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SPRING 2017

Connecting Europe's Stakeholders in Energy and Transport

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European Commission

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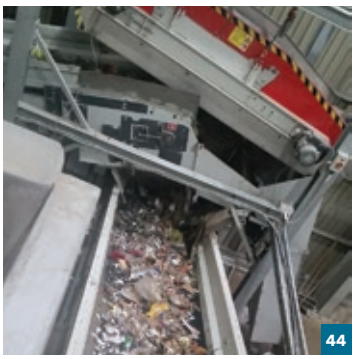

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Foreword

Welcome to the Spring edition of the magazine. Since the last issue, Holland, Germany and France have become distracted by election fever, while Greece remains stubbornly mired in economic difficulty. Meanwhile, the European Parliament has welcomed a new President and there is speculation that the Commission will do so, too – bringing about a revolution in Brussels, according to Italy's 'La Repubblica', which even goes on to name the Finn Jyrki Katainen as likely successor to Jean-Claude Juncker. Such uncertainty must not deflect Europe's policymakers from the ever-present threat posed by climate change.

Praising the resilience of Europe's forests, Emma Berglund reminds us of their role in decarbonizing Europe. She points out that although Sweden's forests are managed for many purposes, the value of the bioenergy they produce is much less than that of the sawn timber, which highlights the potential for domestically-sourced biomass. She also argues that policymakers should support the role of wood in the transition to a fossil-free bioeconomy.

Andreea Strachinescu examines how the complex nature of the European energy system has been further complicated by the rapid growth in (variable) renewables generation. In her excellent article, she argues that the resulting pressures, particularly on the electricity network, create the need for a forward-looking energy policy; and provide a strong argument for Energy Storage technologies. This is particularly so if interconnection does not create enough flexibility in supply; and particularly important in the context of security of energy supply.

Dr. Eecen illustrates some of the technological developments driving the offshore wind industry. ECN Wind Energy, he tells us, is a group of experts "focusing on offshore wind energy cost reduction and engaging in numerous collaborative research programmes" - which provides the bridge between academia and industry. It is salutary to contrast the growth in the generating capacity of turbines with reduction in the cost of the electricity they generate.

Water: at present, Europeans can take this basic resource for granted, but Gérard Bonnis of the OECD suggests that the "outlook is grim", with global demand rising by more than 50% within thirty years, leading to severe water stress for nearly 4 billion people worldwide. He discusses water risks, such as those associated with major floods or droughts and an approach to managing them, concluding with a suggestion to define water as an issue in terms of risk, so uniting the scientists, policymakers and the world of business.

Increasing climate scepticism and regulatory complexity are just two of the issues hampering efforts to decarbonise maritime transport, according to a thoughtful article by Michele Acciaro. Professor Acciaro nevertheless sets out a clear rationale for such efforts: maritime transport is a substantial contributor to global emissions and shipping emission reductions are far behind those required to meet 2050 emission targets. He calls for a clear and decisive regulatory response and for additional resources to be invested in the sector.

Echoing these themes, Jos Delbeke from the Commission highlights the potential for shipping to make a significant contribution to global efforts to fight climate change. Emphasising COP21 commitments to limiting emissions to combat climate change, he discusses the need for further effort in the sector, concluding that any strategy must clearly define emission reduction objectives for the mid- and longer term.

So there is uncertainty and there is potential. And there is much more for you to read inside…

Michael Edmund
Editor

European Commission

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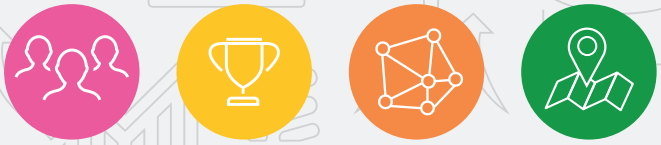

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Energy

How shipping can contribute to the global climate effort

By Jos Delbeke, Director-General, DG Climate Action, European Commission

Untapping the emissions reduction potential in the shipping sector could make a significant contribution to global efforts to fight climate change.

Maritime transport emits around 1000 million tonnes of CO_2 annually and is responsible for about 2.5% of global greenhouse gas emissions, which is equivalent to the annual emissions of Germany. Without mitigation measures, these emissions could grow by between 50% and 250% by 2050, according to estimates by an International Maritime Organization (IMO) study.

Decisive action to reverse this trend will allow the shipping sector to contribute to the global low-carbon transition – and reap the benefits of further energy efficiency improvements. At the same time, maritime transport is currently the only transport mode and economic sector without a greenhouse gas emissions reduction objective.

ACCELERATING THE LOW-CARBON TRANSITION

The historic Paris Agreement concluded in 2015 sets out a global action plan to put the world on track to avoid dangerous climate change by limiting global warming to well below 2°C, and to pursue efforts to limit the increase to 1.5°C.

As part of its contribution to the Paris Agreement, the EU committed to further reduce its greenhouse gas emissions, by at least 40% below 1990 levels by 2030. Sectors covered by the EU emissions trading system (ETS), such as electricity and heat production, industry and intra-EU aviation, will have to cut emissions by 43% compared to 2005. Other sectors, including road transport, will need to cut emissions by 30% compared to 2005. This commitment is currently being translated into legislation.

After the Paris Agreement, sectors outside the UN climate negotiations followed suit. Last year, the International Civil Aviation Organisation (ICAO) agreed to establish a global scheme to stabilise CO_2 emissions from international aviation. This measure will require airlines to offset the growth of their CO_2 emissions after 2020. In the first phase, 65 countries will participate on a voluntary basis. After 2027, participation is mandatory, except for Least Developed Countries or countries with small aviation activities.

Another major achievement last year was the agreement on the global phase-down of climate-warming hydrofluorocarbons (HFCs). These potent greenhouse gases were added to the list of substances controlled under the Montreal Protocol, the successful international treaty designed to protect the ozone layer. The phase-down of HFCs could save around 80 Gigatonnes of CO_2 equivalent by 2050 and make a significant contribution to fighting climate change.

FURTHER ACTION NEEDED TO CUT SHIPPING EMISSIONS

While other sectors are making headway on tackling their emissions, the maritime transport sector does not yet have a greenhouse gas emissions reduction objective. This cannot be considered as fair. It also undermines the efforts of other sectors towards the "well below 2°C" objective of the Paris Agreement.

Some progress has already been made to address emissions from shipping. The UN body in charge of maritime transport, the International Maritime Organization (IMO), started working on the reduction of greenhouse gas emissions in 1997. In 2011, it adopted a mandatory minimum efficiency standard for new ships (Energy Efficiency Design Index, EEDI) and the

obligation for ships to carry energy efficiency management plans on board.

These measures are expected to dampen further emissions growth, but not reduce emissions from today's levels. Moreover, latest IMO figures show that many ships built in 2013 and 2014 already go beyond future requirements under the current efficiency standard. This raises concerns over the standard's level of ambition and its ability to incentivise the uptake of existing technologies and the development of new technologies.

SHIPPING'S DECARBONISATION POTENTIAL

It is clear that further action to reduce emissions from shipping is urgently required. The good news for the sector is that it also makes good economic sense.

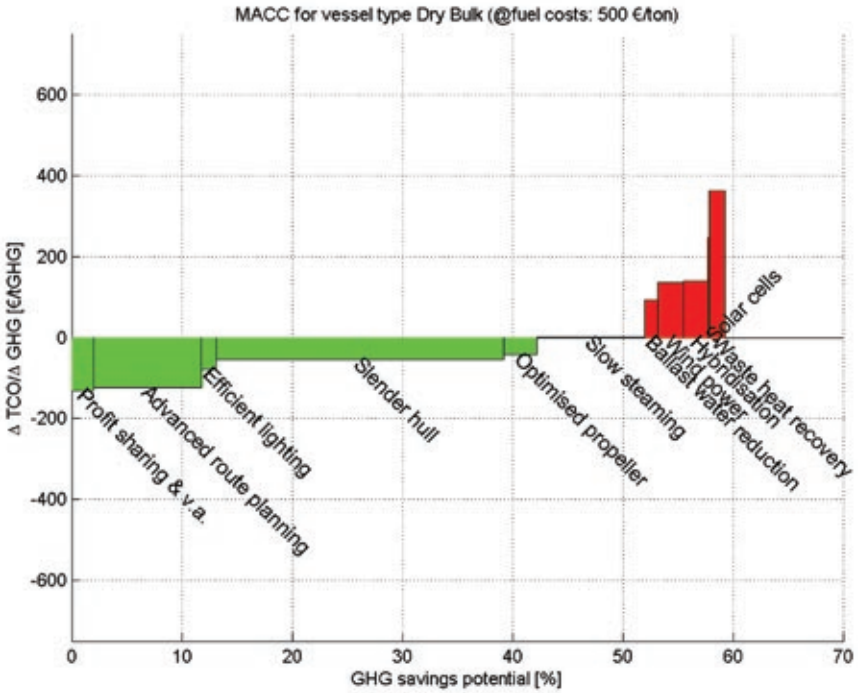
The second IMO greenhouse gas study, published in 2009, identified technical and operational measures that could tap into the sector's significant emissions reduction potential. If implemented, these measures could increase efficiency and reduce emissions by 25% to 75% below the current levels.

Moreover, many of these measures are cost-effective: reduced fuel bills ensure the pay-back of operational or investment costs. Non-financial barriers, however, may discourage their implementation.

Recent studies confirm these findings. The following graph ('marginal abatement cost curve') visualises the emission reduction potential and the related costs for a very common ship type – dry bulkers used for example to transport iron ore or grain. Measures in green are cost-effective and those in red would trigger net costs for the ships.

On top of these measures, additional reductions could be achieved by implementing new innovative technologies.

Figure 1: Marginal abatement cost curve for dry bulkers (source: TNO: GHG emission reduction potential of EU-related maritime transport and on its impacts, study carried out for the European Commission, 2015). The graph shows that significant emission cuts can be achieved with low cost measures. Measures in green are cost-effective and those in red would trigger net costs for the ships.



Wind energy, for example, could be used on a number of ship types to support the conventional propulsion powered by diesel engines. A recent study commissioned by the European Commission identified a market potential for around 3,700–10,700 wind propulsion systems installed on bulkers and tankers by 2030, creating up to 18,000 new jobs.

In the long run, alternative fuels could offer further decarbonisation opportunities, as long as these fuels come from renewable energy sources.

AN EMISSIONS REDUCTION OBJECTIVE FOR MARITIME TRANSPORT

By tapping into this tremendous potential, the shipping sector can contribute its fair share to the global efforts to limit climate change. For a sector that is global by nature, the most effective way forward is taking action at global level through the IMO.

An important next step will be the development of the IMO's strategy for reducing greenhouse gas emissions from ships, to be adopted in spring 2018. This initial strategy will list possible short-, mid- and long-term measures with possible timelines for completion. The idea is that it would allow the shipping sector to announce its contribution to the international effort under the stocktaking process of the Paris Agreement.

It is of utmost importance that this strategy clearly defines the sector's level of ambition – in other words, its emission reduction objective for the mid- and longer term. This should constitute a fair share contribution to the Paris Agreement objective to limit global temperature increase to well below 2°C above pre-industrial levels.

We invite all stakeholders to actively contribute to this important work to ensure the shipping sector's contribution to the global climate effort.

The role of the storage in the future European energy system

By Andreea Strachinescu
Head of Unit "New energy technologies and innovation" – DG Energy – European Commission (pictured)

It is a top priority of European Energy Policy to have secure and cost-effective energy for European citizens and enterprises. The internal energy market should play an important role in the achievement of the EU's targets by providing the necessary cost signals. These targets aim to obtain greater decarbonisation, increased deployment of renewables, better affordability and greater energy efficiency, which will ultimately deliver progress towards all the objectives of the Energy Union and boost the clean energy transition by modernising our economy.[1]

The energy system in Europe has a great degree of complexity, partially due to its historical national focus and more recently due to the rapid changes in demand and supply patterns. This applies to the gas, heat and the electricity grids. Recently the large-scale deployment of variable renewables generation has created challenges especially for the operation of the European electricity system. The power generation mix has changed with unprecedented speed and therefore new solutions for the electricity system need to be considered. The role of forward-looking energy policy plays a crucial role in enabling the needed solutions.

Investments in storage, both for Security of Supply and grid flexibility, have been challenged by increasing levels of risk in energy infrastructure related investments, resulting in sub-optimal level of investments in flexibility from system point of view. We need a market framework that supports and incentives flexibility in existing and new generation assets and other flexibility mechanisms.

Storage can contribute to a much more effective use of today's existing grid infrastructure, at all voltage levels. A more flexible grid will contribute to making the most efficient use of the existing infrastructure, reducing the peak load in the main transmission and distribution lines. This will have a positive effect on the capacity needs of the interconnections, where even the interconnection target (10% by 2020 and 15% by 2030) could be insufficient for the needed flexibility.

The generation technology mix and the location and size of these generation capacities determine the grid flexibility needs. Many storage technologies are scalable and geographically rather independent, making storage a prime solution in the evolving energy system, accommodating the changing

generation and consumption mix.

The optimal location of storage is determined by economic, technical, physical, public acceptance and political variables. It is now the moment to reflect on how to optimise the EU level energy system with an urgent implementation of flexibility solutions to enable more renewables and less curtailment. Small and medium scale batteries can be installed quickly, and represent a fast solution at customer or even distribution grid level. Other technologies could provide optimal solutions as a function of the specific grid needs.

While cables sometimes face criticism, local storage benefits from high public acceptance. In some cases storage can provide temporary solutions, until cables are operational. Hybridisation of several technologies seems to be a new trend in many local projects in order to ensure clean, secure and affordable electricity, heating and cooling.

Significant progress has been made in Power-to-Gas for large scale storage, in Power-to-Heat for demand response, in battery systems at grid and home level and other hybrid systems on islands and remote areas. Power-to-Gas technologies are developing very quickly, providing a possibility to link the electricity grid to other energy grids and uses, like transport and industrial feedstock. This should provide additional opportunities for integration of higher shares of variable RES. Further progress is required on all technology fronts, as we need a mix of all technologies for all sizes and all locations.

The trend towards more decentralised electricity generation and self-consumption has been triggered by the ongoing energy transition. The benefits of distributed generation are can be better seen when there is higher levels of self-consumption and when energy storage is a significant part of the distributed system. Also the coupling the distributed system with smart grids provides additional value to distributed generation.

The role of thermal storage should also be considered in distributed systems. Existing storage of heat, in the form of hot water boilers and the thermal mass of buildings, is in some circumstances of both economic interest and can be quickly installed for usage. Also a more efficient use of waste heat, especially low-temperature heat, could further contribute overall energy efficiency targets.

In general we can see that energy storage can be a bridge from centralised to distributed generation, which is another path worth to explore further.

The recent geopolitical developments have increased the focus on energy security in the energy system. Energy Security can be understood in two ways, as security of electricity supply and as security of energy supply. In both of these cases, storage options have strong attributes to contribute to increased levels of security.

The security of electricity supply relates to grid stability and power generation capacity. A number of factors have reduced the quantity of spare capacity in the grid; increased load on transmission lines, increased variability in generation and slowly decreasing amounts of conventional generation capacity. These factors, if not adapted to, can result in lower safety margins and increases the risk of black-outs. Energy storage can support reducing these risks while supporting at the same time integration of RES and the transition to a low carbon economy.

The geopolitical frictions have underlined the need to strengthen the European security of energy supply. Using the available renewable and other domestic energy resources would mitigate the risks related to energy supply. Large-scale energy storage, both for electricity and gas, has a key role to play. Today gas storage can buffer and store the available energy resources, providing gas, electricity or heat security of supply over months. It is expected that energy storage technologies related to the use of electricity, such as chemical storage (allowing days and weeks of storing capacity), could play a growing role in relation to security of energy supply as well.

Storage can also improve the system Energy Efficiency - being one of the cornerstones in the Energy Union - and contribute to an optimal design of the European energy system at affordable costs. As a conclusion, energy storage allows for energy efficient use of existing assets, including conventional and renewable power generation, and can provide energy efficiency benefits at both the grid and at consumer level.

1) Clean Energy for All Europeans – unlocking Europe's growth potential- http://europa.eu/rapid/press-release_IP-16-4009_en.htm

Managing energy innovations

The German government has set itself the objective of ensuring safe, affordable, and clean energy for a sustainable and environmentally friendly economy. It has also outlined ambitious CO_2 targets, which are part of Germany's new Climate Action Plan 2050. Renewable energy and energy efficiency will be the focus of future investment. The main strengths of the German economy lie in mechanical engineering and automotive technology, and also in the chemical industry. With the Climate Action Plan 2050, the federal government has created the necessary conditions for the economy to remain competitive – even in a decarbonizing world.

THE FUTURE DIRECTION OF GERMANY'S ENERGY TRANSITION

A major contribution to this process is the transformation of the energy sector – one of the most significant political initiatives for the next three decades. It is, in particular, the responsibility of the Federal Ministry of Education and Research (BMBF) to continuously promote this radical restructuring process with support from science and research, to critically monitor this process, and to supply long-term solutions.

BMBF is funding research projects on renewable energies, energy storage and distribution, materials research for the transformation of the energy sector, energy-efficient cities, load flexibility in the use of renewable energies, and an intelligent approach to CO_2. The funding of such research is linked to technological issues with economic and social aspects, and therefore follows a systemic approach. BMBF prioritizes projects that are most crucial to ensuring a secure and clean energy supply in Germany. The Project Management Jülich (PtJ) supports the ministry in the implementation and administration of these projects.

THE KOPERNIKUS PROJECTS: A NEW FUNDING PHILOSOPHY

In 2016, BMBF launched the largest research initiative for the energy transition so far: the Kopernikus Projects. The philosophy behind the projects is as follows: research networks that include science, industry, and civil

GEFÖRDERT VOM
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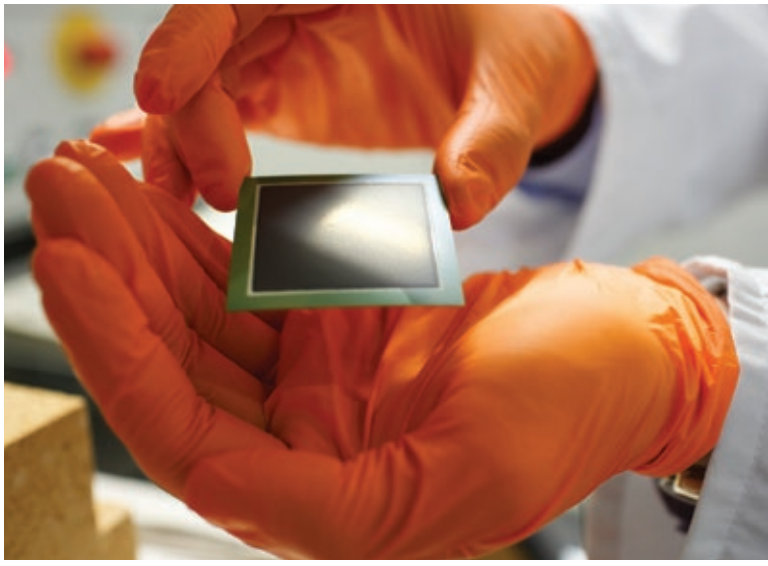
society aim to build a bridge between basic research and large-scale applications. BMBF aims to achieve a targeted concentration of key stakeholders, which is why the projects are designed to run for ten years – an innovative approach in the German government's conventional research funding practice. €400 million has been earmarked for the Kopernikus Projects.

