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Minister of Infrastructure, Republic of Slovenia

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Foreword

March 29 2019: even as the rhetoric surrounding Brexit becomes more strident, we must remember that the world is still turning. The situation between India and Pakistan remains alarming and though these countries be far from Europe, both have nuclear weapons; and radiation respects no borders. Nuclear power appears also to have subverted talks between Iran and the US after the abortive DPRK summit. Meanwhile, Europe still faces many pressing energy and transport issues; and the recent Council of Ministers held a public policy debate on "A Clean Planet for All" as well as discussing the Gas Market and the Connecting Europe facility.

With the new 0.5% global sulphur cap now looming large, we are delighted that Sandro Santamato from DG Mobility and Transport explores the maritime use of LNG. His well-balanced article outlines a string of measures that already support LNG deployment, including its availability in the TEN-T maritime ports, before addressing some of the outstanding challenges. However, he points out that LNG can really only be considered an intermediate along the road to zero carbon.

Gundula Konrad explores hydropower, explaining that its generation can be altered within milliseconds to even out variations in wind and solar generation. She also explores hydropower in the future energy mix, advocating better integration of energy policy with environmental regulation; and a level playing field for energy storage technologies.

In his excellent review, Jeffrey Skeer explains how renewable biojet might contribute to halving aviation emissions from 2005 levels. Key factors are the GHG impact of the the land growing the feedstock, the type of feedstock itself and the production process. Crucially, with continuing investment, the cost of biofuel can become competitive with kerosene even if the price of oil remains in the $50 – $100 price range.

We feature Slovenia: in her highly-informative article, Minister of Infrastructure Alenka Bratušek outlines the country's energy sector, which stands 10th in the The World Energy Council rankings. She goes on to explain that Slovenian electricity is already "one of the least carbon-based in the EU", while the country is at the forefront of research in smart grids, energy efficiency and renewable energy sources. Minister Bratušek also discusses Slovenia's ambitious plans to reduce energy consumption by 60% by 2025, in a technological revolution that will "fundamentally change the way we live, work and relate to each other."

Calling Carbon Capture "The opportunity that Europe cannot afford to waste", Graeme Sweeney points out that these technologies can help sustain Europe's energy-intensive industries while creating new jobs, adding that they could help deliver €1.15Bn worth of savings by 2050.

It's encouraging that the Romanian presidency has just announced provisional agreement on basic road and rail safety and connectivity in the event of no-deal Brexit. It's encouraging that people are still talking. And still thinking...

...and there's a lot more for you to read inside.

Michael Edmund
Editor

What does sustainable shipping look like?

By Gesine Meissner, MEP (pictured)

The terms 'sustainability' and 'shipping' or 'transport' inextricably remind us of greenhouse gas emissions, our carbon footprint and oceanic pollution. We know that our oceans have saved our hide more than once in absorbing our growing emissions. The last United Nations Conference on Climate (COP) in Katowice calls for significant changes, but only confirms that we are far from achieving our goals set out in the Paris Agreement of 2016 - let alone the United Nations Sustainable Development Goals (SDGs) 14 and 14.1 against pollution – because of political division, lack of investment and lack of a unified approach. In my last contribution to European Energy Innovation of spring 2018, I addressed the technical feasibility of Hydrogen fuel as an alternative for marine vessels, which should abate rising numbers of emissions and greenhouse gasses.

This contribution will address the parallel to achieving viable and sustainable fuel alternatives for marine transport: adopting new policies on plastic pollution and marine litter in our oceans. The effects of micro plastics on our oceans are largely unknown but its influence and that of toxic waste on the ocean's ability to absorb CO_2 has already proven to interfere with natural oceanic currents, which capture and release heat and cold from our atmosphere. What we do know however, is that those plastics are not entirely biodegradable and that therefore the chance of plastic finding its way into our food chain and consequently their way into our bodies, is more than just a minor possibility.

In 2017, the Commission enhanced its focus on plastic production and use to work towards the 2030 goal to ensure that all plastic packaging is recyclable by 2030.[1] In spring 2019, the European Parliament will go even further by endorsing a continent wide ban on certain single use plastics. With an estimation of an astounding 4.8 to 12.7 million tonnes of plastic waste entering our oceans every year, these steps are quite welcome and

show progress in the right direction. These efforts have to span a wider scope, however, to cover more than just conventional plastic waste.

The next step therefore is to tackle marine litter. While shipping crews and seafarers are already obliged to correctly dispose of their litter and waste, more progress needs to be made to ensure adequate solutions and positive incentives against illegal discharges in the ocean. My work in the Transport Committee of the European Parliament and as rapporteur on the 'Directive on port reception facilities for the delivery of waste from ships´ does just that. It encompasses two goals, to reduce the discharges of ship-generated waste at sea and to reduce the administrative burden on ports, port users and competent authorities, in an effort to combat pollution.

Concerning what is called 'leakage' of plastics into our oceans from unconventional locations or means, this directive offers three significant and impactful changes.[2] Firstly, a 100% indirect waste fee, which ships will automatically have to pay at the arrival in ports, which means there is no financial benefit to illegally discharge waste instead of bringing it into the ports for recycling or adequate disposal. The directive forces seafarers to deliver all of the garbage aboard their ship without being limited to maximum amounts of waste that can be delivered. More specifically, this fee concerns those elements which have been listed in Annex 5 of the International Convention for the Prevention of Pollution from Ships (MARPOL).[3] It includes household items, lighter forms of toxic waste, restauration materials and plastics. At the same time, this directive guarantees that those fishermen whose garbage is caught as 'by-catch' during their fishing runs can deliver this garbage to the port free of charge. This will avoid that fishermen throw this "passively fished waste" overboard again. Lastly, the Port Reception Facility directive incentivises Member States to launch a so-called 'Fishing for Litter' program to financially support the disposal of waste picked up during fishing runs.

