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GERMANY ENERGY TRANSITION

Includes editorial contributions from:

Prof. Dr. Angelika Niebler
MEP

Lily Riahi
Lead of District Energy in Cities Initiative, UN Environment

Prof. Dr. Klaus-Dieter Borchardt
Director for the Internal Energy Market, DG ENER, European Commission

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The publishers of European Energy Innovation would like to offer their sincere thanks to all individuals and organisations who have contributed editorial images photos and illustrations to the magazine. Whilst every effort has been made to ensure accuracy of the content, the publishers of European Energy Innovation accept no responsibility for errors or omissions.

European Energy Innovation is published by:
Prologue Media Ltd
1a Shire Lane
Chorleywood
Hertfordshire WD3 5NQ
United Kingdom

Tel: +44 1923 286238
www.europeanenergyinnovation.eu

To obtain additional copies please email info@europeanenergyinnovation.eu

Editor
Michael Edmund
editor@europeanenergyinnovation.eu

Business Development Director
Philip Beausire
philip@europeanenergyinnovation.eu

Head of Brussels office
Sophia Silvert
Mob: +32 4737 30322
sophia@europeanenergyinnovation.eu

Design & Production
RayHeathDesign.com

Website design
pulseart.co.uk

Print
The Magazine Printing Company, Enfield, Middlesex, United Kingdom

Foreword

"Greenhouse gas concentrations surge to new record"

This recent headline must surely have caught the attention of the green energy community, while the story behind it can hardly make easy reading for anyone. Atmospheric concentrations of CO_2 are rising 100 times faster than at the end of the last Ice Age, to values not seen on Earth for three million years, when sea levels were up to 20m higher than today. Twenty meters! No wonder climate change has been called "humanity's greatest threat in thousands of years."

Fortunately, Lily Riahi, of the UN's District in Cities Initiative offers a route to the Paris targets by tackling emissions from heating and cooling. She does not mince her words, immediately making clear that decarbonising the sector requires a "revolution". Fortunately, modern district energy solutions can provide a major impetus, such as in Denmark, where they have reduced emissions by 20%. She goes on to explore national-scale projects in India and Chile; and how public-private partnerships may accelerate investment.

German MEP Angelika Niebler explores "home grown" problems arising from her country's green energy transformation. A major one, she says, is the lack of grid between the North (where much renewable wind power is generated), and the energy-hungry South. "The government is pushing for an expansion of the grid" she continues, but "citizens do not want them to be built near their homes and consumers protest against higher energy bills". She contends that the internal energy market offers the best means to accelerate renewable uptake, provide security of supply and stay economically competitive.

We are delighted that Prof. Dr. Klaus-Dieter Borchardt, Director for the Internal Energy Market at DG ENER, discusses the future role of gas. Since 100% renewable electricity is neither technically feasible nor economically acceptable, he outlines how a hybrid RE-Gas model might fulfil climate expectations, even though it too must depend upon decarbonisation of gas. CCS technology, renewable gas – biomethane and biogas; and ultimately hydrogen – will all feature, but we we need dialogue across the energy, transport and heating sectors, and structured cooperation between them all and the energy-intensive industries and customers.

Bart Biebuyck, Executive Director, Fuel Cells and Hydrogen Joint Undertaking (FCH JU) suggests that Europe should continue to support the technology because it will become central to the decarbonisation of energy and transport systems. He goes on to show that FCH technologies can also provide an important means of energy storage, and how polymer electrolyte membrane (PEM) fuel cells can decarbonise even the petroleum industry, before signalling a warning about the 'valley of death' that awaits new technologies that are not properly supported.

In his highly informative article, Javier Gómez Prieto of the Joint Research Centre explores how trends in social innovation are influencing Smart Specialisation, the approach to identifying innovation potential of EU regions. This helps ensure that input from citizens, often given insufficient weight, can be both generated and matched with business requirements.

The internationally-respected naturalist Sir David Attenborough, speaking at the opening of the UN-sponsored climate talks in Katowice, Poland, made apocalyptic predictions about the effects of climate change. Hopefully, with these tools, we can help avert such a catastrophe.

And there is much more for you to read inside...

Michael Edmund
Editor

European Commission

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The future role of gas

By Prof. Dr. Klaus-Dieter Borchardt (pictured), Director for the Internal Energy Market, DG ENER, European Commission

Europe is undergoing a far reaching energy transition in order to decarbonise all aspects of our daily lives and this in a relatively short period. The overarching mission is to move towards a zero-emission, carbon-neutral Europe. The pathway is clear: decarbonising the economy by 2050 in the order of 80-95% compared to 1990, achieving along the way reductions of at least 40% by 2030 and 60% by 2040.

In light of the ambitious decarbonisation targets, it is evident that the energy transition process has to be stepped up. To reach the emission reduction and renewable production goals in the energy sector, some advocate an "all-electric world", where energy is produced as renewable electricity, stored as electricity and all end-applications are switched to electrical appliances.

However, some recent studies and assessments (Frontier) have found that this transition to an "all-electric world" is neither technically feasible nor economically acceptable because it would significantly increase the energy costs for private and industrial consumers. Indeed, full electrification by using exclusively intermittent renewable sources would require smarter and stronger electricity grids, wide-spread introduction of flexibility measures, and higher levels of (seasonal) storage and back-up generation capacity.

It is therefore necessary to investigate specifically whether, to which extent and how gas and gas infrastructure can be compatible with the climate objectives and deliver cost-effective solutions to achieve the energy transition. This will also require investigating optimal use of the infrastructure building on synergies and interactions between the gas and electricity sectors.

My vision of the future European energy system in this regard is clear: it is one of a dual or hybrid model based first and foremost on electricity from renewable sources but sustained and complemented by renewable and decarbonised gas.

With such a hybrid model the European energy system would be much stronger and more resilient because it could be based on two independent and at the same time complementary energy resources and infrastructures. Large quantities of renewable gases can be produced within Europe reducing the import dependency of the European energy system.

And even more: While the energy transition in the EU has so far focused on the electricity sector, it now needs to encompass heat, transport and industrial consumption. The interfaces between both electricity and gas grids and the integration of multiple technologies will increase the resilience of the overall system efficiency The underlying concept is called “sectoral integration” or "sector coupling".

Such a combined approach of renewable electricity with renewable and low-carbon gases would not only lead to quite substantive savings in the energy transition process but would also deliver on economic growth, job creation and strengthening EU's position as a leader in innovative energy technologies.

In the short term, natural gas can play an important role in decarbonising the EU's energy system by replacing more carbon emitting fossil fuels, notably hard coal and lignite. There is no way reaching our climate targets without radically change the share of coal and lignite in the energy mix.

In the mid-term, natural gas will be needed as a back-up or bridge fuel for the increasing production of electricity from renewable sources, mainly wind and solar. Gas is the ideal back-up technology for variable renewables characterised by a high flexibility for balancing the integration of renewable generation (more flexible compared to nuclear production) and by the lowest CO2-intensity of fossil fuels.

For the long-term, however, there is a challenge. If natural gas is to remain in the EU energy mix, until 2050 and beyond, it has to be fully decarbonised. This clearly entails massive deployment of technologies as well as related costs and likely regulatory changes. In this context Carbon Capture and Storage (CCS)/ Usage (CCU) will have to play a decisive role.

The decarbonisation of natural gas will be increasingly complemented by the development of renewable gases. Renewable gases have been gradually emerging in the European energy market as possible alternatives to natural gas in several applications. At present, bio-methane and biogas represent the main source of renewable gases in Europe with hydrogen showing a growing potential. Thanks to its particular characteristics, hydrogen is able to contribute to achieving the climate goals and to translate them into economic activities. Hydrogen is an energy carrier that can be made out of all other energy sources. It can be used as a transport fuel, converted back to electricity or injected into the natural gas network.

One promising option is the power-to-gas technology. It allows renewable electricity to be converted and stored as a gas. This is of particular interest for Europe where the combined generating capacity of offshore wind farms could reach around 100 GW by the year 2030 and the PV capacity installed is expected to increase to almost 60 GW in 2020. Using power-to-gas technology could help to accommodate these quantities of renewable electricity.

However, the precise composition of energy carriers in our future energy system is surrounded with high uncertainty when a time horizon up to 2030 and 2050 is taken.

The exact combination of different technologies will best be determined by market forces, finding the most efficient way to reach ambitious policy objectives in a technology neutral manner. The main objective should be removing any existing regulatory barriers or fill any potentially existing regulatory gaps to create a level-playing field.

In order for the future to happen, a structured cooperation between the renewable electricity and gas sector on the one hand and an intense cooperation with the energy intensive industries is required. Furthermore, a dialogue between the electricity and gas sectors and their customers in the transport and heating sector is essential.

Understanding how consumers engage with energy data is essential in delivering a "Clean Energy Package for all Europeans"

By Willem Strabbing, Managing Director, ESMIG – The European Smart Energy Solution Providers

A new report that gathered 578 pilots involving 5,5 million residential consumers over the past 10 years sheds new light on consumer engagement and learning patterns. The research was commissioned by ESMIG and conducted by VaasaETT in November 2018.

In its new policy framework "the Clean Energy for All Europeans Package", the European Commission highlights the key and central role of consumers in the global transition to a low-carbon society. It proposes to help consumers save money and energy through better information and give them a wider choice of action when choosing their participation in energy markets.

Fortunately, there are several trends converging to make consumer centric markets a reality. Already a majority of the EU member states (17) have taken a positive decision for a full roll-out of smart meters which will make available granular and reliable information about individual energy use. In addition, the increasing penetration of connected objects in homes and the decreasing costs of measuring and analysing ever-larger amounts of data will make real-time data ubiquitous.

However, households are still scarcely knowledgeable on what energy efficiency entails, how much energy they consume, how much they pay for it, why and how they should save energy. Also, increases in knowledge and concern from mass communication campaigns may not translate into observable change of behaviour, unless the general information is combined with other more tailored and targeted techniques.

This study reports on how consumers react to feedback on their electricity and gas consumption and what is the added-value of near real-time data in achieving other customer benefits. It does so by analyzing the biggest database of feedback, dynamic pricing, home automation pilots and commercial roll-outs around the world.

Main findings of the report

1. **Disaggregated consumption feedback followed by total current consumption feedback leads to the highest savings** as it allows consumers to link their everyday activities with energy consumption, being often based on real-time data, and thus better focus their efforts.
2. **The feedback channel that leads to the highest savings is the in-home-display (IHD).** This may be attributable to three main advantages of IHDs over other feedback channels: it can act as a constant reminder of energy consumption, reach the entire family – unlike bills, mobile apps and web portals - and can provide additional information via different dynamic menus.
3. **Feedback is most effective in the short term**, when task learning is most likely to occur, **and over the long term** as the impact of behavioural change becomes more automatic and newer more ambitious household goals are set when previous ones are achieved.
4. **86% of pilot participants are satisfied with the feedback programme** and 85% would have liked the programme to continue.
5. **The impact of feedback increases with the number of feedback types and channels provided.** People, even those living under the same roof, are different and behaviour change is often triggered by different incentives and mechanisms. Energy conservation through feedback can thus only be maximised if the solution attends to different segments of consumers with different interest, norms and rationalities.
6. **The importance of segmentation and targeted messages is**

crucial. Consumers should feel that the information they are given is relevant and that the advice is useful. Recent ICT developments allow creating seemingly tailored information on a mass-scale.

7. **Feedback solutions should, rather than offering one static programme, bring participants through a cycle.** For instance, starting with simple messages and suggesting tasks of low degree of involvement and low perceived complexity, then progressing towards more sophisticated or constraining behaviours.
8. **Providing real-time feedback on both gas and electricity leads to significantly higher savings:** 9.2% for dual-fuel pilots versus 7.7% for electricity only pilots. Natural gas represents 37% of household's final energy consumption in Europe compared to 25% for electricity and in many countries a higher share of household energy expenditure as well.
9. **Home automation alone tends to have an adverse effect on households' overall energy consumption.** While some would argue that there is no point trying to engage and educate customers who have automated appliances, pilot results show that when efficiency improvements come solely from the technological side, people remain passive actors, leading to low levels of awareness, continued inefficient habits and sometimes a rebound effect (seeing its energy expenditures decrease, the customer might become more careless about his consumption).
10. **Innovative customer centric data-driven models and services are staring to appear in Europe** and revolve around two main themes sometimes offered in combination: a) providing households with the ability to automatically increase and decrease energy demand and be rewarded for providing grid flexibility thus preparing the grid for increased electrification of transport and heating (e.g. electric cars, heat pumps) and b) enabling and maximising independence from traditional suppliers by optimising local generation (typically solar PV), battery storage and home control. In the case of gas, new services often focus on remote control and scheduling of water boilers and heating.

Recommendations

Consumers need accurate information based on real-time data, via multiple channels and using targeted techniques. This is key in achieving savings and encouraging their participation in the energy market. For this to happen, several conditions must be met:

1. The technology is available: the roll-out of smart meters must be completed in order to have granular and reliable information about individual energy use.
2. Real-time data is available as a basis for feedback and additional consumer services.
3. There are multiple feedback channels available, with priority to in-home-displays.
4. Consumers are in control of their own consumption/generation data and resources and can voluntarily hand over this control to a 3rd party of their choice.
5. Consumers get the benefits (comfort and/or savings).

This study brings new and compelling analysis which confirms what many in the industry already know, that feedback produces good levels of consumer engagement and results in tangible energy savings. The number of trials included in the study from all over the world makes the conclusions enduring for policy makers everywhere.

Patrick Caiger-Smith, CEO at geo and Chair of ESMIG's Consumer Energy Management Working Group

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About ESMIG

ESMIG is the European voice of the smart energy solution providers. It represents European companies which provide products, information technology and services for multi-commodity metering, display and management of energy consumption and production at consumer premises. These products and services enable better outage detection, customized tariffs and accurate bills, a precise overview of consumption and manageable demand. Therefore, they help in making energy cleaner, more affordable and more reliable.

www.esmig.eu

For information and copies of this report, please contact Georgiana Huiban, ESMIG Marketing and Communications Officer (communications@esmig.eu)

A Clean Planet for all? Energy poverty and decarbonising Europe's economy

By Pierre Jean Coulon, President & Kristian Krieger, Policy Officer Energy Section Transport, Energy, Infrastructure, Information Society of the European Economic and Social Committee

Two publications have been making the headlines ahead of the global climate negotiations of COP24 in Poland. The International Panel on Climate Change (IPCC) released its report on the impact of global warming of 1.5 degree Celsius in early October, highlighting the expected severe impact on natural life and human societies in case of a warming of two degrees Celsius. This report was followed in late-November by the European Commission's long-term strategy for greenhouse gas reduction, in which the Commission spells out its ambition to make Europe carbon neutral by 2050.

Both reports offer important insights into the urgency and complexity of the transition to low-carbon economies. While reflecting on social aspects of different transition pathways to some extent, the reports and ongoing public debate would – in our view – benefit from a more wide-ranging discussion of the implications of the urgency and of different pathways on energy justice, including in particular the challenge of energy poverty. Not discussing these aspects carries the risk of leaving parts of Europe's population behind, creating a "prosperous, modern, competitive and climate neutral economy" but not for all.

It is in this context that the work undertaken by the EU Energy Poverty Observatory (EPOV) seems particularly important. The EPOV was launched by the European Commission in January 2018 with a mandate to generate and gather knowledge about energy poverty and ways to effectively fight this major problem. Energy poverty affects, after all, more than one in ten European households. The EPOV has already made significant contributions to a shared and extended understanding of energy poverty by analysing indicators for measuring energy poverty and ensuring the recognition of additional groups to be at risk of energy poverty.

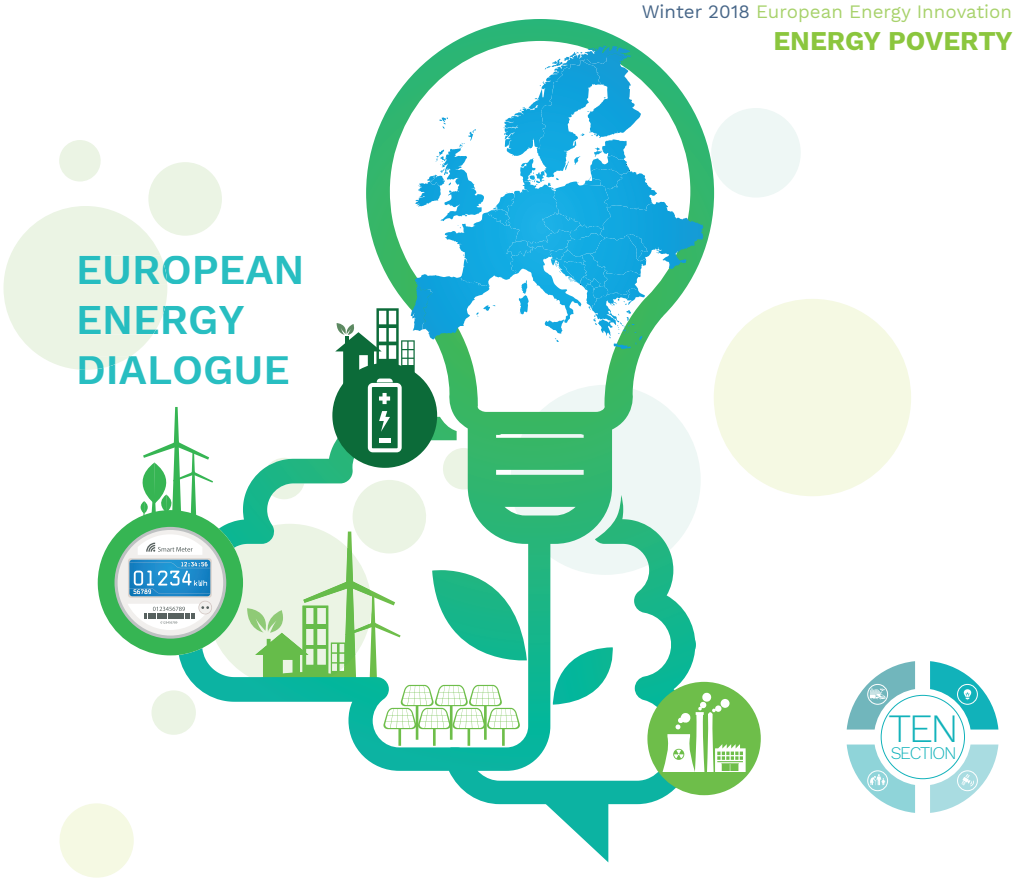
Pierre Jean Coulon

Kristian Krieger

The European Economic and Social Committee (EESC) played an instrumental role in the growing interest and institutional response to energy poverty at the European level. As early as 2001, one of the consultative bodies of the Committee issued an opinion on climate change and emissions trading specifically highlighting the risk of fuel poverty, thereby introducing this issue to the European policy discussions. More recently, in 2013, the EESC advocated for "coordinated European measures to prevent and combat energy poverty", proposing – among other ideas such as the establishment of a comprehensive EU Energy Solidarity Fund – the setting-up of the now existing EU Energy Poverty Observatory.

However, with this opinion, the EESC's work to battle energy poverty has not ended. Rather, the Committee – as the house of Europe's organized civil society – endeavours to (help) mobilize the knowledge and resources of civil society for this struggle.

Concretely, the Committee has developed a positive vision of Europe's energy future in which



citizens are empowered to participate economically and politically in the energy transition. Based on the rich, hands-on experience of EESC members, the Committee has argued that the rapid decline of costs for renewables and the potential of digitalisation and – in the future – artificial intelligence offer an opportunity to develop a decentralised energy system, in which citizens, households, energy communities and cooperatives can assume a central role in supplying energy.

Case studies from across Europe examined by EESC members have demonstrated a strong interest by civil society in becoming actively involved in the energy transition. However, often local and regional governments must play a central role in ensuring that this involvement is inclusive and energy poor households are enabled to fully participate – via public financing, simplified administrative procedures, awareness campaigns, and training. In order to make the energy transition work for the more vulnerable European households in communities, cities, and regions, the Committee seeks to closely cooperate with the Committee of the Regions, the European Commission's DG REGIO, and other organisations from civil society, such as Energy Cities and Rescoop.

In addition, the EESC aims at facilitating information exchange on best practices between civil society and EU institutions. Often unnoticed by civil society organisations across the Member States, EU institutions finance and undertake highly relevant projects and studies that can provide important lessons and practical tools for resolving the challenge of energy poverty across Europe. Beyond the EPOV with its substantial knowledge resources, agencies such as the European Agency for SMEs have funded projects in which, for instance, more inclusive financing mechanisms of a switch to renewables are developed (e.g. collective purchasing groups, consumer stock ownership plans), effective awareness and advisory services designed (e.g. energy advisors and ambassadors with first-hand knowledge of energy poverty), and existing community infrastructures assume new roles in reducing energy bills (e.g. energy prosumer communities promoting energy saving).

By assisting individual project work and cooperating with these bodies, the EESC and its members learn about what has worked and what not and share this knowledge through its networks into the 27 Member States.

Through such and other efforts, the Committee pursues its vision of an inclusive and sustainable energy future for Europe. The EESC emphasises that even in the light of the increasing urgency of decarbonising Europe's economies and energy systems, no-one should be left behind in this process. It welcomes the EU's efforts – via the EPOV, the coal regions in transition platform, its support for prosumers and energy communities in the "Clean Energy for All Europeans" proposals – to address some of the social challenges of the energy transition. The EESC uses its very own resources, the passion, ideas, expertise, networks and tools of civil society, to raise awareness and provide solutions to the economic and social challenges associated with the transition.

St1 pilots sustainable carbon sequestrating through afforestation in Morocco

By Mika Aho

Nordic energy company St1 has signed an agreement with the Université Mohammed VI Polytechnique in Morocco and its affiliated fertiliser company, OCP, for the implementation of an afforestation pilot. Over a period of three years, the project will examine the carbon sequestration by trees under various controlled conditions in Morocco. The pilot is a major step towards creating a validated and approved tool for combating climate change through carbon sinks created via afforestation.

The carbon sequestration is essential

Climate change is the biggest problem facing the humankind, as it is leading to rapid and dramatic changes in our planet's ecosystem. Numerous forecasts indicate that the objective of the Paris Climate Agreement – to limit global warming to less than 2°C – will not be achieved by the current policies and mitigation tools only. A recent report by the Intergovernmental Panel on Climate Change (IPCC) confirms the impossibility of achieving the objective by current means, and highlights that the range of methods require carbon sinks, such as new forests.

Emissions will be further increased by the rapid growth of population, economies and energy demand in developing countries. In addition, some 100 billion tonnes of excessive carbon is already in the atmosphere, which only can be removed through extensive afforestation and reforestation activities. As the problem is global, the mitigation activities should not be artificially constraint to national activities only. Viable land areas could be increased through large-scale afforestation of arid regions. Locally accepted afforestation projects combined with agriculture would help the people in regions affected by drought and desertification, thereby reducing migratory pressures.


Taking soil samples

Moroccan pilot contributes to the creation of a powerful tool for urgent need

The goal of the pilot is to find the optimal solution for the use of land improvement and irrigation systems in cost-effective forest growth and carbon sequestrating. A total of 16,000 seedlings acquired from Morocco will be planted in a four-hectare research area in Rhamna Ben Guerir. Planting will begin in January and the project will involve testing seven tree species, including carob, eucalyptus and acacia. Various types of soil improvement, such as water retention improvements and fertilisation, will be performed to provide a viable substrate in the currently dry soil. In addition, the project will involve studying the role of irrigation and the optimisation of water consumption by using a sub-surface drip irrigation system.

The first results of the three-year pilot will be obtained in a year's time. The university will implement a practical

field test to study and measure the trees' growth both above and below ground. As a partner, LUKE, the Natural Resource Institute Finland, will contribute technical and practical forest know-how and expertise to the project, by directing and monitoring the field test. In addition, the project will involve a local farmer, on whose land different growing methods will be tested.