The projects are focused on four key areas: power grids, energy storage systems, renewable energies in industry, and systems integration. These four critical areas will determine whether the transformation of the energy sector is a success.

The Kopernikus Projects connect the societal, economic, and environmental issues of our time: structuring a new power grid (ENSURE), storing surplus electricity (P2X), synchronizing industrial processes with the renewable energy supply (SynErgie), and navigating through the effects and side effects of economic or policy measures in advance (ENavi). The projects are part of the Research for a Sustainable Development (FONA). The scientific heads are from prestigious institutions, such as the Karlsruhe Institute of Technology (KIT), RWTH Aachen University, TU Darmstadt, and the Institute for Sustainability Studies (IASS).
The funding process of projects is absolutely crucial to implementing research projects with limited time schedules and precisely defined content at companies, research establishments, and universities.

REDUCE AND REUSE CO_2: CARBON2CHEM

The consortium project Carbon2Chem is another very good example of how all the relevant parties collaborate together on this entire process. Together, they are developing a globally applicable solution to convert waste gases from thyssenkrupp's steel furnaces into primary products for fuels, plastics, and fertilizers. The hydrogen required for this solution is produced using surplus energy from renewable energy sources. The Carbon2Chem approach is expected to make 20 million tonnes of the German steel industry's annual CO_2 emissions economically exploitable in future. This represents 10 percent of the annual CO_2 emissions from German industrial processes and the manufacturing industry. PtJ is supporting the Ministry in the implementation of Carbon2Chem as well.



Projects details of the Federal Ministry of Education and Research

For more information about the Kopernikus Projects, please see: www.kopernikus-projekte.de
A short movie about the project Carbon2Chem can be seen here: https://goo.gl/QWnOOy

Photos: FONA/Photothek, Ute Grabowsky

FCH JU: accelerating towards a low-carbon economy

Climate and energy policy is one of the European Union's most important priorities. Affordable, clean and secure energy for all Europe's citizens and enterprises is key to a sustainable and competitive future. Through its Energy Union initiative, the EU is working to establish a fully integrated internal energy market, improve energy efficiency, decarbonise the economy, and fund research, innovation and competitiveness to support breakthroughs in low-carbon and clean energy technologies.

FUEL CELL TECHNOLOGY

Fuel cells are such a low-carbon and clean energy technology. A fuel cell is a highly efficient conversion technology that produces electricity and heat through a simple, clean chemical reaction between oxygen and a fuel. It produces no pollutants or carbon

Photo: HyFive project, © BMW

FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

dioxide. Fuel cell technology is very flexible, can operate with a range of fuels, and can be easily integrated into existing energy infrastructures.

The most promising fuel for fuel cells is hydrogen: the most plentiful chemical element in the Universe and present in abundance on Earth as water, hydrocarbons and in other organic matter. Hydrogen can be produced in several ways including steam reforming of methane (the main component of natural gas) or the electrolysis of water using electricity. When the electricity used is from renewable sources, such as wind or solar, the hydrogen production is essentially carbon-free and avoids any greenhouse gas (GHG) emissions.

Fuel cells bring many benefits being versatile, scalable and with a very wide range of potential uses. Typical applications include in transport – ranging from cars, buses, lorries, forklifts, boats, trams and trains to aircraft; portable applications embrace small charging stations for mobile phones; domestic heating and energy units (micro-CHP); and larger power plants, including for back-up power and power in remote, off-grid locations.

A PUBLIC-PRIVATE PARTNERSHIP

Established in 2008, the Fuel Cells and Hydrogen Joint Undertaking (FCH JU) acts as a catalyst to enable a sustainable energy and transport future through a productive partnership between the European Commission, industry and the research sector. It is a unique European public-private partnership (PPP) with a focus on accelerating the development and deployment of fuel cell and hydrogen technologies.

The PPP contains three members: the European Union, represented by the European Commission, the industry grouping 'Hydrogen Europe' and the research grouping 'N.ERGHY'. During its first phase of operation (2008-2014) the FCH JU held a total ring-fenced budget of EUR 940 million under the EU's FP7 research programme. Its work continues with an allocated budget of EUR 1.33 billion under the current EU Horizon 2020 research and innovation framework programme covering 2014-2020.

By pooling resources and creating a common platform where policymakers, industry and research come together, the FCH JU facilitates industry involvement and collaboration and supports the environment for investment.

The FCH JU's ability to act as a focus for European experts on fuel cell and hydrogen technologies has enabled these fuel cell technologies to progress significantly, especially in terms of reduced life-cycle costs and increased overall performance, durability and efficiency.

EARLY TO MARKET

FCH JU's projects have helped boost commercialisation in some specific markets including public transport (hydrogen powered buses), low noise and emissions-free passenger cars and forklift trucks, in CHP units, and portable and back-up applications. During 2017 FCH JU jumped over the mark of 200 projects.

Two major projects have started in 2017 and are typical of the PPP's approach. The Joint Initiative for hydrogen Vehicles across Europe (JIVE) project will pave the way to full commercialisation of zero-emission hydrogen fuel cell buses with the deployment of 139 cell buses across nine European locations. JIVE will use coordinated procurement to unlock the economies of scale required to reduce the implementation costs. The project will demonstrate the reliability required for commercialisation including testing new hydrogen refuelling stations able to serve large scale commercial bus fleets.

FCHJU Stakeholder Forum 2016, MOU signature ceremony.
Front row: FCHJU Executive Director Bart Biebuck & COR President Markku Markkula

Similarly the H2FUTURE project will build and demonstrate a 6MW electrolysis power plant in Austria that will be prequalified to provide grid-balancing services. The demonstration will access low-cost power to generate hydrogen economically for use in steel-making processes, and also attract additional revenues from grid balancing services. The project should lead to rapid deployment of this technology in the steel, fertilizer and other process industries requiring 'low-carbon' hydrogen streams.

GLOBAL AND LOCAL

Fuel cells and the hydrogen economy are gaining greater recognition in the frame of the global discussion on Climate Change policy, in particular at the recent COP22 meeting in Marrakech. With the ratification of the Paris Agreement governments all over the world are setting up research programmes for green technologies including programmes for fuel cells and hydrogen. With the FCH JU, Europe is already ahead of the game.

The PPP is also reaching out to European regions and cities, which are increasingly acknowledging the unique potential of this innovative technology. Participants are working together to reinforce synergies and collaborations to facilitate and accelerate market introduction.

To find out more about the activities of the FCH JU please visit our website at http://www.fch.europa.eu.

During 2017, amongst many other events, FCH JU will organise, together with its transport projects, a major conference on Transport and Fuel Cells in September; and its 10th annual Stakeholder Forum will take place in November.

The EU Roadmap to Smart Water Management: The WIDEST project and the ICT4WATER cluster

By Dr Lydia S. Vamvakeridou-Lyroudia[1], Gabriel Anzaldi[2], Sander Smit[3] and Aude Glenisson[4]

Water and energy are intimately linked and this relationship is often referred to as the Water-Energy Nexus. The understanding of this Nexus has provided the evidence that saving water saves energy. This encompasses Water Management at two levels: at water utility/operator and at household level, where about 18-30 per cent of final energy across Europe is attributed to home use.

The success of the application of smart technologies in the water domain coined the concept Smart Water Management, which currently is the most efficient way to reduce energy consumption in water supply and distribution networks at both utility/operator and household level. Consequently the Smart Water sector is thriving, with an expected global growth from USD 8.46 Billion in 2016 to USD 20.10 Billion by 2021, at a CAGR of 18.9%.

For the past five years the European Commission (chiefly DG Connect) has been continuously funding several Research and Innovation Projects, related to this domain. Prompted by DG Connect, they have formed a cluster for ICT and Water Management: the ICT4WATER cluster (www.ict4water.eu). Currently 22 EU funded projects have joined this cluster, bringing together over 200 institutions and businesses.

The ICT4WATER cluster is a hub for innovative activities related to ICT for Water Management, organizing/participating at major exhibitions and scientific events and disseminating results through major channels. For the past two years it has been supported by the WIDEST (www.widest.eu) project, a Coordination and Support Action promoting an interconnected ICT for the Water Community.

Moreover, on the request of the EC, Marcin Stachura (m.stachura@mchtr.pw.edu.pl) has drafted, based on the inputs the cluster projects and relevant reports, the Roadmap 2016 on Emerging topics-and technology in ICT and Water management which is closed linked to the policy on EC Digital Single Market : https://ec.europa.eu/digital-single-market/en/news/emerging-topics-and-technology-roadmap-ict-water-management-august-2016. The document presents the main gaps and challenges that need to be addressed in the future development of the ICT for water management sector: Big Data, Data Infrastructures, Links with Smart Cities, Water-food-energy nexus, Standardization. The report proposes a technology roadmap, which suggests the creation of a borderless Digital Single Market for water services to foster the transition of ICT technologies in water sector from pilot scale to wide market uptake.

Currently the ICT4WATER cluster is contributing to the DG Connect "Action Plan to Digital Single Market" (to be delivered at the end of 2017), which will take as reference the previous work and forum of actors/experts related to the ICT4Water cluster, where synergies were very fruitful for project development and knowledge sharing/progress between stakeholders and experts. It will identify the gaps and propose an action plan of concrete actions relating to R&D and possible regulation in the area of ICT and water; it will enhance emerging water issues (current and future trends) in terms of data management, interoperability and standardization including the investigation of the ICT GHG Footprint; it will define classification/justification of problems and solutions; it will identify cost/benefit estimates of problems and solutions and synergies between the proposed solutions and with other related sectors (e.g. circular economy, transport, energy and smart cities).

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What future for hydrogen in shipping?

By Gesine Meissner, MEP (pictured)

In 2015, approximately 1.8 billion tonnes of goods were transported by ships within the area of the EU, Norway, Iceland, and Turkey – representing a significantly higher amount of goods in comparison to air transport (Eurostat, 2016). Statistics confirm that shipping is a fundamental part of the EU's transportation system. At the same time, the sector remains a major emitter of greenhouse gases with negative consequences for the decarbonisation of Europe's transport sector.

As the president of the European Parliament's intergroup for Seas, Rivers, Islands and Costal Areas (SEARICA) and a member of the Transport Committee, I am facing the challenge of strengthening the EU's maritime economy and

promoting more sustainable shipping. However, in my opinion both aims are not mutually exclusive, providing possibilities for innovation and new investment opportunities: Among them alternative fuelling systems, improving efficiency in designing ships or further development of propulsion systems – just to name a few. For this article, I want to focus on hybrid engines and the option of using biofuels like methanol or ethanol as relevant case studies.

Hydrogen – an energy carrier and source for fuelling – has significant benefits. The EU agreed to promote hydrogen fuel cells and hydrogen technologies until 2024 (European Parliament, 2015). Firstly, hydrogen can be produced and refilled during the shipping itself by using solar or wind power. Consequentially, the usage of hydrogen could not only reduce carbon dioxide emissions, but present a solution against the dependence on limited sources of energy. Secondly, methanol as a maritime fuel has the big advantage to only produce water and carbon dioxide when burned. Furthermore, by not discharging any sulphuric oxides and oil methanol has less impact on the maritime environment. Thirdly, to run a container ship a vast amount of electricity is needed for lights, computers, and sensors. Usually the engine is the sole energy source for lights and the ship's instruments. Hydrogen could be used to establish a decentralized energy grid, which would increase efficiency, safety on board and save materials constructing a ship.

However, using methanol and liquefied hydrogen require changes for engine systems, which is costly. Moreover, it raises issues related to safety and spatial adaptation to use both fuels. Both substances are highly flammable and the flash point of methanol is only 12°C making it a dangerous substance. Furthermore, the production and processing of liquefied hydrogen is rather inefficient. Compared to diesel, which has an efficiency of 52%, liquefied hydrogen's efficiency is only 29% (International Energy Agency, 2015). However, hydrogen fuel cells have an efficiency of 52.3%, making this hydrogen technology even more efficient than the diesel used right now.

At this point in time, hydrogen is still a novel maritime fuel and fuelling source for most sectors. In 2010, the first passenger ship completely fuelled by hydrogen went into operation. In terms of container shipping the technology is not in use yet. It will take time to develop the necessary infrastructure and technology to use it on a large scale. Nevertheless, the groundwork for using hydrogen and its potential has to be worked on now. That is why I support the EU's decision to improve the research on hydrogen by using up to 470 million Euro of EU funds and including money of the private sector in the context of public-private partnerships (European Parliament, 2015). In the end, market dynamics will determine if these energy sources can succeed. It is our obligation as politicians to set the right legal framework, which can unlock investment, facilitate research and ensure a safe implementation. If these steps are done the right way, I believe it will be valuable for the future of shipping and the maritime economy.

Gesine Meissner (MEP/ALDE) *comes from the German state of Lower Saxony. She is the FDP's delegate for Germany's Northern and North-eastern regions in the European Parliament. She is the liberal group's vice-coordinator in the EP's Transport Committee and substitute member in the Environment and Industry Committees. Moreover, she is president of the European Parliament's Intergroup on Seas, Rivers, Islands & Coastal Areas (www.searica.eu/en/) as well as vice-chair of Germany's Liberal Women. Maritime and transport issues are close to her political heart because of the sectors' immense importance for the future.*

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The E-ferry project: breaking new grounds in Green Electric Mobility

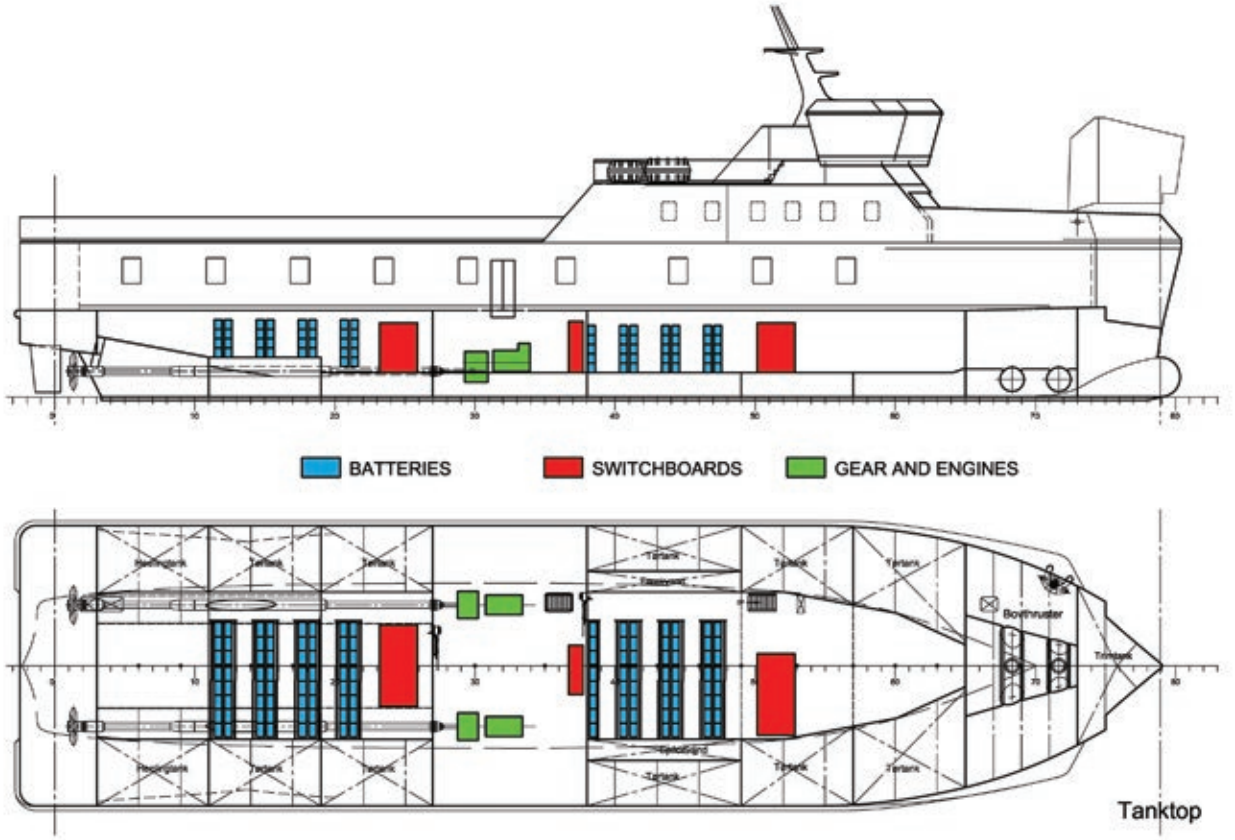
NEW ENVIRONMENTAL TRENDS AND CHALLENGES

One of the major trends, in the world, is to move towards environmental-friendly solutions in as many fields as possible. Ferry services are facing significant challenges, among which, increasing price of energy, demand for energy-efficient sources and evolution of the regulation on GES emissions. Recent studies indicate that fully electric battery powered ferries provide the most optimal solution to these challenges. However, at this stage, introducing these electric ferries involves serious investment and bares an innovation risk. These downsides have often lead to conservative, less environmental-friendly solutions that are hybrid ferries, as they are considered more commercially viable. Although it is not often considered, this notion of cost-effectiveness should include the cost for society of the resort to polluting diesel fuel powered ferries, leading to important pollution, health induced problems and global warming. The E-ferry project was created to concretely demonstrate the great potential of fully electric ferries and to help the emergence of a cost-effective vessel.

A GROUNDBREAKING-EU SUPPORTED SOLUTION

Co-funded under the Horizon 2020 Programme, with a total budget of more than 20m €, the E-ferry aims to support and promote energy efficient, zero emissions waterborne transportation for island communities, coastal zones and inland waterways in Europe and beyond.

E-Ferry is coordinated by the Danish island municipality, Ærø, currently operating 3 conventional diesel ferries on 3 different routes. The new vessel will be demonstrated in real-life conditions on the Soeby-Fynshav (a) and Soeby-Faaborg (b) connections in the Danish part of the Baltic Sea. To keep investments reasonable and to limit the stress induced by the



E-ferry
connecting blue and green

The E-ferry demonstration area

charging dock to electrical infrastructure, the E-ferry will only be charged in Soeby meaning the vessel will have to cover distances of up to 22 nm and be able to charge for only 15-20 min each time.

To meet the operating profiles, E-Ferry relies on a battery capacity of 4.3 MWh. Leclanché has optimized the energy density and the design of its Lithium-ion Graphite/NMC batteries to keep the physical dimensions of the full system at a reasonable level in terms of weight and size.

Weight and space savings are also accomplished through the implementation of Visedo's, electric propulsion and drive train system, offering unmatched energy efficiency and an extremely compact lightweight design, yet providing the required 1.5 MW propulsion power necessary to operate the E-ferry at the speed of 14.5 kts. The overall electrical system is based on Visedo's DC/DC converter technology and by charging the system directly with DC power, placed on shore, reducing the total weight by 20 tonnes.

Søby Shipyard and Naval Architects are jointly optimizing the performance of the entire vessel through an optimized hull-shape while Tuco Marine Group and The Danish Institute of Fire and Security Technology have joined forces to investigate the degree to which lightweight composite materials can be safely implemented in the E-ferry. On the safety side, Leclanché has been working for months on the certification of its entire Marine Rack System to meet the highest standards of the Danish Maritime Authority and DNV-GL (Certification in process).