To tackle fuel and chemical waste dumping into the ocean, this directive goes even further, by making sure that the Commission soon proposes updated legislation on chemicals and wastes that are not allowed to be discharged at sea, which should make the enforcement of discharge bans more effective. The Parliament has enclosed a revision clause for Directive 2005/35 on 'ship-source pollution and on the introduction of penalties for infringements'.[4] It tasks the Commission with following up on changes at the international level. Aligning the contents of directive 2005/35 to MARPOL, which provides for clear provisions on the types of wastes concerned and covers the prevention of pollution of marine environments by ships from operational or accidental causes, will effectively strengthen these rules.

To ensure that discharge bans are correctly enforced, additional mechanisms such as the monitoring of the European Maritime Safety Agency (EMSA) might be necessary. Their cooperation with European space monitoring systems, such as the Copernicus satellite, can pin point the location and ship from which an illegal waste discharge can be identified. This work shows that achieving sustainability in shipping and more broadly the sustainable development goals, to which the European Union among other states and entities are committed, calls for efforts on all possible levels: From the individual consumer, to the manufacturer and finally to the policy makers. ●

Gesine Meissner (MEP/ALDE) comes from the German state of Lower Saxony. She is the FDP's delegate for Germany's Northern and Northeastern 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 the Special Envoy of the President of the European Parliament on Maritime Policy. Maritime and transport issues are close to her political heart because of the sectors' immense importance for the future.

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LNG for maritime transport
Challenges and prospects

By Sandro Santamato (pictured), Head of Unit, Maritime Transport & Logistics, European Commission (DG Mobility and Transport)

With a little less than a year before the entry into force of the 0.50% sulphur requirements, the use of Liquefied Natural Gas (LNG) in shipping is one of the most stimulating topics in the maritime industry. For about a decade now, LNG as an alternative fuel for shipping has been increasingly adopted as a strategy for environmental compliance, either sailing or at port.

With an immediate and significant impact on the reduction of Sulphur Oxides emissions (SOx), Particulate Matter (PM), and also of Nitrogen Oxides (NOx), the use of LNG as fuel in maritime transport is an attractive option for complying with the requirements of the revised MARPOL Annex VI, and, in the European context, the Sulphur Directive (2016/802/EU).

For some time, LNG vessels were mainly operating in the short sea shipping sector, such as the ferry market or platform supply vessels. However, other market segments are increasingly taking advantage of the benefits offered by LNG as marine fuel. The recent order of ultra-large LNG powered container ships and the delivery of LNG cruise ships are clear indications of the maturity of this technology and its potential for supporting the sustainability of the sector.

Europe is becoming a leader in the use of LNG in the maritime sector. The Commission has supported the LNG deployment in the maritime sector through a package of measures, covering regulatory aspects, technical issues and financial support.

In addition to the Sulphur Directive, which provided a strong incentive for the use of cleaner fuels in the maritime sector, the European Union has adopted in 2014 its Alternative Fuels Infrastructure Directive (2014/94/EU), which establishes a clear obligation for EU Member States to make LNG available in the maritime ports of the Trans-European Network of Transport by 31 December 2025 at the latest. The Directive also covers inland ports, which would need to provide LNG bunkering infrastructure by 31 December 2030 at the latest. Following the provisions of this Directive, Member States are in the process of preparing their National Policy Frameworks to establish more than 250 LNG refuelling points until 2025.

In order to support the maritime sector in meeting the requirements of the Sulphur Directive, the Commission has also established an expert group, the European Sustainable Shipping Forum (ESSF), to serve as platform for addressing technical issues faced by the Member States and the maritime industry. Since its creation in 2013, a significant part of the ESSF activities has focused on the development of LNG. It served as a platform to discuss LNG-related issues, such as safety aspects, training needs, methane slip and gas quality, as well as results from EU funded R&D Projects. The forum also offered specific recommendations, notably on the need to develop an international standard for LNG Bunkering Connectors or a proposal for a standard format for LNG delivery notes.

One of the latest ESSF's deliverables has been the publication by the European Maritime Safety Agency (EMSA) of LNG Bunkering Guidance to Port Authorities and Administrations, dealing with the development, evaluation and control of LNG bunkering activities. By providing a review of the applicable framework and of good practices for LNG bunkering, the guidance becomes an additional element in the EU strategy to support the deployment of alternative fuels for shipping.

Last but not least, the Commission

has strongly supported the deployment of alternative fuels, and in particular LNG, through financial schemes. In the current multi-annual financial period (2014-2020), investments in LNG deployment projects represented nearly 12% of the entire maritime portfolio under the Connecting Europe Facility, the key EU funding instrument for infrastructure investment. In addition, the European Investment Bank has set up in 2016 the Green Shipping Guarantee Programme, to provide financial guarantee through the Connecting Europe Facility Debt Instrument and the European Fund for Strategic Investments (EFSI) for maritime green solutions. The first transaction signed under the Green Shipping Guarantee Programme dealt with the order of an LNG vessel in France.

Nevertheless, a number of challenges remain for further expanding the use of LNG in the maritime sector. These include the lack of commonly available LNG refuelling points; the relatively high investment costs for retrofitting existing ships, as well as for construction of new vessels; the overall planned fuelling capacity, which seems to be distributed unevenly across the Member States; and the problem of uncontrolled methane emissions (methane slip).

One limitation of LNG, is that while being an excellent solution for air pollution, it does not have a major impact on greenhouse gas (GHG) emissions and can only be transitory solution towards zero-carbon fuels. Nevertheless, the investment in LNG is a positive route to follow. It delivers a satisfactory solution to the upcoming challenges on air pollution and its limited CO2 savings can still help the sector in initiating the transition towards low emissions solutions.