Scientists developing an international measuring concept for carbon sequestration

An internationally accepted and standardised method of carbon measurement is an absolute prerequisite, if carbon sinks created through afforestation are to become an official and commercial method of reducing carbon dioxide emissions. During the summer, the University of Helsinki began a measurement conceptualisation project with the aim of creating an internationally accepted comprehensive measurement method for carbon-sequestrating projects. During the project, in collaboration with the Finnish Meteorological Institute and ICOS RI (International Carbon Observation System Research Infrastructure), the University of Helsinki will create a comprehensive concept about how the climate effects of forests and carbon sequestration in forest trees, soil and other forest plants can be reliably measured. The research group will also create recommendations for how the world's carbon sinks can be reinforced and what kinds of measuring equipment and methods should be used to measure them. An internationally accepted comprehensive measurement method for carbon-sequestrating would enable the carbon trading of the future.

EU should add afforestation to its climate policy

Only the private sector has sufficient financial resources for rapid large-scale global afforestation. However, companies are currently lacking the business case to engage with and invest in biogenic carbon sequestration. EU's current climate policy does not allow to use carbon sinks as a tool in the Emission Trade nor in Effort Sharing sectors, such as transport for example, although negative emissions are described as imperative in the global climate work. In addition to all current climate mitigation methods and tools, measurable, auditable and transparent carbon sequestering through afforestation needs to be added to the means of combating climate change as soon as possible. Carbon sinks has to be seen as an incremental tool, not as substitutive one. We must harness the financial strength of the companies in creating carbon sinks through enabling companies to fulfill part of their greenhouse gas reduction or renewable energy targets with carbon sequestration. If we don't do it, the mankind will lose the battle of climate. ●

Mika Aho

How to harness carbon sequestering for common global use

- A market place for the atmospheric carbon cycle must be created (CO_2 Exchange). Companies emitting and capturing carbon would trade CO_2 in the market place, thus create a market price for CO_2.
- The amount of sequestrated CO_2 must be reliably measured according to the standardized methods.
  a. For the emitted CO_2 there are already international standards and calculation rules in place.
  b. An international standardized, by the scientific world accepted, measurement concept for the sequestrated CO_2 is needed.
  c. A pilot is needed, where the feasibility and reliability of the measurement concept can be demonstrated and proved.

Link to press release by Helsinki University

Watch a video about Carbon Farming

For further information please contact:

Mika Aho
Director, Public Affairs
St1 Nordic Oy
+358 50 500 2072
mika.aho@st1.fi
www.st1.eu

Social innovation in energy, implications for Smart Specialisation

By Javier Gómez Prieto (pictured)*, Scientific Officer Smart Specialisation, Joint Research Centre, European Commission

As part of the EU Cohesion Policy, Smart Specialisation is a place-based approach useful to identify the innovation potential of EU regions and stimulate their competitive advantage. The application of Smart Specialisation takes place through a policy process which allows the design and implementation of the regional innovation strategies (also known as RIS3)[1]. This process is carried out by following key principles such as: (i) selection of strategic priorities for investment, (ii) inclusive participative process with the participation of local authorities, academia, business spheres and civil society organisations and (iii) embrace a broad view of innovation, including social innovation.

Social Innovation, generally understood as new solutions that simultaneously meet social needs, can contribute to a better use of assets and resources, therefore playing a key role in Smart Specialisation dynamics. In this spirit, the study: "Smart Specialisation and social innovation: from policy relations to opportunities and challenges" has been elaborated aiming at analysing current tendencies of social innovation and their relation with Smart Specialisation.

The study focuses on social innovation tendencies in the domain of energy as two thirds of Member States and regions have designed a Smart Specialisation Strategy including energy-related priorities.

Key findings

Based on the analysis of six cases in different Member States and interviews with experts, a categorisation of social innovation trends has been carried out. These categories address the following elements:

(1) Organisational element, referring to how social innovation in energy is structured. This category is related to consumer/producer associations and cooperatives for renewable energies. Countries in Western Europe have dominated the trend, including Belgium, Germany, and Denmark. A significant share of these cooperatives are organised in well-structured networks that bring together citizens towards joint ownership and participation in renewable energy or energy efficiency projects.

(2) Social element, referring to measures addressing energy justice and energy poverty. Energy poverty is affecting people and to date several million households in the European Union are struggling to secure adequate heating, pay their utility bills on time and live in homes not plagued by humidity and mould. This situation can be more or less accentuated depending on geographical location or social status, resulting in different levels of access to options in energy provision services and state-of-the-art technology.

(3) Funding element, referring to innovative financing schemes for energy involving citizen investment. This category can further differentiate into sub-categories such as: (a) shareholding participation in energy cooperatives; (b) crowdfunding initiatives, notably in the sectors of renewable energy and energy efficiency; (c) citizens financing renewable power stations; (d) allocation of public resources via vouchers or grants and (e) donations, i.e. citizens voluntarily providing financial support to an energy action without expecting any return.

(4) Educational element, referring to raising awareness and contributing to increasing the acceptance of renewable energy and energy efficiency measures and projects. This mode of social innovation can explore synergies with cultural and entertainment activities addressing general messages such as the fight

Summary of case studies analysed

Innovation/ Region	Western EU	Central EU	Eastern EU	Southern EU	Norhrtn EU
Innovation Leaders	Crowdfunding (Germany)				Business (Finland)
Strong Innovators	REScoop (Belgium)				
Moderate Innovators		Energy coop. (Croatia)	Energy poverty (Hungary)	Strategy and citizen engagement (Spain)	

against climate change and the protection of the environment.

(5) Business element, referring to involving citizens and their know-how in energy business. Such measures are at an early stage of development. They can be implemented via various citizen engagement methods, which bring company representatives in direct contact with citizens.

Policy implications for Smart Specialisation process

Combining citizens' engagement with innovation in firms within a co-creation approach can be achieved by including social innovation as a key element of smart specialisation. Input from citizens can be generated and matched with business requirements in the frame of Entrepreneurial Discovery Processes. This socially innovative approach may allow for example local energy business to integrate citizens' requirements into their energy innovations.

Bottom-up innovative citizens' initiatives have great potential for advancing towards energy transition. Regulatory barriers must be overcome at various governance levels in order to allow these cooperatives and social innovation initiatives to flourish and contribute to identifying competitive advantages.

Cooperatives and associations addressing energy action help to pre-identify smart specialisation priorities. With their focus on citizens' involvement, they ensure the contribution from civil society which is normally underrepresented in comparison to other actors of the quadruple helix (e.g. academia, public and private sector).

Finally, regional strategic thinking and strategy development can underpin and lead to a multitude of socially innovative actions. Many smart specialisation strategies in EU highlight renewable energy and energy efficiency as focus areas of specialisation. These choices need to be accompanied by implementing complementary actions operative at regional and municipal levels.

1 RIS3 stands for Regional Innovation Strategies for Smart Specialisation

More about the S3Platform

The Joint Research Centre of the European Commission, through the Smart Specialisation Platform provides support to EU regions and Member States in the design and implementation of their research and innovation strategies for Smart Specialisation. Some of the services provided by the S3Platform include: guidance and methodological material, identification and sharing of good practices; research analysis, information to the whole policy-making process; peer-reviews and mutual learning; access to relevant data and information sessions for policy-makers and stakeholders. One of the central activities of the S3Platform is to facilitate inter-regional cooperation among regions with similar or complementary smart specialisation priorities. S3Platform website

For further information please contact:

Javier Gómez Prieto
@Jagopri
Scientific Officer Smart Specialisation
Joint Research Centre, European Commission

* The views expressed are purely those of the author and may not in any circumstances be regarded as stating an official position of the European Commission

Q-Air
Innovative Six-Layer Glass Facade System

It is a rare thing in the construction sector when something truly innovative comes along, but the development of Q-Air marks the arrival of a real game-changer and something that sets the standard for energy efficiency and helps move the industry closer to a cost-effective and human-friendly, nearly zero-energy building.

Glass facade for sustainable architecture and living – Horizon 2020

Q-Air represents one of the leading European innovations, which is underlined by being selected and supported by Horizon 2020 programme, a Fast Track to Innovation Pilot scheme. The Q-Air project is being implemented by five international consortium partners Trimo d.o.o. and ZAG – Slovenian national building and civil engineering institute from Slovenia, Kohlbecker Gesamtplan from Germany, Cantori s.r.l. from Italy and Skandinaviska Glassystem from Sweden.

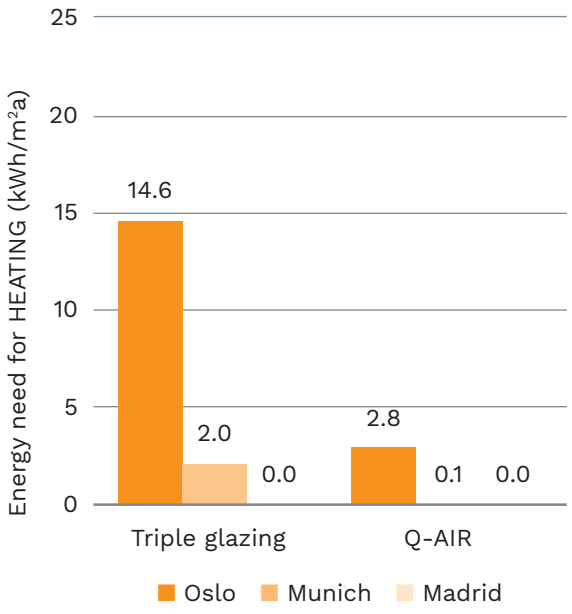
Perfect solution for nZEB, no need for external sun shades

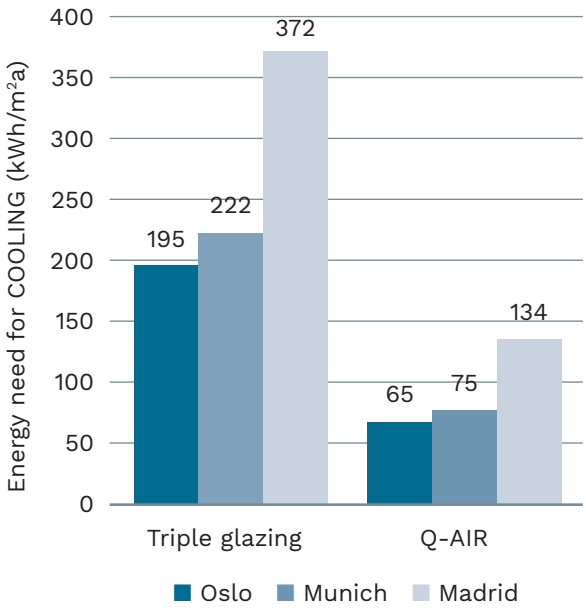
Q-Air is a unique, multi-chamber insulating glass facade system, requiring no exterior sun shadings. Up to six layers of glass create an innovative insulating core, which is available in transparent, translucent and opaque options to allow Q-Air to deliver unparalleled energy savings. Q-Air is a perfect solution for nearly zero-energy buildings (nZEB) delivering outstanding thermal insulation of complete curtain wall system. Specifically, the fully transparent glazed façade offers an extreme level of thermal insulation, where thermal transmittance is only Ucw ≥ 0,30 W/m²K.

Constant indoor temperature - no cold draught, no excessive solar heat gain

Q-Air provides constant interior thermal comfort by keeping the temperature at a stable level at all times, personal well-being and productivity of occupants are improved. Using Q-Air, seasonal climate peaks for highly glazed buildings are perfectly managed:

- Winter: Due to high thermal insulation level (low U value),





Comparison of energy need for heating (left) and cooling (right) for office building with façade with 100% of transparent surface with view to the outside both day and night (without shading)

energy loss in winter is low and low solar heat gain (low g value) is sufficient. That's why less energy for heating is consumed.

- Summer: Due to low solar heat gain (low g value), no excessive solar heat gain appears and less energy for air conditioning is consumed.

Maximised natural daylight

Q-Air maximises natural daylight and helps create a visually stimulating and productive environment for building occupants. Due to superior thermal insulation level, low solar heat gain and world class engineered system using no external sun shades, Q-Air enables large areas of the facade to be transparent therefore allowing the building interior to be naturally illuminated during the day and views to the outside both day and night.

Energy use for heating lower than 5 kWh/m²a

As a result of the research work in the field of multiparametric analysis of daylight and thermal performance within the Q-Air H2020 project an office building model was created and calculated in BIM environment. The results are very promising for the current and future built and environment and were presented by ZAG and Trimo at Advanced Building Skins conference in Bern. In case of using Q-Air glass façade system (six-layers of glass) instead of conventional triple glazing (three layers of glass), the reduction of energy need for heating is in the range of 81% to 98% (based on calculations for three locations – Oslo, Munich, Madrid). More accurate, energy need for heating is up to 2,8 kWh/m²a in Oslo and up to 0,1 kWh/m²a in Munich. Also, energy need for cooling is lower.

Case Study: Office building refurbishment in Oslo, Norway

The installation of the Q-Air glass façade on a multi-storey building Wergelandsveien 7 listed as a protected monument in the centre of Oslo in Norway is an important accomplishment.

- The installed Q-Air glass elements have Ug value of 0.24 W/m²K, while the system has a Ucw value of 0.36 W/m²K and sound reduction of 45 decibels (Rw).

- The occupants of the building are very pleased with the interior comfort. A person can stand by the glass wall in the restaurant on the ground floor with an outside temperature of minus 15 degrees Celsius without feeling any cold draught at the glazing. Furthermore, in summer, the low solar gain coefficient (g) of 0.25 prevents the overheating of the inside of the building.

- The refurbishment resulted in significant annual energy savings. During the renovation, the building was fully in operation and the architecture of the building dating back to 1960's is completely preserved.

A new generation of glass facades

The Q-Air innovative glass façade really is a next generation building product and one that looks set to define how sustainable glazed buildings can be constructed now and in the future.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 737757.

For further information please contact:

q-air@trimo-group.com
www.trimo-group.com
www.zag.si/en

Indoor Environmental Quality: towards healthier buildings for the occupants

By Roberta D'Angiolella (Buildings Performance Institute Europe, BPIE)

We spend most of our life in buildings: homes, schools, offices, bars and more, amounting to 90% of our time being indoors, impacting our health, productivity and well-being. If this number is coupled with the fact that air quality is one of the major environmental health concerns for Europe and the high number of deaths caused by indoor air pollution in particular, it is easy to conclude that the way we feel while being indoor is of paramount importance.

THE ELEMENTS OF INDOOR ENVIRONMENTAL QUALITY

But what is considered when evaluating our comfort and well-being indoor? The answer is Indoor Environmental Quality (IEQ), consisting of four key elements:

- Indoor air quality, referring to the quality of the air inside buildings and related to people's health, comfort and ability to work.
- Thermal comfort, strongly linked to environmental factors such as air temperature and humidity as well as to personal factors (clothing insulation, metabolic heat). When building occupants feel too warm, it can cause a feeling of tiredness, when they feel too cold, they can be restless and distracted, resulting in productivity losses and discomfort.
- Lighting combined with daylight, necessary to perform various visual activities efficiently and accurately, and with a significant positive impact on the overall health and sleep quality of office workers.
- Acoustic comfort, the capacity to protect building occupants from 'unwanted sound' which can prevent speech communication, disturb activities and concentration, and at high levels even cause hearing damage.

These elements play a key role in in our everyday lives: buildings should therefore be designed to ensure a good IEQ if they are to be at the service of their occupants.

THE ROLE OF BUILDING OCCUPANTS IN IEQ

Many times, however, people complain about high-performing buildings where everything is supposed to work well in an automatic way, without possibility for the building occupant to intervene, and in reality, it does not. This is where, to build future-proof and well-functioning buildings, subjective evaluations become as important as calculations and measurements. As happiness and health are directly proportionated to the level of comfort offered by the buildings we live / work / study in, building occupants' surveys on the acceptance and general perception of IEQ are a crucial

"We spend most of our life in buildings: homes, schools, offices, bars and more, amounting to 90% of our time being indoors, impacting our health, productivity and well-being."

As happiness and health are directly proportionated to the level of comfort offered by the buildings we live / work / study in, building occupants' surveys on the acceptance and general perception of IEQ are a crucial qualitative indicator for ensuring the satisfactory operation of a building.

qualitative indicator for ensuring the satisfactory operation of a building. Several initiatives at the EU level are already moving in this direction.

THE EXCEED IEQ TOOL

The EU-funded project ExcEED, for example, will release in January 2019 the Indoor Environmental Quality survey tool[1] as part of its database for measured and qualitative data on beyond the state-of-the-art buildings and districts. The web-based survey

Source: BPIE

Photo by Nastuh Abootalebi on Unsplash

collects primary information coming from the building occupants and consists of an Indoor Environmental Quality assessment, in which users are asked to evaluate all elements of IEQ, and an additional section covering building-related health effects, such as headache, fatigue, nose or throat irritation.

The innovation lies in the combination of the Post-Occupancy Evaluation survey results with data collected onsite from the Building Management System (BMS). This information will benefit a range of stakeholders, from the design of the buildings of the future to the drafting of upcoming policies, and can also help building managers improve the IEQ for the occupants by focusing on what was graded "badly".

THE COMFORTMETER

The Comfortmeter[2] is instead a measuring instrument offering information on the level of comfort inside the building and can further estimate the impact of the building scores on employee productivity (€/year). Based on scientific research performed by 6 European Universities and Factor4 and supported by the European Commission, the tool focuses on 6 subjects: lighting, acoustics, thermal comfort, office environment, quality of air and individual control.

It documents the performance of the building(s) in respect of the most important technological criterion of success through the eyes (and answers) of the daily users. The Comfortmeter can also determine the potential for comfort improvements. The innovation lies in connecting indoor air quality to benefits and costs for the building owner, a crucial step to boost knowledge and interest to renovate.

IEQ IN THE EU LEGISLATION

Even if the recently revised Energy Performance of Buildings Directive (EPBD 2018/844) includes elements of health, comfort, indoor air quality and indoor climate conditions, it still falls short on how a satisfactory IEQ should be achieved.

IEQ requirements also vary substantially at national level, but, according to the recently launched BPIE report[3], it is where real opportunities lie. National policy frameworks have indeed four

It is important to remember that a good IEQ, consisting of optimized acoustics, lighting, air quality and thermal comfort does not lead to short term effects: it is instead a long term lifestyle change leading to better health and comfort in our buildings – and therefore in our lives.

areas where IEQ could be given the deserved importance.

1. Long-term renovation strategies, where Member States should highlight IEQ, and the significant benefits renovation can bring, both in terms of health and societal gains.

2. Energy Performance Certificates (EPCs) and building renovation passports, including evidence-based IEQ aspects originating from measurements, building occupant questionnaire survey outcomes and/or computer simulations.

3. Smart readiness indicator, capturing and promoting the benefits of smart buildings, that beyond being energy efficient and healthy, should recognise and react to users' and occupants' needs for optimised comfort, indoor air quality, wellbeing and operational requirements.

4. Finally, adequate compliance and quality control mechanisms must be in place to ensure enforcement and implementation of IEQ requirements.

Good IEQ is a cornerstone of ensuring health, comfort, wellbeing and productivity in buildings, but this should take into accounts the different needs of building occupants (energy savings, comfortable temperature, sufficient daylight and good indoor air quality) and find a balance between what is measured and what is perceived.

New initiatives at EU level are getting close to the perfect balance but strong action and implementation at EU and Member State levels are still needed. It is important to remember that a good IEQ, consisting of optimized acoustics, lighting, air quality and thermal comfort does not lead to short term effects: it is instead a long term lifestyle change leading to better health and comfort in our buildings – and therefore in our lives. ●

BPIE

[1] http://www.exceedproject.eu/evaluation-tool/
[2] http://comfortmeter.eu/en/home-eng/
[3] BPIE, 2018, The inner value of a building – Linking indoor environmental quality and energy performance in building regulation, http://bpie.eu/publication/the-inner-value-of-a-building-linking-indoor-environmental-quality-and-energy-performance-in-building-regulation/

Contact information

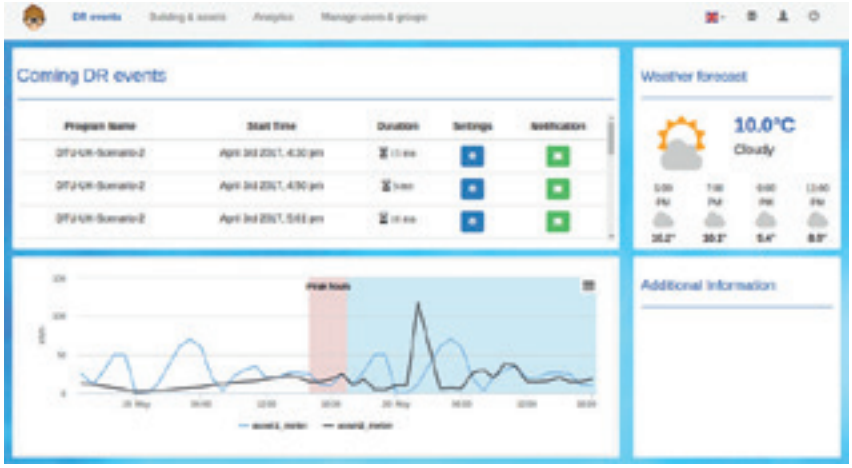
For more information on BPIE's work visit **www.bpie.eu**

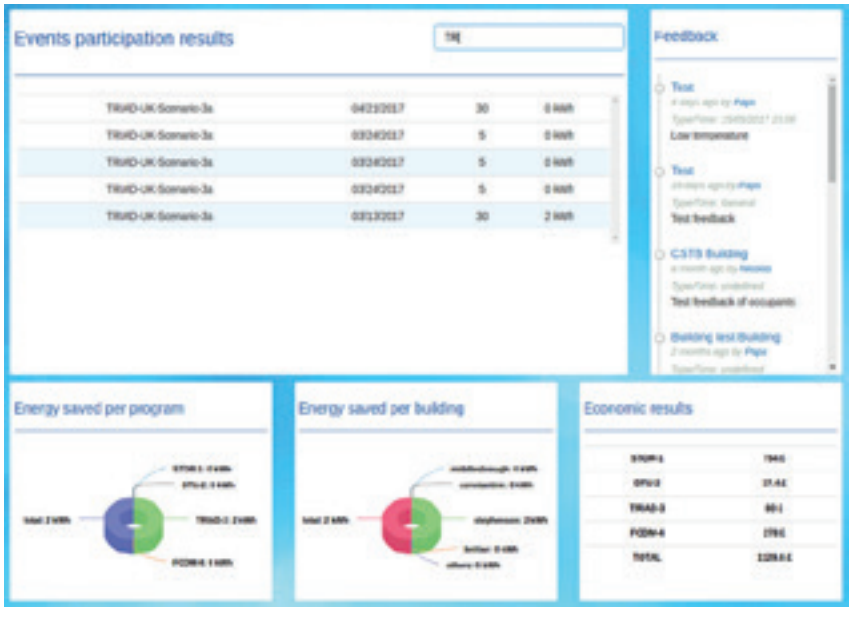
Demand Response in Blocks of Buildings (DR-BOB)

The EU H2020 project DR-BOB has developed a Demand Response (DR) IT solution that integrates ICT tools, developed at Teesside University, with Siemens commercial products and a user interface provided by GridPocket. This IT solution is a scalable cloud-based energy management system applicable to single and multiple blocks of buildings. It provides the ability to maximise revenue from demand response while minimising energy consumption and carbon emissions.

The DR-BOB solution is highly intelligent and adapts to fluctuations in energy demand, tariffs and weather conditions. The DR-BOB team aims for the system to become central to organisations' energy management and environmental strategies.