Altogether, the E-ferry is a state-of-the-art vessel on every aspect of its design and construction. The environmental goals foreseen target reductions in CO_2 emissions by approximately 2.000 tonnes, NOX by 41.500kgr, SO_2 by 1.350kgr and particulates by 2.500kgr per year.

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Shipping in Changing Climates

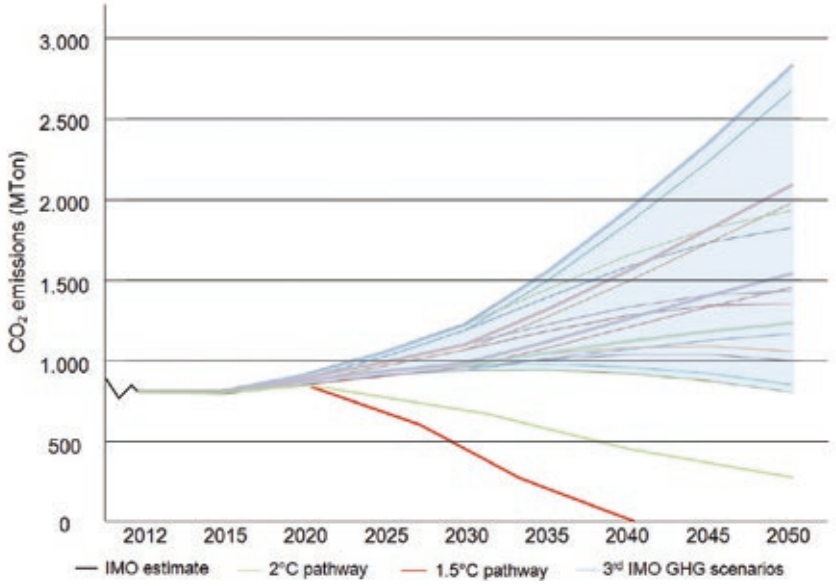
A multi-university and cross-industry consortium looking at the future of shipping in a carbon constrained world.

By Dr Nishatabbas Rehmatulla, Research Associate, UCL Energy Institute (pictured)

Shipping carries around 80% of the volume of international trade and although the high efficiency of deep-sea shipping leads to it contributing 2-3% of current global CO_2 emissions, without further action this share is likely to rise in the future due to rising demand and emissions reductions from other sectors. Shipping faces unique set of challenges in the coming decades due to a number of interacting factors, such as climate change (sea level rise, storm frequency); regulatory change (mitigation and adaptation policy); and macroeconomic environment (increased global trade, and changing trade patterns).

From the climate change perspective, the challenge for shipping is to bridge the emissions gap between the business as usual scenarios to a level consistent with limiting global mean temperatures to 1.5°C or 2°C. Figure 1 shows the gap between the blue fan of BAU scenarios forecast in the Third International Maritime Organization (IMO) greenhouse gas (GHG) study 2014, and the 2°C and 1.5°C pathway. If shipping is required to maintain its current share (2-3%) of global CO_2 emissions out to 2050, steep supply side reductions in CO_2 intensity will be required. Translating this at the ship level, the aggregate average operational CO_2 intensity for all ship sizes of containerships, tankers and drybulk (which account for 60% of emissions from shipping) requires a reduction of 80-90% on 2012 levels by 2050 in the 2°C scenario and net zero emissions in the 1.5°C scenario.

Figure 1: Shipping emissions trajectories under various scenarios



A HOLISTIC APPROACH

In light of the challenge, five UK universities joined hands with leading industry organisations to provide a holistic analysis and understanding on the subject of the shipping system, its energy efficiency and emissions, and its transition to a low carbon, more resilient future. The £4m Shipping in Changing Climates (SCC) uses a whole systems approach to understand the scope for greater energy efficiency of the supply side, understand the demand side drivers and to understand the supply and demand interactions and potential future evolution in shipping. In recognition of the challenge of managing and delivering outcomes in a multi-university, multi-disciplinary systems research, the SCC project is organised into three themes.

Theme 1 investigates the interconnection of ship design and performance analysis with environmental conditions and operational strategy validated using real-world operator data to propose improvements to existing vessels and step-change solutions for future. The Ship Impact Model (SIM) models the design and operational performance of all the components of the ship together, which allows for the ship performance (such as cargo capacity, fuel consumption and emissions) for many different design options to be assessed and compared. Key technologies for both potential new-

builds and retrofit options for the existing fleet are evaluated and their impact on the ship is noted. Emissions reduction, performance impacts, weight, cost and size, along with knock-on effects such as reduced cargo capacity are accounted for.

Theme 2 investigates the plausible future developments of international trade and resource availability to produce a suite of global scenarios for shipping. In doing so assesses the direct and indirect impacts of climate change on shipping. The framing of particular decarbonisation pathways will inform how future energy commodities might be traded in scenarios exploring future sea trade. Regarding non-energy commodities, a workshop discussed how socioeconomic indicators (such as those contained within the shared socioeconomic pathways) and projections might be used to establish future trade patterns. The findings suggest that a wide range of scenarios for trade and patterns of trade can be envisioned, all interacting closely with the evolution of the supply of transport (ships and shipping).

Theme 3 develops tools and deploys them in combination with the work on supply side energy efficiency (Theme 1) and demand side drivers for the analysis of the different pathways (Theme 2) and how transitions can be accelerated. The findings feed into a holistic system model (GloTraM), which has been in development and refinement by the consortium since 2010. GloTraM (Global Transport Model) is a socio-techno-economic model which starts with a definition of the global shipping system in a baseline year (2010) and then evolves the fleet and its activity in response to external stimuli (changing fuel prices, transport demand, regulation and technology availability). The model is underpinned by rigorous analysis of the existing fleet, along with the economics of technology investment and operation in the shipping industry.

The modelling is informed by qualitative research into behaviour

Figure 2: SCC consortium

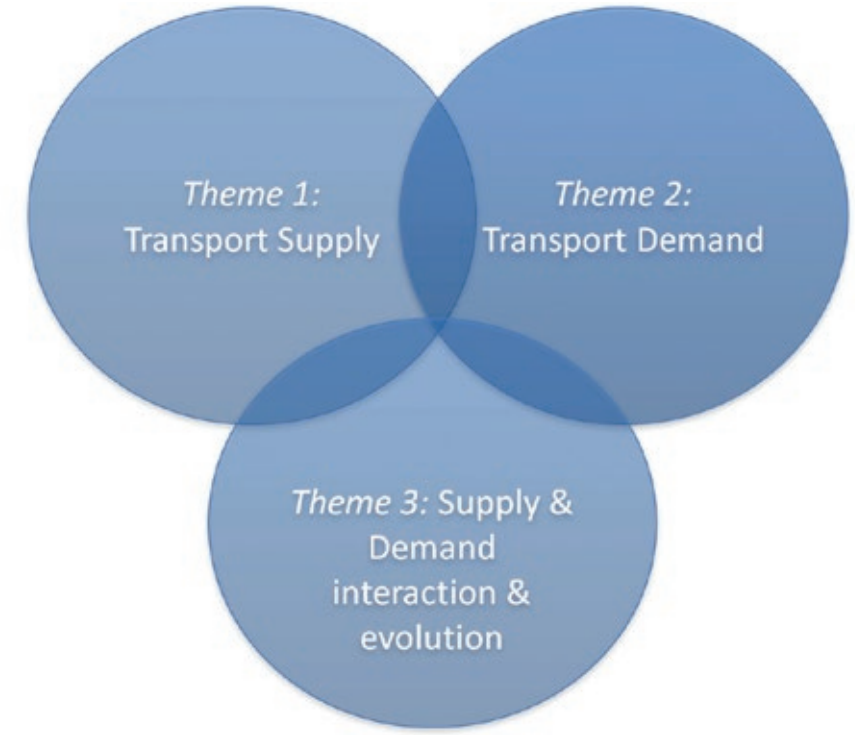


Figure 3: Cross-cutting themes in Shipping in Changing Climates project

in the current market and in order to understand current levels of implementation of energy efficiency measures a survey was conducted to which 270 shipping companies responded. The survey sheds light on the type of measures being implemented at the ship and company level. The survey shows that in general the uptake of energy efficiency technologies is low and the technologies that have higher uptake have small energy efficiency gains at the ship level and therefore not enough to lead towards decarbonisation in the face of rising shipping demand. Thus, decarbonising the shipping sector would have to be sought from step change technologies as well as dependable operational improvements and eventually weaning off from fossil fuels.

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Innovation and challenges in small scale and LNG bunkering in South-West Europe

The Spanish company, Enagás, is the coordinator of CORE LNGas hive project, co-financed by the European Commission, with the leadership of Puertos del Estado, it involves 42 partners from Spain and Portugal: 8 state-owned institutions; 13 port authorities; and 21 industrial companies such as ship owners, Liquefied Natural Gas (LNG) operators and suppliers of different services in the value chain. The total budget of the project is €33.3 M and its execution is planned to last until 2020.

The aim is to develop a logistics and supply chain for LNG that will allow it to be used as a transport fuel, particularly for maritime transport. Fostering the use of LNG in the Iberian Peninsula as the project will contribute to the decarbonisation of the European Mediterranean and Atlantic corridors. The

Iberian Peninsula is geostrategically located and has key gas infrastructure with which to consolidate its position as the European leader in this field.

LNG is the most environmentally friendly fuel, given that it generates about 30% fewer emissions of CO2 than oil. Moreover, it reduces emissions of sulphur oxides (SOx), particulate matter (PM) and nitrogen oxides (NOx), which will allow complying with increasingly tight environmental regulation demanded by the International Maritime Organization and the European Union, particularly improving the air quality of port environments.

The project aim to accomplish two specific objectives: one already done, the contribution to the National Policy Framework fulfilling the requirements of the directive 2014/94/EU on the deployment of alternative fuels infrastructure (Clean Power for Transport); and the other, to provide a roadmap and investment plan to scale up the results, in order to reach a larger commercial roll out of LNG infrastructure and equipment for maritime transport and port services.

CORE LNGas hive involves 14 studies and 11 studies with integrated pilot. The first ones are being considered the "software" of the project. They will allow, for example, identifying the standards needed to develop LNG as a fuel. They include:

- The prediction on the demand of LNG as a marine fuel both in Portugal and Spain, including and special study for the Gibraltar Strait since it is one of the most important bunker areas in the world.
- The identification of safety, environmental and technical national standards in order to assure an adequate frame in LNG bunkering operations, supported by the experience of Enagás. Taking into account the regulation that is being developed by international organizations, the project will go further, giving right inputs to the national regulators.
- The deployment of different kind of actions aiming to improve LNG social perception.
- The identification of the training needs in the whole logistic chain, and the definition of the training actions and accreditation processes. Training is vital in LNG as a new alternative fuel, to assure safety and security in operations. A whole structure needs to be defined, and the project helps the national regulators to construct it.

Regarding the studies with integrated pilots, known as the "hardware" of the project, they will test real parts of the LNG logistic chain, including the adaptation of LNG Terminals, and the:

- Development of the logistic chain, including the retrofitting of two bunker barges in order to supply LNG as marine fuel. Moreover, the project develops a pilot to test the multimodal transportation of LNG, by means of an ISO container, since it is necessary to increase the capillarity of the logistic chain and this solution can provide huge benefits.
- The use of LNG within the port environment. For example, it will perform the retrofitting of a straddle carrier (to move containers around the terminals) or the construction of a tugboat powered by LNG.

Note that in addition, the project will include in this "pilot testing" a real tank-to-wheel analysis that should confirm the better position of this alternative fuel with respect to others.

We believe that natural gas is the fuel of the future of transportation. Especially in maritime transportation, LNG is a down-to-earth alternative fuel to oil that also allows to comply with emissions regulations with the potential to produce saving to ship owners.

Co-financed by the European Union
Connecting Europe Facility

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Revolution/evolution in the natural gas markets

By András Gyürk, Member of the European Parliament (pictured)

We are living in times when we are witnessing a very important step in the evolution of fossil fuels. Observing it in a historical context, the evolution of fossil fuels closely resembles the evolution of species. The changing environment induces changes in the status quo, and the more adaptive and more complex are to prevail.

The large scale utilization of fossil fuels started with the use of coal in the days of the industrial revolution. The profound transformation based on the availability of coal provided unprecedented amounts of energy. It was relatively easy to exploit and to transport, spreading industrialization all around the globe. The next step in this evolution took place before World War I, when most navies switched from coal to oil as the fuel of their ships.

Winston Churchill, as First Lord of the Admiralty was the first to press for such a change, and after the British had switched to oil, other nations followed suit. With major developments in its exploitation and refining, oil could offer enhanced manoeuvrability and smaller scale application, which provided a competitive edge in naval warfare. This marked the beginning of the age of oil, as its use became predominant in transport and heating. Eventually it has replaced coal as the primary global energy source.

What we are experiencing nowadays is very similar to that shift. Natural gas is harder both to exploit and transport than oil, but it has some features – particularly its cleanness and efficiency – which make it a superior source of energy. Substitution is not possible in every application, for example it cannot be used as a feedstock in all cases, but the technological changes foretell a shift from coal and oil to natural gas. The prediction of the International Energy Agency about the coming golden age of gas could have been premature, but it is clear that the role of natural gas will grow in the next decades.

When contemplating the evolution of fossil fuels, we cannot overlook the common fate that will come to most species eventually: extinction. Natural gas might be the cleanest, but it still creates harmful emissions. Mass scale electrification and the spread of renewable energy challenge the rule of fossil fuels, but in my opinion, the end is not yet close. Not every application can be electrified and the intermittence of renewable power sources requires a flexible backup, which is most efficiently provided by natural gas. In the coming decades, both its overall demand and its share in the global primary energy consumption are expected to grow. It seems that natural gas will not become extinct soon, on the contrary, its importance is about to increase considerably around the globe.

The supremacy of oil started when it gained a truly global market. I would call a market truly global, when one can buy a standard amount in a fairly standard quality for a somewhat uniform price all over the globe. You can buy a barrel of Brent quality crude in Singapore and in Rio de Janeiro for about the same price at a given moment. Natural gas markets cannot perform like that because of the costs of transport (both for pipeline and LNG) and the lack of liquidity. Inadequate demand, combined with high fixed costs halted the development of natural gas markets, when suppliers tended to be monopolistic and long term contracted. With increasing demand and decreasing transport costs, the competition has intensified and the markets have become more liquid. We can already see the contract time horizons shrinking, while the terms of the contract become increasingly loose. With the LNG projects under way, which are to be realized in the next 2-3 years, we will see not just a boom in LNG trade, but also a massive and unprecedented integration of the markets.

This rapid development and integration of markets is essentially due to innovation. In the last decades we could see innovation reducing costs all over the supply chain, while unlocking previously untapped reserves. From the improvements in liquefaction and regasification, to the vast new shale gas production, the natural gas market has seen many fundamental changes, both incremental and transformational ones. These changes have revived industries and altered geopolitics, and those who adapted to them usually gained momentum.

I believe that, due to the rapid developments, gas markets will change fundamentally in the coming five to ten years, and I do not see the pace of the changes slowing down. Take for example Floating LNG (FLNG). The first operating floating facility, stationed in Malaysia, received first gas in last November, and is about to launch its first cargo in early March 2017, a historical moment. With such a novel technology, there are bound to arise new challenges and unexpected difficulties, but further innovation will surely tackle them, expanding natural gas production to previously untapped reservoirs.

As we have seen, the evolution of fossil fuels has accelerated, changing the status quo on the energy market. Technological and consumption changes have paved the way for a radical shift in business models. Although oil and coal are to stay with us for many years, they will not significantly question the primacy of the new champion: natural gas.

András Gyürk

- Born in 1972, graduated in history in Budapest
- 1998 – 2004 member of the Hungarian Parliament
- 2004 – member of the European Parliament (Committee on Industry, Research and Energy, EPP)
- 2010 – head of the Hungarian EPP delegation
- Shadow rapporteur on the Energy Union Package – A Framework Strategy
- Rapporteur on the EU Strategy for LNG and Gas Storage

LNG CASE (Clean Available Safe Economical) in shipping – early 2017 update

by Katarzyna Chrulska, Gas Infrastructure Europe (GIE)

ADVANTAGES OF LNG

A previous GIE[1] article published at European Energy Innovation in 2016 expanded on the advantages of LNG (liquefied natural gas) as a fuel. In brief, these include what we refer to as the CASE for LNG:

CLEAN

An unquestionable benefit of LNG as a marine fuel concerns its ecological character: compared to traditional oil-based marine fuels a nearly complete removal of SOX, low levels of particle (PM) emissions, reduction of NOX emissions of up to 90% and a reduction of CO_2 emissions by at least 25%.

European and international environmental regulations are one of the main catalysts for the use of LNG transportation fuel (see SECA and ECA zones). Several new environmental regulations are now on the horizon for the shipping community. Some examples are the EU CO2 monitoring, reporting and verification put in place in 2018, the Energy Efficiency Design Index (EEDI) phase 2 in 2020, the global IMO regulation setting a 0.5% sulphur cap by 2020, additional ECAs to be established, and a global CO_2 monitoring, reporting and verification system, among others. All these environmental regulations push fleet owners and shippers to find cleaner solutions and LNG fuelled vessels are a good choice for them from the

Liquified natural gas (LNG) is the alternative shipping fuel, reducing emmissions by up to:

…and emits few particulates.

Source: GasNaturally. Air Quality Brochure[2]

perspective of environment and human health given the proximity of sea ports to highly populated areas.

AVAILABLE

The technology is proven and the LNG distribution network continues to expand. LNG is available in large quantities and is able to meet the demand in the shipping industry. Moreover, the production technology of ship engines powered by LNG is mature and fully available.

SAFE

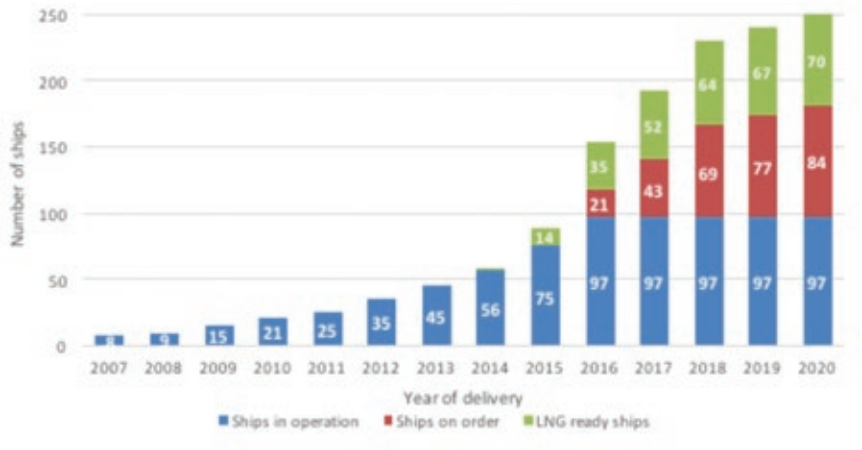
The LNG industry's highest priority has always been safety and security, which is reflected in the industry's enviable safety record for LNG operations over the last decades. This results from proven and detailed industry standards, strong regulations, and an industry commitment to risk management. Today, it is confirmed that LNG can be produced, transported and distributed on a safe manner.