In addition, and more importantly, alternative fuels are likely to play an important role in the basket of measures that the shipping sector will have to use to deliver its GHG reduction strategy. The accompanying measures to support the deployment of LNG could be used as a blueprint for similar actions with respect to low-carbon fuels.

“The recent order of ultra-large LNG powered container ships and the delivery of LNG cruise ships are clear indications of the maturity of this technology and its potential for supporting the sustainability of the sector.”

The most innovative project for European shipbuilding

Fibreship will entail an important energy saving reducing by 70% the structural weight of the vessels by means of composite materials.

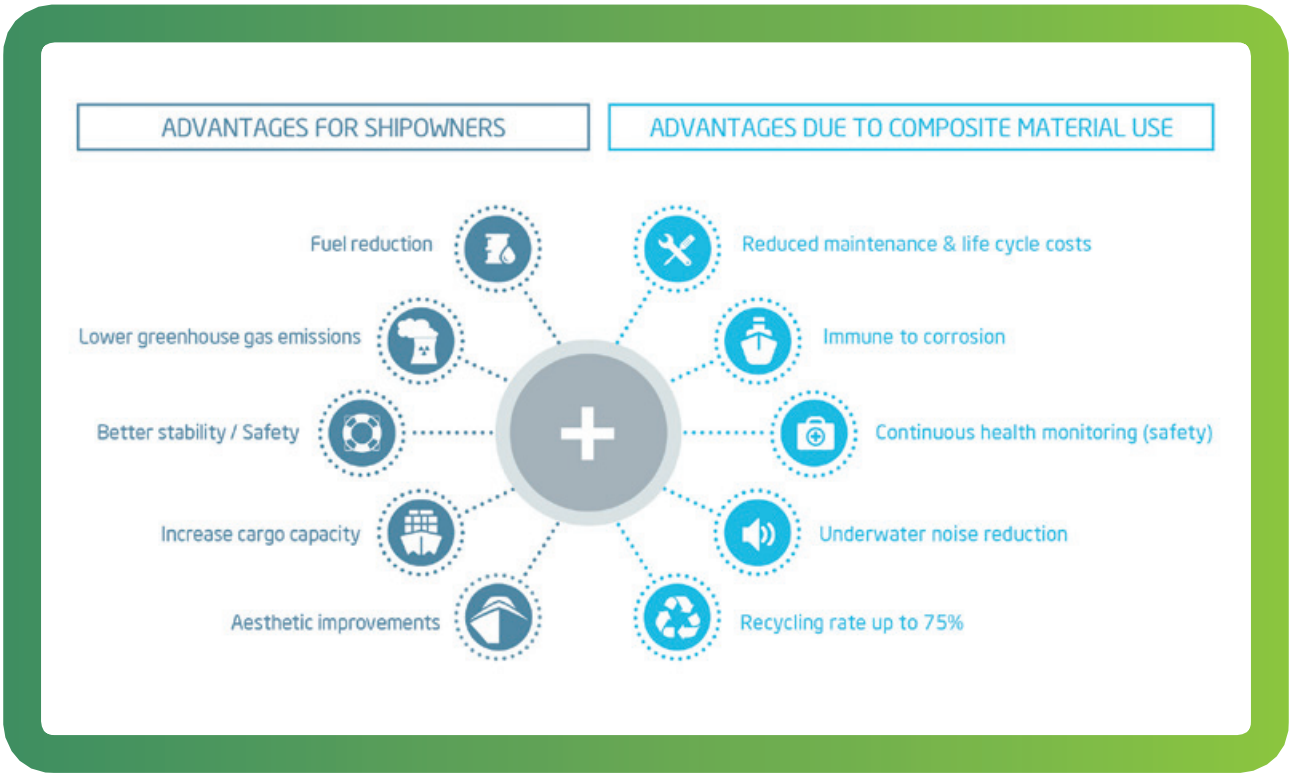
FIBRESHIP (H2020, Grant 723360) is an ambitious R&D project aimed at developing a new market focused on the design and construction of commercial vessels in composite materials (FRP, Fibre-Reinforced Polymers) greater than 500GT (approximately 50m in length). From the energy point of view, this project will imply a significant reduction in energy consumption thanks to the reduction in structural weight of the vessels, among other advantages for shipowners. FIBRESHIP has a overall budget of €11M, being partially supported by the European Commission (EC) within the H2020 research program and it is participated by 18 partners led by TSI S.L.

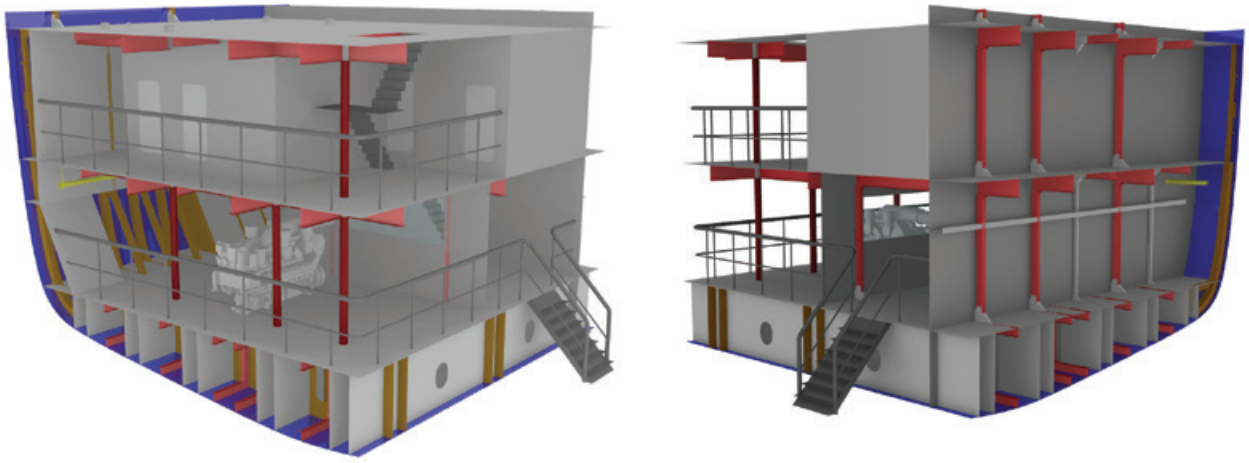
The main objective of FIBRESHIP project is to generate the regulatory framework for designing and building of large-length ships in FRP materials overcoming the technical challenges identified. In order to achieve this goal, the project is auditing innovative FRP materials for marine applications, elaborating new design guidelines, generating production and inspection methodologies, and developing numerical software tools for assessing the structural performance.