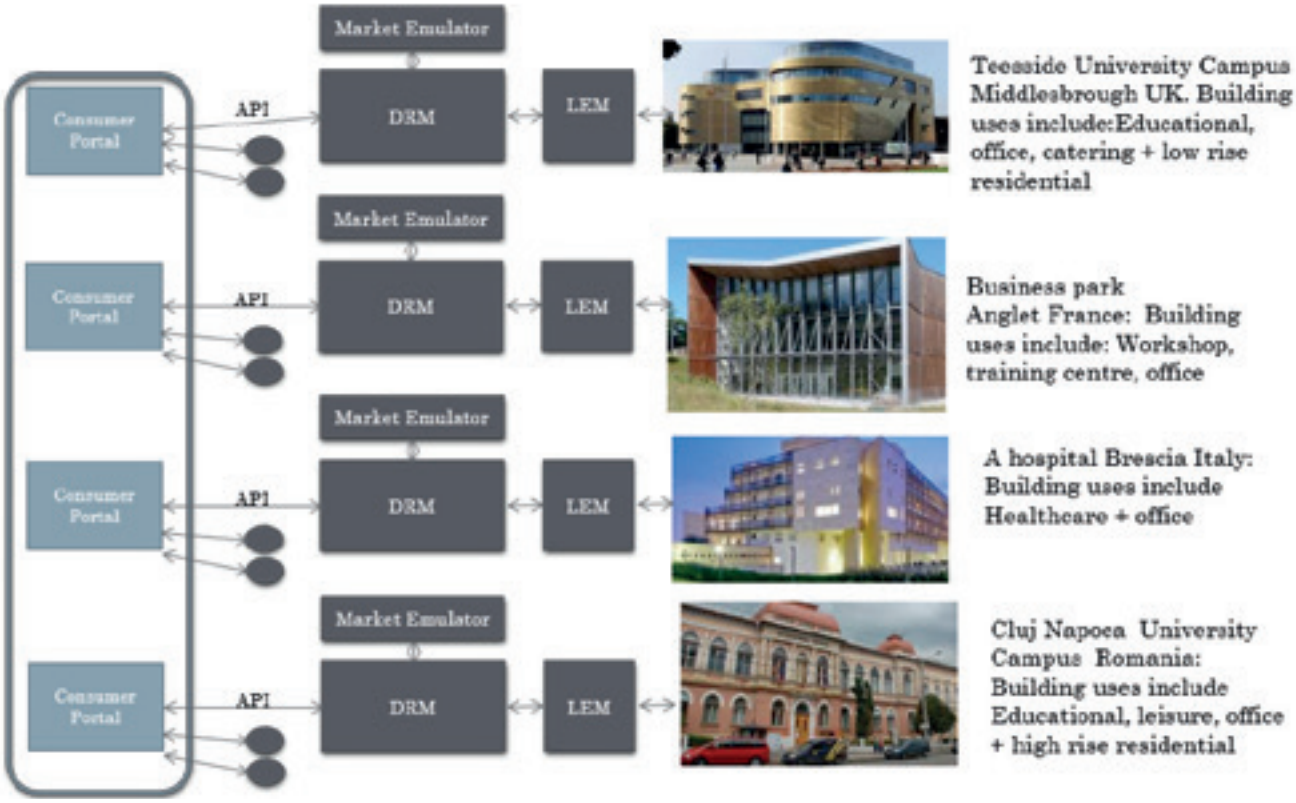
To test the DR-BOB solution Nobatek developed a market emulator, which replicates real market signals. The solution is piloted at four sites, including Teesside University in the UK, the Fondazione Poliambulanza hospital in Italy, the Technical University of Cluj-Napoca in Romania and the Montaury commercial district of Anglet in south west France. The Pilots directly involve 153,650 m2 of building space and 16,625 occupants. Energy use over one year from these four sites alone will reduce by 1.53 GWh – saving enough energy to power 400 homes for one year of average energy demand.

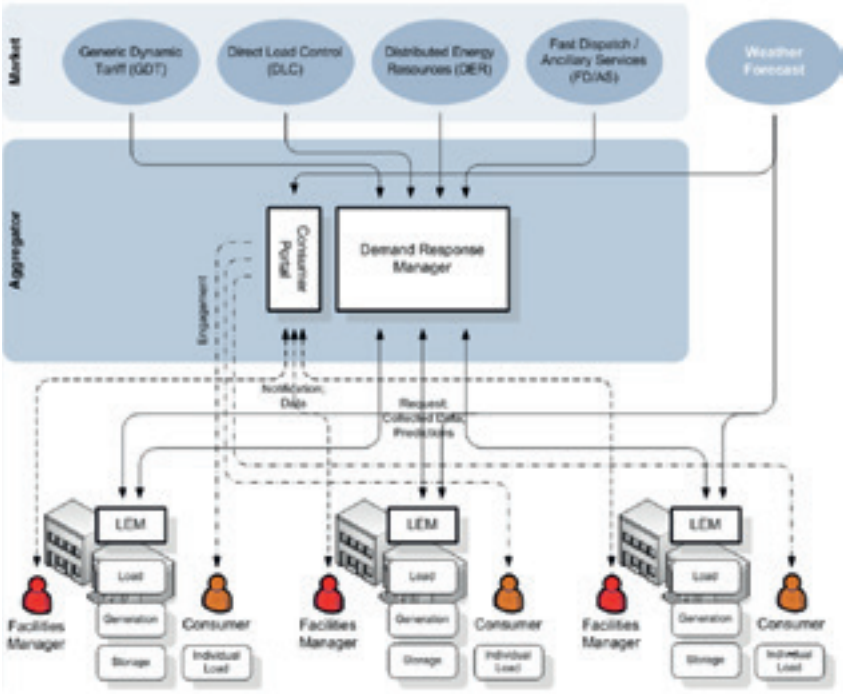




To monitor the impact of the solution at the pilot sites the project has developed a method of providing a dynamic and versatile baseline for demand response, with a low run time. The baseline method is also adaptable to different levels of granularity and asset integration and provides a DR-baseline that meets European standards.

The project also developed 'Demand Response Technology Readiness levels' DR-TRLs, which participating institutions can use to assess their technology readiness to participate in energy management solutions for blocks of buildings. If the framework shows they are not ready, it gives





institutions information on how to improve. The concept of DRTRLs may be expanded to offer a useful, common way to measure the maturity of buildings' energy systems for DR. This is particularly interesting in the light of the recent European Commission's Directive (2018/844/EU) amending the Energy Performance of Buildings Directive and introducing the "smart readiness indicator".

DR-BOB brings together 10 organisations from around Europe, working in 4 different domains: energy, construction, ICT, and public bodies.

Further information:

Twitter: @drbob_eu
Web: www.dr-bob.eu
Email: contact@dr-bob.eu

The DR BoB project is co-funded by the EU's Horizon 2020 framework programme for research and innovation under grant agreement No 696114.

Environmental Product Declarations (EPDs)

A Success Story: Will This Currently Voluntary Construction Industry Standard for Environmental Impact Product Disclosures Become a Legal Requirement?

By Frank Grootens, Institut Bauen und Umwelt e.V. (IBU), Berlin

It is generally acknowledged that the construction sector plays an especially important role when it comes to the advancement of sustainable construction. The European Construction Products Regulation (CPR) issued on 9 March 2011 marked the first time that European institutions designated building resource efficiency as one of the seven current Basic Requirements for Construction Works. In addition to the "sustainable use of natural resources", as the new Basic Requirement No. 7 is titled, the requirements for environmental protection (Basic Requirement No. 3) have been expanded from those of the since-repealed Construction Products Directive (CPD). For example, buildings now are also required to be designed and constructed in such a way that their impact on the climate is mitigated over the course of their entire life cycle.

The Basic Requirements for Construction Works can also have an indirect effect on product requirements. This means that essential product characteristics with respect to the Basic Requirements for Construction Works need to be defined and stipulated in harmonised technical specifications. These could either be harmonised European standards or European Assessment Documents (EADs). The product manufacturer is required to declare data on all of the product's essential characteristics in the Declaration of Performance (DoP). This declaration, in turn, forms the basis for CE marking.

The new Basic Requirement 7 and the extended Basic Requirement 3 have not yet, however, resulted in the inclusion of concrete product requirements in any of the total of ?x? harmonised construction product standards. Normally, this would take place in response to one or more standardisation mandates the European Commission would request from the CEN.

Nevertheless, in the recitals, which are not legally binding, the Construction Products Regulation recommends that evaluation of the sustainable use of resources and assessment of the environmental impact of buildings be based upon Environmental Product Declarations (EPDs) (recital 56). EPDs represent a standardised instrument for providing product-related environmental data. The information they contain is based upon a life cycle assessment and in recent years, EPDs have

established themselves in Germany and throughout Europe as a voluntary construction industry standard. In Europe, the basis for EPDs is the European standard EN 15804:2012+A1:2014, which, as a horizontal standard, provides basic product category rules that EPDs must follow for construction products and all types of construction-related services. According to this standard, a total of 25 different environmental indicators must be declared in an EPD: potential environmental impact, energy and material resource use, output flows, and waste categories. At a minimum, these must take into account the production phase ("cradle to gate"). However, as declaration holder, the manufacturer has the option of including further life cycle phases, such as the use phase or the disposal phase ("end-of-life"). Before an EPD can be published in a dedicated program, it must first be evaluated by an independent verifier.

At the request of the European Commission, EN 15804 is currently being revised. Among other changes, declarations will now have to take into account the entire life cycle. In addition, EPDs will require a number of new life-cycle-assessment indicators. Publication of this revised standard is not expected until 2019, at the earliest.

It can be assumed that, on the basis of the revised standard and with the aim of transferring the environmental performance indicators defined in EN 15804 as essential characteristics into harmonised product standards, the Commission will issue one or more mandates to the CEN. The individual CEN-TCs (Technical Committees) would then need to develop uniform reference scenarios for the various product groups, e.g. for use or end-of-life phases. Because the EN 15804 is a horizontal standard for construction products and all types of construction-related services, it cannot provide this itself, but can only provide a standardised framework of conditions for defining the scenarios. However, to enable comparisons of the environmental indicators contained in the EPDs, the use of standardised scenarios is critical. In addition, manufacturers, as distributors, have no influence over – and cannot be held liable for – what is done with their products once they leave the factory.

The politically-driven future focus on the entire product life cycle also leads to an issue that is a legal formality. A key additional question here will be how to maintain the high quality of EPDs, which currently is ensured through independent verification and publication in an EPD programme, if, in the future, environmental performance indicators will be required to be stated directly in the declaration of performance. This would require the establishment of a AVCP system 3 (AVCP: assessment and verification of constancy performance) that would conform to CPR regulations. The recourse to a higher

Frank Grootens

system for the assessment and verification of constancy performance (system 3 or higher) has until now, however, been required only when the safety of workers and/or occupants was directly affected.

Should the key figures and regulations set forth in EN 15804 be converted into harmonised product standards, thus becoming a component of the declaration of performance, "ECO Platform", as the umbrella organisation for the various national EPD programme operators in Europe, advocates the use of a System 3 assessment and verification of constancy of performance. To ensure a consistently high level of quality, a requirement should be established that EPD programme operators continue to participate in the verification process. Whether this will make accreditation and/or notification of the EPD programme owner necessary is a topic for further discussion.

With regard to the legal formality issue mentioned above, one possible alternative to the direct inclusion of individual environmental indicators in the declaration of performance could be to include a simple reference to an EPD in the declaration. This approach would, in any case, likely come closest to fulfilling the original intention of recital 56. ●

For further information please contact:

Frank Grootens
Institut Bauen und Umwelt e.V.
Email: grootens@ibu-epd.com
Web: www.ibu-epd.com

Realising the clean energy revolution in the existing building stock

By Stijn Verbeke, Senior researcher at the EnergyVille/VITO research institute on sustainable energy and intelligent energy systems

The existing building stock plays a pivotal role in transforming our society towards a low-carbon and clean energy future. Not only is around 40% of our energy consumed in buildings, the construction sector is an important energy consumer in itself, and indirectly, the layout of the built environment also greatly affects mobility needs and the related energy consumption.

Figure 1: Urban energy scenario for the city of Roeselare (BE), City-zen Roadshow, 2018
Image credits QUBelfast, Th!nkE, TUDelft, UCLAN, USiena, VITO. City-zen is a project funded under the FP7 program of the European Commission

The European Energy Performance of Buildings Directive (EPBD) has set the legal framework to limit the operational energy demand of buildings. EU member states have implemented regulations on improving the energy performance characteristics, reaching the nationally defined thresholds of 'nearly zero energy buildings' for newly constructed buildings from 2021 onwards. Given the long service life and low replacement rates of buildings, the predominantly poor energy performance of the existing building stock remains a major challenge. The EPBD requires issuing energy performance certificates for buildings being rented or sold and demands individual member states to develop long-term renovation strategies. These provisions focus mainly on informing and motivating consumers, rather than setting strict performance requirements, except for specific major upgrades of buildings.

A crucial accelerator to effectively realize the large untapped energy efficiency potential of the existing building stock is to be found in coordinating building retrofit actions at the scale of districts or cities. Firstly, actions at this higher scale level can unlock economies of scale. Furthermore, upscaled actions can allow for an optimal application of resources and introduce additional technical solutions complementary

to retrofit measures which focus on individual building upgrades:

- At individual building level, unfavorable conditions might limit the uptake of renewable energy measures such as solar PV, solar hot water boilers and ground sourced heat pumps. At larger scales, there will be more opportunities to install these technologies in optimal conditions, e.g. with respect to available and accessible surfaces with a favorable orientation, limited external shading, etc.

- Some renewable energy technologies such as wind turbines or combined heat and power plants are strongly affected by economies of scale, and are seldomly viable at the level of an individual building.

- District heating and cooling networks can be an alternative to individual fossil-based heat or cold generators. These networks allow to connect multiple heat or cold generators to ensure an optimal production mix. Fourth generation district heating and cooling networks are designed to work at low temperature gradients, increasing their efficiency and enabling the utilisation of renewable energy and residual heat and cold sources from industry, datacenters, etc.

- In a future energy system with intermittent generation from distributed renewable energy sources, storage will be an important factor to help balance the demand and generation profiles. For many types of dedicated thermal, electrical or thermo-chemical storage equipment, implementation at district level can be more promising due to scale effects. As demonstrated in various case studies, seasonal thermal storage can even become a viable technology to cover space heating and domestic hot water demands.

- Some technologies, e.g. deep geothermal energy, are only applicable at a very large scale. Geothermal installations are well known in geographic regions where high temperatures are readily available at the earth's surface, such as in Iceland and in northern Italy. In a pilot project in Belgium, VITO is successfully demonstrating that geothermal energy can also be a viable technology in many other places. From the 3.5 kilometres deep boreholes of this plant, heat is extracted at 125°C, which enables the conversion into electricity via an Organic Rankine Cycle (ORC). The excess heat will be further distributed to buildings, greenhouses and industries through a district heating grid.

Given the large range of available technologies and the broad diversity of existing districts, we need a novel approach to urban energy system planning. An optimal future urban energy system will require an apt combination of energy efficiency measures, energy generation and the capacity to balance energy flows, e.g. through storage or flexible control of energy demands. By combining various energy sources and energy vectors and by aggregating demands at larger scale levels, peaks can be smoothened out and the system can be operated more efficiently than on individual building level.

Three important aspects need to be covered to have an effective urban energy planning:

Firstly, urban energy planning requires a spatial analysis to adapt to local needs and conditions: space constraints, locally available excess heat from industry or biomass, the state of the building stock, local demand profiles, etc. An in-depth spatial analysis of the assets and potentials of the urban areas can


Stijn Verbeke

for example define areas for which the preferential choice is a rollout of district heating and cooling networks, whereas in other areas all-electric solutions can be preferable. This can affect the desired retrofit levels for the buildings in the district. Another outcome of such analysis would better be that specific buildings are rather to be replaced by new constructions than retrofitted, even when we take into account the environmental impact of building materials.

Secondly, the temporal aspect of the energy system design is critically important. This incorporates fluctuations of demand and supply to define an optimal mix of energy generation and storage assets. But equally essential is the longer time horizon when upgrading an existing urban area. Building retrofits are executed gradually over a period of many years, installing a district heating network can be jointly executed with major roadworks, residual heat sources might become unavailable over time, etc. District

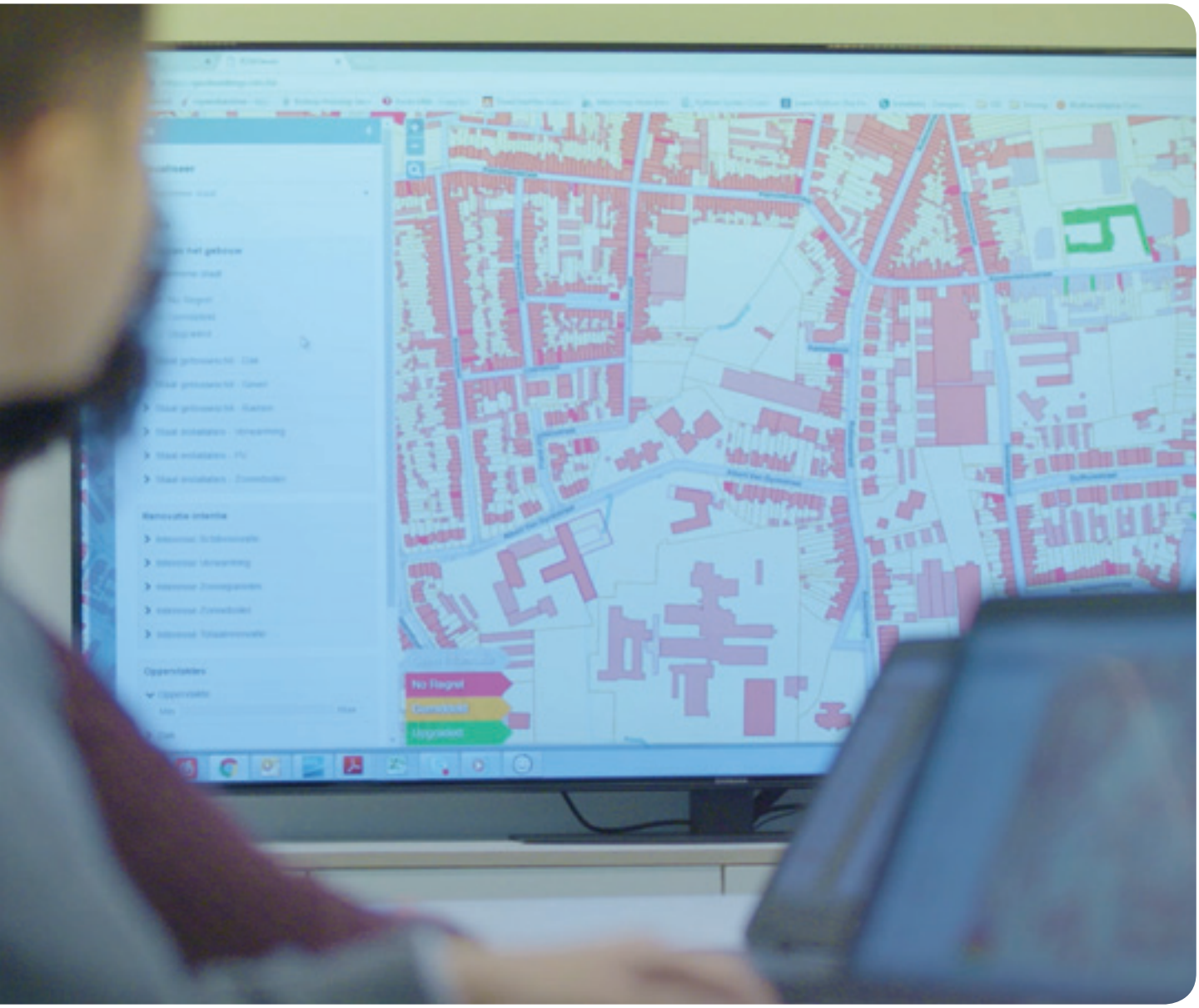


Figure 2: Assessing building stock performance with the EnergyVille/VITO CityPortal cloud service

energy planning needs to consider all these timescales for a robust plan.

And finally, urban energy transitions require a broad coalition of many stakeholders including individual building owners and occupants, policy makers, urban planners and industrial actors. All have an important role to play. It is thus imperative that all stakeholders are engaged throughout the planning and execution process, and that the actions which are expected to be taken by the stakeholders fit their interests.

In conclusion, realizing an energy transition in the building stock requires a combination of energy efficiency measures, a diversity of energy generation assets and the capacity to balance energy flows. This can be achieved more effectively on aggregated district or city level. Realizing sound urban energy plans requires detailed insights into the spatial configuration of energy demand and supply, knowledge on their evolutions over time, and collaboration of all relevant local stakeholders.

For further information please contact:

Stijn Verbeke
Senior Researcher – Building and District Energy Assessment
Unit Smart Energy and Built Environment EnergyVille – VITO NV

Office: EnergyVille I, Thor Park 8310, BE-3600 Genk Belgium

Tel. +32 14 33 59 61
Email: stijn.verbeke@energyville.be

RE⁴ PROJECT: REuse and REcycling of CDW materials and structures in energy efficient pREfabricated elements for building REfurbishment and construction

Thirteen partners from nine European countries and one non-EU country (Taiwan) joined together to develop a prefabricated energy-efficient building concept that can be easily assembled and disassembled for future reuse, containing up to 65% in weight of recycled materials from CDW.

HOW IT WORKS

RE⁴ Project is built upon four main pillars. The first two are technical pillars and focus on the maximization of CDW recycling and reuse.

In terms of CDW recycling maximization, RE⁴ has developed advanced CDW sorting technologies to improve the overall quality of CDW-derived products, as one of the main constraints for a large use of these materials is the quality not good enough when compared to virgin materials. At this aim, the CDW recycling potential has been verified with the development of RE⁴ materials (normal-weight concretes, lightweight concretes and earthen building materials) and prefabricated elements incorporating high ratios of CDW-derived materials. RE⁴ aims at improving the state of the art recycling rate of CDW from 80% to 95% and to increase the degree of resource efficiency in terms of virgin material replacement of at least 65%.

When it comes to reuse, RE⁴ has developed new sustainable strategies for the disassembly and reuse of concrete and timber structures and building components at the end of their service life. Moreover, RE⁴ is developing innovative design concepts for a fully prefabricated, easy dismountable RE⁴ building, with up to 90% of reusable structures. The concepts will be designed in such way that multiple applications for different building typologies, climatic and structural requirements will be easy implemented.

Examples of the RE⁴ components: 01 – Concrete building blocks made of CDW mineral aggregate; 02 – Insulation panels made of CDW wood fibers; 03 – Reconstituted roof tiles made of CDW bricks and tiles

However, just technical improvements are not sufficient to push the EU to the forefront in the area of the CDW management, because other non-technical barriers have to be tackled as well. The first one is related to the overall management of the CDW value chain. By tackling the CDW management at different levels (e.g. before, during and after the sorting phase) RE⁴ aims at contributing to reach the target of recovery/recycling CDW by 2020. The second one is related to the end-user awareness of CDW reuse and recycling potential and its acceptance. It is well known that people are sceptical of products and materials from waste, for this reason, RE⁴ proposes technical and non-technical activities in order to increase end-user acceptance of secondary raw materials as valid alternative to virgin materials.

DEMONSTRATION

Previously mentioned RE⁴ technology will be demonstrated in two specifically constructed mock-ups – one residential and second non-residential. In order to show that the technology is fitting for various climatic regions, two countries with different climates were chosen to serve as demo-site locations. These are Spain and the United Kingdom.

To demonstrate that the RE⁴ solutions are not only suitable for new construction, but also for refurbishment, a building in Italy will be retrofitted with technology developed under RE⁴. As the project aims to enable disassembly and re-use of materials from dismantles building, a building in the ACCIONA demo park will be selected and used for this purpose. Demonstration of the high replication potential of the developed solutions outside EU will be achieved through the construction of an additional demo building in Taiwan.

Contact information

Project ID: 723583
Website: www.re4.eu
Start date: September 2016
Duration: 42 months
Project coordinator:
Alessandro Largo
Contact email:
alessandro.largo@cetma.it

What consequences for increasing levies on electricity?

By Sébastien Doligé, Senior Advisor Markets & Customers, Eurelectric

More and more consumers struggle to pay their energy bills and to heat or cool their homes. Faced with this reality, European and national authorities must act. Consumers' electricity bills should stop being a vehicle for financing other – sometimes totally unrelated – policies.

