fresh look but also saves a lot of electrical energy: Enhanced comfort with less energy consumption.

But this will not happen, lighting is not a fashionable B2C business.

But it would be necessary to take full advantage out of the energy saving potential of the LED:

THE LED IS A COMPLETELY DIFFERENT LIGHT SOURCE FROM THE ONES WE ARE USED TO:

It generates heat – but not in form of infrared radiation which is distributed like the visible light into the room but which is to be transferred by heat transfer and dissipated by heat sinks.

The LED is a low voltage DC semiconductor element which is run on a high voltage AC supply.

The LED has a much lower power consumption than the old lighting

technologies already installed; cables, dimmers, other electrical components are overdimensioned and will no longer work properly.

The LED is a long lasting light source. It's 50.000 hours nominal lifetime will only be reached after decades in normal residential usage.

The LED is a digital light source: If necessary, it can be switched off and on in milliseconds and can easily be dimmed on the right equipment.

The LED is a revolution to lighting – not an evolution.

Klaus Vamberszky

To make full advantage out of its potential it is necessary to redefine the whole lighting system.

LED lighting for energy efficiency therefore does not mean to replace the old light source by a new one – no. It means to start from scratch, develop new systems with new components.

Then – and only then – the full potential in terms of energy efficiency can be tapped.

In opposition to Denis Diderots view this is not a question of taste, of style – it is a question of technology and energy saving potential.

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Power by light: Optical power transmission replaces copper wiring

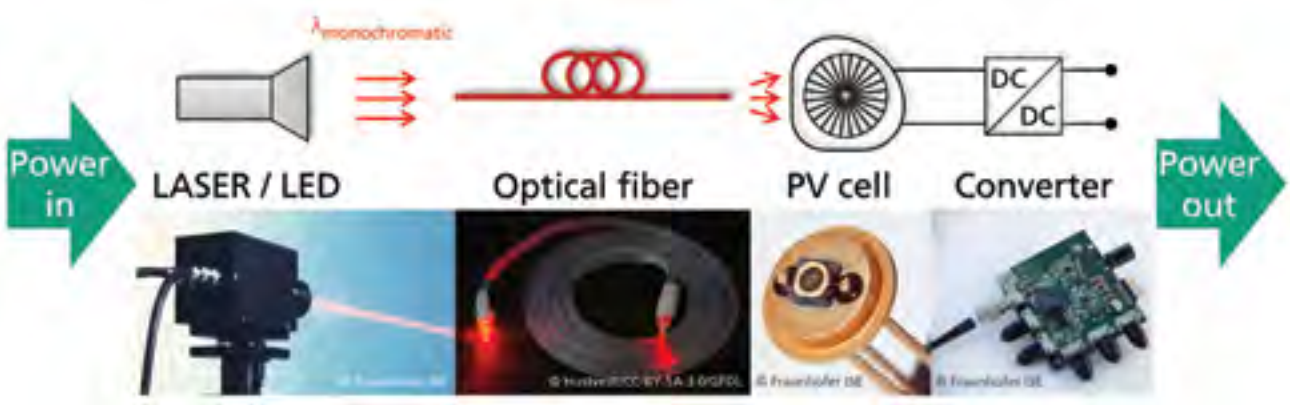
By Dr. Henning Helmers, Fraunhofer Institute for Solar Energy Systems ISE

Optical power transmission is an elegant way to replace copper wiring with fiber optic cable for supplying power. The technology is ideally suited for applications where conventional power supply is challenging or even impossible due to electromagnetic interference, the risk of short circuits and sparks, the need for lightning protection, the need for galvanic isolation, high magnetic fields, heavy weight of long distance cabling, or the susceptibility to corrosion and moisture. In addition, the replacement of copper wire by optical fiber enables combination of power and data transmission into a single fiber.

In an optical power transmission system the energy is transmitted in the form of light. At the base station electrical energy is transformed into (monochromatic) light by a LASER or a LED. The light is usually coupled into an optical fiber which guides the light to the receiver unit. At the end of the optical fiber the light is targeted onto a specialized photovoltaic cell which converts the monochromatic light back into electricity.