ECONOMICAL

LNG provides an attractive solution from both economic and commercial points of view. As availability of infrastructure and competition increase, prices will continue to reduce further. The price of LNG is already much lower than the price of Marine Fuel Gas Oil (MGO) or Marine Diesel (MDO). Reducing pollution will lower emission fees and provide marketing benefits by highlighting the environmental nature of the fuel used.

According to DNV data[3] LNG propelled ship operation costs may be even 45% lower in comparison to standard MGO fuelled units over a 20-year period of operations. Efficient distribution planning combined with the use SSL NG units enables operators to divide fuel transport costs between several locations. Furthermore, the implementation of technical solutions based on LNG may well be a stimulus for further development of the industry at a local level.

LNG fuel ship projects



Source: Source: HHP Insight[6]

LNG IN SHIPPING

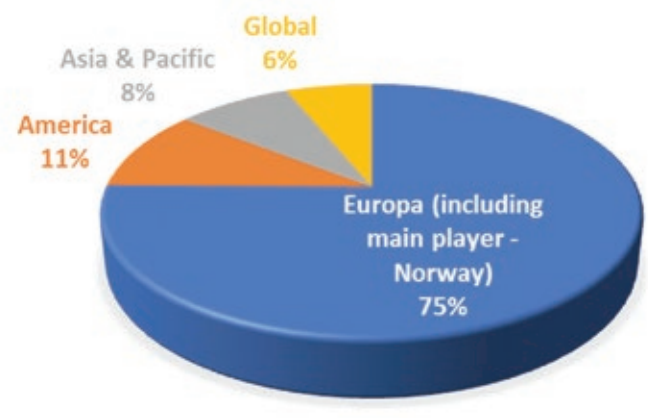
2016 Update and Factors Influencing Further Development

Since the first GIE article on LNG as marine fuel at European Energy Innovation Magazine one year ago many new developments have taken place. Below we briefly analyse some of the important factors influencing the further development of LNG.

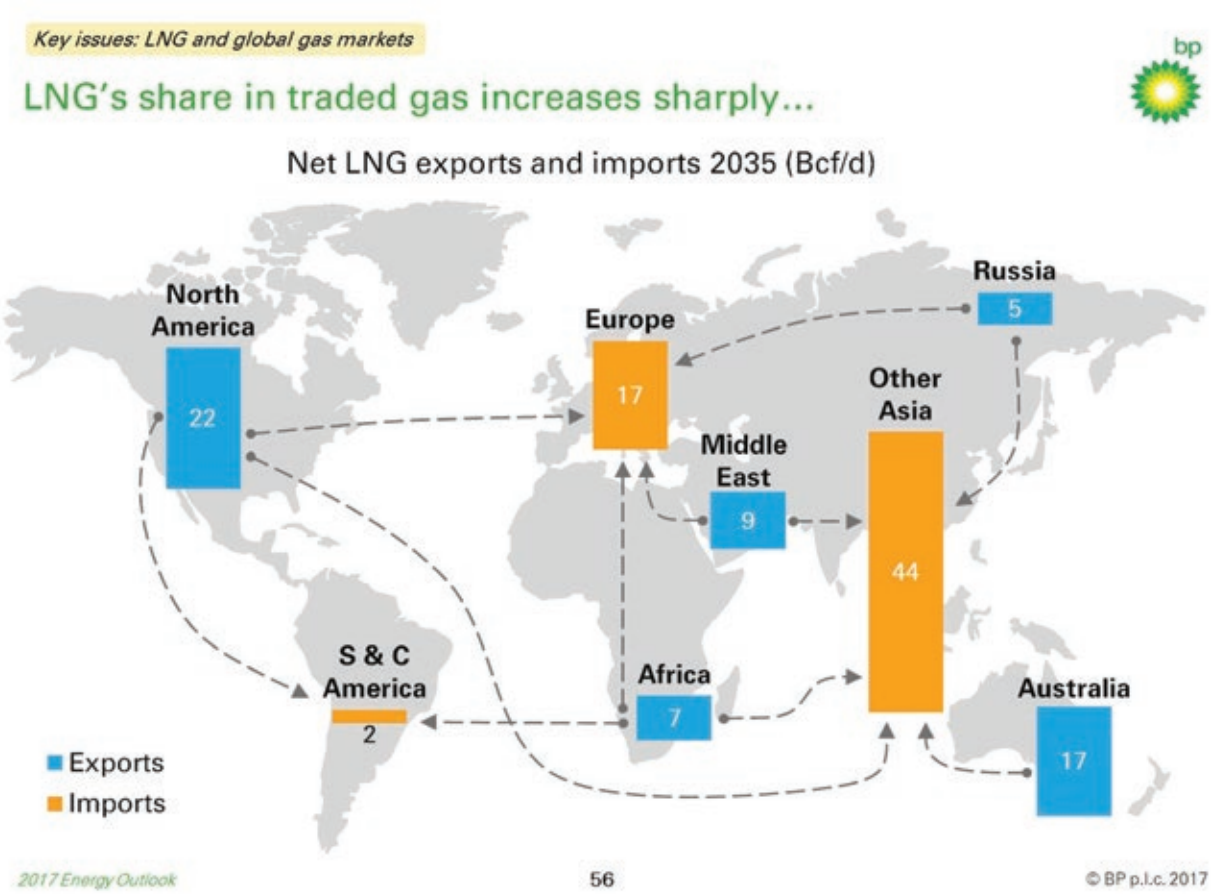
The number of LNG-fuelled vessels in operation has significantly increased in 2016. By the beginning of 2016[4] there were 75 LNG-fuelled ships in operation worldwide, with another 84 new ship-building orders confirmed. At the end of 2016 there were 97 ships in operation and a further 91 ships on order worldwide. Therefore, a 29% increase in the number of LNG-fuelled vessels (22 more) within one year! Furthermore, not only many new ships have been built but some ships have also been converted to run on LNG.

With these figures **Europe is currently the frontrunner in the operation of**

Operating area of LNG-fuelled vessels in operation in December 2016



Source: GIE based on DNV data[7]



Source: BP Outlook 2017

LNG-fuelled vessels: out of 97 LNG-fuelled vessels worldwide, 75% (73) are in operation in Europe.

A continued work in R&D and the emergence of interesting solutions further improving LNG technology in the maritime sector has also been observed during this period. A good example is *Project Forward* that is led by bulk carrier owner Arista Shipping, and in addition by Deltamarin other participants are ABS, GTT and Wärtsilä. The project is developing a technically feasible and commercially viable design for LNG-fuelled ocean-going vessels complying with the IMO standards. The concept is based on the optimized B.Delta design suitable for ships between 82,000 and 210,000 DWT. It will employ GTT's membrane-type LNG tanks for fuel containment. *Project Forward* will ensure a long sailing range for LNG which can easily be adjusted to fit the specific needs of each owner or trade pattern.

We can also observe increased development of intelligence software. A good example may be the *LNGi* portal[8] which offers comprehensive insights on the availability of LNG bunkering in the world as well as market data on LNG as fuel for ships. This platform also provides a map and positions of LNG-fuelled fleet's operating area, detailed statistics of the LNG-fuelled fleet and other related useful data.

SMALL SCALE LNG

Small Scale LNG offers a variety of different business services by the LNG terminals that go beyond the traditional unloading, storage and regasification services. For some specific Small Scale LNG activities, Europe (particularly some specific EU countries) has a long experience, with several hundred thousand LNG truck loading operations over the last four decades, together with very numerous LNG reloading activities over the last 20 years.

The current situation shows that investments in small-scale LNG are still being made everywhere in Europe. This includes not just LNG for use as a fuel but also increasing opportunities for using LNG in off-grid applications where the existing pipeline infrastructure is insufficient. Globalisation of LNG market increases competition and has a positive influence on the market by stimulating the innovations.

There is indeed a **visible tendency to invest in small-scale as well as in the majority of the large-scale LNG terminals in Europe**. The loading of bunkering ships is available for example in Spain, the Netherlands, Belgium and France. GLE (Gas LNG Europe) a column of GIE, regularly gathers and updates the *LNG New Services Inventory*[9]. It provides an overview of the new services (reloading, trans-shipment, bunkering ships, trucks and rail-loading) offered by the European LNG terminal operators.

An important factor in the development of small-scale LNG is not only the

increased availability of small-scale LNG infrastructure, but also it is also equally important to ensure **the increased availability of LNG on the supply side**. In this regard, European market players are particularly interested in observing the developments associated to US LNG. The US Henry Hub prices are still well below prices in Japan and the EU. This makes US LNG exports to these regions profitable. DNV GL analysis expects a substantial increase in LNG exports from North America (from 6 to 105 mtpa[10]) between 2016 and 2025. These projections can be supplemented by BP analysis that expects the global LNG trade to grow seven times faster than pipeline gas trade[11].

LNG terminals in Europe offer abundant available capacity to receive LNG either from US or other parts of the world. For several reasons, including security of supply and market functioning, several new LNG terminals have recently been commissioned in Europe (e.g. Swinoujscie LNG in Poland and Dunkerque LNG in France) and the capacity of others is still being expanded (e.g. Revithoussa in Greece). Enhanced availability of LNG regasification capacity ensures that the potential of LNG is explored across the EU member states, including in those countries where LNG is expected to have a positive influence from the perspective of diversification of gas supply sources and gas-to-gas competition.

This observed intensive development confirms our thesis put forward in the previous article that the chicken-or-egg problem regarding the issue of using LNG as fuel in shipping no longer exists. Indeed, we can observe both a significant development of bunkering infrastructure at different LNG terminals, while a significant increase in the number of LNG-powered vessels is taking place.

GLE SUPPORTING SMALL-SCALE DEVELOPMENT

GLE is active in LNG advocacy and interested in the small scale LNG business. **GLE sees the direct use of LNG as transportation fuel as an exciting opportunity for cleaning up the heavy transport sector**. GLE regularly gathers data and actualizes the *Small Scale LNG Map*. The last map was published in 2015, and there will be a new updated map available on the GIE website in the middle of 2017.

GLE has also published a GLE Position paper on Small Scale LNG, where it concludes as follows, "GLE is excited about the opportunities offered by Small Scale LNG and will play its part in promoting its further development in a safe way." Today, GIE/GLE confirms again our statement and fully supports the LNG CASE (using LNG because it is Clean, Available, Safe and Economical). GIE/GLE is looking forward to its great future and taking an active part in its creation as GIE members are key players in the European gas market.

1 See for more details – LNG CASE (Clean Available Safe Economical) in shipping by Katarzyna Chrulska (GIE) Spring 2016 European Energy Innovation
2 www.gasnaturally.eu/uploads/Modules/Publications/air-qualityfinal.pdf
3 The age of LNG is here. Most cost efficient solution for ECAS, June 2010
4 Data from DNV actual for 11 January 2016: DNV GL – LNG-fuelled vessels. Ship list – Vessels in operation and vessels on order
5 Data from DNV actual for 9 December 2016 – Presentation: Enabling LNG Infrastructure presented by Johan Holstein at DNV GL Gas Day 2017- Warsaw
6 hhpinsight.com/marine/2016/03/dnv-gls-new-lngi-man-rolls-shell-sign/
7 Data from DNV – Presentation: Enabling LNG Infrastructure. DNV GL Gas Day 2017 – Warsaw
8 launched by DNV
9 www.gie.eu/index.php/maps-data/gle-lng-services-inventory
10 million tonnes per annum
11 www.bp.com/content/dam/bp/pdf/energy-economics/energy-outlook-2017/bp-energy-outlook-2017.pdf

Author:

Katarzyna Chrulska

GIE Member and Manager LNG Division of GAZ-SYSTEM in Poland, GLE[1] Gas Advocacy Chairwoman within GIE in the years 2011-2014

Gas Infrastructure Europe (GIE) is an association representing the interests of European natural gas infrastructure operators active in natural gas transmission, storage and LNG regasification. 16 European LNG terminal operators from 9 countries, operating around 90% of the existing LNG regasification capacity in the European Union, are members of GIE.

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EUCASS is offering two conferences with great relevance to energy this year

The state of the art in European Aeronautics and Space will be presented in July at the seventh EUCASS conference. The gathering will be hosted by POLIMI in Milano (http://www.eucass2017.eu/). We'll be over 600 participants among the best professionals in Continental Europe, Russia included. A significant number of experts from all other continents are also joining. Indeed, EUCASS, the European Conference for Aero-Space Sciences, is the second largest scientific conference on the continental scale after AIAA's SciTech in the USA. The association was launched in 2004 and ran its first ever conference in Moscow in 2005. Since then, this biennial event has set foot in the major European countries engaged in aeronautics and space.

The agenda this July will comprise:

- 600 presentations on all of the relevant enabling sciences, organised in workshops and five major symposia;
- comprehensive reviews of the main European aeronautics and space programmes;
- lectures from decision makers about future programmes on launchers, space missions, flight economy in commercial aviation, ATM, etc.

In many ways, the conference is singular. Its focus is mainly on enabling sciences and R&T. At the outset, its programme is structured to stimulate cross-fertilisation between the two domains aeronautics and space. This year it will also showcase the virtues of multidisciplinary research management and present some of its success stories.

Cross fertilisation and multidisciplinarity can be very fecund if implemented in partnership with other end users in the field of energy. Consider for instance launching or further developing bridges between:

- Helicopter rotor and windmill developments;
- Electric/hybrid propulsion of passenger planes and ground production of electricity and/or hydrogen;
- Surveillance of power lines, motorways and railroad tracks with automated or remotely controlled drones;
- Development and storage of alternative fuels;
- Advanced methods using pulsed high pressure plasmas for flow and combustion control;
- Etc..

Join us in a two-way exchange. You may have solutions unknown of the aerospace world and vice versa. Joining our EUCASS 2017 conference may open new visions, new markets for you, or allow us to leapfrog our competitors in key areas and/or pass on to you advanced expertise. You may still be able to submit a paper[1].

In any case it is in your interest to come, catch up with us and embark in discussions about your own activities and solutions, and so much so whether they address basic science or prototype development. You may also want to follow the plenary on funding opportunities in Europe. Expect presentations from the EC, the major space agencies, and some foreign agencies that have supported us like AFOSR or ONR.

Last but not least, if you prefer quieter environments and blue-sky research, please consider joining our forthcoming Aerospace Thematic Workshop on Plasmas for Flow and Combustion Control (https://www.eucass.eu/index.php/conferences-and-publications/atw-2017) scheduled near St Petersburg in April. The field is over two decades old and maturing. It may hold the solution to your problems in atmospheric pressure fluid flows or in control of flames and pollution. The 20 best specialists worldwide will lecture in the physics and chemistry of this promising discipline. Fundamentals, instrumentation and applications will be presented.

This community of specialists is very warm, like a family, and the venue is outstanding.

If you believe you do have a presentation that could be of interest to us, please contact taran@onera.fr




Technical efficiency and socio-economic impact of clean shipping in focus

Environmental Impact of Low Emission Shipping: Measurements and Modelling Strategies – EnviSuM

Shipping regulations and environmental investments have been discussed widely in the media, as well as by politicians and lobbies. However, only limited information is available on the technical efficiency and socio-economic impacts of the different clean shipping solutions and of their capacity to comply with the regulations. Cross-sectoral , cross-border discussions and novel tools are needed by the authorities, policy makers, NGOs, and the private sector for knowledge-based decision-making. Specifically, policy makers and authorities are faced with a lack of information for the development of future environmental regulations. Similarly, the shipping sector needs to make knowledge-based investment decisions.

We answer questions on the shipping industry's compliance with the environmental regulations for shipping such as the efficiency of different techniques or fuels for removing pollution (e.g SOx, NOx, particulate matter, CO_2 and methane) from exhaust gases. The cost-effectiveness of various measures taken to comply will be studied.

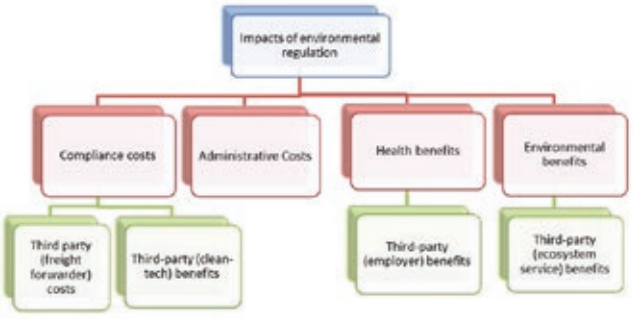
Measurement and modelling strategies, for compliance with the regulations, will enable us to assess current and future compliance costs as well as the effects on health and the environment. We will provide analysis and tested tools, as well as recommendations, which will be a benefit for the welfare of the people of the Baltic Sea Region

At the same time, the outcomes of the project will support maritime businesses and economic growth. The clean shipping solutions provide business potential in the form of eco-innovation. The Baltic Sea Region is a forerunner in this respect, and it acts as a living lab for clean shipping.

The development of clean shipping solutions and technologies supports spin-off companies and provides leadership for European industry in the global markets

The effectiveness of one specific regulation, namely the Sulphur emission control area (SECA), will be analysed by comparing the costs and benefits of the regulation ex post. As part of this work, we will offer a free web-based economic decision tool for companies to be able to decide on the best investments to cope with SECA regulations, and for other maritime target groups to estimate investment costs .

Figure 1 Direct and indirect categorical impacts of environmental regulation



In addition to promoting technological development and improving future regulation, we will be active in integrating the results into the wider community and society. Answering the globally increasing demand on air quality improvement will ultimately bring economic opportunities and well-being for BSR citizens. We propose a comprehensive regulation impact framework for socio-economic effects that can be extended to other environmental regulation to support the needs of consistent and reliable evidence-based maritime policy (Figure 1).

The flagship project involves 12 partners from Denmark, Estonia, Finland, Germany, Norway, Poland, and Sweden. In addition, there are 17 associated organizations, including Russian partners.

Lead Partner: University of Turku, Finland.

Funding: European Regional Development Fund, EUR 3.2 million.

Deadline: February 2019.

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Greening maritime transport: what options in an increasingly climate sceptic world?

By Michele Acciaro

The change in the US leadership and the consequent emboldening of climate change sceptics can have far-reaching implications on the success of shipping climate-change policy globally. The complexity of regulating a global sector such as shipping has stalled the efforts to develop a comprehensive policy for Greenhouse Gas (GHG) emission reductions in maritime transport, notwithstanding the clear mandates to the IMO from the UNFCCC, the positions taken by IMO secretary general Kitack Lim, the discussions at recent COP22 and pressure from environmental groups, individual countries and the European Union.

Developing sound climate change policies for shipping is already so challenging from a technical and operational point of view, that a shared political vision is essential. As in the case of many policies, also regulating GHG emissions in shipping raises complex ethical and economic issues, and a shared political vision can only be built on scientific evidence and verifiable facts, as well as an honest commitment to the wellbeing of humanity.