Three vessels categories were targeted as the most promising for market orientation in the framework of FIBRESHIP project: i) lightweight commercial vessels, ii) passenger, transportation and leisure vessels and iii) special service vessels.

Along the first period of the project, the following objectives have been reached:

- A evaluation of impacts and a cost-benefit calculator have been performed for large ships of composite materials.
- A SWOT analysis (Strengths, Weaknesses Opportunities, Threats) focused on all involved marine stakeholders (shipyards, suppliers, shipping principals) was carried out, showing the roadmap of composite adoption in EU Shipping Market.





FIBRESHIP solution demonstrator: Fishing research vessel block built in composite materials

- Several experimental tests were performed, consisting of mechanical, fatigue and fire performance assessment of composite materials.
- A composite material selection methodology for large vessels was carried out as well as a set of eligible joining techniques.
- A literature review was conducted on the current marine regulatory framework relevant to the use of FRP materials.
- The design of 3 different vessel in composite material is progressing according to the plan: containership, ROPAX and fishing research vessel.
- A production methodology which meets the needs of composite material shipbuilding of large vessel was conducted to reach a cost-efficient balance, considering modular subdivision and production sequencing recommendations.
- Different strategies regarding inspection, life cycle, structural health monitoring and waste treatment were raised and their assessment is ongoing.
- A software suite made up of different validated coupled numerical models able to simulate the structural behavior was developed.
- Vibro-acoustics tests were performed in a small length vessel of composite material for underwater radiated noise for numerical model validation and on board vibration & noise assessment.
- A full-scale testing campaign in a container ship in harsh sea states is scheduled for April 2019 to obtain useful data to assess the defined structural healdh monitoring strategy.

In order to show the achievements and technological breakthroughs of FIBRESHIP in composite materials vessel design, a full-scale block of a Fishing Research Vessel (FRV) is being built at IXBLUE shipyard. It is scheduled to be finished for the 2nd FIBRESHIP Workshop at the end of June 2019.

Small-scale fire test

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www.fibreship.eu

This project has received funding from European Union's Horizon 2020 research and innovation programme under grant agreement N° 723956

Producing CO_2-free hydrogen from natural gas for energy usage

By Dr. Alexander Gusev, former IASS Employee

KIT / IASS won the GERMAN GAS INDUSTRY INNOVATION AWARD for innovative technology to help achieve a low-carbon energy future after 2050.

The associations of the German gas industry, under the auspices of the German Federal Minister of Education and Research, Ms Anja Karliczek, awarded the 20th GERMAN GAS INDUSTRY INNOVATION AWARD to honour innovative developments and concepts from industry, skilled crafts, trade, and science. The award in the category "Research and Development" went to the Karlsruhe Institute of Technology (KIT) and the Institute for Advanced Sustainability Studies (IASS) in Potsdam for their joint work on the technological innovation of methane pyrolysis. This innovation was also the subject of a professional workshop in which participants discussed several issues, including how the technology can be used on an industrial scale in the future.

What role can natural gas play in a low-carbon energy future? And how can it contribute to the achievement of the global climate goals? More and more experts from politics, science and the energy industry have come to the realization that a fully electrified energy transition based solely on renewable energies is neither technologically nor economically feasible. The focus will therefore be on technology-open approaches that concentrate on gradual carbon avoidance through energy efficiency, replacement of the particularly carbon-intensive energy sources coal and oil, and the gradual transition to low-carbon energy sources within the existing infrastructure.

Hydrogen production from natural gas to accompany renewable energies

In addition to hydrogen from wind energy, another low-carbon energy carrier is CO2-free hydrogen from methane. Corresponding technologies are currently under development, and the next step will be to build the systems that will make it possible to use them efficiently and economically on an industrial scale. Currently many experts favour methane pyrolysis. Prof Dr Thomas Wetzel from KIT Karlsruhe explained this procedure in a professional workshop. The procedure, which involves splitting natural gas into hydrogen and solid carbon (graphite / black carbon), does not generate any harmful emissions. While hydrogen can be used as a clean energy source in a low-carbon energy system, the by-product of the pyrolysis, solid black elemental carbon (graphite), can be used as an industrial raw material for the production of steel, batteries, carbon fibres as well as numerous carbon-based structures and materials. In that way this process could potentially also contribute to reducing emissions in other sectors.

Two cracking products can be fully utilized

If you compare the entire life cycle of both technologies, methane pyrolysis within a liquid metal reactor releases significantly fewer emissions compared to water electrolysis with renewable electricity, says Dr Alberto Abánades from the Polytechnic University of Madrid.

With regard to the economic viability and market potential of the technology, Dr Abánades states that it is currently possible only to estimate the full costs and revenues to be expected. What is however clear is that in this new clean hydrogen production technology all outputs are valuable commodities (e.g. hydrogen, heat, and solid carbon/ graphite). In general, however, hydrogen and carbon can be produced at competitive production costs compared with other procedures if the carbon price is €50 per ton.