Energy efficiency is key for alleviating energy poverty. Therefore, financing tools that leverage private investments should be chosen ahead of regulating prices or taxes and levies reflected through an increase of the energy bills.

As the Clean Energy Package is close to being finalised, rapid transposition by Member States will be key to addressing the energy poverty issue. But this European action is only the first step, since social and tax policies remain the sole responsibility of national governments.

Electricity prices and "energy poverty" have recently made the headlines in several European countries, with suppliers being the main defenders. However, reality shows that policy costs and levies have been the main driver for higher households' electricity prices over the past few years. According to European Commission's figures, they have indeed increased by no less than 71% between 2008 and 2015[1].

As consumers struggle to pay their electricity bills, companies – facing arrears amounting to millions of euros[2] – have to find effective solutions. To assist consumers that have difficulties in managing their electricity usage and bills, suppliers provide energy efficiency advice, payment arrangements, and appropriate debt management processes. Many suppliers have also signed agreements with local authorities and social services to support low income consumers and help avoid supply interruptions due to unpaid bills.

What are the structural solutions to this problem? How can Europe face the challenge of energy poverty?

First of all, it is key to recognise that Member States are best placed to define criteria and policies for alleviating energy poverty. National situations differ greatly in terms of

Figure 1: Evolution of components of average EU household retail electricity bill – Energy prices and costs in Europe, EU Commission, Nov 2016

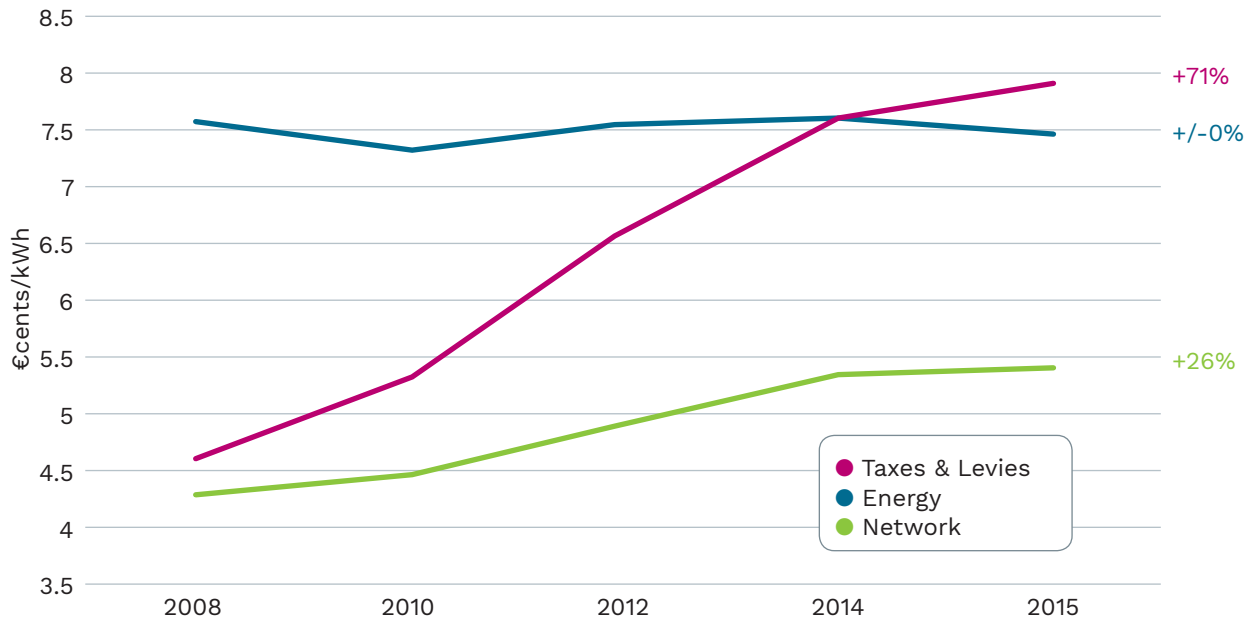
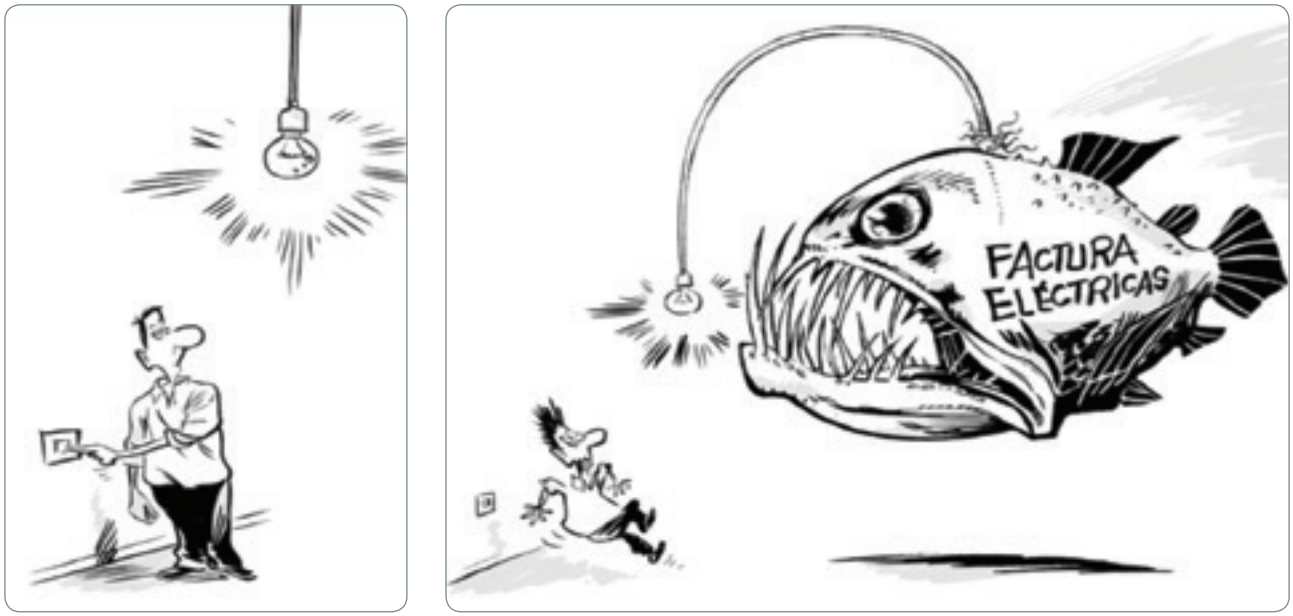


Figure 2: http://www.eemg-mediators.eu/downloads/Paper_on_Energy_Poverty_-_May_2017.pdf



employment, social security systems, climate, electricity consumption, home insulation, energy retail prices and so on. Thus, it is more efficient to tackle the issue locally, in line with the principles of subsidiarity and better regulation.

Second, governments should be aware that increasing taxes and levies on electricity does not combat energy poverty. Consumers' bills should reflect, as much as possible, the market-based cost of electricity and should not finance other policies. Besides, with the progressive decarbonisation of electricity, a higher uptake of electrical solutions should be encouraged, not discourage. One way to do so would be to opt for burden sharing: by spreading the costs of decarbonisation to other energy sources according to their carbon footprint.

Third, the way network charges and levies are charged to consumers is problematic. Even though network costs are largely fixed, they are regularly charged based on consumption. With technological developments, like distributed generation, storage, or electro-mobility, consumers use less electricity from the grid. Thereby they do not contribute to the system through tariff payments. Eventually, those costs will be supported by a smaller consumer base – including by those not willing or not able to invest in such technologies – though an effective increase of their tariff payments. To reverse this trend, regulated costs should be charged in an efficient way, progressively removing cross-subsidisation.

Fourth, energy efficiency is key to alleviate energy poverty. However, it is not sustainable to finance such measures through the bill, as costs are distributed among consumers regardless of their ability to pay. We must transition to using financing tools which leverage private investment such as Energy Performance contracts (EPC), Energy Saving Agreement (ESA) or on-bill repayment.

Last but not least, customers having energy debts are likely to struggle to pay for other essential services too (e.g. housing, food, etc.). Therefore a wider social policy is the best mechanism to tackle the root causes of debt, including energy debts. Considering the progressive nature of taxation, using social policies and State budget would also allow for a fair burden-sharing, as people would pay depending on their income and not consumption.


Sébastien Doligé

[1] More recent data should be available in the 3rd version of the European Commission's energy prices and costs report, expected by the end of the year.

[2] See "Energy Poverty – A Eurelectric position paper", April 2017

The Reslag Workshop "Turning steel waste into value" was successfully held in Spain

CIC energiGUNE, the coordinator of the RESLAG project, hosted the 1st Workshop of the European project at Vitoria-Gasteiz (Spain) on the 14th and 15th of November. More than 60 people attended the Workshop from 11 countries, and 14 technical talks and 10 posters were presented.

The Workshop brought together an interdisciplinary panel to present RESLAG project results and current efforts, challenges and future directions for eco-innovation and circular economy initiatives in the field of waste recovery. It included talks from institutions (EUROSLAG, SPIRE), companies (Optimum Cement, Renotech, Life Cycle Engineering, FEHS, Max Aicher) and research centers and universities (CIC energiGUNE, IK4-Azterlan, DLR, ENEA, VTT, Fraunhofer IWKS, Tecnalia, SINTEF). The next project Workshop will be hosted by the project partner MASEN in Morocco on 2019.

The RESLAG project is aligned with the challenges outlined in the call WASTE-1-2014: Moving towards a circular economy through industrial symbiosis of the European Horizon 2020 programme. The main aim of RESLAG project is to prove that there are industrial sectors able to make an effective use of the 2.9 Mt/y of landfilled steel slag, if properly supported by the right technologies. In making this proof, the RESLAG project is also proving that there are other very important environmental benefits coming from an active use of the slag in industrial processes.

To achieve this ambitious goal, four demonstration pilot systems have been built within the RESLAG project targeting the following industrial applications:

1. High value and critical metal extraction from slag. The recovery of metallic raw materials, such as Cr, Mn and others is one of the European Commission priorities for better exploitation of the available resources.

2. Waste heat recovery. A cost effective heat recovery concept to capture and store the heat content of the exhaust gases from the electric arc furnace in the steelworks is proposed by using the steel slag as heat storage media. .

3. Heat storage systems for the concentrated solar power (CSP) industry. The use of steel slag using molten salts and air as heat transfer fluids is being tested to promote greener and cost-effective storage solutions for the CSP.

4. Production of innovative refractory ceramic compounds. The inclusion of the steel slag as an aggregate in innovative refractory recipes will decrease the overall cost of the produced material without any interference on the required material performance.

All these demonstrations have been led by a well-balanced project consortium conformed by leading industries and also research centers and universities involved in the European material, energetic efficiency and technological scenario

Contact information

Project website links: http://www.reslag.eu/
https://twitter.com/reslag_eu
https://www.linkedin.com/company/reslag
Project video link: http://bit.ly/REslagYoutube
CIC Energigune – Project Coordinator
http://www.cicenergigune.com/

THERMOSS

THERMOSS project "BUILDING AND DISTRICT Thermal Retrofit and Management Solutions"

THERMOSS is an on-going research project which began in September 2016 and is funded by the European Commission Horizon 2020 programme. The project gathers 15 partners from 8 different European countries, coordinated by Exergy.

GOALS OF THE PROJECT

The main goals of the project are to produce an outstanding contribution to the EU-wide deployment of advanced technologies for heating and cooling, enhance the energy efficiency of residential buildings and facilitate their connection to district heating and cooling networks. To do so, THERMOSS is:

- ensuring an efficient match between supply and demand of energy through real-time management of thermal energy
- increasing the efficiency of residential building thermal retrofitting through advanced heating and cooling technologies
- sharpening the construction and energy industry awareness by providing an open access to a heating & cooling technology database to promote the deployment of the most effective solutions
- demonstrating a high potential of replication throughout Europe, allowing a large market introduction of the selected THERMOSS solutions before 2025

THERMOSS SOLUTION

THERMOSS focuses on 6 main technologies, to be installed alone, in combination, or with solar thermal panels. The electric heat pump (1) is the most common THERMOSS technology. It uses an electric motor to extract heat from the outside air and warm the house or hot water for the taps. Heat pumps have higher efficiency than conventional gas boilers, which only use the heat from gas combustion. Due to the lower price of gas compared with electricity, a convenient combination in most European countries is the hybrid version (2). The hybrid heat pump selects electricity or gas according to the COP (coefficient of performance) – an indicator of efficiency that changes with external temperature. Another type of heat pump uses the absorption cycle. The gas absorption heat pump (3), uses gas as its source but generates heat more efficiently than a gas boiler can. The micro CHP unit with solid oxide fuel cell (4) uses gas to produce electricity and heat at the same time, saving the user from purchasing electricity from the grid, whilst also warming the home. These technologies are installed both in individually central heated buildings and district heating networks. For the latter case, the Heat Interface Unit (5) will be also deployed, providing a heat exchanger with higher control capabilities to reduce heat losses. The bi-directional substation (6) is designed for prosumers (producers and consumers of energy), enabling the exchange of heat in two directions. Real time optimisation algorithms and control strategies will also be developed and deployed at the sites concurrently with the hardware.

DEMONSTRATION

THERMOSS technologies were first validated using the district heating & cooling experimental network provided by the CEA-INES laboratory. After the laboratory tests, the THERMOSS technology and associated optimisation will be deployed in representative pilots, showing the potential for replicability. At four different locations (Southampton, Portsmouth, Riga and San Sebastian) we will deploy our technologies to prove that THERMOSS solutions can be effectively applied to most buildings, leading to savings of up to 30% in primary energy consumption!

Contact information

Project ID: 723562
Website: www.thermoss.eu
Start date: September 2016
Duration: 42 months
Contact: Federica Fuligni
Contact email: federicafuligni@exergy-global.com

San Sebastian demo site: 90 m² of solar thermal panels have been deployed. They will work in combination with the existing systems and the new heat pumps, to warm up the district heating ring.

Driving the technology innovation agenda through cooperation

Managing to stay competitive in a changing energy world

Upper Austria is a European leader in the clean energy transition. Greenhouse gas emissions in the buildings sector have been reduced by 43 % in 10 years through a combination of energy efficiency and renewable energy. The regional government has been following a strategic and long-term vision in the face of the changing global energy world. Fostering cooperation among key market actors along the entire value chain has resulted in a strong innovation ecosystem and the growth of a vibrant industry that successfully exports worldwide.

COMPETITIVENESS AND QUALITY OF LIFE THROUGH DECARBONISATION

The progress seen in Upper Austria is mainly attributed to the clear vision pursued by the regional government for over two decades. The ambition is to achieve competitiveness and quality of life through energy decarbonisation. A strong focus is on energy and buildings, but also on developing and maintaining leadership in niche markets of energy and building products. The aim is to create and nurture an innovation ecosystem where this innovation can grow.

INNOVATION ECOSYSTEM IN THE BUILDING SECTOR

Transforming the building sector requires an awareness of its entire value chain. Every step of the process – R&D, manufacturing of technologies, sales, planning and construction, operation and maintenance – involves different actor groups and needs to be addressed. The OÖ Energiesparverband (ESV), the regional energy agency, is a main driver of the innovation process. Key stakeholders include technology companies, research organisations, public bodies and a community of "first movers" (private households, municipalities, businesses). A crucial element is a user-centred approach where energy users are important actors for innovation creation.

MARKET PUSH AND PULL THROUGH REGULATORY AND FINANCIAL MEASURES

In Austria, building legislation and the implementation of the EPBD are regional. In Upper Austria, regional legislation for buildings and heating and cooling systems are strategically used to drive innovation by regularly updating them towards higher efficiency and lower emissions.

Funding programmes that target the various steps of the innovation process are also strong tools. Different programmes support R&D, market introduction of new technologies and their subsequent mass deployment. The region has implemented market introduction programmes for solar batteries, small-scale biomass CHP, large scale PV systems for self-consumption and several other energy efficiency and renewable energy technologies.

Christiane Egger – Deputy Manager OÖ Energiesparverband, Manager of the Cleantech-Cluster Energy

Photo: ©Boris Stroujko/Alamy Stock Photo

THE IMPORTANCE OF "EARLY ADOPTERS"

Early adopters are typically interested and knowledgeable about energy technologies, keen to try new things and willing to suffer certain "growing pains". These are homeowners, business owners, leaders in municipalities or installers that take a conscious decision to try something new. They are valuable in an innovation ecosystem as they help companies test their products and services on the home market. The ESV puts a special focus on making them an integrated part of the innovation process by keeping them updated on new technologies, providing training courses and developing dedicated funding programmes. Energy technology companies can more easily export products and services to the rest of the world if they have a reliable home base where they can test innovation and that offers economic stability.

INNOVATION THROUGH INFORMATION AND NETWORKING

Information is a "glue" that keeps an innovation ecosystem together. This works best if applied as a range of day-to-day activities that reach out to actors in different ways. For the ESV, this takes many forms: 10,000 face-to-face energy advice sessions to homeowners, businesses and municipalities every year supporting them in their investment decision making process; the participation in tradeshows (such as the Energiesparmesse that takes place every year in Wels in parallel with the World Sustainable Energy Days); newsletters, events and the provision of trainings that are usually focused on new technologies and funding programmes. The ESV supports more than 140 energy technology companies in the context of the Cleantech-Cluster Energy.

The long term efforts invested in fostering the innovation ecosystem in the building sector have paid off. In addition to enabling a significant reduction in greenhouse gas emissions, they have ensured a strong market of competitive companies and the development of a range of innovative products and services.

THERE IS NO END TO INNOVATION

Innovation is an ongoing process. Upcoming tasks include managing the opportunities and challenges of digitisation, continuing to look for niche markets and setting a strong focus on the decarbonisation of the manufacturing sector. However, the small Upper Austrian innovation ecosystem is imbedded in the much larger worldwide innovation ecosystem. In order to move towards an energy system that is both sustainable and that helps maintain European competitiveness, the ESV invites you to join the next edition of the international conference World Sustainable Energy Days in Wels/Austria from 27 February – 1 March 2019.

For further information contact:

Christiane Egger, OÖ Energiesparverband
Landstrasse 45, A-4020 Linz
Tel: +43 732 7720 14380
Email: christiane.egger@esv.or.at

Photo: ©OÖ Energiesparverband, AustrianImages.com/Erwin Wodicka

Transforming Energy, transforming society

dynamis – who we are
dynamis is a 'think-do-rethink' tank created by the innogy Foundation for Energy and Society, the Institute for Advanced Sustainability Studies (IASS) and the 100 percent renewable foundation.

dynamis brings together various players from civil society, enterprises and academia to systematically, comprehensively address an important yet frequently overlooked aspect of the discourse surrounding the transition to renewable energy: the social dimensions involved.

Previously, the discourse on a future energy system was all too often reduced to economic, technical and legal aspects. This meant that key societal risks, opportunities and challenges were not sufficiently explored. How can we achieve fair and equitable participation for all in terms of economic involvement, political participation and realizing opportunities which affect quality of life? Answering this question will shape the energy system of the future and determine the transition's popular support. These factors will prove pivotal along the path towards decentralized energy supply as well as in terms of the societal impacts of digitalizing the energy supply.

Renewable Energy for the benefit of society
We believe transitioning to decentralized renewable energy sources will bring substantial societal benefits. It will pave the way for new forms of social engagement which will give people the opportunity to experience social solidarity in a new way and become more involved in political processes. In sum, this will create chances for society to reap the benefits of technical, economic and social innovations. Our goal is to make the development of a renewable energy system a participatory process in which people from all parts of society can get involved.


Photo: ©Johanna Landscheidt

Art as a transformer

A worldwide movement of climate changemakers has emerged to engage citizens in artistic action because media art in the urban space acts as a space-time compressor. Urgent issues of climate change raise awareness and catalyse common solutions which are embedded in the citizens' everyday analogue and digital communication practises.

dynamis is aware about the impact and outreach of artistic urban projects and presented the Public Face II (2017) and the Fake Star (2018) to raise awareness for its project Energieavantgarde Anhalt and to communicate with the citizens of Dessau and the region of Bitterfeld-Anhalt in Germany about the urgent issues of the energy transition.

Public Art Lab Berlin was commissioned to curate and produce these urban interventions in collaboration with the artists' collective of Julius von Bismarck, Benjamin Maus and Richard Wilhelmer: The Fake Star generated its own energy and the Public Face II enabled the visualization of data related to the energy consumption and production of renewable energy sources. Both light installations were temporarily set up in the public space and made use of two different artistic approaches:


Photo: ©Matthias Ruttke

Public Face II was presented as an energy barometer for the city of Dessau and the region of Bitterfeld-Anhalt. The artists developed an algorithm for this installation, that measured the balance of energy consumption and energy generation from both renewable and conventional resources in the area. The more the region consumed energy from alternative sources, the bigger the smile on the Public Face. When Dessau electricity networks were fed by fossil fuels, the Public Face looks sad. The dates were provided by energy and meteo GmbH.

The **Fake Star** was the second urban intervention. Conceived as a flying windmill in the sky, the Fake Star generated its own energy to feed an LED lamp and looked in the dark like a real star. The work could be interpreted like an artistic comment to mankind depending on the power of nature and its volatility. Furthermore the flying 'starpower station' operated from renewable energy explored in a poetic way the effects of the 'post-fact' period and our collective perception of truth. In the time of digital media, facts and credibility are measured based on each individual's social reality and influences as well as on what the majority agrees.

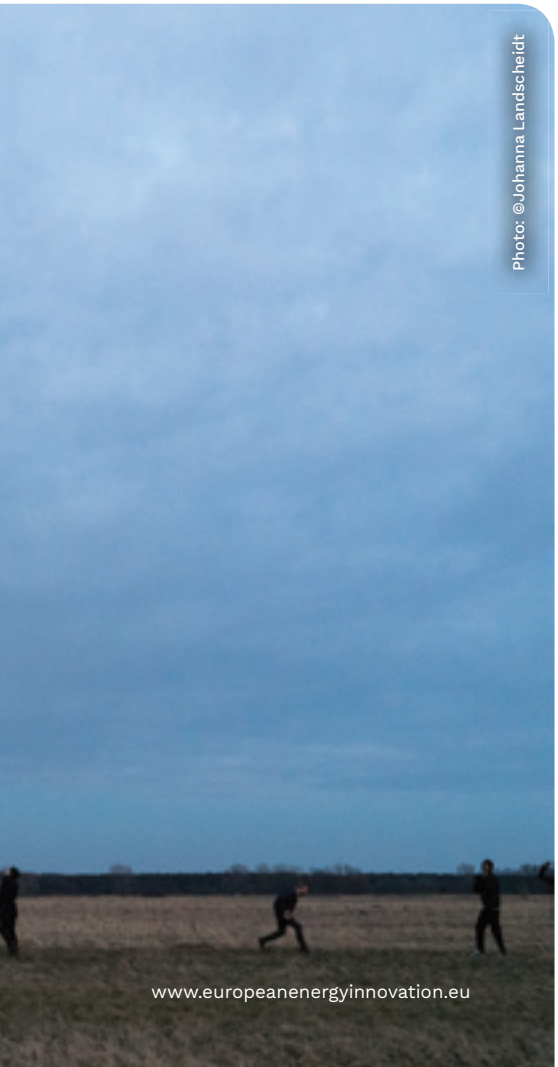


Photo: ©Johanna Landscheidt

For further information visit:

dynamis-online.de
energieavantgarde.de
publicartlab.org
futurediversities.eu
co-funded by Creative Europe

Heating just got cool

By Federica Sabbati, Secretary General, European Heating Industry

Few would consider the heating sector as cool.

For a long time, in Brussels, "heating" has been a technical, not a political issue. Partly, it is because it is way too complex to regulate: fragmented, different from country to country, climate zone to climate zone, building to building. A regulatory nightmare.

What's more, nobody even knows what heating system they have at home – and they will not know until it breaks down next Christmas Eve.

This is probably why discussions on heating and buildings have been left to a few dedicated engineers on either side of the regulatory line: a few engineers-turned-Commission officials, and many more engineer-engineers. That is, until Paris happened. Paris forced policymakers to get creative and find new potential solutions.