It is beneficial for this technology that photovoltaic cells convert particular wavelengths of monochromatic light into electricity at much higher efficiencies as compared to conversion across the entire solar spectrum. By tuning the photovoltaic cell's semiconductor bandgap to the wavelength of the light, the energy of the photons is just sufficient to excite an electron into the conduction

Fig. 1: Schematic of an optical power transmission system.



band. Thus, both main loss mechanisms existing in solar cells become negligible: Because all photons can be absorbed by the semiconductor, transmission losses nearly vanish. Furthermore, thermalization losses, which occur from hot electrons that are excited into the conduction band and release their surplus energy as heat to the crystal lattice, become negligible. That way, efficiencies over 50% have been demonstrated with laser power converters.

Tuning of the semiconductor's bandgap can be readily achieved when employing III-V semiconductors, such as GaAs, GaInP, GaInAs, AlGaAs, GaInAsP, and AlGaInP, in different compositions. Using these materials, common laser wavelengths of 650 nm, 808 nm, 980 nm, 1310 nm, and 1550 nm are well covered. Furthermore, advanced cell concepts, which were originally developed for high efficiency space and concentrator solar cells, can be adopted for laser power converters: Based on monolithic series connection of several subcells, such as vertical multi-junction designs or integrated lateral series connection, high output voltages can be achieved. The range of suitable applications for optical power transmission is vast. Examples are as diverse as powering of remote sensor systems in extreme environments, e.g., structural heath monitoring systems in wind turbines, fuel gauges in aircraft wings, and current transducers in high voltage power lines, implantable medical microsystems, subscribers in optically powered networks, or monitoring units in passive optical networks.

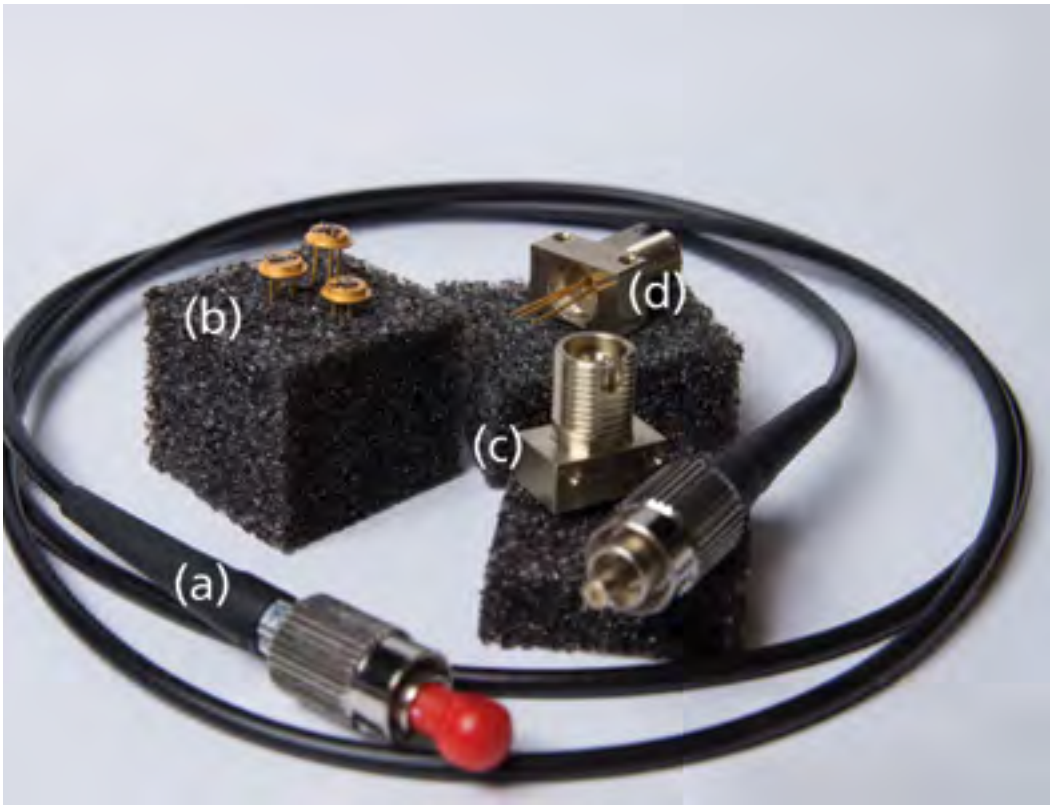


Fig. 2: (a) Optical fiber with connectors on both ends. (b) Laser power converters mounted on transistor outlines (TO headers). (c) Optical connector. (d) Laser power converter integrated into optical connector.

Fig. 3: Automatic packaging of laser power converters on transistor outlines at Fraunhofer ISE: thin wire bonding for electrical contacts.