Dr Abánades says, though, that a more accurate cost-benefit analysis also depends on how the markets for carbon and hydrogen as raw materials evolve in the future, but that significant market potential exists for both products. With regard to applications for hydrogen, he says the possibilities include use in fuel cells, for power generation, in hydrogen-powered vehicles and as a raw material for the production of ammonia. Carbon could be used in a number of applications, including the production of steel, as a conductor for batteries, carbon fibres and even enhanced building material. Although the market for high-grade elemental carbon is currently still small, there is great potential for the material, especially in Europe, according to Dr Abánades. While 70 per cent of the currently produced carbon comes from China, Europe contributes just one per cent, although it consumes ten per cent of the total produced.

Long-term integration into the energy systems to achieve the climate goals

Gazprom also pointed out possible business models

for the future use of CO2-free hydrogen generated from natural gas, saying they could be an important method for reducing carbon emissions. With regard to the national and international climate goals, the company says this energy source could play an important role in minimising carbon emissions if it is integrated more strongly into the energy system.

One of the ways to reduce the carbon footprint will be to blend natural gas with hydrogen, into a new product called "Hythane" and thereby establishing a low-carbon energy product. However, the first step is to transition in the energy and transport sectors from coal and oil to natural gas, for example through power plants based on natural gas, cogeneration of heat and power, and natural gas vehicles.

Taking this step would already cut back between 13 and 18 per cent of total carbon emissions in the European Union compared to 2016 (or 35 to 39 per cent compared to the 1990 reference year), according to Gazprom. If in the next step methane-hydrogen mixtures are used in these sectors, the EU's 2030 climate targets could be achieved without costly changes in the distribution systems. Overall, a 25 to 35 per cent carbon reduction is possible compared to 2016 (45 to 51 per cent on 1990). And finally, says the company, switching energy systems to hydrogen from methane as the main source of energy could achieve an 80% reduction in carbon emissions in the European Union by 2050.

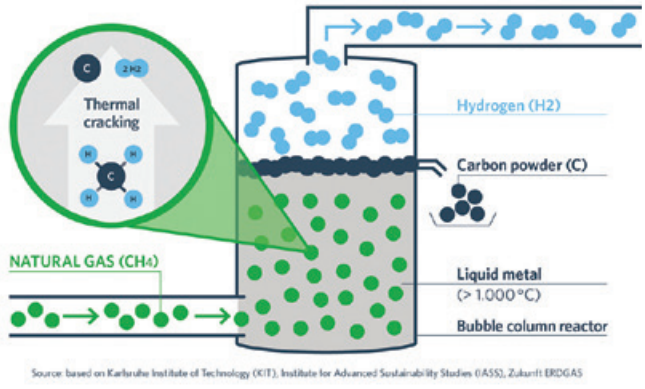
Gazprom's assessment matches the findings of the "Integrated Energy Transition" lead study published last year by the German Energy Agency (dena). According to this study, demand for hydrogen with the lowest possible carbon content will increase in the coming decades from around 30 terawatt hours (TWh) in 2030 to more than 150 TWh in 2050. In fact, these are conservative assumptions that assume usage primarily in the industrial and mobility sectors. If the use of hydrogen and renewable syngas also progresses in the energy sector, the need could even rise to more than 900 TWh.

The natural gas industry is already making progress in this regard and is using hydrogen-methane mixtures for the operation of compressors in gas transport. As a result, carbon emissions can be reduced by around 30 per cent, according to initial analyses.

Conclusion

Methane pyrolysis is a very promising alternative to minimise the carbon footprint in the energy system. CO_2-free hydrogen produced from natural gas is a very relevant opportunity, not only to reduce CO_2-emissions of the energy industry as such, but also as a basis to make an important contribution to achieving the 2050 climate objectives of the European Union.

CO_2-emmission free hydrogen production from gas
Innovative process supplies high-quality industrial raw material



Source: based on Karlsruhe Institute of Technology (KIT), Institute for Advanced Sustainability Studies (IASS), Zukunft ERDGAS

The procedure uses a reactor based on liquid metal technology for the pyrolysis. Small methane bubbles are placed in this reactor from the bottom into a column filled with molten tin. As they rise in the liquid metal, the cracking reaction takes place. The carbon is secreted onto the bubble surface, and when the bubbles disintegrate, the carbon is deposited as a powder at the top of the reactor (solid, black, elementary carbon). In the laboratory set-up, the reactor ran in a continuous operation for two weeks and produced hydrogen at a conversion rate of up to 78 per cent at temperatures of around 1,200 degrees Celsius. The successfully-tested continuous operation is the crucial requirement for future, comparable reactor types on an industrial scale. Modern digital technologies can help to implement the procedure in a particularly economic manner. Falling prices for sensor technology and micro-controller devices lead to substantial cost advantages in this regard. Smart sensor technology and Big Data analysis methods can be used, for example, to enable automated, predictive maintenance.

Alternative methods for breaking down methane include plasma arc technology or iron ore catalysts. Although these methods are already more developed than the procedure with a liquid metal reactor, the latter is superior to the other methods in terms of material use and costs, as well as energy consumption and safety, according to expert opinion. In addition, Gazprom is currently developing further procedures that are suitable for smaller applications and which are characterized by lower specific energy consumption per cubic meter of hydrogen produced.

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CCS and CCU

The opportunity that Europe cannot afford to waste

By Graeme Sweeney, Chairman of the European Zero Emission Technology and Innovation Platform (ZEP)

The climate change debate in Europe is about to heat up this year. Much of that will be influenced by the Parliament elections and how the new MEPs approach this challenge as they take the concerns of their local constituencies to Brussels. The big question many of them will be tasked to take forward is how we can ensure a transition that works for all and does not disproportionally affect the regular citizen; a transition that is just.

This debate will accelerate as further details on the Commission's strategy for long-term greenhouse gas emissions reduction are expected to come out during the course of the year, with adoption to the UNFCCC Secretariat expected by early 2020. Carbon Capture and Storage (CCS) and Carbon Capture and Utilisation (CCU) technologies can facilitate an economic transition that creates positive socio-economic factors rather than only an industrial transition. Whilst CCS and CCU creates new jobs and economic benefits, it also crucially helps to retain Europe's vital energy intensive and process industries in a net-zero world, helping to avoid carbon leakage.