Luckily, it turns out that buildings have a huge untapped potential in terms of energy saving. Ali Baba's cave of energy saving, in fact.

Space heating and hot water production account for 85% of the energy consumption in a house. European buildings have mostly been built before the 1960s – before energy performance codes existed – while heating systems installed are on average class D or E on the energy label (if they had one, but that's another story). District heating does not fare better: according to the European Commission's Strategy for Heating and Cooling, close to 75% run on fossil fuels (mainly gas and coal) and are old and inefficient networks.

New-builds perform very well but at a rate of 1% per year, they are too slow to make us reach our 2030 climate goals in time, let alone the 2050 ones.

Can we look at this as an interesting opportunity, instead of a discouraging challenge? I think so, provided that we resist the temptation to try and find ONE magic word to open Ali Baba's cave: I'm afraid there isn't. "Open sesame" works only in fairy tales.

The energy performance of your building depends on the heating system you have, but also on whether your building is well or badly insulated. It depends on whether you live in a skyscraper in the middle of Frankfurt, connected to the electricity and gas grid; or if you are in a guesthouse in Sicily.

That's why you cannot decarbonize buildings working in silos, just like you cannot use the same solution everywhere. You cannot say: 'we'll put biogas condensing boilers everywhere in Europe' because it all depends on whether there is enough supply and suitable distribution of biogas, and on whether appliances are able to run on biogas.

But you can say: 'I'll use a hybrid heating system in an apartment building in Rome and a pellet boiler with solar thermal in that Tyrol cottage'. And 'I'll have an electrical heat pump in my refurbished house outside Berlin', with good insulation, a cellar and a garden for my outside unit.

This means two things: first, there are different solutions to decarbonize different types of buildings, across different climatic regions in Europe. These heating technologies are already there, that's the good thing.

Second, we need to look at integrated solutions across energy sectors. Sector-coupling is already happening, so it makes sense to sit together with all the chain of energy supply, distribution and use, including manufacturers of heating appliances, installers and the insulation industry, to build the puzzle of decarbonized buildings in 2050. Only this way can we be in line with the Paris climate goals, as well as make sense to our consumers.

This is exactly the spirit of the European heating industry's initiative #Build2050 (www.ehi.eu/build2050/). The first things to tackle together is clear: to accelerate the renovation rate of buildings and, particularly, of the installed stock of heating appliances, which today is largely inefficient.

To that end we need to work with installers: they are the gateway to innovation in the market. How can we support this precious network of specialists that you and I rely on for choosing a new heating system?

We also need to raise awareness amongst consumers, because knowing how (in)efficient your heating system is, is the first step towards finding innovative, renewable solutions. How to do that? We propose to use the new energy label: next time your maintenance technician comes over to check the safety of your boiler, he will also tell you how efficient it is, and make you think of efficient and renewable alternatives.

We have to start working with those local administrations willing to improve energy efficiency in their

Federica Sabbati

communities. We can establish projects of cooperation between appliances industry, energy suppliers, insulation industry, consumer organisations and local administrations to renovate buildings and then scale the project up to the next level: start small but think big.

At the same time as the renovation work, it will be necessary to produce together with energy suppliers and distributors a roadmap for renewable gas and electricity for the heating market towards 2050.

This should take into consideration the energy demand from heating in buildings; it should consider the new technologies that are entering the market such as hybrids, but also the growing share of heat pumps, mCHP, solar thermal, biomass and consider the thermal storage possibilities; finally it should take into account the innovation of smart heating, which will make production and management of energy in our houses more intelligent and efficient.

In conclusion, it is undeniable that heating is a key part of the energy transition in Europe. It is also a connecting point for the different energy players in the building sector, and as such it can play an important role in turning our buildings into efficient, green buildings in 2050. That's why heating is cool.

Federica Sabbati is Secretary General of the European Heating Industry (EHI www.ehi.eu), which brings together companies that are leaders in the production of efficient heating systems. EHI members cover 90% of the European market for all heating solutions from boilers to solar thermal systems, from heat pumps to fuel cells, from radiators to underfloor heating. For today's changing energy landscape, EHI members are innovating in hybrid and digital solutions, as well as ever more energy-efficient and renewable-based integrated systems.

"Closing the loop" opens new opportunities for renewable power

A new world record to help the planet

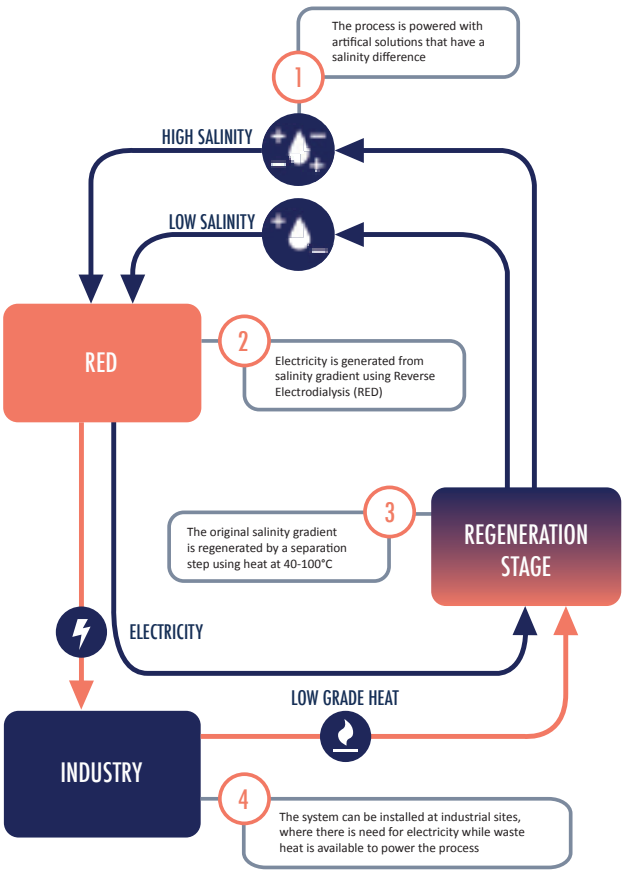
The sustainability challenges facing Europe and the whole world are often defined by what society lacks rather than what we waste.

Rightly, policy makers and campaigners focus on what could well be in short supply or even extinction by 2020 or 2050, but there is also much to be gained from exploring what we have but waste right now.

Every day, large amounts of primary energy are wasted in the form of low temperature heat. This overlooked but valuable resource is simply discarded into the environment – indirectly, or via cooling facilities at industrial plants across the European continent.

Turning this lost heat – this lost opportunity - into a new, clean source of energy was the driving force behind the RED Heat-to-Power project.

Established in 2015 and funded by the European Commission, the RED Heat-to-Power project brings together a partnership of corporates, academics and small, innovative businesses from across Europe; including FUJIFILM which is bringing its membrane technology to the energy sector, REDstack from the Netherlands, the universities of Palermo (UNIPA), Edinburgh (UEDIN) and Catalunya (UPC) and the Spanish research centre CIEMAT-PSA. The project is managed by WIP, a trail-blazing consultancy based in Munich which has been working on renewable energy projects for the last 35 years.



Together, the consortium has developed a game-changing approach to turn this waste of primary energy to electricity, achieving world record results.

As the graphic below shows, in the RED Heat-to-Power project electricity is generated from salinity gradients using Reverse Electrodialysis (RED) in a closed-loop system, with artificial saline solutions being used as working fluids.

The solutions which exit the RED unit are then regenerated using the low-temperature heat to restore the original salinity gradient, and inspiring the system's name; the RED Heat Engine.

Michael Papapetrou, the project coordinator from WIP said: "The RED Heat-to-Power project has developed the materials, components and know-how required to turn low grade heat into power, to the point where we now have several prototypes operating in the lab. We have successfully gone through the proof of concept phase and are now moving towards optimisation and scale-up, which means the RED Heat Engine has great potential to contribute to the mix that will form the backbone of the future energy system."

From the last three years, four things stand out about this exciting new project;

1) Competitive electricity generation: The use of artificial solutions provides the flexibility to choose the salts and the conditions that maximise the productivity of the Reverse Electrodialysis process, making it possible to drive costs down.

2) Exploiting widely available low-grade heat: The system can be installed practically anywhere in the world as low-grade heat can come from renewable sources like solar or geothermal while most industrial sites also have waste heat availability.

3) Offering flexibility to the power system: The technology is a fully controllable source of electricity. This flexibility is a distinctive advantage over variable renewable energy, but also against conventional thermal technologies, which are not very flexible.

4) A safe and clean source of energy: The technology involves only simple circulation pumps and any noise will be minimal. There are very low operation and maintenance requirements.

Reflecting on the project's progress since 2015, the partners have much to be upbeat about – especially two world record performance milestones;

- Record power density in the RED system of 39 W per m^2 of cell pair
- Record minimum specific thermal energy consumption of Membrane Distillation: 46.1 kWhth/m^3

In a new video about RED Heat-to-Power's achievements so far (https://youtu.be/HgZCcWijSp0) Andrea Cipollina of the University of Palermo said: "We started working three years ago from scratch. We started building new knowledge based on experimental and modelling activities and based on this we developed a process that enabled us to build the first operating pilot system."

Sebastian Mortier, from the European Commission, said: "We are glad to have projects like RED Heat-to-Power to show that we are confronting real issues in a sound manner and that innovation can happen wherever in Europe. Good collaboration, and cross-border collaboration, are very important to us. This project is a good showcase for that."

The next step is taking the RED Heat Engine to scale. From detailed modelling and simulation, results show the most efficient regeneration technology is multiple effect distillation (MED). When MED is used, efficiencies of conversion close to 10% can be achieved for waste heat at 100 oC, while levelised cost of electricity (LCOE) below 0.10 Euro/kWh is possible, reaching values below 0.05 Euro/kWh over the next two decades.

Analysis shows there are large amounts of heat available to power the heat engine across Europe and beyond. These resources are mostly in the form of industrial waste heat. The most applicable sources of heat are:

- **Industrial sector.** It includes various segments with different characteristics of waste heat (temperature, heat capacity, and thermal carrier).
- **Decentralized power plants based on biogas engines.** Biogas plants reject large amounts of waste heat, with a fraction already utilized for CHP operation or even for the biogas production. The remaining can be recovered by the proposed technology for electricity production.

- **Marine sector.** Ships are using low/medium speed internal combustion engines for their propulsion, which are already equipped with heat recovery systems for steam production in most cases. However, in the auxiliary engines on-board only their exhaust gases are exploited, with large amounts of waste heat in their cooling circuit (cooled by seawater) readily available.
- **Gas compression stations.** For the supply of natural gas in the long piping networks, gas compression stations are used, which usually operate with gas turbines fuelled with natural gas. These reject large amounts of waste heat in their exhaust gases.

Michael Papapetrou said: "We have analysed the potential environmental impacts which shows the substitution of grid electricity with electricity generated by the RED Heat Engine would lead to reduced environmental impacts. All the partners are inspired and excited by the potential of the RED Heat-to-Power project." ●

For further information please contact:

Michael Papapetrou
+49 89 72012712
michael.papapetrou@wip-munich.de

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 640667. The sole responsibility for the content of this article lies with the authors. It does not necessarily reflect the opinion of the European Union. Neither the INEA nor the European Commission are responsible for any use that may be made of the information contained therein.

Getting to 1.5 degrees

Tackling one-third of global carbon emissions through heating and cooling

By Lily Riahi (pictured below), Lead of District Energy in Cities Initiative, UN Environment*

Heating and Cooling – the Opportunity

Heating and cooling is vital to human existence. We don't need these systems for comfort only. They are often a question of survival: regulating temperatures in extreme weather conditions and keeping our vaccines, medicines and food viable for long periods.

But we face a problem. In Europe and globally, half the energy consumed is for heating and cooling, mostly for buildings and industry. Almost all this demand is met by fossil fuels. In 2015, renewable energy accounted for only 10.3% of heating.

This means we can't accomplish the energy transition and be on the path for 1.5 degrees to avoid the most catastrophic impacts of climate change, unless we act now to change how we heat and cool our buildings. And that's nothing short of a revolution – one that is urgently needed, given the ticking clock the latest IPCC report has stated. In planning and infrastructure terms, 2050 is the day after tomorrow and everything must change, so we cannot go fast enough.

But the biggest opportunities for change often come by tackling the biggest problems. This is where our work, focused on district energy, comes in.

One Giant Leap: District Energy

District Energy. It's pipes and water and when done properly, it's an elegant solution to bring local energy resources to our buildings – to heat and cool as few as a dozen in a district or an entire city. Modern district energy systems connect renewables, waste heat, thermal storage, power and thermal grids and heat pumps.

These hidden technologies are a big deal for climate change mitigation goals – modern district energy can reduce primary energy consumption for heating and cooling by up to 50%.

Many countries in Europe are already on the fast track to achieve their climate targets, just by implementing modern district energy technologies. District energy knocked 20% off CO_2 emissions in Denmark. Germany is using district heating systems to expand solar thermal systems collector field area by 800,000 m^2 by 2020 (IKZ, 2017).

Cities are harnessing modern district energy to meet their energy efficiency, zero energy building and renewable energy objectives. Paris historically used district energy to reduce coal consumption and today is expanding and modernizing the network to connect social housing, improve energy efficiency and increase the renewables share, powering 50% of the network with renewable and recovered energy. From now and into the future, district energy will play an important role in carbon reduction commitments, helping Paris meet its 25% reduction commitment by 2020.

Imagine the energy and carbon emissions we could save if we accelerate the transfer and replication of these experiences in cities and countries worldwide.

That is why at UN Environment, we launched the District Energy in Cities Initiative, to take exactly these kinds of successes and spreading them elsewhere.

Fast-Tracking Cities and Bringing Impact to Scale

When you consider that the average connection to district energy is 12% in Europe and under 7% globally, we can see big potential for growth.

The Initiative is taking advantage of this potential.

Launched in 2014, the District Energy in Cities Initiative started with a few interested cities and committed partners like Danfoss, ENGIE, and the

European Bank of Reconstruction and Development. Within four years, we have tripled our partners, while increasing the number of pilot cities committed to implement district energy six-fold with the accompanying amount of investment and carbon emissions reductions.

And more is coming.

When we started our work in countries like India and Chile, for example, district energy was not on the political agenda.

Today India has included district energy under its National Cooling Action Plan to phase down hydro-fluorocarbon (HFC) refrigerants. We are working with the city of Thane/ Mumbai, among several others in India, to determine a tendering strategy for two district cooling projects, along with a 20-year city wide plan of district cooling action plan.

Looking to scale, we are designing a national programme together with Energy Efficiency Services Limited, the largest publicly-owned ESCO in India, including a US$200 million revolving fund to leverage investments in district cooling worth US$2.8 billion.

Chile, meanwhile, is prioritizes district heating under its 2018 Presidential Plan and its National Air Quality Plan. Ten Chilean cities have prepared district energy project assessments and the Ministry of Energy recently created a specialized district energy unit dedicated to support this project pipeline to investment, employing Initiative tools and methodologies.

We achieve such scale by understanding that demonstration projects shift markets, creating a replicable approach. The Initiative works with cities until we get to a tipping point that can drive national policy change. Then we set up a national delivery unit to support roll-out nationwide.

Public-Private Partnerships to Accelerate Investment

The majority of new district energy investment involves the private sector. That is because district energy is good for planet and pocket, like many energy efficiency investments.

On average, district energy projects make returns from 12 to 20%, break-even in 2 to 8 years, providing steady annual revenues over the long term.

But to really take advantage, we need to address upstream barriers and make it easier for the private sector to invest.

The Initiative's model encourages investment by partnering early in market development to prepare financially sound projects. In Banja Luka, this approach unlocked US$22 million in project finance to upgrade the city's 35-year old network.

The Initiative worked alongside the European Bank for Reconstruction and Development (EBRD) from the outset to ensure that plans and assessments conform to finance providers' requirements. The Initiative also worked with the CTCN, private sector, local stakeholders, and the city authority to build consensus and trust on planned interventions.

Engaging relevant and diverse stakeholders from the beginning proved vital in turning uncertainty on the district heating network's future into an agreed financing plan and new business model and leading the project to market with a US$9.8 million investment loan from the EBRD.

The retrofits increased the share of renewables by 75%, slashed CO_2 emissions by 91%, improved air quality, and saved US$1 million a year in reduced fuel use. The utility has gone from a negative balance sheet to making US$1.5 million in annual revenues.

As you can imagine, the utility is happy, the city is happy, and so are the taxpayers.

To sum up, acting on heating and cooling through modern district energy can take an enormous bite out of climate change, bring other benefits across sustainable development, and support healthy and green bottom lines – but it can only be done through partnership.

Europe's capacity to lead the energy transition through innovation and leadership is vast and the call to accelerate the energy efficiency revolution is clear – we hope you join us in this urgent mission.

**District Energy in Cities Initiative, a global network of 46 partners accomplishing energy efficiency projects in 36 cities across 14 countries, housed in UN Environment, Paris office.*

UN environment

DISTRICT ENERGY IN CITIES INITIATIVE

For further information please contact:

Sophie Loran, Communications Officer, Energy & Climate Branch,
United Nations Environment Programme
E-mail: sophie.loran@un.org, Tel: +33144374283

InDeal project

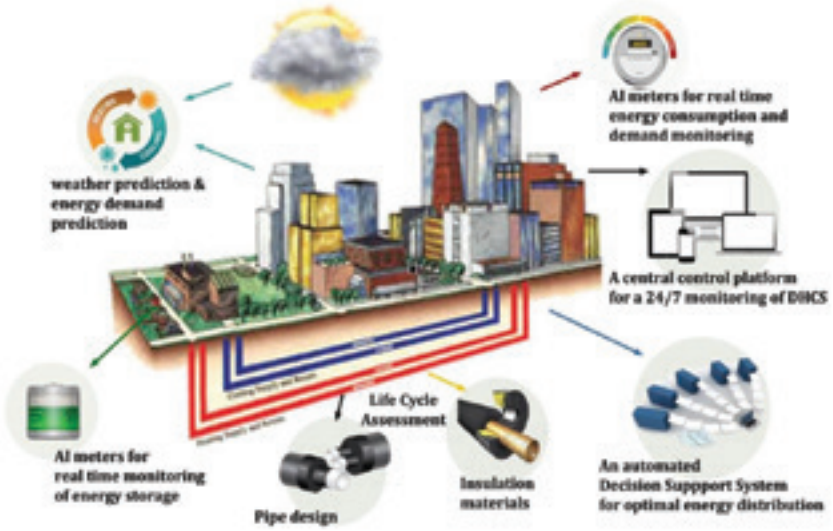
Innovative technology for district heating and cooling

By Dr Serafeim Moustakidis and Prof Nicos Karcanias

Challenged by climate change and coupled with the need to secure sustainable economic growth and social cohesion, Europe must achieve a genuine energy revolution to reverse present-day unsustainable trends and live up to the ambitious policy expectations. A rational, consistent and far-sighted approach to heating and cooling is key for ensuring such transformation. Toward this direction, district heating and cooling systems need to be more efficient, intelligent and cheaper.

The InDeal project (Innovative technology for district heating and cooling) is a project funded by the Horizon 2020 Framework Programme (topic: H2020-EE-2015-2-RIA) of the European Union under grant agreement No. 696174. The InDeal project team is comprised by leading organizations in their respective fields from across the European Union. The project is coordinated by City University of London and the consortium consists of 11 organizations from eight EU member states: NAITEC (Spain), Centre for Research and Technology Hellas, the French Alternative Energies and Atomic Energy Commission (CEA), IZNAB Sp. z o.o. (Poland), Center for Technology Research and Innovation (Cyprus), Net Technologies Finland, PROMAR Ltd. (Poland), Energetika Projekt d.o.o. (Slovenia), Syndicat national du chauffage urbain et de la climatisation urbaine (France) and SERM Société d'Équipement de la Region Montpelliéraine (France).

The project brings together a number of organisations from varying areas such as control and machine learning experts, software developers, experts in system integration and district heating and cooling services providers, to solve a number of technological challenges (i.e. distribution of heating and cooling,



network monitoring and control, energy prediction) that relate to a cluster of industries in many sectors (district heating and cooling, software, energy efficiency, intelligent meters, etc.).

InDeal project will offer an innovative platform that will impose a fairly distribution of heating and cooling among the network's substations by:

- real–time energy consumption data gathering via artificial intelligent meters
- identifying and evaluating the network's need and demand for heating and cooling depending to energy efficiency, energy consumption and type of building
- predicting the short-term weather conditions and forthcoming need for heating and cooling
- monitoring the level of energy stored in network's storage stations and substations
- 24/7 monitoring and control of the district heating and cooling system by a central control platform
- developing energy harvesting solutions to enable future deployment of autonomous sensors and
- minimizing heat losses via novel pipe design solutions and innovative insulation materials

The target of InDeal is to turn the current district heating and cooling networks into a new next-level automated networks that will guarantee increase of the overall energy efficiency accomplishing a fairly distribution of heating and cooling energy demands. InDeal will make a significant step forward contributing to wider use of intelligent district heating and cooling systems and smart integration of renewables, waste and storage.

Contact information

Professor Nicos Karcanias
Professor Emeritus in Systems and Control Engineering
City University, Northampton Square, London, EC1V 0HB, United Kingdom
Email: N.Karcanias@city.ac.uk

This project has received funding from the European Union's Horizon 2020 research and innovation programme

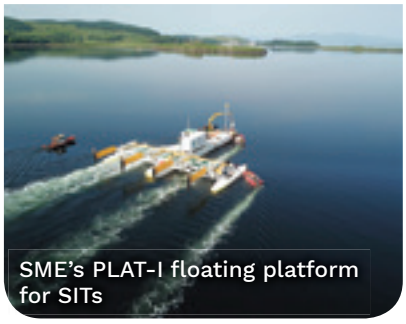
Role of certification

in advancing marine renewable energy technologies

Internationally recognised standards and certification schemes bring a wave of renewable growth opportunities as a new initiative sets out to accelerate the use of marine energy technology across the low carbon industry.

The MET-CERTIFIED project initiated by the Dutch Marine Energy Centre (DMEC) is helping to progress the development of a global standardisation for marine energy devices destined for use by industry in the next years. This in turn will increase the interest from investors seeking to invest with confidence in multiple or large scale marine energy projects.

The Eastern Scheldt Tidal power plant built by Tocardo


SME's PLAT-I floating platform for SITs

Interreg
2 Seas Mers Zeeën
MET-CERTIFIED
European Regional Development Fund

An initiative which aims to increase the adoption of insurable and bankable marine energy projects in the Interreg 2 SEAS region – a European Territorial Cooperation Programme covering South of England, North of France, the west-coasts of Netherlands and Belgium (Flanders) – is using the expertise from certification bureaus and test facilities in the development of internationally recognised standards and certification schemes for the sector.

The project consortium consists of 10 project partners and several observer partners. The project partners are: Dutch Marine Energy Centre (DMEC), Ghent University, European Martine Energy Centre (EMEC), Netherlands Standards Institute (NEN), Perpetuus Tidal Energy Centre (PTEC), POM West-Flanders, DNV-GL, Lloyd's Register, Ifremer, Tocardo.

Peter Scheijgrond, project manager for **DMEC** says: "Certification helps to reduce perceived risks of new technologies used in marine energy power generation projects and can help to increase market confidence in how devices perform and their structural integrity, as well as helping this sector attract previously untapped finance schemes and making exporting marine energy technology across the world easier."

MET-CERTIFIED is assessing the entire process of certification, from concept to construction through to the installation of a full-scale tidal power solution with the support of the industry partners. The initiative is of huge importance for stakeholders seeking information and comfort in how technology can be, and should be, certified – critical to groups such as banks and insurers through to consenting authorities, end-users, test facilities and certification bureaus.

"The MET-CERTIFIED partnership is working on standards and certification schemes for marine renewables both at the national and international level through the International Electrotechnical Commission (IEC) and the IEC System for Certification to Standards Relating to Equipment (IECRE)," highlights Scheijgrond. "We will provide feedback to the IEC committees by applying the standards and certification schemes in eight real-world demonstrations projects. Amongst others, we will apply the principles of certification in projects using the Tocardo turbines, the EEL Energy technology and the PLAT-I platform developed by Sustainable Marine Energy (SME) using SCHOTTEL Instream Turbines (SITs)."