The contribution of shipping to climate change is substantial. According to the *3rd IMO GHG Study*, published in 2014, CO_2 from shipping accounts on average for 3.1% of annual global CO_2 emissions for the period 2007-2012. International shipping, that excludes domestic shipping, military and fishing vessels, accounts on average for 2.6% of annual global CO_2 emission for the same period, while CO_2e emissions for international shipping, accounting for methane emissions (CH_4) and nitrous oxides (N_2O) are estimated at an average 2.4% of global emissions for the period 2007-2012. It should be noted that these estimates are averages and on some years CO_2 emissions from shipping and international shipping reached 3.5% and 2.9% of total yearly emissions respectively.

Notwithstanding the uncertainty that characterises this type exercises, the IMO estimates are considered reliable by all stakeholders and most importantly, by the International Chamber of Shipping as a representative body of the global ship-owning community, which in multiple occasions has reiterated the willingness of the shipping world to do its *fair share* to curb GHG emissions. But what this *fair share* actually is, is a subject of heightened debate. One of the main challenges is that estimating the growth of emissions from shipping in the coming decades depends quite dramatically on the growth of the volumes of cargo and passengers transported by seagoing vessels, ship productivity, the uptake of energy efficiency technologies, the fleet renewal rate, and international as well as regional regulation, among other factors.

Those factors are inherently difficult to estimate but it might be worthwhile at least to get a feeling of the order of magnitude of these emissions to be able to appreciate the challenge ahead. The already cited 3rd IMO GHG report projects emissions from shipping to rise between 50% and 250% in the period to 2050. It is worth noting that the International Panel on Climate Change suggested in 2014 the need for a global CO_2e reduction in emissions from 2010 baseline by 2050 in the range of 72% to 41% to be able to maintain global warming below 2°, and even higher reductions by 2100. Shipping emission changes are far away from the required reductions, notwithstanding the impressive year on year relative reductions that the sector has been able to achieve, admittedly also as a result of the world economic downturn following the 2008 financial crisis. The level of emissions from shipping that should be generated by 2050 to meet emission targets similar to the global ones are 5 to 20 times lower than the business as usual scenarios and equivalent to an approximately sustained 10%-15% yearly reduction in total emissions from shipping.

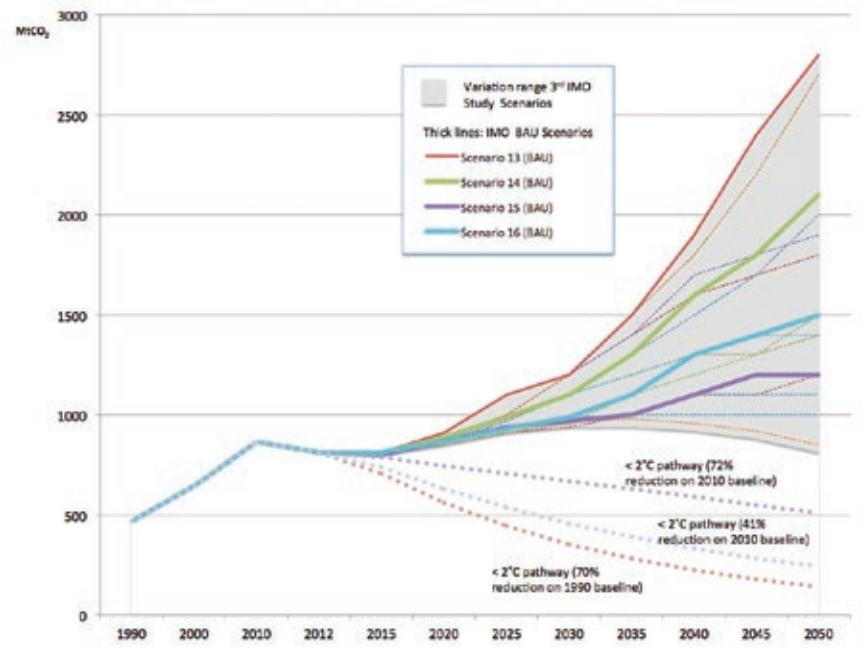
Achieving such cutbacks in emission levels will be challenging and will

require the deployment of all existing GHG reduction measures and the development of new technologies and operational strategies to increase energy efficiency. Given that emission reductions often result in cost savings, these measures are categorised in economic terms by listing them on the basis of the costs reductions or increases that they can generate, often making use of the so-called *Marginal Abatement Cost Curves (MACCs)*. Generally these measures are divided into operational measures, technical measures and alternative fuels and forms of propulsion.

Operational measures include changes in ship operational variables such as speed, routing, etc. that can be performed without or with limited technical changes on board of vessels. Technical measures refer to the physical modification of machinery or the structure of the vessel, while alternative fuels and forms of propulsion entail more substantial modification of the type of fuel burned by the ship or the main form of propulsion, such as LNG, methanol, wind, etc.

Assessing how GHG emissions can be reduced through these measures is a complex exercise and estimating *MACCs* a few decades ahead needs relying upon assumptions on technology cost reductions, demand development and innovation uptake rates, among other factors, that inevitably limit the accuracy of the estimates. Existing literature on the efficacy of these measures, however, shows that the emission reductions for the global fleet achievable with cost effective measures will not allow meeting the targets associated with a fair allocation of CO_2e budgets to shipping. Depending on maritime transport demand growth and regulatory developments, even non-cost effective measure could fall short

Figure: CO_2 emission projections (million tonnes).



Source: IMO 3rd GHG Study, table 78; and assumptions based on Anderson, K., and Bows, A. (2012). 'Executing a Scharnow turn: reconciling shipping emissions with international commitments on climate change', Carbon Management, 3(6): 615-628, and IPCC, 2014. Climate Change 2014: Synthesis Report, Cambridge: Cambridge University Press.

of meeting the required emission reductions simply because of lack of fuel-stock for alternative fuels, limited technology uptake or slow shipping fleet renewal rates.

Such outlook does not only call for a clear and decisive regulatory response to shipping but also for additional resources to be invested in the sector. The pace at which regulation in this area is being developed has been slower than what would be advisable considering the challenges ahead and the long times that the industry needs to react to new environmental regulation under rather challenging market conditions. The last thing that the sector needs is to start questioning the foundations of climate science on which to develop its future policies.

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LNG as an alternative fuel for the Transportation Sector
The Inland Shipping Sector

The Transportation sector will grow enormously in the coming years. Today freight transport - especially on the road and on the waterways - has been mainly depended on mineral oil as an energy source. This would lead to an even higher air pollution and noise level as much as to an increase of CO_2 emissions for the climate. According to the climate protection plan of the state of North Rhine-Westphalia, a part of the expected growth in freight transport should be shifted from road to rail and inland waterways. In general inland waterway vessels generate lower CO2 emissions compared to road and rail transport, based on the transported goods and distance kilometers (emissions / t * km). Although a ship can replace many trucks, the old diesel engines blow a lot of pollutants into the air. Especially the emissions of nitrogen oxides (NOx) and particulate matter (PM10) in marine engines are now higher than those of road and rail.

Concerning possible measures to reduce emissions from the European barge fleet (about 14,000 vessels), there is a lot to be done in comparison to advanced engine and exhaust gas technologies in road traffic. Already air pollutants such as particulate matter, sulfur and nitrogen dioxides are causing a high air pollution, especially in cities along the waterways. This is also confirmed by the emission cadastre of the State Office for Nature, Environment and Consumer Protection of North Rhine-Westphalia (LANUV NRW). The measurement cadastre showed that in 2014 only 12% of the measuring stations moved within the limits of the EU according to Directive 2008/50 / EC. The increased air pollutants can lead to health damage to the population, especially in agglomerations. The consequences are respiratory diseases, especially asthma, bronchitis and cancer. In the case of an increase in inland waterway transport, the deterioration of air quality, especially in the cities near to the ports, is to be feared when the engines currently in operation are used.


LNG Barge, source: Shell

Liquefied natural gas (LNG) could be a climate and environmentally friendly alternative to diesel and heavy fuel oil. LNG is produced when natural gas is cooled and compressed at -162 ° C with constant pressure. Compared to the compressed gas (CNG = Compressed Natural Gas), the considerably higher energy density allows ranges of up to 1500 km for trucks and enables the use of an alternative fuel in heavy-load traffic and in shipping. The advantage of LNG is that there are no particulate matter emissions, no SO2 emissions (sulfur), 80-90% less NOx emissions (nitrogen oxides) and a CO_2 savings potential of 10-20%. The addition of biomethane could even reduce CO_2 emissions by up to 80%.

On the other hand there is almost no infrastructure in North-Rhine-Westphalia nor in Germany at all. Technical and legal standards and framework conditions must be harmonized and established across Europe. In the autumn of 2016, two European projects have been launched to promote LNG as an alternative fuel for heavy duty vehicles and inland vessels (LNG PILOTS) and

measures for clean inland waterways (CLINSH).

The EU-funded project LNG PILOTS (INTERREG V A Program) is supporting the development of innovative solutions for the transport (heavy duty vehicles and Inland Shipping) as well as the industrial sector in LNG. Under the leadership of the Stichting Energy Valley (Groningen, Netherlands), a consortium of 36 partners from North Rhine-Westphalia, Lower Saxony and the Netherlands has formed to promote the introduction of LNG as an alternative fuel in cross-border freight transport and support building up an infrastructure.

The EU Life project CLeanINlandSHipping (CLINSH) is a European consortium promoting clean inland waterway transport. Within CLINSH dutch, belgian, german and english public and private organizations are working together. The main objective of CLINSH is to improve air quality in urban areas by accelerating emission reductions in Inland Waterway Transport. Despite several improvements Inland Waterway Transport is still a major source of air pollution. The performance of various emission reduction techniques (e.g. after-treatment of exhaust gases) and alternative fuels (LNG, GTL) will be tested on 30 ships. Before and after these adjustments the ships emissions (NOx and PM) will be monitored under real life conditions. Also the chances for further introduction of on-shore power supply will be investigated. The Measurement results are collected in a database that provides a tool for local, regional, national and European governments for (new) policies on the greening of waterways. Also, these data provide skippers with more insight into the most cost effective environmental measures for their ship.

For a transit state like North-Rhine-Westphalia with a high population density the need to reduce CO_2 emissions and to improve the air quality especially in the cities along the waterways is crucial. The Fuels and Drives of the Future Network of the EnergieAgency.NRW has supported the project initiation and accompanies the relevant projects to support the introduction of climate and environmentally friendly fuels in freight transport. To implement an alternative fuel for the transport sector international cooperations are needed. Together with the Gas and Heating Institute Essen (GWI = Gas- und Wärme-Institut Essen e.V.) the EnergyAgency.NRW organizes an international workshop the„4th LNG Roadmap– LNG as a driving force for cross-border cooperation within Europe" on the 31st of May 2017 in Düsseldorf, Germany. The event will highlight the development of the LNG as an alternative fuel for inland navigation and for heavy-duty commercial vehicles as well as for industrial applications. The 4th Workshop "LNG Roadmap" is a follow-up event, which gathered in 2014, 2015 and 2016 more than 100 guests each year from all over Europe (Germany, Austria, Belgium, France, Norway, Great Britain, the Netherlands and Switzerland). ●

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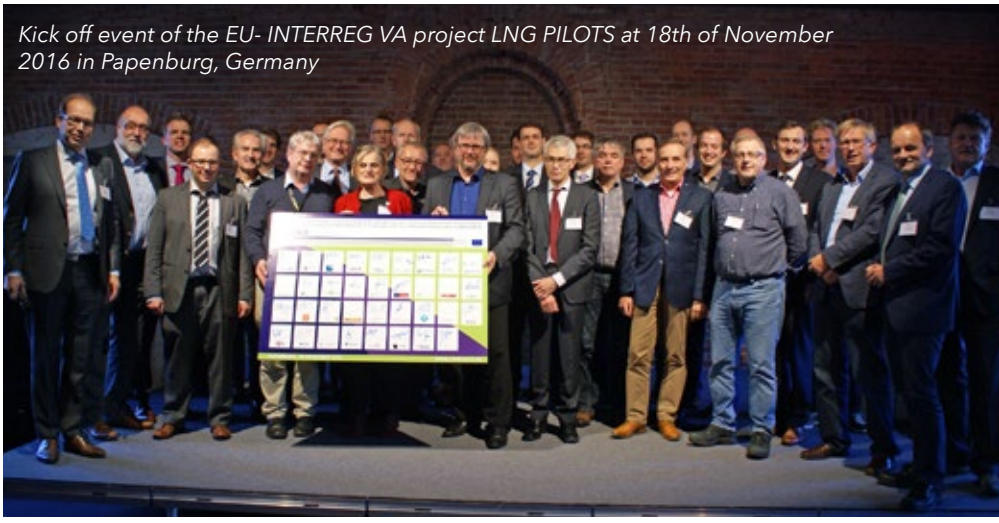
LANUV- press conference at the laboratory ship Max Prüss during the Kick off event of the EU Life Project CLINSH on 27th of Octobre 2016 in Düsseldorf, Germany

Kick off event of the EU- INTERREG VA project LNG PILOTS at 18th of November 2016 in Papenburg, Germany



Interview with Kristian Ruby, EURELECTRIC's new Secretary-General

Kristian Ruby took the helm of EURELECTRIC at a time when Europe's electricity market is embarking on a major transformation. Kristian is Danish and he joined EURELECTRIC from Wind Europe, where he served as Chief Policy Officer. Kristian provided us with his views on his priorities, the Clean Energy Package and the upcoming challenges facing the sector.

You took the helm of EURELECTRIC in January 2017. What are your immediate priorities for EURELECTRIC?

I would like to unite the sector around a new vision for the future. Sector coupling and decarbonisation will be my main priorities. For me, electricity is the energy carrier of the energy transition and I believe there are huge business opportunities for our industry in this societal transformation.

The Clean Energy Package, presented by the European Commission last year, provides a business case for investments in the energy system of the future. In this context, we would like to see a reform of the ETS system and further progress on the electrification of the transport sector.

Speaking about the Clean Energy Package, how do you assess the package from a current perspective? What do you agree with?

EURELECTRIC was pleased with the content of the Clean Energy Package. The publications underpin market integration and the removal of some regulatory interventions, which distort market functioning. The EU was in need of a level playing field, as well as proposals to ensure that energy prices truly reflect scarcity situations. We were also pleased to see the common principles for the design of support schemes and the acknowledgement of the prominence of distribution system operators (DSOs) in the energy transition.

What do you think still needs to change in the Clean Energy Package? What will EURELECTRIC focus on?

We expected the Clean Energy Package to show more consistency, not only between the climate and energy targets, but also on market design. One issue that needs calibration is in relation to the adequacy assessment meant to assess the need for a capacity mechanism. While, we support the move to introduce a regional adequacy assessment to inform Member States decisions before any capacity mechanism can be set up, we don't agree that ENTSO-E should have the sole responsibility of carrying out all these assessments. Individual Member States are well-positioned to apply the methodology once it has been developed.

ENTSO-E should do an adequacy assessment at the European level to provide the overall view, but this should only be one perspective in informing decisions to be put in place for capacity markets.

You mentioned before the prominence of DSOs in the energy transition. What is going on in Brussels that DSOs should know about?

DSOs are increasingly dealing with cross-border issues, whether it is data standards, storage or redispatch. They are all facing the same challenges: the same new customer expectations, and the same investors. Not to mention the same EU-level policies: The Clean Energy Package suggests a new representative body

for DSOs. This body can very well end up taking crucial decisions for DSOs and set the scope for DSO activities in Europe.

DSOs will need a bigger toolbox to cope with the challenges of a more decentralised energy system, in which power. These issues should be of interest to all European DSOs and they can count on EURELECTRIC to represent them at EU level.

Q What is the biggest threat that the energy sector is facing? Do you see any threats to the energy sector – and what should the sector do to prevent them?

The biggest threat in this period of transition is fragmentation - both politically and in the sector. If we lose sight of the common objectives and wander off in different directions, we all lose.

Brexit is a real risk for the sector. What will happen to companies that are going to be isolated in a new U.K. entity? Will Brexit cause a delay in the adoption of the Clean Energy Package?

Q Indeed, the world is going through turbulent times. What do you think will be the impact of Brexit on the EU power sector and how will it impact the current legislation process?

Brexit could lead to delays in the development of the European Energy Union. This is mainly because of institutional issues, such as the new number of parliamentarians, voting weight in the Council and so on.

The EU Emissions Trading System (EU ETS) will need to be recalibrated, and the energy efficiency directive will need to be revisited in terms of how much energy needs to be saved essentially. Due to Brexit, there are many other different regulations that impact on the functioning of the power sector.

We know that we are losing a good partner, but we will have to find solutions to collaborate. As far at the EURELECTRIC membership is concerned, we are happy that our UK members would like to continue being a part of EURELECTRIC and I am sure we can build on that.

Development of Second Generation Biorefineries

Production of Dicarboxylic Acids and Bio-based Polymers Derived Thereof (The BioREFINE-2G Project)

THE BIOREFINE-2G PROJECT

The project BioREFINE-2G aims at developing commercially attractive processes for efficient conversion of pentose-rich side-streams from biorefineries into dicarboxylic acids, which can be used as precursors for bio-based polymers including biodegradable polymers.

STRAIN ENGINEERING

Microorganisms are among the most powerful resources on earth, but their potential has not yet been fully exploited. BioREFINE-2G aims at engineering the well-known baker's yeast to produce industrially relevant dicarboxylic acids. In order to develop a sustainable process, the goal is to use industrial wood waste as substrate.

Wild-type yeast can neither produce dicarboxylic acids, nor utilize C5 sugars, which are the major fermentable components of the waste streams. Furthermore, the inhibitors usually present in the complex biomass hydrolysates can significantly affect cell growth and performance.

With the aid of advanced genetic engineering, modelling tools and adaptive evolution, these challenges can be overcome and strains with the desired traits can be obtained.

PROCESS DEVELOPMENT

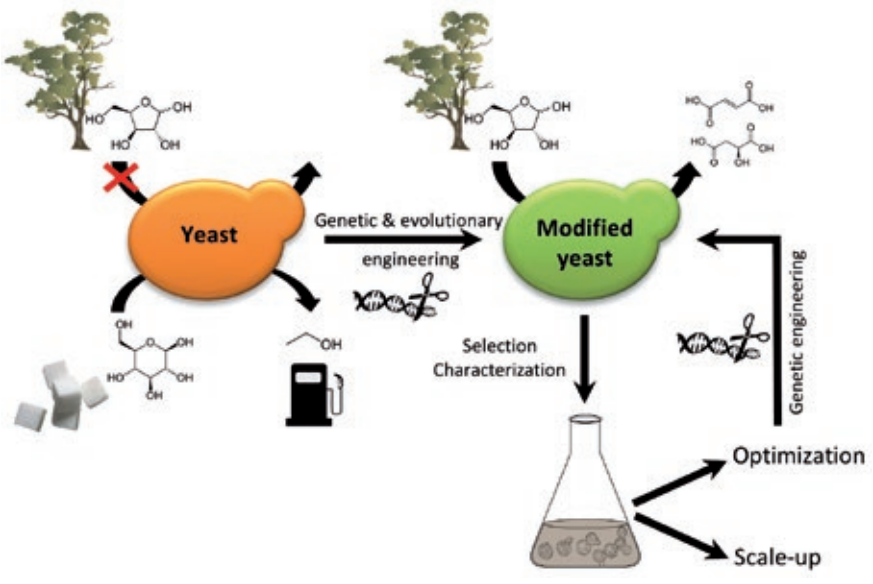
The challenges in the process development include firstly, designing the fermentation of a complex raw material, and secondly, purifying the desired carboxylic acids from the fermented broth to a required degree of purity for polymer applications.