In fact, there is a strong case for treating CCS and CCU as a societal good to reduce CO_2 emissions across various sectors of Europe's regional and national economies. We can compare its development to water systems; the collection, treatment, storage, distribution and drainage. Water system infrastructure was a public investment when undertaken in the 19th century in Europe. It is a common public resource we now take for granted, but continues to be one of the backbones of our society. CO_2 transport and storage infrastructure should be seen in the same way; an enabling infrastructure underpinned by the public sector through direct investment and/or appropriately structured regulation. This will be needed now that it is becoming increasingly clear that CCS and CCU are crucial technology solutions that must be urgently deployed to enable Europe to meet its contribution under the Paris Agreement.

Since the Paris Agreement was adopted in 2015, attention has turned towards the goal of net-zero emissions and how to achieve this. It is important to stress that all solutions will be needed to achieve this goal and certain solutions provide cross-cutting benefits which will be vital to enabling the transition to a low-carbon economy. One such solution is CO_2 transport and storage infrastructure.

The development of CO_2 pipeline and storage networks in key European regions such as the Port of Rotterdam and Norway creates strategic CCS and CCU clusters which can unlock decarbonisation in a number of important sectors, such as energy intensive industries, power and heating. Such networks can also be linked to natural gas infrastructure, thereby providing low-cost low-carbon hydrogen. In the German federal state of North Rhine-Westphalia, CCS and hydrogen is becoming an attractive concept for achieving carbon neutrality in heavy industry – with proposals to connect to North Sea storage sites for permanent CO_2 storage.

The short story is that CCS and CCU technologies are proven and readily available, and much progress has been made in the last few years with regard to operational projects. According to the Global CCS Institute, there are now 23 large-scale CCS projects in operation or construction around the world – spanning sectors such as power generation, natural gas processing, cement, iron and steel, chemicals and fertiliser. There are also a large number of small-scale and part-chain projects and some of these are located in Europe. Interestingly, one application of CCS has really stepped into the spotlight in the last eighteen months – the combination of CCS and steam methane reforming of natural gas to produce hydrogen (blue hydrogen). This has become a particularly significant solution in the debate around how to decarbonise heating and transport – and hydrogen can also be used as a low-carbon source of electricity.

There are those who believe CCS is purely a CO_2 mitigation solution. While this is technically true, it is only half the story. CCS and CCU also represent a massive growth industry for Europe and, where CCS is included in scenarios that achieve a 2050 net-zero emissions energy system, it delivers a saving of over €1,150bn. This is one opportunity that Europe cannot afford to waste. As we approach the EU Parliament Elections, let's make sure MEPs hear this one message loud and clear: CCS and CCU is ready and now is the time for action.

NANOMEMC²
Innovative membranes for Carbon Capture applications

Within the current environmental concerns about global warming, Carbon Capture, Utilisation and Storage (CCUS) is seen as a necessary medium-term technology to reduce greenhouse gas emissions into the atmosphere while waiting for a complete transition towards a more sustainable energy system.

Currently, the main downside to the application of carbon capture (CC) technologies is the high implementation cost; therefore, strong research efforts are required to optimize current capture processes and make CC an economically viable solution for the decarbonisation of industry.

The NANOMEMC² project aims to overcome such limitations through the development of CO_2 capture innovative materials, membranes and processes which are able to achieve a substantial cost reduction, and help achieve the reduction of CO_2 emissions.

To that aim NANOMEMC² applies new membranes to both Pre- and Post-combustion capture stages in order to increase the flexibility of the proposed solutions and maximize the resulting technologies' chances of success. NANOMEMC² also addresses the development of new, high efficiency capture processes, which are selected through techno-economic and environmental analysis, to obtain solutions tailored for a competitive implementation of membrane-based capture applications in relevant industrial plants.

The above targets are being validated during the project, in suitable industrial environments, to build a solid business case for the future deployment of membrane-based carbon capture solutions in industry.

Finally, NANOMEMC² seeks strong collaboration with the Republic of Korea in the field of CCS to exploit complementary expertise and synergies in the development of new capture solutions.

During the project, different types of nanofillers based on cellulose nanofibers or graphene and graphene oxide have been analised so as to understand their ability to boost the separation performance of conventional membranes materials with interesting CO_2 capture capabilities.

Two main families of membranes were investigated, the so-called Facilitated Transport Hybrid Membranes (FTHM) which separate the CO_2 through a selective carrier mediated transport mechanism, and the Continuous Phase Hybrid Membranes, which mainly exploit the molecular sieve mechanism to separate CO_2 from other gases. More than 50 1st generation and about 30 2nd generation materials have been produced and tested, most of which are very close to or above the Robeson's upper limit which is usually applied to compare membranes separation performances.

Most promising 1st generation materials have already been tested in the Colacem cement production facility in Gubbio (Italy). The results were very interesting and made it possible to obtain lab scale permeability data in an industrial environment. A hollow fiber module of the 2nd generation materials is now being prepared by the consortium for the second industrial experimental campaign, while new 3rd generation membranes based

On April 11th 2019 in Brussels, Belgium, join us at the "CO_2 selective membranes for carbon capture and decarbonised fuels" workshop. Have a look at the full agenda for the day and register for free on www.nanomemc2.eu/industrial-workshop/

on modified nanocellulose and graphene are being tested at labscale to prepare the basis for further advance in membrane based carbon capture applications.

In parallel with the experimental analysis, a number of modelling tests were made on both materials and processes.

For the designs of new materials, modelling processes were produced by focusing on the development of micro and macro-scopic tools for transport membranes.