To accurately reflect the needs of the marine renewable sector, MET-CERTIFIED also organises workshops for stakeholders. A recent finance workshop, led by Andrew Smith of Deja Blue Consulting, had as goal to raise awareness about international certification as a positive tool in fundraising, and to discuss both the benefits and challenges of implementing certification during technology development.

More information:

http://met-certified.eu/

MET-CERTIFIED is receiving funding from the Interreg 2 Seas programme, co-funded by the European Regional Development Fund under subsidy contract No 2S01-020. Also the Ministry of Economic Affairs in the Netherlands, the provinces of South and North Holland and the Belgian Province of West Flanders are providing financial support.

EMEC
Clean energy from the ocean

By Neil Kermode (pictured, below right), Managing Director, European Marine Energy Centre, Orkney Islands, Scotland

Harnessing the power of the ocean to provide clean energy for our planet is on a par with the most demanding of engineering challenges ever faced by humanity.

The prize, however, is enormous and it's one that has far reaching implications at a time when our atmospheric CO_2 has crept over 410 parts per million.

The World Energy Council has estimated that around two terawatts (two million megawatts) of power could be generated from Earth's oceans – about double current world electricity production – and in Europe we're blessed with some of the finest marine energy resources in the world.

And the challenges associated with unlocking Europe's marine energy

CorPower C3 WEC deployment at EMEC Scapa Flow site

potential are daily being overcome, thanks to the determination, patience and resilience of tidal and wave energy developers.

At the European Marine Energy Centre (EMEC) in Orkney – the world's only fully accredited marine energy test centre - we've been privileged to witness much of that tangible progress over the past 15 years.

The developers who come to EMEC – many of them from our close European neighbours – are deploying prototype devices that do exactly what they were designed to do – turn seawater into electricity.

Recent highlights include the record-breaking performance, at EMEC's Fall of Warness tidal test site, of Orbital Marine Power's (formerly Scotrenewables Tidal Power) SR2000 device. In a year of testing, this floating tidal turbine generated in excess of 3GWh of renewable electricity and on occasions was supplying seven-per-cent of Orkney's weekly electricity – an outstanding achievement.

The company is now preparing to start work on its next generation device, the Orbital O2 2MW, under the Floating Tidal Energy Commercialisation (FloTEC) project. This aims to demonstrate an advanced, full-scale device in real conditions with high levels of reliability and survivability, while developing a greater understanding of installation, operation and decommissioning costs.

We've also just welcomed Spanish tidal energy developer Magallanes Renovables back to Orkney, with the company set to install its full scale ATIR tidal turbine at the Fall of Warness. ATIR's deployment is part of the Ocean_2G project, which aims to test, validate and pre-certify Magallanes' second generation (2G) 2MW tidal platform.


Photo: ©Colin Keldie


Neil Kermode, EMEC's Managing Director

Project Natick, preparation to deploy Microsoft's datacentre at EMEC

Photo: ©Scott EklundRed, Box Pictures

At EMEC's Billia Croo wave energy test facilities we're preparing to host Belgian developer Laminaria with its surge operated attenuator. This device's selling point is its unique storm protection system that lowers the attenuator's ride height when wave power exceeds nominal power production. The company say this feature prevents the device undergoing excessive forces, ensuring power production during even the heaviest of storms, and lowers cost of construction.

A device that's already experienced the very worst of Orkney's weather is Finnish developer Wello Oy's Penguin wave energy converter. The Penguin, which has been on station at our Billia Croo site since March 2017, has been subjected to wave heights in excess of 18 metres, marking a milestone in survivability.

Wello is currently building a second Penguin device to be installed alongside the current one, as part of the CEFOW project, early next year. The ultimate aim is to deploy three Penguin devices, all connected by a subsea hub, in what will be the first wave energy array in the UK to use a single cable.

And Swedish developer CorPower recently completed a rigorous 18-month test programme for its C3 wave energy converter which culminated with ocean trials at EMEC's scale test site in Scapa Flow.

Just beyond Orkney, the Pentland Firth is now home to the MeyGen project which, at 6MW rated capacity, is the world's largest tidal stream array. MeyGen has generated over 8GWh of energy to the grid to date.

Magallanes Renovables' ATIR

Photo: ©EMEC

At EMEC, we're particularly proud to see the progress made at MeyGen, which employs technologies only one generation on from devices tested at our facilities in Orkney.

Whilst not on the same scale as the MeyGen project, Nova Innovation's tidal turbine array in Bluemill Sound, Shetland, has completed a successful first year of operation, chalking up some notable achievements along the way. The array, which comprises of three 100kW tidal turbines, was recently integrated with a Tesla battery storage system to produce a constant output and Nova Innovation is planning to increase the number of turbines on the site to six.

All of this encouraging activity – most of which is European in origin – is potentially very good news for the world's climate. However, we now have a choice to make. Wave and tidal resources are inexhaustible and will always be there. But if we are to make the leap to full-scale commercial wave and tidal energy harvesting and generation, then significant and sustained investment has to be made.

We must ensure that the most capable marine renewables developers get all the help they need to unlock the ocean's potential, which in turn will help support the economies in some of Europe's most remote and peripheral communities.

In Orkney, very much a peripheral community, we're seeing hard evidence of the economic value of marine energy with a supply chain that now supports over 200 jobs locally across a range of sectors, from world-leading environmental consultancies, to marine operations specialists. Studies have also shown that the £36 million invested in establishing EMEC in Orkney has since delivered to the UK a GVA of £284.7 million, with 4,224 full-time equivalent (FTE) job years.

For European communities once heavily reliant on industries such as shipbuilding or fishing, marine renewables represents an opportunity they cannot afford to let pass. Tidal developer Orbital Marine Power's SR2000 turbine was constructed in Belfast, while Magallanes Renovables utilised local manufacturing expertise in Vigo. Marine energy provides real work in economically disadvantaged areas by using existing skills within communities.

Solving challenges around marine energy also engenders a culture of innovation within these already resourceful areas. At EMEC we deal with innovators every day, both at a developer level, and in a local supply chain context. Marine energy is full of solution-focused groups of professionals who see opportunity in the seemingly impossible.

It's just that kind of mindset which is helping Orkney overcome some of the issues around grid capacity – the islands produce well over 100 per cent of electricity needs from renewable sources, but many generators have been constrained due to grid inadequacies. Those restrictions sparked a local hydrogen generation scheme, now successfully up and running, which combines wind and tidal energy to create hydrogen for use in island transport.

And, if further evidence was needed that innovation breeds innovation within peripheral communities, consider Microsoft's endorsement of Orkney as the chosen location for its ground-breaking seawater cooled data centre, currently submerged at EMEC's Billia Croo wave test site.

In conclusion, only time will tell whether Europe fully seizes the opportunities that marine energy presents or allows this enormous potential to be realised elsewhere in the world. But governments and investors have to realise that the nature of marine energy requires a degree of patience that's uncommon nowadays. Equally, creating an entirely new industry takes sensible amounts of money, along with vision and passion.

Marine energy isn't a sprint, it's a marathon, but not finishing this race simply isn't an option for the planet or the economy.

Orbital Marine Power SR2000 at EMEC tidal test site

Photo: ©Orbital Marine Power

For further information please contact:

European Marine Energy Centre (EMEC)
Web: www.emec.org.uk
Email: info@emec.org.uk
Tel: +44(0) 1856852060

OCEAN ENERGY ERA-NET COFUND

The Ocean Energy European Research Area Network (OCEANERA-NET COFUND) is a five-year project coordinated by Scottish Enterprise, with partner from the Basque Country, Brittany, Ireland, Pays de la Loire, Portugal, Spain and Sweden and part funded by the European Union under the Horizon 2020 programme.

The Cofund model is designed to combine funding from nation and regional agencies and the European Commission, to support collaborative, cross-border research and development projects. OCEANERA-NET COFUND will run two joint calls for collaborative projects and a range of events and activities designed to encourage knowledge exchange and disseminate project results.

UMACK system to be tested alongside CorPower full scale device

Funding has been announced for eight demonstration projects under the first call:

SEABLADE – systematic evaluation and analysis of blades for a 2mw floating tidal energy converter – Led by Irish company Eire Composites, working with Scottish tidal developer Orbital Marine Power.

TOPFLOTE – Targeted optimal pitch module for floating tidal energy – Led by Scottish tidal energy developer Orbital Marine Power.

RESOURCECODE – Resource characterisation to reduce the cost of energy through coordinated data enterprise – Led by the European Marine Energy Centre.

CF2T – Competitive Foundation for Tidal Turbine – Led by the Brittany-based tidal company Sabella.

INNOTEX – Innovative Thermal Exchangers – Led by French company Naval Energies, this project focuses on ocean thermal energy conversion (OTEC).

SPhorcis – Reshaping eforcis: wave energy converter for offshore small power applications – Led by Spanish company Smalle Technologies.

UMACK – Universal mooring, anchor & connectivity kit demonstration – Led by Swedish wave energy developer CorPower Ocean.

WEP+ – WAVE+ Energy Project – Led by Neureus Technologies from Spain – operation of the wave energy technology in conjunction with a newly designed energy storage system.

The total grant funding is **€7.8 million**; €2.6 million from the EU as co-funding with the national and regional funding organisations.

The projects are just getting started and over the next three years will develop, test and validate new technologies and approaches which will contribute to lowering the cost of energy and accelerating the commercialisation of the sector.

Second Call for Projects to be launched early 2019:

A second joint call for projects will open January 2019. The confirmed funders are Scottish Enterprise, Sustainable Energy Authority of Ireland, Swedish Energy Agency, Region Pays de la Loire, CDTI (Spain) and FCT (Portugal). The call will cover all ocean energy technologies, components, subsystems, materials, grid connection and power systems, installation, operation and maintenance, resource and impact assessment. Outline information is available on the project website and full call documents will be published in January. The deadline for proposals will be in April 2019 with applicants informed of the decision in October 2019.

Contact information

Karen Fraser, OCEANERA-NET COFUND Coordinator, Scottish Enterprise
karen.fraser@scotent.co.uk
https://www.oceancofund.eu

The TAOIDE Project

On November 1st, 2018 the TAOIDE Project entered the final year of its 3-year duration and this signals the beginning of the all-important test phase of the Project. The overarching goal of the project is to develop a novel 'wet gap' electrical generator powered by a Marine Hydrokinetic (MHK) turbine that performs in the hostile deployed environment with a high degree of reliability and availability.


The ORPC RivGen® Power System on station in Kvichak River, Igiugig, Alaska

Over the first two years of the project a detailed design of the 'wet gap' generator was developed for MHK developer, ORPC, and the designed machine is currently being built by their chosen manufacturer, IKM Elektro in Norway. Other important contributions developed during this first phase were the bearing and seal systems for both the generator and driveline by project partner, SKF and the predictive maintenance procedures and operating protocols of the entire system developed by Letterkenny IT (LYIT). A suite of algorithms to control the torque, speed and power of the generator has been developed by project partner, Fraunhofer IEE. Researchers from MaREI, the Centre for Marine and Renewable Energy at University College Cork (UCC) have undertaken the development of the power electronics to control the variable voltage, variable frequency output from the 'wet-gap' generator to enable grid connectivity and optimised performance.

The test phase involves the operation of elements of the generator system under lab conditions in two test programmes. The first will be a test of the subsystems. This will involve the testing of the SKF developed SIMPLEX© seals and an ORPC developed PCD (Polycrystalline Diamond) bearing, both mounted on the test driveline. Preparations for subsystem testing are well underway with the programme to commence in December at UCC. The learnings from the subsystem testing will inform system improvements before the second round of testing which will involve a rigorous programme of running the 'wet gap' generator itself. This lab testing will commence in the Spring of 2019 and will continue to project end in October. The test data gathered will be validated against field data gathered from a deployment of the same design of generator by ORPC in Alaska later in the year.

The innovative 'wet-gap' generator system developed during the project will be the first of its kind for a Marine Renewable Energy (MRE) device. Once successfully proven, it is believed that the generator would be highly suited for use with other MRE systems. By developing a common architecture system, developers can focus on enhancing performance of their prime mover. The acceptance of a common platform will result in a reduction of risk and should present cost advantages due to economies of scale. Reduction in capital costs and adoption of high reliability components will reduce overall life cycle costs of MRE projects and should accelerate commercialisation of the technology. Lower cost systems will allow lower intensity resource sites to be considered as commercially viable, and so will expand the available market for MRE.

To be able to provide reliable electrical generation within a marine environment it is crucial to develop a generator that can withstand water intrusion. By designing and developing a 'wet-gap' generator capable of continuous operation in a fully-flooded condition, the TAOIDE project is striving to fulfil this current gap in the market.

More information:

The H2020 TAOIDE project is co-ordinated by the MaREI centre at UCC. For more information, please visit www.TAOIDE.eu and http://www.marei.ie/

This project has received funding from the European Union's H2020 research and innovation programme under grant agreement number 727465

Hydrogen and fuel cell technologies: Europe and Germany reach milestones

Successive German governments have recognized the strategic importance of hydrogen and fuel cell technologies for the future integrated energy and transport system and have thus given it a high priority. For this reason, the National Innovation Programme Hydrogen and Fuel Cell Technology (NIP) was launched in 2006 and subsequently, NOW founded in order to manage it. Important milestones have been reached in the first ten years: cost reductions were realized, a multitude of products reached market maturity, Germany's position as technology leader in many applications along the value chain was secured and considerable follow-on-investments were secured. The continuation of the programme was the logical next step so funding was extended until 2026.

The publication of the Climate Action Plan 2050 and the consequent setting of sectorial climate reduction targets once more increased the pressure to act. In the course of the deliberations on how to reach these targets the indispensability of green hydrogen as a key for achieving a climate-neutral society while maintaining prosperity and employment became clear. It can be put to use in a multitude of German core industries apart from automotive manufacturing, such as the steel or chemical industry where

greenhouse gas intensive practices can be replaced. Therefore, in order to be benefitting from this strong industrial base in the future as well, its use seems essential.

Since its inception, the focus mainly lay on applications in the transport sector. We began to build up a basic network of refuelling stations, connected the key players of the sector to enable an exchange of knowledge in a pre-competitive setting. Consequently, we are setting the conditions for market ramp-up and counteract market failure.

In the meantime, our range of tasks has expanded and also comprises battery-electric mobility, the build-up of charging infrastructure as well as various gaseous and liquid fuels across all modes of transport. It is against the backdrop of our wide range of experiences and profound insights into the opportunities and limitations of all of these technologies and fuels that we are convinced that the electrification of the transport sector – which is paramount to reaching our climate targets – will not be possible without hydrogen and fuel cells. In our view batteries and fuel cells complement one another. The experiences made by market actors and the exchange with our international partners, some of which have advanced further in electrifying transport than we did, corroborate our approach.

In particular, for large applications – also in road transport – electrification using hydrogen is key. Frequently-made arguments based on efficiency do not apply to larger and therefore heavier vehicles. Furthermore, we still see a lot of potential for further efficiency gains with regard to electrolyzers and fuel cells. Notwithstanding, hydrogen and fuel cell applications remain imperative to reaching our climate targets in specific sectors, such as aviation and maritime shipping. Achieving greenhouse gas reductions in these will only be possible by using synthetic fuels in the long term. It is our view that such fuels should preferably be put to use here. However, an economically viable application necessitates economies of scale and it is unclear whether these can be reached in aviation and maritime shipping. In order to economically produce green hydrogen, changes in the regulatory framework also become necessary.

Positive developments emerge primarily from the European arena. The recent adoption of the Recast of the Renewable Energy Directive will potentially create a boost for the sector. For example, incentivizing the use of green hydrogen in the production of conventional fuels makes us hope for economies of

scale with regard to electrolyzers and therefore reductions in the cost of green hydrogen. In this context, a lot depends on the national transposition though.

The same applies for the full accounting of green hydrogen from installations with a grid connection. Enabling the full accounting of green hydrogen from such installations that operate with electricity from renewable energy sources that would otherwise have been curtailed or originates from power purchase agreements is verifiably green and meets the condition of additionality. Hence, we expect these possibilities to be part of the European methodology that is to be drafted by the Commission. It is imperative that this issue is tackled as soon as possible given the urgency of reducing greenhouse gases in the transport sector.

Shifting the perspective to the overall system, we are observing that storage is deemed ever more important. This manifests itself in the closing negotiations on the internal market for electricity where the rules for owning and operating storage facilities are set. In this context, hydrogen is an ideal long-term storage solution that becomes increasingly crucial with rising shares of renewable electricity generation. The German power system serves as a prime example: lacking large potentials for biomass and hydropower, we have to rely on the fluctuating renewable energy sources wind and solar power and therefore, the need for storage solutions becomes apparent. High costs for curtailed generation and thus further decreasing acceptance for the further expansion of renewables by the citizens increase the pressure to find adequate solutions. Water electrolysis offers a solution to counteract the lagging grid expansion and the associated waste of energy by making sector coupling a reality until the noble objective of a European copper plate is reached.

Consequently, we are optimistic about the future. It is clear though that the next decade will be decisive: for our climate, our mobility and the future of our industry. ●

NOW GmbH National Organisation Hydrogen and Fuel Cell Technology coordinates and manages the federal government's National Innovation Programme Hydrogen and Fuel Cell Technology (NIP) and the Electric Mobility (Elektromobilität) and Charging Infrastructure (LIS – Ladeinfrastruktur) funding guidelines of the Federal Ministry of Transport and Digital Infrastructure (BMVI – Bundesministeriums für Verkehr und digitale Infrastruktur). On behalf of the BMVI, NOW also supports the further development of the Mobility and Fuel Strategy (MKS – Mobilitäts- und Kraftstoffstrategie) and the implementation of the EU Directive 2014/94/EU on the development of infrastructure for alternative fuels (Clean Power for Transport, CPT). In concrete terms, NOW is involved in the development of an overall strategy, taking into account the individual fuel options, analysing the positions of relevant stakeholders and coordinating projects with German participation, such as within the scope of the trans-European transport network (TEN-T). Furthermore, NOW GmbH is commissioned by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU – Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit) to support the Environmental Technologies Export Initiative (Exportinitiative Umwelttechnologien) in the area of hydrogen and fuel cell technology as well as enhancing German-Japanese cooperation in the field of power-to-gas technology.

For further information please contact:

Jan Wegener, NOW GmbH
Programme Manager Europe
E-mail: jan.wegener@now-gmbh.de

Thorsten Herbert, NOW GmbH
Divisional Head Transport and Infrastructure | Head of Programme NIP
E-mail: thorsten.herbert@now-gmbh.de

Hydrogen technologies in Slovenia: a question of space and time

The production of hydrogen from excess renewable energy (RE) is an important means of energy storage, offering the opportunity to balance energy supply during periods of low RE availability - or whenever production is insufficient to meet demand. This is why there is intense interest among experts in Slovenia in the challenges currently facing the development of fuel cell technologies and in the opportunities they represent. It is clearly important for the Slovenian economy to develop the necessary knowledge and manufacturing capabilities to exploit this opportunity, and long-term scenario analysis indicates a period of relative economic stability, suggesting that there is time (perhaps as much as ten years) to prepare for the development of these emerging technologies.

Greenpeace Slovenia is enthusiastic about fuel cell technologies, principally because of the cost of their development compared to other RE technologies and for the need to achieve security of energy supply during the transition to low-carbon energy. Slovenia possesses an important advantage according to the Secretary of State in the Ministry of Environment: as a small country, its infrastructure is less susceptible to rapid changes in the energy sector that may arise during the somewhat longer period of implementation of strategies. However, knowledge of hydrogen technologies among the general public appears to be low according to the **Development Centre for Hydrogen Technologies (RCVT)**, a partner in the **Hyacinth** project, which used a Social Acceptance Management Toolbox (SAMT) to analyze opinions of different stakeholders regarding the social acceptability of hydrogen technologies.

Two low-carbon technologies for generating heat and electricity are receiving support towards commercialization as potential replacements for fossil-fuel based powertrains. These are: residential fuel cell micro-Combined Heat and Power (FCmCHP) and hydrogen fuel cell electric vehicles (FCEV).

Ene.field (with RCVT as a consortium partner) has recently undertaken the largest European demonstration of FCmCHP, deploying up to 1,000 units in 11 key European member states over a period of 5 years. Outputs of the project include life cycle assessment (LCA) and life cycle cost (LCC) analyses, market analysis, commercialization strategy, and policy recommendations. In particular, it was learned that current national administrative barriers are preventing access to existing support schemes and funding, possibly through lack of political recognition of the benefits of FCmCHP technology. Policy development should therefore closely follow and complement the industry's commitment to FCmCHP cost reduction and performance improvements.

INEA is RCVT's industry partner and is a leading Slovenian company in the field of energy management and smart grid solutions, industrial automation, process control and manufacturing informatics. INEA has been involved in the **Diamond** project, a Fuel Cells and Hydrogen Joint Undertaking (FCH JU); meanwhile our participation in the **Grasshopper and MAMA MEA** projects under the umbrella of the Fuel Cell and Hydrogen 2 Joint Undertaking (FCH 2JU) researches a cost effective modular Megawatt-sized Proton Exchange Membrane (PEM) fuel cell power plant.

The Faculty of Mechanical Engineering, University of Ljubljana, is RCTV's Centre of Knowledge partner. The faculty has been involved in the field of hydrogen technologies since 2007, participating in several national projects (hydrogen production technologies in Slovenia; and Slovenia's transition to a hydrogen economy) and international projects (including FluMaBack, HyTechCycling, SustainHuts). Of these, **HyTechCycling**, which will be completed in 2019, aims to deliver reference documentation and studies about existing and new recycling and dismantling technologies, and strategies applied to Fuel Cells and Hydrogen (FCH) technologies. **SustainHuts** (Sustainable mountain huts in Europe) is Life+ demo project that aims to reduce CO_2 emissions in the environments within in huts by implementing novel and original renewable energy-based solutions. They are also the leading Slovenian institution for ***Life Cycle Assessment methodology***, a tool for assessing environmental impacts of technologies, products and processes.

For further information please contact:

Tadej Auer M.Sc.
Director
Email: info@rcvt.si
Tel: +386 51 649314
Web: www.rcvt.si/eu

Razvojni center za vodikove tehnologije

Fuel cell and hydrogen technology promises a greener world for all

Bart Biebuyck, Executive Director, Fuel Cells and Hydrogen Joint Undertaking (FCH JU), explains why Europe must continue to support development and deployment of this key low-carbon technology.

The latest report from the UN Intergovernmental Panel on Climate Change (IPCC) is unequivocal: there is a limited time window during which we must act to radically reduce carbon emissions and limit the worst effects of global warming. A major part of the solution is shifting to clean energy and transport systems, and hydrogen is set to play a pivotal role in this transition.

During the past ten years, the Fuel Cells and Hydrogen Joint Undertaking (FCH JU), a public-private partnership between the European Commission, European industry, and research organisations has worked to develop and deploy fuel cell and hydrogen technologies. Our projects demonstrate that fuel cell and hydrogen (FCH) technologies represent one of the pillars of future European energy and transport systems, making a valuable contribution to the transformation to a low-carbon economy by 2050.

In transport, a challenging sector to decarbonise, FCH JU projects continue to demonstrate the hydrogen fuel cell technology's reliability and financial viability, bringing down costs and building investor confidence. Compared to internal combustion engines, hydrogen fuel cells enable the production of electricity with improved efficiency. They emit only water, and produce no CO2 emissions, nor any other atmospheric pollutants.

Photo: ©DEMCOPEM

As more renewable energy comes onto the grid, we need more energy storage. Here, hydrogen's role has become increasingly important for the FCH JU, with significant research progress since 2011. An excess of hydrogen produced by electrolysis – the splitting of water into hydrogen and oxygen – led to the realisation of hydrogen's potential as backup power: enabling higher penetration of renewable energy.