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Innovative 3D-Photonic Crystal Backside Foil for Thin-film Solar Cells

By Alexander Sprafke, Daniela Schneevoigt, Ralf B. Wehrspohn

In demand for cheap and clean energy sources progresses in photovoltaics are a key issue. This involves a notable cost reduction as well as a significant increase of conversion efficiency from solar to electrical energy of photovoltaic systems. These two issues are not independent from each other, e.g. a higher conversion efficiency can result in a more efficient use of materials and thus a reduction of costs.

Increasing the absorption probability of solar photons impinging on a photovoltaic device increases its conversion efficiency. The more solar photons are absorbed by the active layer of the solar cell, the more electron-hole pairs are generated which contribute to the attained electrical current and voltage. Therefore, photon management in photovoltaic devices becomes inevitable. Photon management comprises all approaches to influence the properties of the incoming light with the aim to increase the efficiency of the cell. These approaches include manipulation of the light path (e.g. light trapping) or changing the photon energy (e.g. up-/down-conversion).

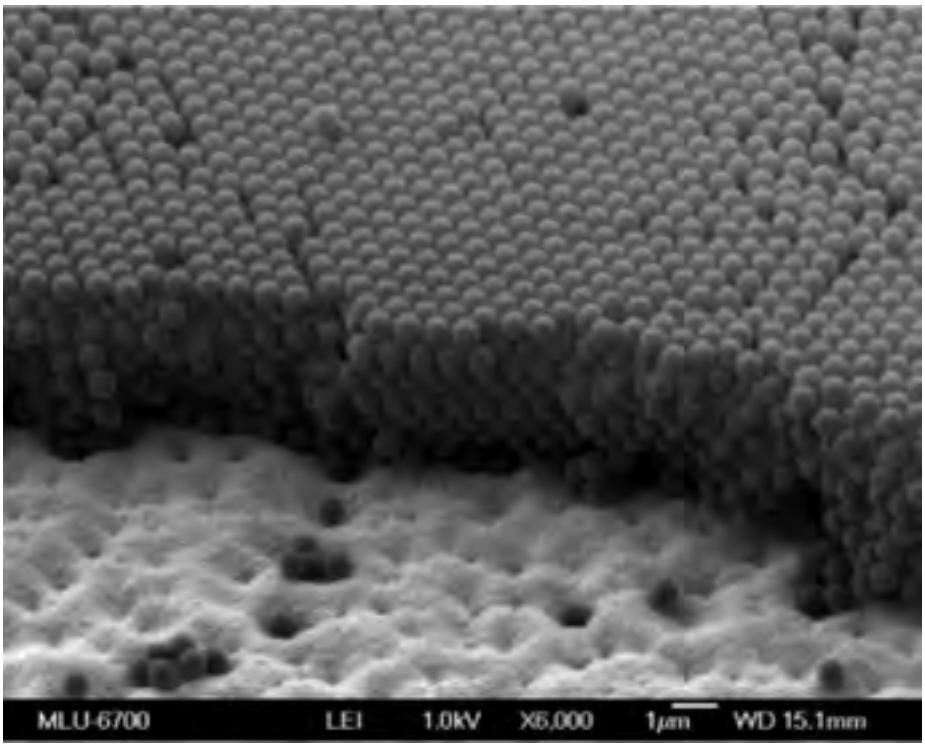

Figure 1: Scanning electron microscope image of an artificial opal at the backside of a μc-Si thin film solar cell.

3D-photonic crystals, such as artificial opals (see Fig. 1), are a promising material class for the use in advanced photon management concepts in solar cells. Their special photonic band structure leads to remarkable wavelength-dependent and directional optical reflection and transmission properties. The optical properties of artificial opals can easily be designed within a broad range, as opals of many varieties can be synthesized by self-assembly of monodisperse nanoscaled colloids. The optical characteristics of the opal are defined by the material and size of the colloids. Inverted opals are of particular interest as they exhibit a complete photonic bandgap.