FERMENTATION OF A COMPLEX MEDIUM

BioREFINE-2G works with raw materials containing several sugars - including a large fraction of pentose sugars – as well as several other compounds, which may affect the physiology of the host. The yeast Saccharomyces cerevisiae is a well suited host to function in these environments.

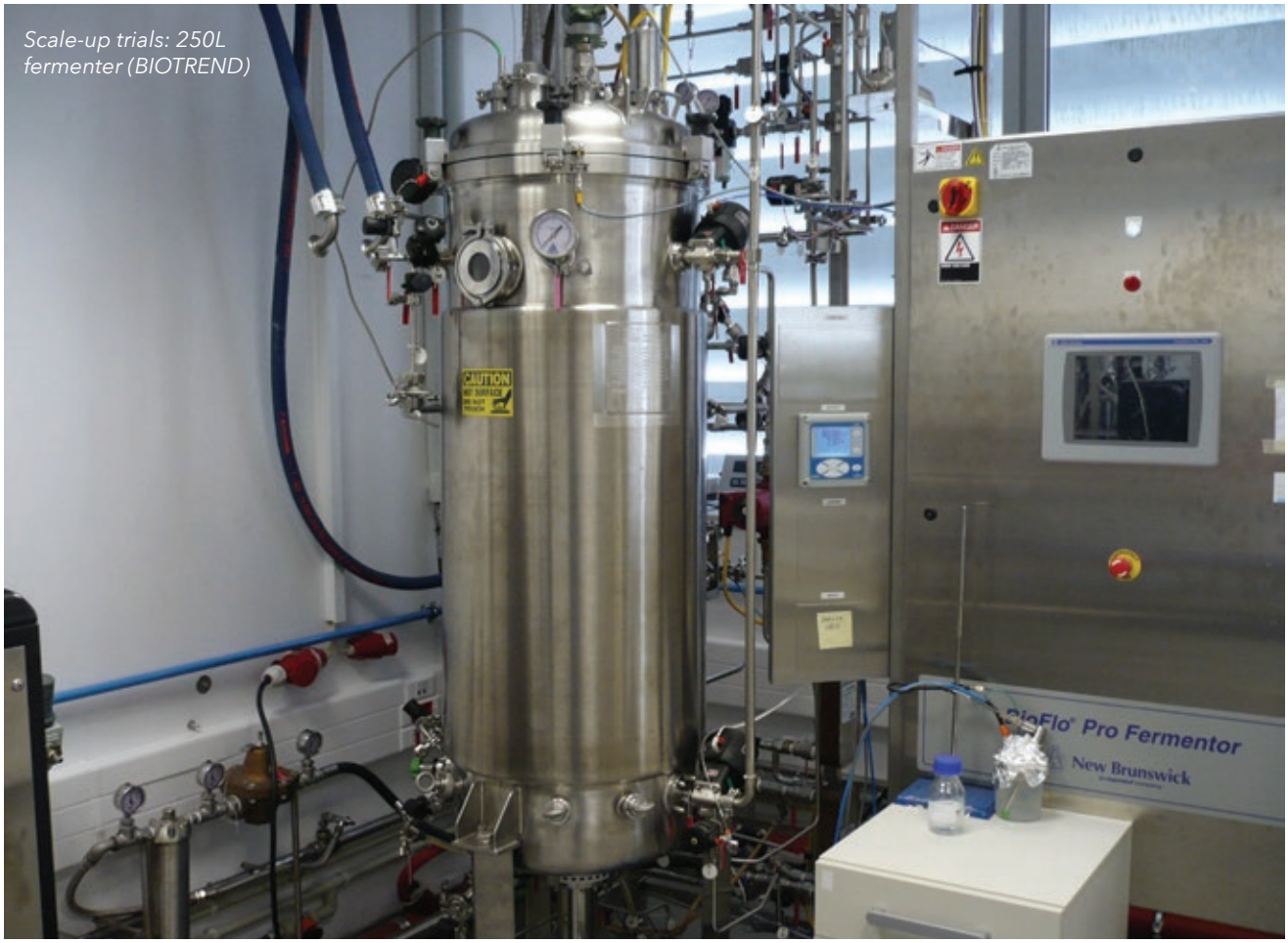
To enable efficient fermentation, the process conditions are tuned to reach a suitable compromise between needed fermentation time, product yields and titers. This is done in close collaboration with the strain development efforts by the molecular biologists.

Strain engineering scheme (DTU)



DOWNSTREAM PROCESSING

The development of a downstream processing method for the recovery of bio-based dicarboxylic acids faced many challenges to reach the purity standards suitable for polymerization. A multi-stage approach was developed to overcome the issues posed by the high amount of lignocellulosic impurities in the fermentation broth and by the fermentation by-products. Recovered solids from complete process experiments showed that purity specifications were achieved in high product yield. The optimization efforts in recycling and re-use of streams reduced the economic and environmental impact of the process.



Scale-up trials: 250L fermenter (BIOTREND)

POLYMERISATION METHODS

European and American biopolymer markets are experiencing huge growth expected to continue in the near future. The objective of BioREFINE-2G is to prepare bio-polyesters from dicarboxylic acids obtained from genetic engineered yeast. The bio-polyesters are then converted into commercially interesting products, such as polyurethane dispersions (PUDs) and thermoplastic polyurethanes (TPUs) used as adhesives and coatings, and polylactide(PLA)-copolymers, which can be used as biodegradable packaging plastics. We have prepared bio-polyesters of different molecular weight by adjusting parameters such as temperature, pressure, reaction time and type of catalyst.

SCALE-UP AND PRODUCT DEVELOPMENT

Scale-up trials are underway to transfer the fermentation technology from lab-scale to industrial application. The process developed at lab scale by ULund will be implemented at pilot scale at Biotrend. The resulting scaled-up process will be transferred to Borregard's Demo Plant. Synergies between partners will be instrumental for a successful scale-up of the fermentations using real raw materials and in conditions suitable for downstream processing.

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European forests at a crossroads

By Emma Berglund, Secretary General, Confederation of European Forest Owners (CEPF)

Two years ago, I wrote an article for EEI on the topic "Forests are Europe's green gold". I stated that "it's easy to fall in love with the forest", as it offers us so many diverse and important benefits, like climate change mitigation, renewable materials and energy, jobs and growth, recreation and biodiversity.

Since then a lot has happened. The Paris Agreement was a milestone, embracing the importance of forests for combatting climate change, and the EU has put forward concrete proposals with a direct impact on how we manage and use our forests. Most pertinent for forests is the Commission's proposal on how to account for the carbon dioxide removals and emissions from forests, the so called LULUCF regulation, and the proposal for a Recast of the Renewable Energy Directive, which for the first time introduces sustainability criteria for forest biomass.

SEEING THE FORESTS FOR THE TREES

Seeing these latest EU policy developments and discussions in Brussels, I'm starting to wonder if we are really seeing the forests for the trees. The coming years will be decisive for bringing EU on track to combat climate change. In the development of EU climate and energy policy, decision makers must strengthen the role of sustainably managed forests and create frameworks that support forest management and the enhanced use of

wood in the transition to a fossil-free bioeconomy.

We need to remember that forests are our largest non-food renewable resource and an actively managed forest is better for the climate. It is kept in vigorous growth, maintaining carbon sequestration and offering renewable timber resources and bioenergy to replace fossils. The green carbon is circulating in the natural forest carbon cycle, which is maintained and can be enhanced by forest management. This offers us an opportunity to replace the black carbon and stop introducing new fossil emissions into our system.

FORESTS IN THE EU 2030 CLIMATE AND ENERGY FRAMEWORK

The RED Recast introduces for the first time sustainability criteria for forest biomass, despite the fact that Member States have in place rigorous legal frameworks to ensure the sustainable management of forests. It is now of utmost importance that this does not in practice mean additional legal and administrative constraints on the manifold use of forest biomass. This holds true also in the LULUCF framework, which needs to take into account the biological reality of forest ecosystems, where net carbon removals are ensured when harvesting does not exceed the long term growth.

In the discussions on the Commission's Clean Energy Package, we have seen many alarmistic messages about European forests being destroyed because of bioenergy use and that it is better to use coal (!) than bioenergy. Unfortunately, a simplistic black and white picture has been painted, where bioenergy has been portrayed as all bad.

However, as is mostly the case, nothing is black or white. In order to understand forest-based bioenergy, there is a need to look at the full picture of how forests are managed and used and a few misconceptions concerning forests and bioenergy need to be clarified:

1. **Increasing demand for forest-based bioenergy does not put our forests at risk**
   European forests are sustainably managed regardless of the functions they fulfill and the end use of the biomass produced. We have a comprehensive legislative framework in place to ensure the sustainable management of forests. Moreover, forest owners have absolutely no interest in destroying their own forest. On the contrary, a strong wood demand provides the right incentive to forest owners to invest into sustainable forest management and mobilise their wood. In the EU, we harvest around 65% of the annual growth. Since the introduction of RED in 2009, and the subsequent introduction of support schemes for bioenergy, we have not seen this alleged devastation of our forests. In fact, harvest levels in the EU have declined or stagnated in the past 8 years.

2. **Bioenergy demand does not drive forest harvests**
   Bioenergy from forests is part of an integrated use of wood, where different parts of a tree is used for different things. How a certain part of a tree is used depends both on its type and quality, but also on dynamic societal and market needs, which are in turn dependent on the development of technology and innovation. Europe's forest owners are managing their forests for multiple products and purposes, where high-value sawn timber is the most important from an economic point of view. To give an example, when a forest owner in Sweden sells her wood, 70% of the income comes from timber, 27% from pulp wood and only 3% from bioenergy. Artificially regulating the market by imposing restrictions, such as placing a cap on biomass use or imposing a compulsory cascading principle, would be not only unfeasible to implement but also endanger the sustainable use of biomass.

UNTAPPED POTENTIAL

There is further potential for increasing the mobilization of domestically sourced biomass from sustainable forests by for example increasing market demand for lower quality assortments. It is possible to more efficiently use low quality wood and forest residues, while at the same time improving the resilience of forest ecosystems and strengthening the economic performance of forestry and the forest-based sector.

In addition to the aspects related to climate change mitigation by replacing fossil-based energy sources, bioenergy from locally-sourced biomass can contribute towards achieving the objectives of the Energy Union by improving energy security, supporting rural development through green growth and employment and developing a sustainable bioeconomy.

Going forward, let us keep the forest in sight when transitioning our society to tackle climate change. Not only should we love our multifunctional forests, we also need to recognize the power and drivers of the millions of individuals and families who are investing in, managing and taking care of this crucial natural resource. Without these people and their engagement on the ground, we would lose out on the multitude of benefits which we are all so much in need of.

Bioenergy from forests help decarbonize Europe

Forests play a key role in meeting the EU renewable energy objectives. Currently, bioenergy represents 63% of renewable energy consumption and forest biomass is the most important bioenergy feedstock in the EU, representing around 70% of of bioenergy consumption. With 97% of this biomass being sourced within the EU, bioenergy is a truly local energy source.

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Visions of Bioenergy
Bringing Local Initiatives to Brussels

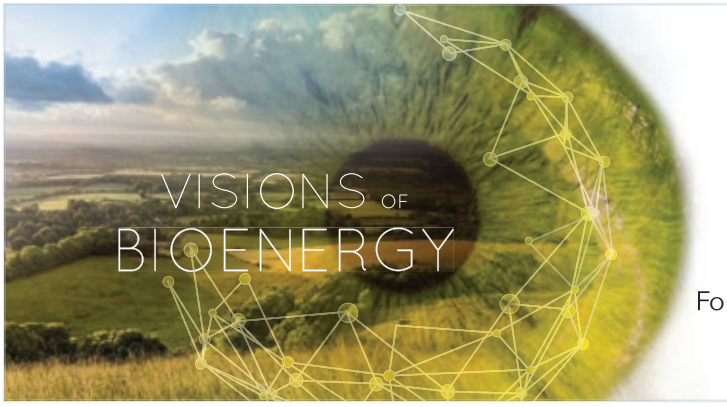
Think global, buy local does not hold for food only. It is becoming increasingly important for energy generation and consumption, especially when describing the situation of bioenergy. It is important to remember that bioenergy is the most important source of renewable energy in Europe, having a key role to play in the future European energy mix. Most of the bioenergy consumed in Europe comes from wood resources that are locally produced and utilised. In this context the development of bioenergy depends on the willingness of local communities to use it sustainably.

To reap the benefits and to ensure a sustainable and environmentally sound concept, innovative projects and well-structured supply chains are required: This is what BLTCs are all about! BLTC stands for Biomass Logistic and Trade Centres, which are regional hubs linking wood supply from forest owners, saw mills and other wood producers with demand from bulk and small buyers. BLTCs organise provision, processing and dispatching of pellets, woodchips and other woody bioenergy products. These services are often complemented by heat contracting and maintenance. The focus lies on domestic market uptake with short transport distances. BLTCs assure quality and negotiate delivery contracts. Thus, a reliable service along regional value chains will develop. Such an initiative should be supported and understood. This is why we are organising a dedicated event - Visions of Bioenergy – Bringing Local Initiatives to Brussels within the scope of the BioRES project. This event will demonstrate the key role BLTCs, along with other remarkable local energy initiatives across Europe, play in local and regional energy strategies.

The local examples shown at the BioRES conference will also shed light on what the European Commission's recast renewable energy directive may imply in practice. The conference will consider the place of bioenergy in the renewable energy targets of the EU and the specific sustainability criteria that are suggested herein.

Last but not least, participants to this event will also have the chance to visit a BLTC. Not physically, but through total immersion in a 360° video. It'll be like travelling to the place…

BioRES has received funding from the European Union's Horizon2020 research and Innovation programme under grant agreement No645994



Join the conference

VISIONS of BIOENERGY

Bringing Local Initiatives to Brussels

at the Representation of the
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For more information and application please go to
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or contact frank.mischler@giz.de

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H&Vnews

Interview with Bendt Bendtsen, Danish MEP of the Group of the European People's Party

Mr. Bendt Bendtsen, Danish MEP of the Group of the European People's Party is considered a thought leader for Decarb Heat 2017, a forum taking place in Brussels on 11-12 May 2017 . Below his views on the decarbonisation of the heating and cooling sector in Europe which are fully in line with the mandate of the conference:

Q What is your vision for decarbonising heating and cooling in Europe by 2050?

Decarbonisation of heating and cooling is a clear necessity to achieve a Europe less dependent on imports and more sustainable.

The decarbonisation efforts must be cost-effective and should activate all available tools and technologies - renovation of the existing building stock, minimising the consumption of fossil fuels, further integration of renewables in the energy mix and motivation of consumers play an active role. Clearly, the heating and cooling sector is essential in this respect to achieve the European targets for decarbonisation. We spend too high a degree of fossil fuels in this sector, which is particularly unfortunate when we import half of it and thereby make Europe dependent on Russia and the Middle East.

Q What is your contribution to this vision as Member of the European Parliament, but also as individual?

As an individual, I integrated several renewable sources in my own household - geothermal, heat pump and solar thermal. I believe in leading by example. In my capacity of MEP, I am rapporteur of the revision of the Directive for energy performance of buildings, EPBD. It is my responsibility and aim that we can achieve a broad compromise behind an ambitious EPBD, where we stimulate both public and private financing into energy renovations so we can make the European building stock much more efficient - to the benefit of consumer, competitiveness and growth in Europe.

Q Who do you think is the strongest ally in making your vision of a decarbonised Europe a reality?

I think we have a broad and strong support for these efforts - from the heads of state and government to the European industries and consumers. Currently, low coal prices and a fragmented legal framework challenge us, makes it cheap to pollute, and lacks sufficient incentives to decarbonise. Once the framework is set, I truly believe we will see that the ones who achieve decarbonisation first, are the global winners. Not just in terms of sustainability, but also in terms of competitiveness and independence.

For more information please visit www.decarbheat.eu

Energy from waste: looking ahead to the future

By Dr Stuart Wagland (pictured), Lecturer in Renewable Energy from Waste, Cranfield University

Waste management in the UK and across Europe has changed considerably over the past 20 years as we have moved from a predominantly 'disposal' mind-set to one of recovering value from our waste streams. Thus viewing such materials as 'resources'. There has been a considerable uptake in thermal treatment technologies (i.e. combustion), partially due to the need to move away from our reliance on landfill, and the associated costs of landfill disposal increasing significantly in recent years. Landfill disposal across Europe overall has decreased sharply as recycling practices have advanced

A Cranfield University team undertaking sampling

along with the combustion of wastes on a large scale; highlighting a substantial movement towards a more sustainable resource management society. Recovering energy from wastes has a number of benefits, mainly in reducing the volumes of wastes which can otherwise not be practically or economically recycled and in producing clean energy as a substitute to pure fossil-derived energy. Energy security is much talked about in the movement towards renewable and cleaner energy sources. Whilst not completely renewable due to the plastic content of waste, waste is a secure source of energy. However, the appropriate technology is required and the need to recover recyclable material needs careful consideration.

In 2009 the UK managed 11% of its municipal wastes through thermal energy from waste [EfW] facilities; today over 26% is managed in this way. For EU member states a similar increase has been observed, with the amount of waste per capita sent for thermal treatment almost doubling since 1995 levels (from 67 to 128 kg/capita). The case for thermal energy from waste processes is also evident in the amount of waste exported from the UK to fuel plants located in mainland Europe, at cost (current prices paid by UK producers is around €60 per tonne). The fuel leaving the UK has been processed to various degrees, so has been shredded and some recyclables (mostly metals) removed, therefore this is termed 'refuse-derived fuels' [RDF]. Since 2010, when less than 100,000 tonnes were exported, the export of RDF has grown to around 3 million tonnes in 2016. Over half of this goes to the Netherlands.

The export of RDF from the UK is likely to be affected in a number of ways, one of which being the impending exit from Europe ("Brexit"). There is uncertainty about the exact effects of Brexit on RDF export. Changes to the exchange rate will cause minor fluctuations, whilst changes to, and differences in, regulations may present further challenges. UK-based RDF exporters will need to meet any EU requirements, potentially in the form of a quality standard including composition, if RDF is to continue to move from a non-EU member state to a member state. Another way in which RDF export could be affected is the expected growth in the total capacity of thermal treatment within the UK, which subject to being economically favourable over export, could see RDF being retained within the UK. RDF is, generally, more homogeneous than unprocessed municipal waste and has a higher calorific value. Municipal waste contains high-moisture food waste, which is unfavourable in thermal energy recovery, so RDF is a higher quality fuel overall. This quality, along with being more homogeneous, means that it is an ideal feedstock for advanced thermal treatment [ATT] processes.

Gasification and pyrolysis, collectively termed ATT, have potential benefits over incineration such as the scale of such processes and the flexibility in the way in which the energy is utilised. For instance, the energy-rich gases (syn-gas) can either be combusted directly, with cleaning can be used as a fuel in gas engines/turbines, it can be stored, or it can be processed to produce liquid fuels or chemicals. The liquid fuels can be very versatile, and yield higher commercial benefits than the direct energy recovery route. These facilities can viably operate at a lower scale than combustion, thus recent research by Cranfield University, funded by the Energy Technologies Institute [ETI], concluded that the development of town-scale facilities represented a key opportunity in the UK. Unfortunately, ATT in the UK has had recent setbacks, with companies entering administration and the notable failure of 2x 350,000 tonne per year gasification plants in the North East of England. This adds to the argument that smaller-scale facilities present the most viable way forward for ATT.