Now Europe is a world leader in the key technology, the polymer electrolyte membrane (PEM), and green hydrogen production sites are setting up all over Europe, from Scotland's remote Orkney Islands to the industrial heartlands of Austria.

Decarbonising industry

The expertise we have developed in Europe is opening up new global markets. One example is the DEMCOPEM-2MW project which is demonstrating PEM fuel cells in China, at the Ynnovate Sanzheng Fine Chemicals chlor-alkali plant. Hydrogen produced onsite can be directly fed into the 2 MWe cogeneration unit, generating electricity, heat and water - and lowering overall electricity consumption by 20%. And with the PEM technology coming from Europe,

the project is a clear win-win in international collaboration.

Where hydrogen is a byproduct - in petroleum refining, as well as chemicals production - it can be used to produce clean, local, load-following power, and replace or reduce fossil fuel use. However, the lack of multiple megawatt-scale European reference sites is a significant barrier to widespread adoption. To tackle this, the FCH JU-supported CLEARgen Demo project is constructing a large-scale fuel cell system, in Martinique, an overseas territory of France. The fuel cell system will be purpose-built for the European market, and will validate technical and economic readiness at the megawatt scale, showing that large stationary PEM fuel cell systems are environmentally friendly and commercially relevant, especially for chemical process industrial applications where, today, excess hydrogen is vented.


Photo: ©Sara, 2018

Looking to the future

These, and many other FCH JU-supported projects, have helped the European industry to make great strides. We now have the potential to move to commercialisation, with the associated benefits of economic growth, high value-added jobs, and creating a supply chain of EU companies around a new suite of products based on hydrogen and fuel cell technologies.

But to capitalize on our knowledge, we must continue to support field trial demonstrations. High- volume rollout trials bridge the gap to commercialization and support the market entry of new products. This is when simplified, product-specific market activation schemes become necessary. These schemes enable further cost reductions and ensure cost-competitiveness with conventional, fossil fuel-based solutions.

Furthermore, building manufacturing capacity with a high degree of reliability and quality control and assurance will have a strong multiplier effect. Investing in the manufacturing capacities of companies ready to take the next step in commercialisation will help to produce high-quality, reliable products and ensure that European companies are competitive worldwide, avoiding the failures made in other innovative technologies.

For these efforts to succeed, we must decisively support the European supply chain. A healthy well-developed European-based supply chain that can provide top-quality components to OEMs in a competitive environment will allow Europe to attain a level of leadership, attract top talent and create highly skilled jobs.

A number of FCH products are entering the marketplace now after having achieved a high level of technical maturity; without decisive focused support, there is a risk they may suffer from the well-known 'valley of death' that afflicts many companies when launching new and innovative products. This is particularly true in markets where regulations do not yet recognise the added value of these low or zero emission, highly efficient products. To avoid this situation and strengthen European industry, providing the right kind of assistance to the commercialisation of these early products is crucial, and plays a key role in boosting public confidence in these technologies.

It is amazing to see the enormous progress that fuel cell and hydrogen technology has made over the past decade. The hydrogen economy is just at the beginning of a long journey: one that we must continue to support, so that we can all enjoy a greener, cleaner and more prosperous low-carbon world. ●

FCH | FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

Efficient long-term storage of renewable energy as synthetic natural gas

By Anke Hagen, DTU Energy, project coordinator

As electricity production from renewable sources such as solar and wind increases, the need for efficient energy storage and transportation concepts that can bridge the gap between production and consumption patterns become increasingly pressing.

The FCH-JU funded project **ECo** is currently developing and validating one such highly efficient technology, **Electrolysis through Solid oxide cells (SOEC)**. This electrolysis technology has the ability to split water and CO_2 using electricity with exceptionally high efficiencies (approaching 100%) in a process called co-electrolysis. The resulting gas mixture can then be converted into synthetic natural gas (SNG) or other compounds through standard catalytic processes.

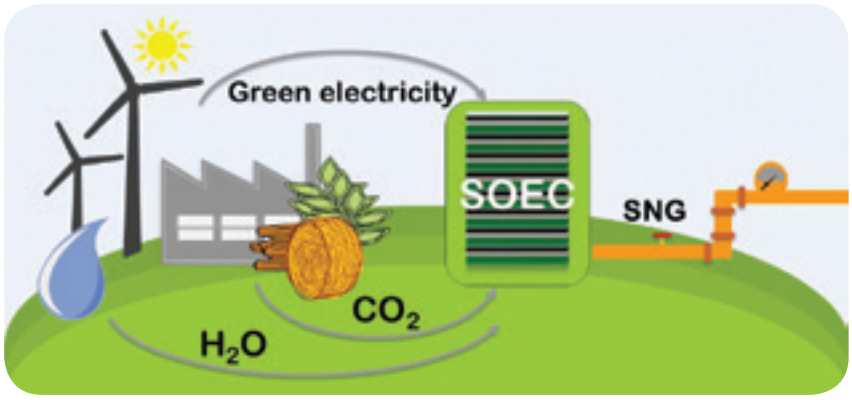
SNG is an attractive large-scale storage medium. An extensive natural gas distribution network and spacious storage tanks already exist in Europe, which can accommodate as much as 50% of the present electricity production from renewable sources in the form of SNG without costly investments in new infrastructure.

However, SOEC technology is still too expensive – the lifetime and cost have to be improved. The overall goal of the ECo project is to prolong lifetime of SOECs and to progress the technology. A comprehensive study of co-electrolysis under realistic operating conditions, such as dynamic electricity input and high pressure operation, was carried out. Based on the results, improved SOECs were developed through electrode optimization aided by advanced electro-chemical and microstructural methodology. These improvements allow for decreasing the operating temperature of the SOEC by 50-100˚C while keeping the same performance. The lower operation temperature means lower degradation and increased lifetime, as well as cheaper balance-of-plant components making the technology more economically viable.

The above activities were complemented by a design study of an SOEC plant. Using this platform it was possible to identify a range of optimum operating parameters maximising overall efficiency and the yield of the SNG production. These parameters can then serve as a guide for the development and testing of improved SOECs. Another important activity of the ECo project was to demonstrate the claimed environmental benefits for specific applications using a life-cycle analysis.

Those are mainly governed by the nature of the electricity input into the SOEC. Indeed, with a large share of electricity from renewable sources, environmental parameters, for example the reduction of the global warming potential, are positively affected by the integration of SOEC into existing industrial processes. This was shown for such diverse examples as (i) use of CO_2 flue gas and heat from cement production to reduce fossil carbon input, (ii) use of process heat and excess CO_2 from biomass gasification for additional SNG production, and (iii) boost of methane yield by converting CO_2 to methane during biogas production.

“This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking under grant agreement No. 699892. This Joint Undertaking receives support from the European Union’s Horizon 2020 research and innovation program and Hydrogen Europe and Hydrogen Europe Research.”



For further information please contact:

Project Coordinator
Prof. Dr. Dr. Anke Hagen

Technical University of Denmark
Department of Energy Conversion and Storage
Frederiksborgvej 399,
DK-4000 Roskilde, Denmark
Phone: +45 46775884
Email: anke@dtu.dk
www.eco-soec-project.

Decarbonisation of heat in Europe: implications for natural gas demand

By Dr Anouk Honore, Senior Research Fellow, Natural Gas Research Programme, Oxford Institute for Energy Studies

Decarbonisation of energy systems has become a key topic in Europe as both the European Union (EU) and member states attempt to achieve goals set out at the COP21 meeting in Paris to limit the impact of the human race on global climate change. The EU is committed to reducing greenhouse gas (GHG) emissions to 80-95 per cent below 1990 levels by 2050. So far, the electricity sector has been the main focus of low-carbon policies, but if Europe is to meet its objectives, decarbonisation efforts will need to expand to other sectors, including the heating and cooling sector.

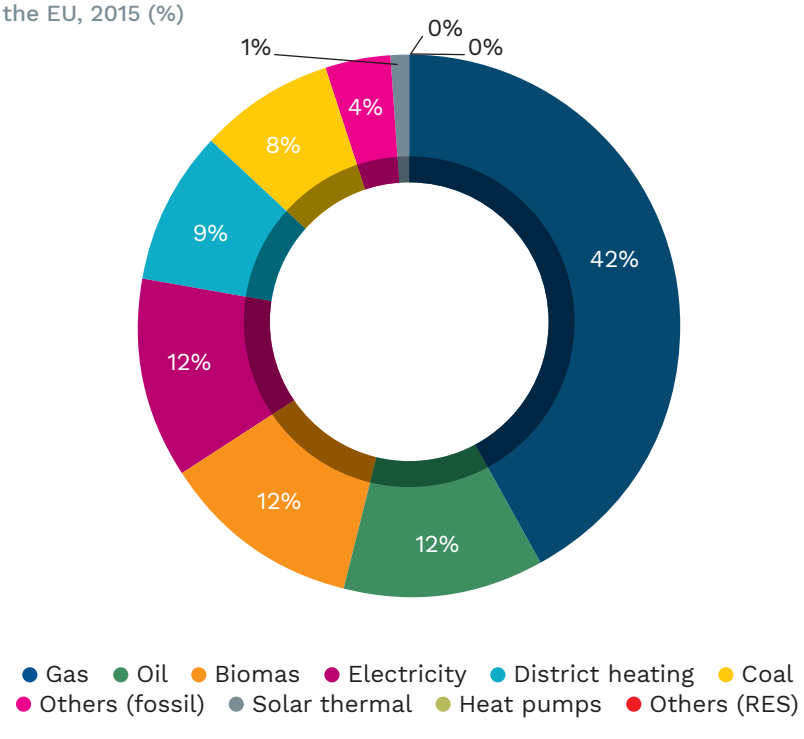
The heating and cooling sector is the largest energy user in Europe, representing about 50 per cent of the final energy demand (data for 2015). Although the sector is moving towards low carbon energy, about two thirds of energy demand still comes from the direct combustion of fossil fuels (oil, coal, or natural gas) and over 40 per cent comes from natural gas alone [Figure 1].

The heating sector is responsible for about two thirds of the gas consumed in the EU. Any policies to decarbonise heating in buildings and process heating in industry will have important consequences for natural gas demand in the future, but how much and by when is uncertain and neither the impacts nor the timeframes are likely to be uniform across Europe.

The main focus of EU decarbonisation policies for heating and cooling production so far has been on two main categories of measures: energy efficiency and the promotion of renewables, essentially for final energy demand although some work is also being done on district heating systems. The implementation of low-carbon options faces critical energy challenges with few simple answers as heat can be produced by a wide range of technologies, and for the end-user, there are many options to choose from for their heating systems, both in terms of fuel type (energy input) and the operating principle (appliances), but not all these options have the same efficiencies and not all will be available or desirable for all buildings or all industrial processes.

In the building sector, the main options include efficiency improvements (upgrade boilers, develop CHP and fuel cells, and switch to more efficient heating systems, all of which could potentially still include natural gas as an input), raising the renewable share (replace fossil fuels by renewables, install hybrid systems – which may include gas- and repurpose the gas network for hydrogen), electrify the heating sector from zero-carbon electricity supply, and expand heat

Figure 1: Final energy demand for heating and cooling by fuel source in the EU, 2015 (%)



Source: Heat Roadmap Europe, a low carbon heating and cooling strategy 2050 (2017)

networks. Active policies promoting low carbon options in buildings only started in the early 2010s and the effects may take time to materialise in the European market where buildings are old and waste energy.

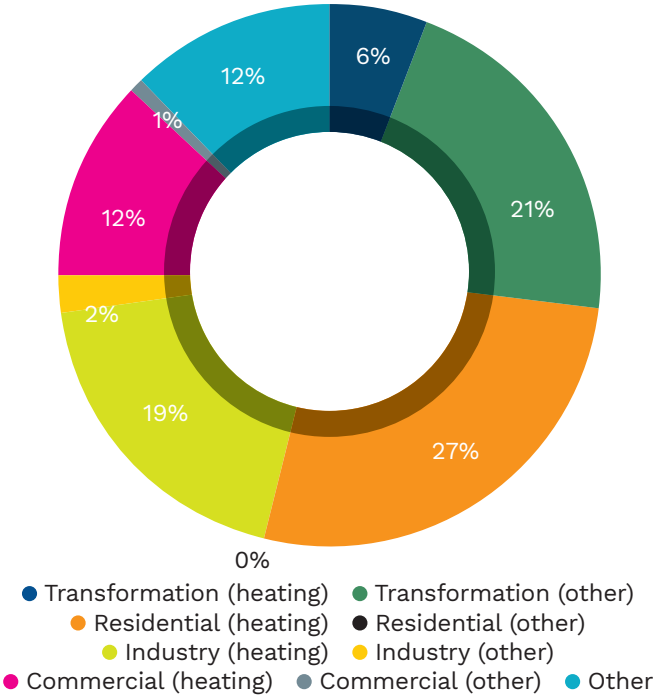
Reducing carbon emissions in the industrial sector and reaching the 2050 targets will essentially depend on a mix of energy efficiency, electrification of heat (and heat recovery techniques), fuel switching (to biomass or hydrogen as feedstock and/or fuel) and carbon capture utilisation and storage (CCU/CCS). The heterogeneity across the sub-sectors and energy uses will be one of the main challenges in designing a framework to decarbonise the sector as some sub-sectors will be more complex to decarbonise than others, such as cement, steel, ethylene, and ammonia for example, as these are characterised by high emissions from feedstock and also high-temperature heat processes. This last point is important because not all technologies and fuels are capable of achieving high temperatures. As a result, fossil fuels can be more easily displaced by traditional renewable energies for low-temperature applications, but not so much for high temperatures heat.

At least up to 2030, most current policy scenarios consider a relatively modest decline in gas used for heating, which will be essentially concentrated in space heating use in buildings. This is explained by efficiency gains through thermal refurbishments and minimum energy efficiency requirements for new buildings and, consequently, lower demand for space heating. On the contrary, energy use in the industry sector may increase slightly due to favourable economic assumptions and fewer options to improve energy efficiency than in the residential sector, especially in energy intensive industries.

The longer horizon to 2050 is more complicated to assess due possible technological development by then. The possible paths and options for decarbonising the systems will multiply. Interestingly, most of the scenarios focus on the buildings sector, highlighting its importance in the transition to a low-carbon heating sector. Natural gas faces an increasingly competitive environment with higher penetration of renewables and electricity, but the total changes in gas demand by 2050 may still not be dramatic at the European level (as shown for instance in the IEA World Energy Outlook, including their sustainable development scenarios).

Decarbonising the heating sector in Europe will take time and probably longer than many anticipate, and it will necessitate additional measures. However, if the gas industry in its current form is to have a long-term future beyond the end of the next decade then it needs to develop a strategy now not only for the power sector but also for potential changes in the heat sector as well. Interaction and collaboration with electricity may be one answer, while developments such as the use of hydrogen and biogas may be another.

Figure 2: Role of the heating sector in natural gas demand by sub-sectors of consumption, 2015 (%)



Note: The chart shows that most of the non-heating uses were in the power (transformation) sector, but the data available in the public domain only shows derived heat produced in CHPs and heat plants and does not account for the share of electricity generation that is used for heating and cooling. As a result, the total share of natural gas used for heating (and cooling) in the transformation sector should actually be higher if it accounted for the use of electricity.
Source: Author's calculations

Further information:

Dr Anouk Honore
Senior Research Fellow
Natural Gas Research Programme
Oxford Institute for Energy Studies
57 Woodstock Road
Oxford OX2 6FA, UK
Tel: +44 (0) 1865 889 132
Email:
anouk.honore@oxfordenergy.org

Assessing the impacts of SECA in the Baltic Sea Region

"AIR POLLUTION IS THE NEW TOBACCO" according to the World Health Organization (WHO) in the first Global Conference on Air Pollution and Health (October 2018), calling the attention of all countries to work towards meeting WHO global air quality guidelines. The call goes aligned with the International Maritime Organization (IMO) plans to ban the use of high sulfur fuel in the global shipping fleet by 2020 by forcing vessels to either use cleaner fuel with a lower sulfur content or install an exhaust gas cleaning system onboard. Meanwhile, the Baltic Sea Region (BSR) has already been benefiting of better air quality since the Sulphur Emission Control Areas (SECA) entered into force in 2015. EnviSuM project results reveal the significant decrease of SOx from ship emissions, the impact of the shipping emission on air quality & human health, levels of compliance and the economics effects within SECA in the BSR.

Since 2015, all the ships navigating the North European SECA (Baltic Sea, North Sea and English Channel) are obliged to comply with the limit of maximum sulfur content of 0.1% in ships fuel. Before the regulation entered into force, the shipping sector sparked criticism claims against it, fearing huge economic losses due to increasing costs and a modal shift from ocean freight to road.

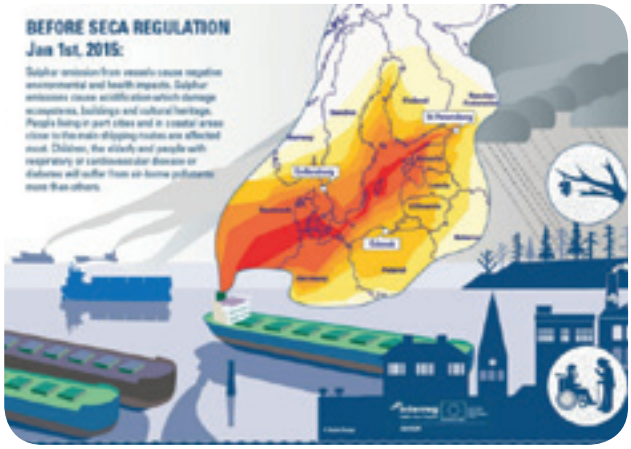
Three years later, the results from EnviSuM shows the economic impacts of SECA are so far negligible in the BSR. Benefits surpasses costs overall. Also, results shows no statistical evidence for modal shift from sea transport to other modes and no evidence of transfer of supply chains outside the SECA zone. In addition, SECA has created markets for emission abatement technologies and motivated investments in cleaner fuels.

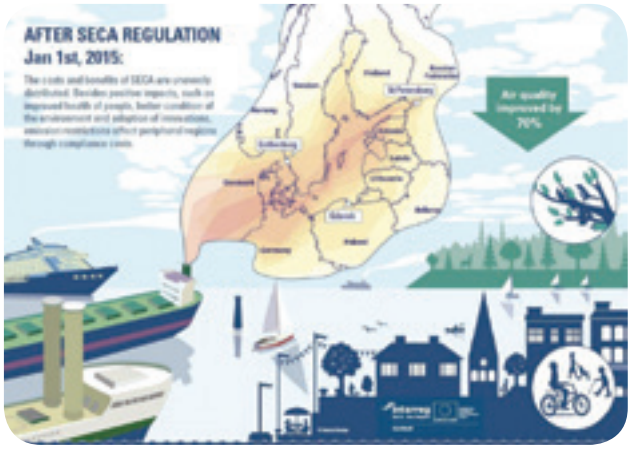
EnviSuM results show a significant decrease of SOx (-88%) and particulate matter (PM, -36%) emissions in the BSR due to SECA. By 2030, BSR is expected to benefit even more from better air quality since emissions will continue to decrease. Absolute nitrogen oxides (NOx) and PM impacts will also be reduced.

Among all the benefits of SECA, perhaps the most valuable is the impact on human health, considering exposure to ship emissions damages human health - especially cardiovascular and respiratory system diseases. While assessing the exposure to particulate air pollution from shipping in the Baltic Sea, in countries bordering the Baltic Sea, results shows a decrease from 1544 to 1019 in premature deaths.

EnviSuM has also been tracking the sulfur fuel content of ships exhaust gases in the BSR in the scope of compliance. Results show the Middle Baltic Sea with the highest level of non-compliance. Good compliance near the ports Gothenburg and Gdansk (99%) and less in Saint Petersburg (95%), where 2% were gross emitters.

Altogether, emissions regulations have been a game changer to the shipping industry. The BSR has a long history of cooperation to improve its environmental status, which has stimulated clean tech knowhow and innovations. Significant SECA impacts were attributed to innovation and reputation of BSR, which benefits from the opportunity to be on the forefront in clean shipping worldwide.





The EnviSuM team is an international and multidisciplinary consortium of University of Turku (lead partner), Finnish Meteorological Institute, Chalmers University of Technology, Maritime Development Center, Norwegian Meteorological Institute, Maritime University of Szczecin, Tallinn University of Technology, City of Gothenburg, University of Gothenburg, Baltic Marine Consult, HELCOM and 17 associated partners. EnviSuM is funded by the European Regional Development Fund and co-financed by the Interreg Baltic Sea Region.

GERMANY'S ENERGIEWENDE

"Home grown" problems of the German energy transition

Social sustainability is a must

dena Study – Integrated energy transition

Energy efficient buildings technology in Germany

Social sustainability is a must

By Daniela Setton, Senior Research Associate, Institute for Advanced Sustainability Studies (IASS) Potsdam, Germany

Daniela Setton
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The Energiewende or energy transition is one of Germany's largest and most ambitious reforms. It is the centrepiece of the Federal Government's efforts to achieve the emissions reduction targets agreed in the Paris Climate Agreement. But it amounts to far more than a mere technological challenge. As a broad societal task, the Energiewende also depends on the cooperation, political support, and active participation of all parts of society.

Without the broad agreement and approval of the German population, the large-scale expansion of wind and solar power plants and other essential infrastructure, such as grids and storage facilities, will not be possible. People's willingness to change their behaviour and consumption habits – by switching to energy-efficient technologies in the home or more sustainable modes of transport, for example – is another prerequisite for the required transformation. Public acceptance of political reforms is also essential. The protests of the "gilets jaunes" against a rise in fuel taxes that we are currently witnessing in France is evidence of what can happen when people's sense of justice is offended by the decisions politicians make.

What can be done to ensure that the energy transition is socially sustainable? And where do we stand on that score in Germany? These are the questions that the IASS systematically addresses in the context of the Dynamis partnership (www.dynamis-online.de). Its findings are presented in the annual "Social Sustainability Barometer for the German Energiewende" (first edition: 2017), which provides comprehensive empirical data on the social dimensions of the Energiewende. Every year, the Barometer takes stock of the attitudes, sense of justice, experiences, and preferences of different sections of the German population with regard to central aspects of the Energiewende and highlights areas where there is a need for political action. Its main empirical basis is an annual panel survey of over 6,500 German households.

The main idea behind a socially sustainable energy transition is that the needs, wishes, preferences, and feelings of broad sections of the population are taken into account when planning and implementing the transformation. All parts of society should feel equally included in the process and have the opportunity to play an active role in it. What I'm talking about here is meaningful participation in transformation processes and not calculated strategies for procuring public acceptance. In support of the former, we need to gather information on how the population views and

How fair or unfair is the German Energiewende? The Social Sustainability Barometer gauges the attitudes of the population on an annual basis. ©IASS

Many German homeowners are willing to contribute to the transformation of energy systems through their own investments, such as smart heating. In the "Efficiency House Plus with Electromobility" of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, citizens can inform themselves about the technology. ©IASS/Rolf Schulten

experiences the Energiewende, and that's where the Barometer comes in. The purpose of the household survey is to gauge attitudes to the objectives of the Energiewende and its implementation, support levels for the political parties and the Federal Government, the extent of public participation in the Energiewende, as well as people's overall willingness to get involved. It also gathers data on people's preferences when it comes to a fair distribution of costs, trade-offs in the area of climate protection, and new 'smart' energy consumption options in the home. In evaluating the data for the Barometer, we pay particular attention to the different circumstances of different population groups, for example in terms of income, housing situation, mobility behaviour, where they live, and the extent to which they are affected by energy poverty.