Applying inverted opals to the backside of a solar cell may be exploited to elongate the light path in a solar cell. Light that is not absorbed during the first round through the solar cell would either be reflected, diffracted, or scattered back into the cell, preferably into angles which would eventually enable light trapping by total internal reflection. With the appropriate parameters, these light-steering properties can be tuned to critical spectral ranges, e.g. the electronic band gap of the absorber material, where optical

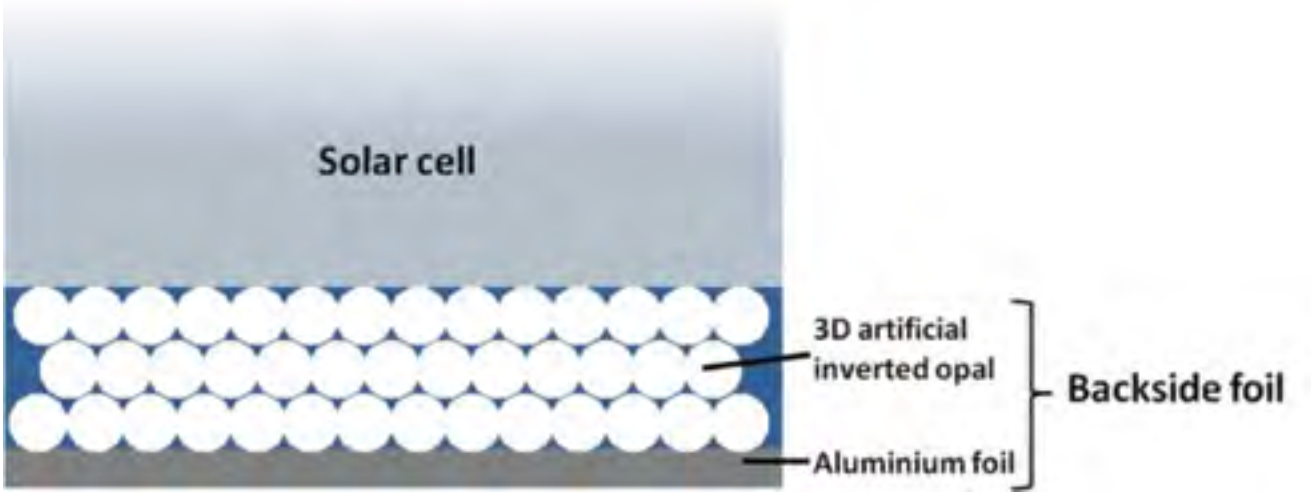

Figure 2: Sketch of proposed photon managing back-contact foil consisting of a flexible substrate (aluminum foil) and a electrically conductive photonic crystal.

absorption typically is very low. Thus, the probability of light absorption and the efficiency of the solar cell may be increased by such a backside structure. This is of particular interest for next-generation crystalline thin-film solar cells, which are much thinner (≈ 10-20 µm) than conventional crystalline Silicon solar cells (about 150-180 µm), but do not possess an equivalent level of conversion efficiency.

Incorporating new concepts, such as photon management by artificial inverted opals, into existing solar cell production lines would involve several issues which the photovoltaic industry commonly is not willing to take. E.g., the fabrication of opals with conventional methods is time consuming and thus cost-inefficient. Additionally, the direct preparation onto solar cells would constitute an extra step which is tied to increased production complexity, cost, time, and possibly detrimental impacts onto the solar cell material because of additional thermal and mechanical exposures.

Here, we propose that these drawbacks can be avoided by implementing a spray-coating method to fabricate opaline structures. In contrast to conventional preparation methods, such as dip coating, this process works on a much faster time-scale and is scalable to large areas. Additionally, the photonic crystal backside structure should be fabricated separately from the solar cell as a flexible foil (patent pending DE102011112696.5). The independent fabrication cuts down possible damaging impacts on the absorber material. The foil consists of a photonic crystal applied to a flexible substrate which is attached to the backside of the solar cell after its fabrication (Fig. 2). Using aluminum foil as a substrate for the artificial inverted opals offers several advantages. It is a low cost material and would not only act as a substrate, but also as a backside mirror for light that was not absorbed in the active layer and not reflected or diffracted by the structure. Furthermore, the whole backside foil may act as a large-scale electrical backside contact for the solar cell. In this case, the photonic crystal needs to consist of a transparent electrically conductive material, such as Al:ZnO or ITO.

The here presented photonic crystal backside foil demonstrates an innovative concept to increase the conversion efficiency of solar cells, combining photon-management with the electrical back-contact of solar cells. Its independent production process makes it feasible for possible integration into photovoltaic industry. Furthermore, it is not tied to one kind of solar cell; the separate production enables this concept to be applied to different kinds of thin-film solar cells, such as µc-Si or CIGS.