This work led to the development of plans for membranes integration within various areas of activity where CCUS applications can be applied, such as:

- Power generation from natural gas
- Power generation by coal gasification
- Clinker production (Cement)
- Hydrogen production via steam methane reforming

During the first half of the project, both the "Business As Usual" case, without any carbon capture, and the "Base Case", applying state-of-the-art CCS technologies, were evaluated for benchmarking purposes. The last year was devoted to the analysis of different process schemes for the implementation of NANOMEMC² membranes. Current results are satisfactory, especially so in pre-combustion capture, where pressure is available as a driving force for membranes separation.

LCA analysis of the different processes is ongoing. Applications in new areas of interest, such as biogas upgrading are also being considered.

Following the successful technical development, an Industrial Workshop will be organised in Bruxelles next 11th of April 2019. The event will aim to disseminate information on the findings from the project and how the technology could contribute towards industrail decarbonisation. Moreover,within the framework of Topic LCE-24-2016 "International Cooperation with South Korea on new generation high-efficiency capture processes", the three European Commission funded projects: NANOMEMC², GRAMOFON, and ROLINCAP will organize a third EU-South Korea joint workshop on "New generation high-efficiency capture processes". This workshop will be held in Paris on the 2nd and 3rd of July 2019. Stakeholders will get an overview of the current status and development of the three projects and their collaboration with Korean partners. Industrial and scientific experts will be invited to share their view on CCS. Register on NanoMEMC² website to get updates on the event and its final agenda.


Project partners visiting PACT facilities at the University of Sheffield

The project is still in progress and will run up to next September 2019. Up to now, NANOMEMC² has obtained a broad range of promising results for the development of membrane-based CC solutions. Most of the materials investigated showed properties in line or above the current permeability/selectivity trade off limit for CO_2 separation membranes and were successfully tested in relevant industrial environments. In addition, techno-economic analysis on optimized integrated processes showed that such membranes can be competitive with other CC technology in reducing the overall cost of the capture stage in different industrial applications.

Project objectives

NANOMEMC² is a project funded by the European Commission. This project has received funding from the European Union's Horizon 2020 Research and Innovation program under Grant Agreement n° 727734.

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An intitiative of the European Commission

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Carbon capture and storage to fight climate change

By Paula Abreu Marques (pictured), Head of Unit, Renewables and CCS policy, European Commission, DG ENER

Just before COP24 in Poland last year, the European Commission published its strategic long-term vision for a prosperous, modern, competitive and climate neutral European economy entitled "A Clean Planet for All". Having put in place a regulatory framework to meet the climate and energy objectives for 2030, the Commission looks towards 2050 and analyses different pathways to meet the target of a net-zero carbon economy as a contribution to the international effort to limit global warming to well below 2°C.

The modelling and analysis which underlie the "Clean Planet for All" communication show that carbon capture and storage (CCS) technologies will need to play a key role in achieving the climate objective. Despite current and past uncertainties in the economics and the public acceptance of CO_2 storage, CCS is amongst the main options for reducing emissions of large point sources, particularly for big industrial sites for which no alternative mitigation measures exist, such as cement-making. If coupled with sustainable biomass, CCS can play a significant role in creating negative emissions. In the long term, carbon capture can contribute to sector coupling, for instance when captured CO_2 is transformed into synthetic fuels with renewable energy.

Given the imperative to reduce greenhouse gas emissions at a faster pace and to develop all technologies that can contribute to this effort, the European Union was ready over the last ten years to support CCS

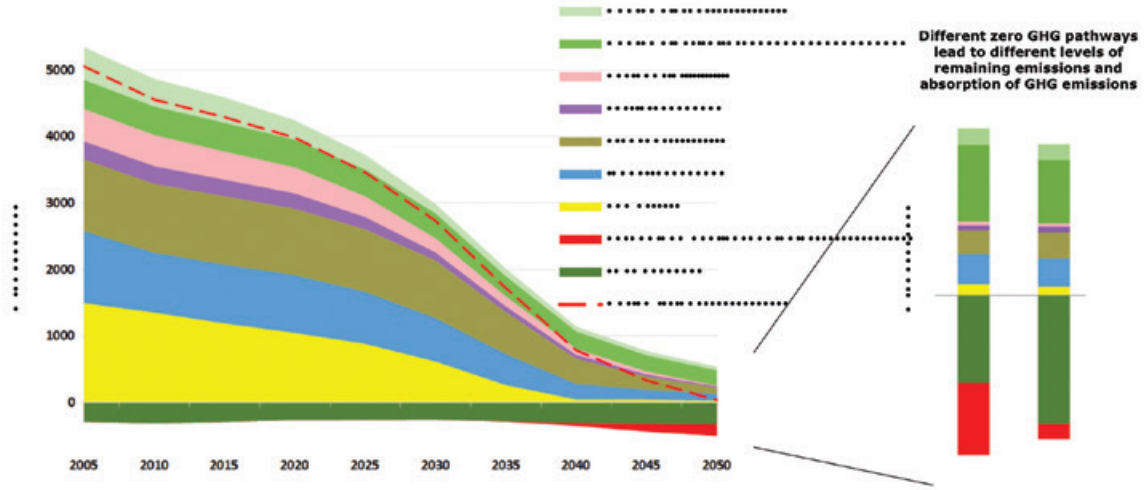


Figure 1 COM(2018) 773 final, "A Clean Planet for All"

technologies through large dedicated funds, in particular the European Energy Programme for Recovery (EEPR) and the NER 300 programme. Despite this EU support and engagement, neither the proposed six large EEPR CCS projects nor the one awarded NER 300 funding took off. Various factors contributed to a withdrawal of national support and project developers discontinuing the projects. These included adverse investment conditions, a carbon price which plummeted during the economic crisis, renewables that started to take off at rapidly decreasing costs and provided cheaper alternatives to decarbonise the energy sector, and, in some cases, hostile public opinion.