Innovation and paradigm shifts could complement the development of smaller scale ATT. One such example is in the recovery of secondary raw

Dr Stuart Wagland, Lecturer in Renewable Energy from Waste, Cranfield University

Dr Wagland is a Chartered Chemist with over 12 years' experience in the waste and resource management sector. He is the course director of the MSc Energy from Waste programme at Cranfield University and has previously contributed to the development of a UK business case for the next generation of energy from waste technologies. His current work combines enhanced landfill mining and energy from waste technologies, with a specific focus on real-time waste characterisation and the recovery of valuable commodities from mixed wastes through thermal conversion.

A conveyor belt carrying RDF as it travels away from a magnet

materials from previously landfilled wastes through the deployment of enhanced landfill mining [ELFM]. This is an emerging field which is being developed rapidly through Cranfield University and fellow members of the European Enhanced Landfill Mining Consortium [EURELCO]. Cranfield, through a Horizon 2020-funded project SMART GROUND, are also seeking to understand the secondary raw material potential of EU landfill sites. ATT processes have previously been investigated by members of EURELCO as a means of converting excavated wastes into valuable products. Through ELFM valuable materials can be recovered, the environmental burden of legacy landfill sites is removed and land is remediated. ATT processes have a significant role to play in ELFM and secondary raw material recovery from our wastes.

Looking ahead there are examples globally which suggest that energy from waste has a firm place in waste management. In China there are plans to develop 300 new EfW facilities in the next 3 years, one of which will be the world's largest facility, located in Shenzhen processing a staggering 5,000 tonnes per day. In terms of large-scale projects, it appears that conventional combustion processes, largely incorporating the well-established moving grate technology, will continue to be constructed. ATT, however, shouldn't be written off; we have seen evidence that large-scale facilities are prone to failure, but smaller town-scale facilities may still have a place in ELFM and an overall sustainable waste management system.

Turning waste from steel industry into a valuable low cost feedstock for energy intensive industry

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. In 2010, the European steel industry generated, as waste, about 21.8 Mt of steel slag. The 76 % of the slag was recycled in applications such as aggregates for construction or road materials, but these sectors were unable to absorb the total amount of produced slag. The remaining 24 % was landfilled (2.9 Mt) or self-stored (2.3 Mt).

The landfilled slag represents a severe environmental problem. The main aim of RESLAG is to prove that there are industrial sectors able to make an effective use of the 2.9 Mt/y of landfilled slag, if properly supported by the right technologies. In making this prof, the RESLAG project will also prove that there are other very important environmental benefits coming from an active use of the slag in industrial processes, as CO_2 saving (up to 970 kton/year from the renewable concentrated solar power (CSP) electricity production, at least 71 kg/ton of produced steel in the electric arc furnace steelmills provided an effective waste heat recovery based on the steel slag), and elimination of negative impacts associated with mining (from the recovery of valuable metals and from the production of ceramic materials). To achieve this ambitious goal, four large-scale demonstration pilot systems are consideredin the RESLAG project:

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) development of a slag-based cost effective heat recovery concept in extensive thermal energy demanding industries, such as the steel prouction activity.
3) development of an economic and technically improved steel slag based heat storage concept for the renewable concentrated solar power (CSP) production.
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 will be lead by a well balanced project consortium conformed by leading industries and also research centers and universities involved on the European material, energetic efficiency and technological scenario.

Contact details:
Project website links:
http://www.reslag.eu/
https://twitter.com/reslag_eu
https://www.linkedin.com/company/reslag

CIC Energigune - Project Coordinator
http://www.cicenergigune.com/

The future of Waste-to-Energy

By Patrick Clerens and Natalia Walczak, ESWET

Year 2016 was an important time for the Waste-to-Energy sector. Works on the EU Circular Economy Package and the Communication on Waste-to-Energy were a good time to reflect on the role and the future of this technology in Europe. Being part of both waste management and energy generation, how can it further improve its contribution to these areas? And asking even a more fundamental question: is there any need for Waste-to-Energy in the future at all?

BENEFITS OF WASTE-TO-ENERGY

Prevention of waste generation, reuse and recycling of materials is rightly promoted as the core of waste management in the EU. But what to do with the waste that makes no sense to be recycled? Should this be landfilled? No! Waste-to-Energy is a complementary solution that deals with waste unsuitable for recycling due to technological reasons or contamination. As a result, it helps to phase out landfilling.

In addition, as a reliable source of electricity and heat it contributes to the energy market and increases security of supply by replacing fossil fuels. It also contributes to resource efficiency – Waste-to-Energy plants recover metals that would be otherwise lost, and the bottom ash that remains after the incineration can be used as an aggregate for construction.

HOW MUCH WASTE WILL WE HAVE?

According to Eurostat statistics, in 2014 each EU citizen generated on average 475 kg of waste. Out of this amount, 28% was recycled and another 28% landfilled, 27% incinerated and 16% composted.

The European Commission proposed in December 2015 revised waste legislation with ambitious recycling targets – by 2030 65% of municipal waste should be effectively recycled, not only send to recycling. It is important to note that part of the material sent to recycling plants is not recyclable and sometimes as much as 10% is rejected and has to be landfilled or incinerated.

Taking into account that landfill should be phased out, it is very likely that the overall volume of waste to be treated thermally could even increase, as also stated in a study by the Joint Research Centre of the European Commission: '"(…)despite the existing potential for waste prevention and reduced generation of these streams through better and more widespread source-separated collection, energy recovery is likely to increase to support the necessary massive diversion from landfill. Moreover, higher recycling rates for other waste types may lead to a further increase in the generation of sorting residues, unless the quality of the materials collected separately at source improves.'".

Assuming that the ambitious recycling targets are met in 2030, it will be still necessary to deal with 30-35% of municipal waste. And the commercial and industrial waste that needs to be treated is not even included in these targets…

WILL WASTE STREAMS CHANGE?

Waste-to-Energy plants are designed to operate with various waste input. As any fuel, also waste has its calorific value that differ depending on the type. Unsorted municipal waste, with a lot of wet matter (mainly biomass), has lower

energy value than some single stream residues.

As it was mentioned earlier, the European legislators encourage recycling and separate collection of different types of waste . It will mean that the input to Waste-to-Energy plants will change as well. The situation will of course differ depending on a country and current waste management policies, but we can make some EU-level predictions. Increased separate collection (also of bio-waste) and recycling will mean on one hand that there will be less mixed waste, and on the other - that there will be more residual waste of more homogeneous nature. As a result, input to Waste-to-Energy plants could have higher calorific value in future.

In brief, it would mean that we need less waste to generate the same amount of energy.

IMPROVING PERFORMANCE

Currently, state-of-the-art boilers recover over 85% of the energy contained in waste and make it usable as steam. However, the actual energy efficiency of a Waste-to-Energy plant also depends on its location and how the energy it produces is used.

In order to encourage operators to improve the energy efficiency of their plants, an R1 formula was established in the Waste Framework Directive in 2008. The formula calculates the efficiency at which the produced energy is utilised, and only if it is higher than 0,6 (or 0,65 for new plants), the operations can be classified as recovery, and not as disposal. The use of heat (opposed to only electricity) significantly increases the efficiency, therefore a plant located in a colder climate with district heating networks or next to an industrial heat customer, will be usually more efficient.

In addition to these 'location' aspects that are important for the performance of Waste-to-Energy plants, also technological developments help to improve their efficiency. According to the above mentioned study by the EU Joint Research Centre technologies such as heat pumps, high steam parameters for boilers and superheaters and flue-gas condensation and component cooling have the biggest technical improvement potential.

INTEGRATED APPROACH

Waste-to-Energy has unique functions – it treats rubbish not suitable for recycling while generating energy and avoiding landfilling. It is therefore an important element that guarantees an integrated approach to waste management, together with waste avoidance, re-use and recycling, and -as presented in this article- will still be needed in the future.

ESWET is the association grouping the European Suppliers of Waste-to-Energy Technology. Our main purpose is to foster the development and dissemination of Waste-to-Energy (also called Energy-from-Waste). This technology has an important role to play both on the energy recovery and on the environmental aspects of managing waste that is not suitable for recycling.

Circular Economy
Finding the Right Balance

By Vanya Veras, Secretary General, Municipal Waste Europe

It is common knowledge that the world's developed countries consume the greatest quantity of materials, fuels and products, also contributing the most to global warming; Europe is one such group of countries. What is less known is that we, in the European Union, import three times more products than we export and that that represents six times more raw materials than we export. Where does it all go? Either directly or indirectly, into our waste.

Creating a circular economy is all about averting the exit of materials and products from the production and use cycle by creating systems to either prevent them from entering the waste stream through direct reuse or by recovering them from the waste stream. The developed West has learned to be a throw-away society in the last 25 years and citizens young and old still believe that their individual efforts as consumers and recyclers don't have an impact. To turn back to respect for value, longevity and resource efficiency we need reliable waste management systems and communication. The citizen must be recognised as being an integral part of this transformation; included and informed.

Municipalities play a pivotal role in all of this. They are responsible for providing services of general interest and as such, are the link between the citizen and consumer, change in purchasing behaviour and the recovery system for products and materials that become waste. European

legislation requires the separation of different products and materials at the moment that they become a waste, even more so in the revision currently in progress, so as to preserve their intrinsic value and facilitate their further use in the economic cycle. European municipalities have the responsibility to create the system to make sure that this happens.

To make it more visible, we are talking here of packaging waste which contains plastics, paper, metals, glass; of biowaste which can be transformed into compost for use in agriculture and biogas for use in vehicles, for heating or to generate electricity; of mobile phones, fridges, washing machines, computers, furniture, bicycles which can be repaired and re-sold and of the heat and electricity that can be generated from non-reusable or non-recyclable waste. All of this is already happening but it needs to become widespread, so that all municipalities in the European Union are doing this and more, and so that we can assist developing nations to follow our good rather than only our bad consumption patterns.

The best way to encourage such best practice is to demonstrate how it works economically as well as environmentally. Several examples of this type already exist, where the costs of waste management have been significantly reduced by moving away from collecting mixed waste and replacing it with separate collection of different waste materials and products at source, which are then sold to the market. EU members still in need of developing their waste management systems are still being told that separate collection is more expensive than mixed waste management but they are not being told the full story. These Member States are still collecting waste every day: this is the key cost in a waste management system and is unnecessary. To be clear, there will always be residual waste; left over after separate collection and recycling and it makes economic as well as environmental sense to use that residual waste as a fuel in those Member States which have the systems and the need for heat to make best use of this resource.

It is neither wise to ignore that need: the existing waste to energy plants, district heating systems, their near to full energy recovery, nor to weaken the efficiency of waste management in Europe by encouraging investments into more mixed waste treatment in countries which are not yet recycling enough to meet the legislative targets that they agreed to. And this should not apply to municipal waste alone which makes up 10% or less of waste generated. If Europe is serious about re-circulating resources and creating economies of scale to make these efforts sustainable then the 75% commercial and industrial waste needs to play the game as well.

It is clear that this is a complex system and to succeed, all parties need to work together to manage their part of the chain. Municipalities may be at the forefront of municipal waste management which includes household waste and waste similar to household waste from commerce and industry, but the producers of packaging, waste electrical and electronic equipment, batteries, vehicles and other products have a responsibility to ensure that their products are taken back from the market once they have entered the waste stream for reuse or recycling. European legislation is currently being revised to promote more recovery and less 'loss' from the European waste stream. At Municipal Waste Europe it is our job to make sure that European municipalities are fully supported in this task and that in turn we support our local economies with the savings and through the new jobs created.

The principle of proximity for waste management as given in the European waste directives should also apply to the sale of the materials recovered for recycling. This is what will boost the creation of a circular economy in Europe by delivering quality materials to European industry. This is not to say that these materials cannot or should not be traded on the global market, but if Europe is serious about growing its economy sustainably, it should focus on reusing what has already been extracted and paid for before buying new primary materials. This is a closed-loop or 'circular' economy.

Economic efficiency through resource efficiency is also not something to be restricted to one region of the globe or to developed countries. Europe is not the only continent that still exports its 'unsustainable' production; suffering itself economically as a consequence. Municipalities are the ones faced with finding jobs for citizens suddenly finding themselves unemployed due to the failure of an industry. The future is linking up all strategies whether they are economic, waste, resources, water, soil or climate as they are not separate. They are intricately interwoven and interdependent and understanding their synergies will ensure that we are able to address the root causes of global warming before it gets out of hand.

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Valorisation of lignocellulosic biomass side streams for sustainable production of chemicals, materials & fuels using low environmental impact technologies – A COST network

By Dr Rafael Luque, Chair of this COST network

In the dawn of the 21st century, scientists have been prompted to seek alternative feedstocks and resources for the production of materials, fuels and chemicals using low environmental impact technologies and greener methodologies. Lignocellulosic residues such as forestry waste, branches and related agricultural products, can constitute a highly promising (and currently largely under-utilised) feedstock with significant potential to be converted into useful end products. However, a joint multidisciplinary effort from several disciplines including (bio)chemistry, biology, (bio)chemical and biological engineering, forest products sciences, as well as environmental sciences and experts in economic assessment, in liaison with industry, is required to appropriately address the efficient transformation of such residues.

This opportunity arose thanks to the funding from the European "Cooperation in Science and Technology" programme (COST), which enables the creation of a unique, highly skillful, multidisciplinary and solid European network. This COST Action was created with the aim of providing a range of innovative approaches to add value to lignocellulosic residues. In particular, the focus is set on hemicelluloses and lignin fractions from the pulp and paper industry to produce chemicals, materials and fuels.

Since its start in May 2014, the COST Action FP1306 has been able to bridge gaps between academic disciplines in academia and industry. It has done so by bringing together expertise from researches from all over Europe and interconnecting different technology hubs which aim to convert residues into valuable products (waste-to-wealth).

For the last two and a half years, the Action's achievements have been numerous and significant. More than 50 European groups (150 active participants) from 31 countries, plus six international partner countries (New Zealand, Hong Kong, Colombia, Argentina and USA) with diverse backgrounds such as chemistry, physics, biology, agronomy, engineering and other related disciplines, have actively participated in all activities of the Action. The network was divided into four working groups to allow for scientific discussion. There were also several multidisciplinary sub-groups targeted at the scientific and technological advances on the field and further initiatives in the EU arena were developed.

The synergies created during the meetings, workshops, short-term scientific missions and training schools, have led to the design and study of improved and new methodologies for lignocellulose pretreatment, as well as to the valorisation of the carbohydrate (hemicellulose, cellulose) and lignin streams via chemo- and bio-catalytic routes.

In addition to the targeted research and technology innovation, activities

related to the coordination of research/education have also been initiated. Among them, the mapping of existing pretreatment methodologies of lignocellulosic biomass and of various lignin streams with their physicochemical characteristics and a number of high-level training courses, which brought significant interactions between trainers and trainees.

Specific activities targeted at the dissemination of the Action's results have been efficiently implemented. These include an Action's website; the generation of a dedicated special issue in the high-impact journal ChemCatChem (Wiley), where the Chair and Vice Chair of the Action were Guest Editors; the participation of Action members at conferences, that reported the Action's results; various joint applications for EU funding under H2020 and other funding agencies; and a large number of joint publications in peer-reviewed journals.

The Action's networking impact has been rather unique. It has found a good balance between the different groups of participants and the participation of early career investigators, female scientists as well as scientists from less research-intensive COST Member Countries. A good example of that are two annual workshops/conferences (Belgrade, Serbia and Dubrovnik, Croatia), eight working group meetings, two training schools (La Rochelle, France and Leipzig, Germany), 25 short-term scientific missions with more than 400 participants, from which almost 45% were early career investigators/Ph.D. students with a 52/48 male/female ratio.

"COST (European Cooperation in Science and Technology) is a funding agency for research and innovation networks. Our Actions help connect research initiatives across Europe and enable scientists to grow their ideas by sharing them with their peers. This boosts their research, career and innovation."

Major publications:

Mild ultrasound-assisted synthesis of TiO2 supported on magnetic nanocomposites for selective photo-oxidation of benzyl alcohol
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Innovative technologies to lower cost of energy offshore wind farms

By Dr. P.J. Eecen, ECN, R&D Manager Offshore Wind Energy

When will offshore wind energy be subsidy free? Which technology is required and where can R&D institutes and industry collaborate to accelerate cost reduction further? These are questions Dutch research institute ECN works on every day. In this article, this pioneer in offshore wind energy shares the latest insights.

At ECN, we are convinced that all options for renewable energy (wind, solar, biomass) play an essential role in the transition towards a fully sustainable energy system. Looking at the current Dutch situation, offshore wind energy in particular is a critical ingredient to reach national renewable energy targets. Fortunately, the political will to invest in offshore wind energy is there and cost reduction targets are well on track.

This is demonstrated by recent Dutch bids for new offshore wind developments at the North Sea, leading to significantly lower cost of energy: DONG Energy will build the Borssele I and II wind farms (700MW) for 7,27 €ct/kWh, a consortium with SHELL and ENECO will build the Borssele III and IV wind farms (700MW) for 5,45 €ct/kWh, both prices exclude grid connection.

The offshore wind industry has evolved rapidly to the maturing industry it is today. The growth has unlocked vast investments and led to mass

upscaling in the industry. Technological improvements have been steady and largely incremental, with the most visible technology trend being ever increasing turbine size. Today the new turbine of choice is 8MW, while in 2000 offshore turbines were in the 1MW range.

Despite the steady progress there is still a long way to go. ECN plays a special role in this process by bridging academia with industry. Together with its partners, ECN brings new technologies, processes and systems to the market for sector and industry growth.

COLLABORATING FOR IMPACT

ECN Wind Energy is a group of 50 experts focusing on offshore wind energy cost reduction and engaging in numerous collaborative research programmes. The five-year Dutch shared research programme FLOW (Far and Large Offshore Wind) had a significant share in the realisation of the large cost reduction since 2010. In this programme, all aspects of offshore wind power have been researched– from foundation design, through to installation, improved operation and maintenance and arranging electrical connections reliably and efficiently. In 2016, the successor programme, named GROW, has been defined with the Dutch research institutes and 15 companies. These companies–from wind turbine manufacturers, offshore contractors through to ship builders– have committed to invest close to 50 million euro in a 100 million euro programme. Together with research institutes and universities they will realise a further cost reduction for offshore wind, thus stimulating the Dutch green economy and strengthening the dominant position of the Dutch offshore sector.

In the Netherlands, priorities for energy research are set and organised through the 'Top Sector Energy' . Top Sectors are the sectors in which the Netherlands excels globally and which receive high government priority. The Top Sector Energy consists of seven Top Consortia for Knowledge & Innovation (TKIs) which provide a forum for the business community, research institutions and the government to work together on sustainable growth. The TKI Offshore Wind coordinates and prioritises the research efforts to realise cost reductions and stimulate economic growth. Collaboration among the European R&D institutes further increases the impact and international collaborative projects supported by EU

have been important to disseminate results of various national projects and creating synergies across the national borders.