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Challenges for the Bioenergy Sector: how EU teams across the EU are addressing them

By Emilio Font de Mora and Silvia Vivarelli (pictured)

Bioenergy production in Europe has increased in the last years thanks to the boost given by the 2020 targets set in the Renewable Energy Directive (2009/28/EC). However, according to the progress report on the implementation of the Directive [COM(2013)175] with the current trend the expected production in 2020 will be lower than planned. On the other hand imports are expected to increase considerably as also indicated in SEC(2010)65. For solid biomass it is assumed that imports could more than double in 2020.

There is a need to increase biomass production to reach the targets focusing on EU internal production as this is deemed to be more sustainable from an environmental, social and above all economic viewpoint.

The bioenergy projects which have been co-financed by Intelligent Energy – Europe (IEE) aim at supporting the development of this key sector and ensuring its sustainability. In future, such "market up-take" projects will be financed by the new Horizon 2020 programme.

The on-going IEE projects address the main challenges that bioenergy is facing. Firstly, the need to foster domestic bioenergy production through the mobilisation of the forest and agricultural sectors and through the revalorisation of wastes,

overcoming barriers along the supply chains; this also requires promoting its use for CHP, heating and cooling, transport and grid injection.

Additionally, biomass sustainability, the interactions between different supply chains, and the promotion of the most efficient uses of available bio-resources should be considered. Furthermore, there is a need to strengthen policies and support schemes at national and regional level.

The **AgriForEnergy 2** project supported the production of forestry and agricultural biomass in 7 EU Member States. Technical assistance was provided to 77 investment projects in bioheat, pure vegetable oil, biogas and biomethane, representing altogether over €71 million of new investments and 60,000 tCO_2 saved annually. The mobilisation and trade of local wood biomass resources has been facilitated through the **BiomassTradeCentreII** project. Until now more than 10,000 stakeholders from 9 EU countries have been participating in workshops, trainings, demonstration and match-making events and study tours. As a result 8 biomass logistic & trade centres have been set up and 42 are in progress, more than 30 farmers and forest companies have started new biomass business and more than 60 have committed to do so.

Natural parks from 5 EU countries will create new supply chains from sustainably managed forests in the **EUBIOPARKS** project. Pilot actions will be developed in the parks for the production of heat or CHP using own bio-resources. Strong awareness-raising campaigns involving inhabitants of the parks and surrounding areas to take active part in the activities are foreseen. About 200,000 tonnes of biomass will be mobilised annually.

Thanks to the project **BioEnergy Farm**, farmers in 6 European countries increased their use of solid biomass or biogas for energy production. 80 business plans were carried out leading to 43 bioenergy projects implemented with a total output of over 50 MW. A follow-up project, **BioEnergy Farm II**, will focus on micro-scale biogas installations to use the self-produced manure and agricultural wastes to cover the energy needs of the farms. 700 farmers will be assisted through feasibility studies resulting in 190 digesters being installed with a total capacity of 28 MW. The framework to produce biomethane for transport from urban waste has been set up in 5 EU cities, thanks to the task forces created and trainings organised in the **UrbanBiogas** project. Up to date 4 additional cities have joined the partnership to promote the same concept.

The establishment and extension of locally used cooking oil collection systems for energy

production is promoted by the projects **OILECO** and **RecOil**. In total, both projects are expected to support the creation or expansion of around 20 collection systems.

A number of IEE projects have contributed to the elaboration and implementation of bioenergy related policies. The **BiomassPolicies** project is supporting EU Member States in developing integrated and balanced bioenergy policies for the mobilisation of indigenous resource-efficient biomass value chains. The interrelation with sectors and policies other than energy is taken into account. An EU bioenergy trade strategy ensuring that imported bio-resources are sustainably sourced and used in an efficient way, limiting distortion of other markets, will be developed in the **BioTrade2020plus** project. The project **BioGrace-II** will help harmonising GHG emissions calculations for electricity and heat from biomass.

At regional level, the **BioRegions** project aimed at creating five "bio regions" across Europe, having one third of their energy needs covered by local bioenergy resources. The regions defined, adopted and implemented Action Plans to trigger investments in bioenergy technologies. Over 130 expressions of interest from a total of 36 additional regions, provinces or municipalities from 12 EU Member States, wanting to implement similar activities, were received.

An impact assessment of IEE bioenergy projects is foreseen in 2014. The preliminary results together with the achievements of recently finalised projects will be presented at a ManagEnergy event in Brussels (http://www.managenergy.net/) on 22 May 2014.

For further information please consult http://ec.europa.eu/energy/intelligent/

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