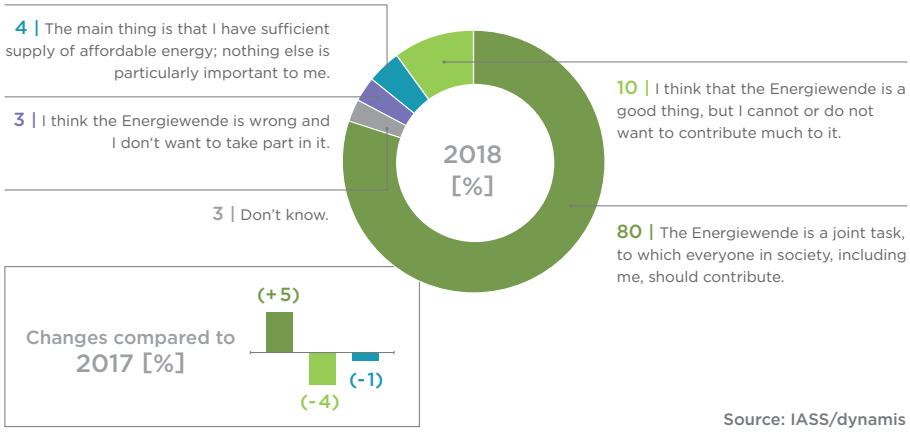
The results of the first two survey waves show just how widespread support for the Energiewende is in Germany: About 90% of people are basically in favour of it regardless of where they live, their level of education, income, or age. And more than three quarters of the population believe that the energy transition is a "joint task" to which everybody should contribute (see figure 1).

The respondents are, however, less satisfied with the way the energy transition is being implemented. Criticisms centre on the questions of costs, fairness and political planning. For example, half of the population (51%) believes that the implementation is "unfair overall", while only one in five people (21%) think that it is "fair overall". At the same time, dissatisfaction with the policies pursued by the Federal Government is growing.

For an overwhelming majority

A BROAD MAJORITY SEES THE ENERGIEWENDE AS A JOINT TASK

If you think of your personal contribution to the energy transition, which of the following statements is most applicable to you?



Source: IASS/dynamis

of Germans, the issues of social equality and participation are very important in the case of the Energiewende. They encompass aspects like sufficient access to energy for everybody, securing tenants' rights when landlords decide to carry out energy upgrades to their properties, distributing the costs of the transformation in a way that is perceived to be fair, and the expansion of onshore wind capacities. Where CO_2 pricing is concerned, a broad majority (77%) believes that higher charges for driving a car with a combustion engine, flying, or heating with oil or gas are acceptable if they contribute to climate protection. However, half of the population (46%) would like to see those charges balanced out by some form of financial relief in another area (see figure 2).

The Barometer's findings on public participation also suggest that the success of the Energiewende is anything but a foregone conclusion. Most people want to take part in it, but many are sceptical about the opportunities and parameters for doing so. Much more needs to be done in terms of communication, education, and financial support to empower all sections of the population in this regard.

Conclusion

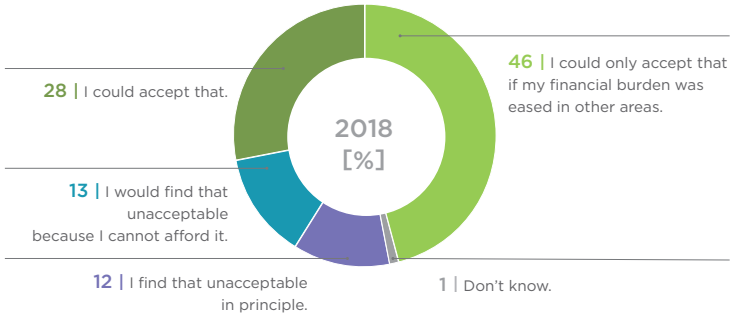
There is a growing consensus that the Energiewende will not succeed without the broad approval and involvement of the population. But there is little evidence that this insight is shaping policymaking in tangible ways. We urgently need to rethink our approach here. To date, the implementation of the Energiewende has been dictated far too much by economic and technological considerations. In the Energiewende Monitoring Report published annually by the Federal Ministry for Economic Affairs and Energy (BMWi), only two social indicators (employment and affordability) are mentioned.

That's why we welcome the fact that the independent expert commission charged with observing the monitoring process has, in its statement on the latest Monitoring Report, proposed new indicators to highlight the significance of the "social dimension" for the further implementation of the energy transition and alerted the government to the need for action on this front. In the case of two of those indicators (overall support for the Energiewende and satisfaction with the way it is being implemented), the experts draw on the Social Sustainability Barometer.

It is safe to assume that the issue of fairness will play an increasingly important role as the implementation of the Energiewende proceeds. The Barometer may not deliver concrete policy recommendations, but it is a valuable source of data that can guide policymakers as they rise to the challenges this transformation presents.

MOST GERMANS WANT SOME FORM OF FINANCIAL RELIEF FROM RISING FOSSIL FUEL PRICES

Imagine that you were told that, for climate protection reasons, you had to pay more for driving a car with a petrol or diesel engine, flying, or heating with oil or gas. What would your reaction be?



Source: IASS/dynamis 2018

For more information contact:

Dr Bianca Schröder
Press and Communications Officer
Institute for Advanced Sustainability Studies e.V. (IASS)
Berliner Straße 130
14467 Potsdam
Germany

Tel: +49 (0) 331-28822-341
Mobile: +49 (0) 151-12019041
Email: bianca.schroeder@iass-potsdam.de
Web: www.iass-potsdam.de
Twitter: @IASS_Potsdam

Reference

Setton, D., Matuschke, I., Renn, O. 2017/ Social Sustainability Barometer for the German Energiewende 2017: Core statements and summary of the key findings. – IASS Study, November 2017.DOI: http://doi.org/10.2312/iass.2017.028

“Home grown” problems of the German energy transition

By Prof. Dr. Angelika Niebler, MEP

Can you imagine a life without electricity, warmth and mobility? Modern life would be unimaginable without these basic guarantees, which is why Germany is committed to realise a stable supply of energy, which is economically viable and environmentally friendly. Germany is in the process of overhauling its energy supply, moving away from nuclear and fossil fuels towards more renewables and better energy efficiency.

Germany has put itself in an exceptional situation. We have committed ourselves to reach four energy transition targets: 40 - 45 per cent share of renewables to be reached in the power consumption by 2025, all remaining nuclear power plants to be shut down by 2022, 40 per cent greenhouse gas emission reduction by 2020 (from 1990 level), 50 per cent planned reduction in the primary energy consumption by 2050 compared to 2008.

Germany has started a new area in energy policy in June 2011 when the Merkel government decided in the wake of the nuclear catastrophe in Fukushima, Japan, to shut down eight nuclear power plants and limit the operation of the remaining nine until 2022. 80 per cent of parliamentarians in the German Bundestag voted for the bill with the remaining 20 per cent only objecting, as they wanted an even faster exit. Internationally, the perception that “German angst” caused the government to go in this direction is misleading. The nuclear phase out is as much a part of the German Energiewende as the move

towards a low carbon economy and has been discussed over years.

This decision has set Germany on a different path than the ones our European neighbours take. Europe has not decided to phase out nuclear power - but Germany did! While the nuclear phase out is a positive sign towards a future that is secure and environmentally friendly, it has put Germany in a tricky situation. We have set ourselves a dual goal with the energy transition: moving away from fossil fuel-based energy generation to a largely carbon-free energy sector, while also phasing out nuclear energy by 2022. In the year 2000 nuclear energy accounted for 29,5 per cent of the power generation mix, in 2016 the share was down to 13 per cent and by 2022 all nuclear plants are supposed to be offline.

Most of Germany's problems with the energy transition today can therefore be described as "home grown". The consequences of which are partly absurd. With the massive expansion of renewable energies, there are times in which Germany is flooding its neighbours' energy systems with its surplus energy due to grid congestions. In times when it is very sunny and windy, Germany's energy system cannot handle the additional energy produced, as conventional nuclear and fossil fuel plants cannot be shut down on short notice. The cumulative amount is extending Germany's energy need, which results in unwanted surges of power through the networks of our neighbouring countries.

The problem increases because of the missing grid extension between the north of Germany, where most of the renewable energy, mostly from wind, is produced and the south of Germany, where an extensive amount of energy is needed. The shift from fossil fuels and nuclear power towards more renewable energy can only succeed if the infrastructure is there to support this shift. So far, Germany's grid is just not up for the task of making proper use of all the renewable power produced. New cross-country power connections are urgently needed but face enormous public resistance.

The Energiewende can only exceed if there is progress with the grid extension. Keeping the grid stable with a high amount of volatile renewables and inflexible conventional power generators in the systems costs our country close to one billion euro each year. With more nuclear power plants in the south scheduled to shut down, even more power from the north will be needed in the south of the country. If the bottlenecks cannot be resolved, there is the risk that Germany will be split into two power-market bidding zones. Additionally to the public resistance of grid extensions, it is also argued that existing capacities can be utilised more efficiently by a smarter automated system able to react to fluctuating renewable power generation.

The missing infrastructure is causing many clashes. The government is pushing for an expansion of the grid, citizens do not want them to be built near their homes and consumers protest against higher energy bills.

Now, more than ever, the completion of a true European internal energy market is the only way forward to guarantee that Europe is contributing its share towards a low carbon future. Europe can only strive in accelerating the renewable uptake, provide security of supply and stay economically competitive if the internal market is working!

Prof. Dr. Angelika Niebler is a Member of the European Parliament from Bavaria representing Upper Bavaria and Munich since 1999. She is Chairwoman of the CSU-delegation and Co-Chairwoman of the CDU/CSU-delegation. Angelika Niebler is Member of the Committee on Industry, Research and Energy and of the Committee on Women's Rights and Gender Equality as well as substitute Member of the Committee on Legal Affairs.

Since 2009, Angelika Niebler is Chairwoman of the Bavarian Women's Union and serves since 2015 as Party Vice-Chair of the CSU. In November 2018 she was also elected President of the Economic Advisory Council Bavaria. Since 1991, Professor Niebler has worked as a lawyer in different law firms in Munich (since 2015 of-counsel at Gibson Dunn & Crutcher). Since 2009, she has been lecturing at the Faculty of Business Management at the Munich University of Applied Sciences where she was appointed as Honorary Professor in 2016.

Integrated Energy Transition

dena Study Integrated Energy Transition

Executive Summary

The dena study combines energy industry analyses with a comprehensive discourse

The dena Study Integrated Energy Transition develops and compares transformation paths for the energy system in Germany to achieve the climate policy targets of the German government by 2050. It outlines paths using an innovative, cross-sectoral scenario approach. At the same time, it builds on the deep industry knowledge of more than 60 study partners from all relevant sectors as well as on the continuous exchange with key players from politics, society and science. The aim is to review and supplement energy industry analyses with assessments of implementation challenges and social issues.

With increased efforts in all sectors, the Paris targets can be achieved

Generally speaking, it is possible to reduce greenhouse gas emissions by 80 per cent as well as by 95 per cent by 2050. However, this requires significantly more far-reaching measures in all sectors than previously planned with a high degree of commitment from all participants, an appropriate political framework, as well as a public discussion on the distribution of the costs of the energy transition. It's not enough to simply keep doing what we are doing.

Even rigorously pursuing current developments, such as expanding renewable energy, would only reduce greenhouse gas emissions by 62 per cent by the year 2050. Since the possible transformation paths and associated reduction of greenhouse gases in the sectors already clearly differ in 2030 and the upper edge of the corridor requires very far-reaching strategies, a decision on the climate protection targets sought must be made in this legislative period. This is the only way to foster the development and widespread market introduction of the necessary new technologies in the individual sectors in a timely manner.

A broad mix of energy sources enables more cost-effective and robust transformation paths

The transformation paths explored in the dena study assuming a broad mix of technologies and energy sources are under the assumptions made more cost-effective by up to €600 billion until 2050 than those that focus more heavily on electricitybased applications.

The use of existing energy infrastructures in their diversity allows these transformation paths more flexible approaches to solutions paths, such as capitalising on technological developments by 2050 that cannot yet be foreseen.

The expansion and integration of renewable energies must be accelerated

Until 2050, an expansion of renewable power generation capacities averaging up to 8.5 gigawatts annually (GW/a) is required. In order to make this possible, the existing expansion corridor must be enlarged and availability of the necessary land areas has to be ensured by the federal states. The further development of the market design and grid regulation is the basis for optimally integrating renewable energys into the system on a regional and national level.

Synthetic renewable energy carriers complement energy efficiency and the expansion of renewable power generation

The reduction of final energy consumption through comprehensive energy efficiency efforts in all sectors (efficiency gains in industry alone 26 to 33 per cent until 2050) as well as the expansion of renewable energy are two key facts to achieve the climate targets. The third decisive factor is the use of synthetic renewable energy carriers, most of which are imported into Germany. In 2050, these energy carriers will cover between 150 and 900 TWh/a in all areas of application where cutting emissions by using renewable electricity directly is either impossible or very difficult. At the same time, these 'Green Power Fuels' close gaps that could arise in the future due to implementation obstacles (such as acceptance for new wind turbines).

A reliable planning horizon turns the necessary structural change into an opportunity to modernise

In addition to the much-discussed changes in the coal industry, the structural change associated with the transformation will also affect many other sectors and industries in the future. For example, ambitious climate targets might fundamentally change the highly integrated value-added network of the basic chemical material industry. In the automotive industry, the change in propulsion technologies will not only affect the major vehicle manufacturers, but also a large number of small and medium-sized suppliers.

It therefore requires a political framework that provides longterm

reliable incentives for reducing carbon emissions and enables a marketbased innovative optimisation across sector boundaries that is open to a range of technologies. The necessary policy decisions on energy infrastructures must be made in good time, to, for example, further develop the gas infrastructure or to build an infrastructure for hybrid trolley trucks.

Building stock and energy sector require the highest investments

A successful energy transition will require continued high investments by all building owners over the next three decades when it comes to refurbishing their building stock, along with increasing the refurbishment rate from 1.0 to at least 1.4 per cent. Stimulating and consolidating this investment dynamics requires a carefully selected mix of incentive-focussed instruments, which emphasise stimulus over compulsory regulations, must be constantly reviewed and, if necessary, adapted.

Extensive balancing effects within Germany and the European integrated grid will be required for an efficient electricity system with very high proportions of renewable energy sources. In order to achieve this, investments must be made in the transmission and distribution grids beyond the existing network development plan by 2030. In addition to the continuous expansion of renewable power generation, new investments in gas-fired power plants are needed in alignment with neighbouring European countries. They ensure security of supply when the guaranteed capacity from nuclear power plants is no longer available and the guaranteed capacity from coal-fired power plants is only available to a limited extent.

The energy transition in transport is based on several pillars

The electrification of propulsion technologies is a major driver of the energy transition in the transport sector – but it is not alone. A major factor is the reduction of the specific energy consumption of transport in order to reduce total energy consumption and significantly increase the proportion of renewable energy in the transport sector.

Electricity as well as gaseous and liquid fuels must be 100 per cent based on renewable energy sources in the future. At the same time, new mobility strategies are needed to curb the further increase in traffic and, at best, reduce traffic altogether. Overall, the transport, energy and IT infrastructures must be planned in a much more integrated manner across the sectors and the fee and taxation systems must be aligned with the energy transition targets.

A successful energy transition is embedded in international developments

A sustainable energy system in Germany requires balancing possibilities of a further-developed common European electricity market, an international trade for synthetic renewable energy carriers (Power Fuels) and a further decrease in cost of key energy transition technologies due to global demand. The energy transition can only succeed if it is also a success in terms of industrial and economic policy. On the one hand, this requires instruments to protect German industry from competitive disadvantages due to German climate protection requirements (carbon leakage protection), which are higher than in other countries, and international agreements for global trade. On the other hand, the growing global demand for energy transition technologies also offers export opportunities for the German companies.

Leeway to make decisions and participation promote social acceptance

The next phase of the energy transition will affect citizens more than today – through distribution issues of energy transition costs as well as structural changes and how they affect each person's own working and living environment. They are challenged to muster the necessary private investments as well as to accept and accelerate the changes with energy applications, such as in the field of mobility. Politicians now face the task of continuously tracking and highlighting the opportunities of the large-scale energy transition project. Citizens themselves need sufficient leeway to take action as well as participate and design options for their investment decisions.

The dena Study Integrated Energy Transition was conducted by the Deutsche Energie-Agentur (dena) – the German Energy Agency – along with scientific experts and more than 60 companies and industry associations from all sectors involved in the energy transition, including energy providers, grid operators, consultancy firms and industrial companies from all sectors as well as industry associations.

The study partners worked together to define and explore various scenarios, opportunities for development and interdependencies. Scientific experts modelled the scenarios. After an interim conclusion in October 2017, the transformation trajectories were once again discussed, revised and calculated. The final version was published in June 2018.

For further information please contact:

Deutsche Energie-Agentur GmbH (dena)
German Energy Agency
Christoph Jugel
Director, Energy Systems
Tel.: +49 (0)30 66 777-757
E-mail: jugel@dena.de
dena.de/integrated-energy-transition

Energy efficient buildings technology in Germany

By Dr.-Ing. Benjamin Krick (pictured), Passive House Institute Darmstadt, Germany

Under the influence of the oil crisis of the 1970s, more than 40 years ago, the first laws regarding thermal protection in buildings were issued in Germany. The main aim was to ensure the general energy supply by using fossil resources sparingly. Since then, the laws have been updated and gradually tightened. Regrettably, legal requirements have become less and less ambitious in Germany since the mid-1990s.

Low energy demand

As of 2019, all EU Member States are bound to implement the European Building Directive EPBD. In Germany however, the nearly zero energy standard defined is below the necessary for effective climate protection and below the level that would be economically reasonable. Both are at the expense of the climate and future generations.

Climate protection

Climate protection was the primary goal of Dr. Wolfgang Feist when he developed the Passive House Standard for extremely energy efficient buildings in the early 1990s. The Passive House Standard was devised to drastically reduce the heat loss of a building and thereby minimise its energy demand. The simple physics: If a building is thermally insulated very well, to the point that the little additional heat required can be provided via the supply air of the ventilation system, then a central heating and distribution system in its classical form can be omitted. The possibility of omitting the classical heating and distribution system starts with a heat load of maximum 10 W/m², which corresponds to a heating demand of 15 kWh/(m²a); the best-known characteristic value of Passive Houses.

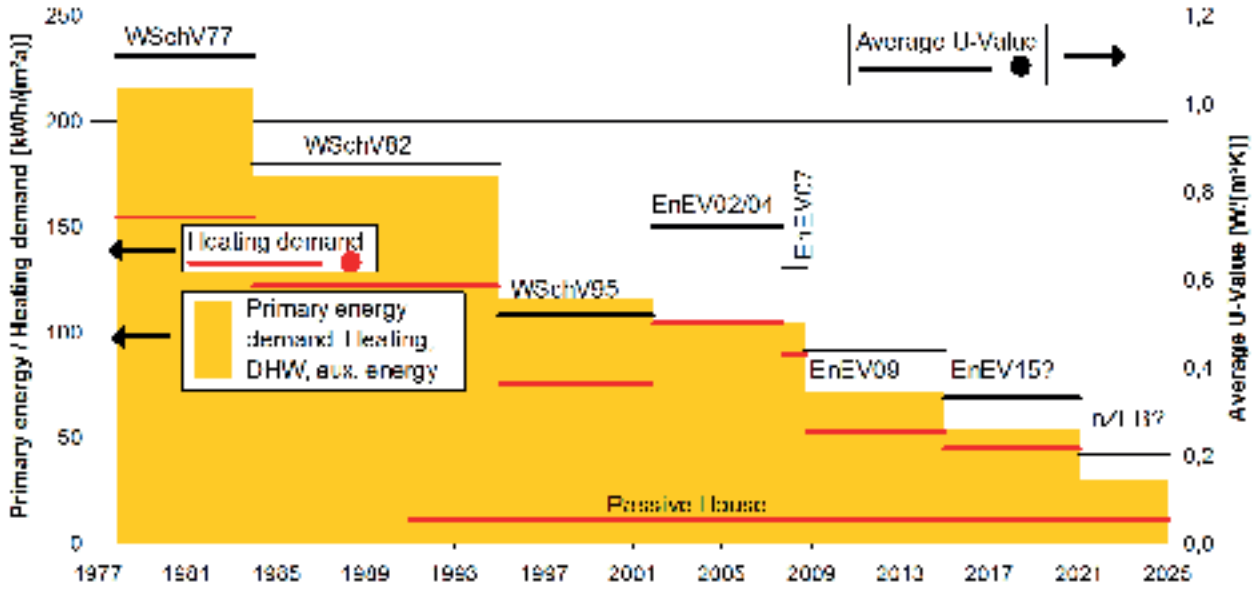
Components available today

In 1991, when the world's first Passive House was built under the scientific direction of Dr. Feist in Darmstadt, this was all just theory. Practical implementation was a challenge, mainly because the energy-efficient components available on the market today did not exist at that time. For example, the windows were made in handwork and thermally improved on-site with polyurethane foam insulating shells. Another novelty was the triple glazing of the windows, which was used for the first time in this Passive House pilot project. As of today, investment costs for Passive House and standard windows, for example, are becoming more and more similar.

Applied worldwide

What started out in the early 1990s in Darmstadt is spreading with increasing momentum throughout

Figure 1: Primary energy demand and mean U-values according to the German legal framework compared to the passive house.






Four single family homes built to the Passive House Standard: Left: The worldwide first Passive House in Darmstadt, Germany, was built by Dr Feist in 1991. It received a photovoltaic system in 2015 (©Peter Cook). 2nd Left: A Passive House in Bavaria, Germany in front of a pittoresque setting (©Lebensraum Holz). 2nd Right: This family home in Leeds demonstrates just how versatile a Passive House can look like (©Eric Parks). Right: A Passive House in Asturia, Spain. Its roof is covered with greenery, it uses solar power to generate electricity and also recycles rainwater (©Carmen Delgado).

the world; a highly energy-efficient building standard that offers its users the benefits of high comfort and lower running costs, while contributing to climate protection through low heating demand. To date, more than one million square meters of Passive House Standard real estate has been built worldwide. For the most part, this development has taken the form of residential buildings, but the Passive House Standard has also been successfully applied to hotels, schools, kindergartens, sports centres, supermarkets, offices and factory buildings.

Large-scale Passive Houses

Examples of note include: the world's first Passive House hospital currently under construction in Frankfurt, Germany; and the world's tallest Passive House high-rise, standing at 88 metres in Bilbao, Spain. The Bahnstadt in Heidelberg is currently the largest Passive House district, and has served as a precedent for a similar scheme to the south of Beijing, China. Once the latter and further large scale projects in China have been completed, the two million square metre mark will have been hit.

Perfect match

At the same time the Passive House Standard itself has been further developed: in 2014, the Passive House Institute extended the standard to include the Passive House Plus and Passive House Premium classes, in order to take into account the generation of renewable energy. The two concepts fit together very well: energy efficiency and renewable energy are a perfect match.

Renewables and Passive House

If a building is erected and the site area is thus deprived of another use, it makes sense to use the roof and facade areas for the production of renewable energy. However, this is done in most cases with photovoltaic panels, which in the winter produce little electricity due to low solar radiation. Here, in turn, the minimal wintertime energy consumption of Passive Houses pays off, because the photovoltaic system can still cover a high percentage of their energy demand, despite the lower solar radiation. Connection to highly efficient heat pumps makes particular sense here.

Energy transition

Yet another plus point to Passive Houses: Due to their excellent thermal insulation, such buildings cool down very slowly in winter Efficiency, thermal inertia and the possibility of generating renewable energy make the Passive House a central component of a successful energy transition.

The oil crisis of the seventies is long gone. Climate protection is the challenge of our time. The Passive House Standard is a solution that has proven itself and can be implemented in the building sector without delay on large scale - let's go for it!

About the author

Dr Benjamin Krick is an architect by training, having focused his doctoral research on sustainable building. As a senior scientist at the Passive House Institute, he chairs the working group for international Passive House Component Certification.

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- Improving the energy performance of buildings
- Indoor environment quality, heating, ventilation and cooling technologies
- Bioenergy
- Advancing hydrogen energy technologies
- Bio-jet fuel technologies
- Waste-to-Energy's contribution to the long-term EU emissions reduction strategy
- Carbon capture and storage
- Water management – optimizing water usage
- Our energy country profile will come from Slovenia.

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OÖ Energiesparverband, Linz/Austria, Tel. +43 732-7720-14386, office@esv.or.at, www.wsed.at