BETTER, FASTER AND MORE EFFICIENT

Together with its partners, ECN has been developing innovations to make offshore wind more reliable and more efficient. Breakthroughs have been achieved at several levels, from blade and rotor innovations, through to wind farm control, optimising wind farms and more efficient operation and maintenance processes. Some examples are provided below:

WIND FARM CONTROL

A characteristic of offshore wind farms is the large number of turbines in the wind farm. These turbines have a negative impact on each other because of the wakes behind the turbines. This leads to performance losses and additional maintenance costs. ECN has developed patented technology called Active Wake Control (AWC). This wind farm controller has been demonstrated to increases the energy production. The reasons wind farm operators and developers are looking into the possibilities of AWC technology are:

- AWC increases the wind farm annual power production (typically 0.5-2.5% depending on farm configuration)
- AWC reduces fatigue loads on wind turbines (about 1-3%), increasing the lifetime by 4-20% while at the same time reducing failure rates (O&M costs saving)
- Implementing AWC on a 350MW offshore wind farm could potentially result in around 20 GWh of additional power production and an increase in yearly cash flows of around 2 million euros for the operator (fast return on investment)
- When used during the design phase of the wind farm, AWC reduces electrical infrastructure costs by reducing the spacing between the wind turbines.

Wind farm controllers are very relevant for all offshore wind farms. Considering that increasing annual energy production is the single easiest way to lower the cost of energy, ECN will continue to work in bringing this to the market on a large scale. At this moment in time, ECN is participating in the EU Demowind program on this topic.

LARGER CAPACITY FACTORS

Capacity factor refers to the percentage of time when the wind farm operates at its maximum efficiency. To do this, the wind turbines should harvest energy efficiently even at low wind speeds and also have a very low down time. ECN contributes by developing larger rotors as well as working on the design and maintenance of support structures.

For larger rotors, ECN's tool to calculate the performance of airfoils (the wing profiles of the blades) called RFOIL needs to be improved with advanced physics. In that way, the tool which has been applied to design the majority of all wind turbines is capable to accurately design future large rotors.

The operation and maintenance of offshore wind farms significantly differs from that of onshore wind farms. The accessibility of the turbines is especially hampered when the wind is strong and waves are high. This means turbines must be robust and redundancy is an important asset. ECN has been working on the O&M optimiser that collects the data within an offshore wind farm. Using smart algorithms, an operator can learn a lot from the data and make intelligent decisions. Which components have failed? Were they too heavily loaded? To improve accessibility, ECN and partners develop and model access systems to allow for easy and safe transport of personnel to a wind farm.

OFFSHORE WIND CONDITIONS

Wind measurements at the North Sea have been performed by ECN in the Dutch part of the North Sea since 2000. First using a measurement mast near IJmuiden, later a 100 metre-high met mast was installed more than 80 kilometres from the coast. For several years ECN has been operating remote sensing LiDAR systems at several locations in the North Sea aiming to characterise the atmospheric boundary layer up to 300m height. These data are very important for the development of the soon to be built wind farms at Borssele and Hollandse Kust. Ultimately a good understanding of wind conditions and variability is the most critical part of the business case for an offshore wind farm.

NOT JUST ONE SOLUTION

The development and implementation of offshore wind power is a multi-disciplinary effort. This article highlighted several R&D developments that already have contributed or will contribute to cost-effective offshore wind power. The fact that the Dutch government, as well as the European Union is assisting with cohesive R&D programmes helps a great deal. Turbines will need to become even more effective, produce more energy for a lower price, and become even more reliable. This is a balancing act which requires innovative technology, brought quickly to the market.

For more information on the R&D programme and innovations of ECN in the field of wind energy, please visit our website **www.ecn.nl/expertise/wind-energy/**

leanwind

FP7 LEANWIND

The FP7 LEANWIND project addresses key targets of both the European Wind and Transport Technology Platforms, with a focus on reducing the cost of offshore wind. The project aims to contribute to cost reduction by seeking efficiencies across the wind farm life-cycle. LEANWIND was awarded to a consortium of 31 partners (52% from industry) from 11 countries and is led by University College Cork, Ireland. The diverse team brings together experts from multiple sectors including oil and gas, maritime, shipping and offshore wind industries with representatives across the supply chain including developers, utilities, turbine suppliers, vessel owners, shipbuilding, classification societies and academics. LEANWIND is a 4 year project which commenced in December 2013 and received funding of about €10million from the European Commission.

Core technical work examines practical ways of improving and developing technologies and strategies to optimise the deployment, maintenance and decommissioning of large-scale wind turbines. LEANWIND considers 5-8MW wind turbines using both fixed and floating substructures to include long-term wind farm prospects. The transport, logistical and maintenance challenges associated with these structures are addressed by developing novel approaches to vessel design, vessel management, sub-structure alterations and O&M strategies and streamlining logistics across each project stage in order to reduce both capital (CAPEX) and operational (OPEX) costs.

Key LEANWIND innovations include:

- Novel adaptations for fixed and floating substructures to improve installation efficiency and reduce costs. These designs incorporate innovative deployment and assembly strategies.
- Development of installation vessel design for transport and installation of 8 no. 8MW turbines
- Service Operations Vessel Design to optimise O&M for far offshore sites
- Development of simulator based tools supporting concept design feasibility studies; the development of operational procedures and training of crews and operators.
- A remote presence prototype to monitor turbine condition to reduce the need for offshore maintenance work.
- For optimisation of O&M activities development of the following; O&M strategy optimisation models, a dynamic scheduling tool, failure/degradation models and an online system for condition monitoring and diagnosis/prognosis of faults in offshore wind turbines.
- Nine inter-connected optimisation models for all life cycle phases and supply chain legs resulting in a holistic set of decision support tools applicable to port logistics, offshore and on-land transportation for the offshore wind industry.
- Various testing and validation exercises including the remote presence prototype, the highwind blade installation system and the PLOCAN platform.
- Holistic financial model considering business models and risk; CAPEX and installation; OPEX; decommissioning; and life-cycle assessment. These models are used in combination with the logistics models to evaluate project innovations and provide recommendations to define a roadmap for the offshore wind industry.

Therefore LEANWIND is committed to developing innovative techniques and technologies tailored to match current and medium term industry needs. These will contribute to cost reduction and EU competitiveness in specific niche markets related to offshore wind.

Floating wind energy platform being tested

The work described in this publication has received funding from the European Union Seventh Framework Programme under the agreement SCP2-GA-2013-614020

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Water security is about learning to live with an "acceptable level of risk"

The water outlook is grim. According to OECD projections, under business as usual, global water demand is projected to increase by some 55% to 2050. By the middle of the next century, over 40% of the world population - 3.9 billion people - could be living in areas under severe water stress. River discharges of nitrogen into the Atlantic, Pacific and Indian Oceans is projected to increase. At the same time, storms, floods and droughts have become more frequent over the last three decades, affecting on average between 100 million and 200 million people and causing USD50-100 billion per year in economic losses. Over the past decade water crises have consistently featured among the World Economic Forum top-ranked global risks.

Unsurprisingly, water risks are of emerging concern for the business sector. Yet much remains to be done when it comes to managing corporate water risks. Back in 2005, at its annual meeting held in Kobe in Japan, the World Conference for Disaster Reduction made an urgent call to better "know" risks (referring to most extreme risks such as major floods or droughts). A decade later, the consideration of water risks remains the exception rather than the rule. In the United States, for example, a survey in 2015 by not-for-profit organization Ceres revealed that two-third of major food sector companies did not consider water risks in their supply chain.

By determining levels of water risks that are deemed acceptable by all (civil society, business and government), a risk-based approach to water management points the way forward. This is the thesis advanced in Water Security for Better lives (OECD, 2013) which proposes two key preliminary steps to manage the four water risks (shortage, pollution, flood, disrupting hydrological systems): know the risk and target the risk.

As with other risks, water risk assessment means appraising (i) likelihood (probability); (ii) the presence of populations, ecosystems or activities in places that could be adversely affected; and, (iii) the propensity or predisposition to be adversely affected (e.g. structural deficiencies in buildings, vulnerable groups, such as women, children and the elderly). Likelihood is mostly local: hydrology commands us to manage water resources (and risks) at the river basin (or groundwater watershed) scale. Climatic conditions also matter as long as there are not too unpredictable (the tyranny of climate). When estimating the impact, we need to think more globally because local water insecurity can have impacts on commodity markets and global supply chains. A major drought in a food exporting country drives up food prices worldwide. The 2011 Thai floods led to the closure of multinational electronics and vehicle industries, with impacts cascading through the global economy.

No risk assessment would be complete without removing public misperceptions about the risks involved. This is crucial to raise public awareness about water risks and, in the end, willingness to share risks. Such "concern assessment" may well come fist in the process (« inverted » risk appraisal).

The second step, target the risk, is tantamount to managing tradeoffs between (often) competing interests. Once the risk has been technically assessed and public misperceptions removed, consensus is required on what could be a level of risk acceptable to all parties. Such consensus building should result in a formal (binding) agreement on risk sharing, the best way to prevent conflicts. Many consensus

building mechanisms have been put in place to manage water but few use risks as entry point. Yet this would allow a constructive dialogue between parties well aware of their own risk.

Bad practices are plentiful. Putting irrigation interest first has led to the shrinking of the Aral Sea, once the 4th largest inland sea, due to massive water pumping in its feed rivers. Conga, potentially the largest single mining investment in Peru's history, was halted by lack of knowledge on water risks; the project would turn several small Andean lakes into reservoirs or tailing ponds. Hydropower development on Chile's Maipo River is sparking mass protests based on perceived (but unassessed) risks to Santiago (the capital city) water supply.

But there are (few) good examples to follow. In Pilbara, a vast desert region in Western Australia (see photo), a risk matrix allows managing tradeoffs between groundwater uses while protecting aquifer integrity. The acceptable level of groundwater abstraction is set considering tradeoffs between the risks to environmental, cultural and social groundwater-dependent values ("in situ values") and the opportunity cost of not abstracting water for use in mining, the main economic activity in Pilbara ("development risk"). The maximum allocation from this process was estimated at up to 70% of recharge. That is, setting aside at least 30% of the estimated recharge protects the resource from the risk of saltwater intrusion.

I would conclude by quoting Peter Bakker, President and CEO of the World Business Council on Sustainable Development, in his statement at the Stockholm Water Week 2013, "I would suggest defining water as an issue in terms of risk. The scientists can give us risk indicators, the policy makers can define water in terms of risk and business people are trained to do nothing but measure, manage and act on risks. That would combine us."

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The water-energy nexus: Making best use of the nexus, saving energy and… water

By Tomas Michel, President, WssTP

The global water supply, treatment and distribution sector is a critical enabler of our society: it guarantees our food, sanitation, energy, health and wellbeing. Without it everything else in the 70 Trillion Euro global economy would fail. Global projections however, predict that growing demands from manufacturing, electricity generation, agriculture and domestic use will push world-wide water use up by 55% in 2050. All these will increase the pressure of human activities on our limited fresh-water sources. Furthermore, water quality is declining due to urban, industrial and agricultural pollution, impacting water availability of sufficient quality for users, and different uses. Diffuse pollution significantly affects 90% of river basin districts, 50% of surface water bodies and 33% of groundwater bodies across the EU.

Highly interlinked with the availability and use of water of desired quality and quantity is the water-energy nexus. On the one hand, several steps of the water use and management cycle (pumping were needed, transportation, distribution in pressurized water networks, heating, treatment, etc.) demand large quantities of energy. On the other hand, energy production by all known available technologies (conventional or renewable) with the exception of wind energy, requires significant quantities of water.

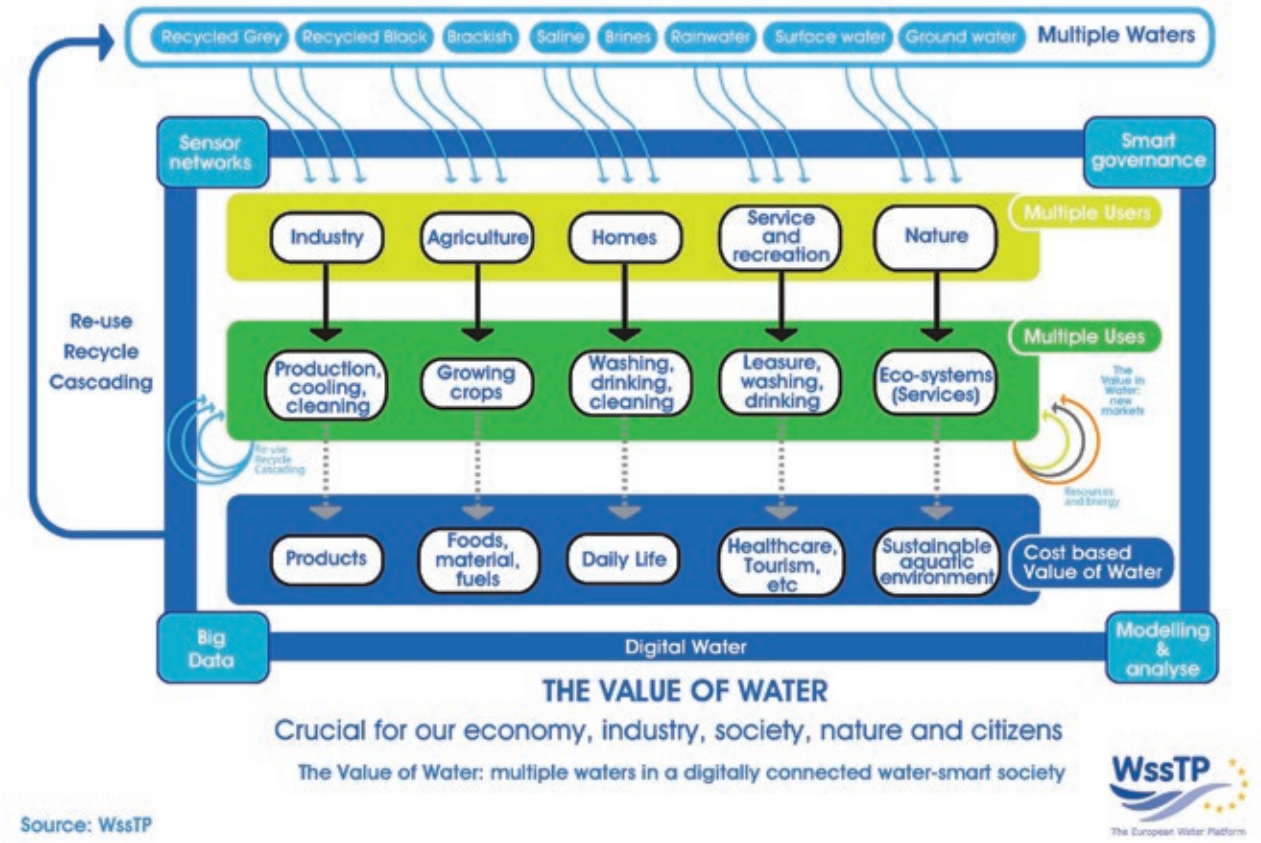
Water is a natural carrier of heat and energy gradients, which hold a high potential to be re-used, and could thus improve energy efficiency in several ways. Examples of this are chemical concentration gradients (e.g. as in brines resulting from industrial activity or saltwater desalination), as well as, low and medium temperature residual heat travelling with used water, which could be used for industrial processes, and or to reduce urban and domestic heating costs. Further, biofuel and/or biogas production from sewage sludge, represents another potential energy source from water.

The water-energy nexus needs to be considered holistically, and at all steps were water intervenes, from the overarching water management (combining smart-water and smart-energy), to new solutions in various steps of the water chain (energy harvesting and production at source, heat recovery from different waters, decreased cooling needs). Water is used in all phases of energy production and electricity generation, and while some sources of fossil energy will eventually be depleted, and then be substituted by renewable energies, availability of sufficient water could eventually become the limiting factor for future energy, even long before predicted stocks of energy are exhausted.

On the supply side, the intersection between water and energy is apparent in the massive amounts of water needed to produce electricity and the large amounts of energy required to treat, process, and transport water. On the end-use side, energy and water are connected in our homes, businesses, and industrial facilities. The water-energy nexus actually means that end-use efficiency programs directed towards saving water will also save energy. Conversely, energetic efficiency or savings, directly saves water, and or makes water available for other uses. There is growing recognition that "saving water saves energy", reducing water cycle related energy use, and carbon emissions. Yet, it is not always fully recognized that energy efficiency initiatives will in most cases indirectly deliver significant water savings.

Regrettably, water and energy resource management and policies are often conducted in separate silos, which in isolation only focus on one resource at a time, often excluding the other resource. When resources become scarce, this narrow focus becomes problematic. The interrelations and interdependencies between water and energy have already been pointed out, and are well known, hence the interconnected challenges and key issues affecting both sectors should therefore be jointly addressed, considering three relations: energy for water, energy from water and water for energy.

European water and energy policies are still not sufficiently integrated, with the result that important interrelations, synergies and mutually important aspects, are often overlooked. Water and wastewater processes could strongly benefit from more, and better, low carbon, low energy technologies. Most of these processes are still designed and operated relying on a constant energy supply, precluding more massive adoption of renewable energy sources, whose energy supply is variable in time. Meanwhile, efficient and cost effective technologies which do exist to recover energy in various forms from wastewater, are not yet fully



recognized, or little adopted.

In this regard, the WssTP vision depicts a future European society which will manage not only our precious multiple direct water sources from clean rivers, lakes, and below ground, but also from alternative sources such as rain-water, sea and brackish water, as well as, brines and regenerated wastewater, all considered within a holistically integrated system, which will take into account, by the same token, the water-energy nexus. In the future, we will optimise water management and allocation, minimizing energy consumption, by storing, treating and distributing the right water for the right purpose to the right users in a synergetic combination of centralized and decentralized water treatment. Water use will be optimised based on the circularity principle for water such as cascading, reuse, recycling, while enacting new economic mechanisms and models based on the true value of water (such include recovering the energy in water, and being able to extract energy from water treatment processes).

This will have an impressive impact on the water related energy consumption, and contribute to decoupling the water-energy nexus, which is essential to the sustainable production and to support the competitiveness of the European economy and business.

WssTP envisions a European water sector that will be significantly transformed with respect to the current situation. New concepts such as "Multiple Waters" and "Digital Water" will be driving decision makers in a new water-smart economy, enabled by new technologies fostered within an Open Innovation environment and a redesigned water infrastructure.

New governance structures, and partnerships to capture the true value of water, new pricing schemes and mechanisms and novel, more profound water stewardship programmes, will influence the water market gearing towards 50% reduced pressure on our natural water systems. This should imply also a dramatic, massive saving of water related energy consumption, and optimized energy recovery from water.

Overall the value of water for all sectors in our society will be better recognized, making more water and alternative water sources available for different uses and users within a circular society.

ICT solutions and technologies will prove to be an important driver, digitally enabling innovations. New markets will emerge if the "true" value of water is better recognized, and if we manage water accordingly. Such an approach can only boost the "traditional water market" and make new market opportunities emerge that valorise important amounts of raw materials, as well as embedded energy, in used water streams, and make those available for our society.

It is time to think and plan in new ways regarding energy and water. We need to make the drops-to-watts connection, and make best possible use of the nexus.

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