However, today we see a renewed interest in carbon capture utilisation and storage hubs and clusters, CCS for clean hydrogen, and the transport of CO_2 by ship, which all could help advance CCS technologies at commercial scale in Europe. Among these projects is the Norwegian Northern Lights development, which provides the infrastructure for storing captured CO_2 from a waste incinerator and a cement plant. If successful, its storage infrastructure could also serve CO_2 that is shipped to Norway from capture sites in the European Union. Another project is happening in the Port of Rotterdam, from whose area 20% of the Dutch CO_2 emissions are emitted. Extending the existing infrastructure to capture CO_2 from various emission

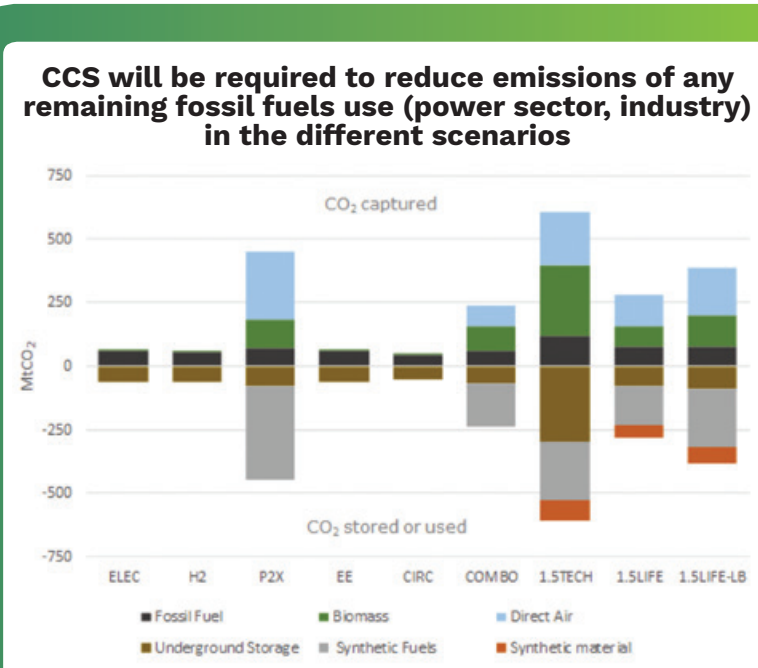


Figure 2 Scenario Analysis Results for CCUS (carbon capture, usage, storage)

Low carbon technologies used for each material in industry

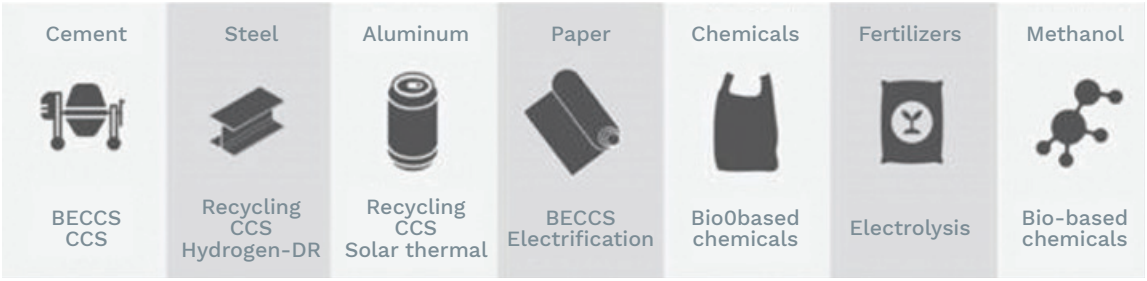


Figure 3 Source: "Energy Transition Within 1.5°C", Navigant, 2018.

sources in the port area, to use some of it and to store the rest in depleted gas fields in the North Sea, could significantly contribute to the decarbonisation efforts of the Netherlands. A successful implementation of these two projects could help carbon capture utilisation and storage technologies break through in Europe.

We want to ensure that all low-carbon technologies are developed and become widely available in the EU and globally because we need all possible tools to reach a zero-carbon economy. Against this backdrop, the European Commission is willing to continue its support for the development and deployment of CCS. Horizon2020 finances several projects to gain knowledge and develop CCS technologies. In particular, a portfolio of industrial CCS projects was established in the hard-to-abate sectors of steel, cement and refineries. The Commission makes further funding available through the Connecting Europe Facility (CEF) for the CO_2 transport projects listed among the Projects of Common Interest (PCI). In addition, revenues from the auctioning of emissions allowances of the European Emissions Trading Scheme will be used to support innovative demonstration projects in energy intensive industries, renewable energy, energy storage and carbon capture, storage and use. This Innovation Fund will complement the Horizon Europe Programme by supporting low- or zero-carbon technologies whose earlier stages of development were financed by Horizon2020.

Through this support, the European Commission pushes low-carbon technologies forward because, as our analysis shows, they are necessary to create a prosperous, modern, competitive and climate-neutral economy. It is also clear, however, that this can only happen with the support of European Member States and the participation of Europe's citizens.

Paula Abreu Marques is the Head of Unit for "Renewables and CCS policy" in the European Commission, DG ENER since August 2013. She is responsible for defining and steering the EU renewable energy policy, including the implementation of the Renewable Energy Directive and the definition of a policy framework for post-2020, and CCS policy.

Importance of the Iron and Steel Industry in the European Union

The Iron and Steel industry produces more than 1 billion tonnes of new steel products every year, which is added to a pool of more than 850 billion tonnes of steel that is in circulation for everything from construction projects to transport vehicles, and many household products. The production is responsible for an annual output of more than 2 billion tonnes of CO_2 per year, of which 10% is directly released through industry in the European Union. This represents 6% of the total CO_2 emission, and 16% of the total industrial emission of CO_2. Moreover, the Iron and Steel industry is predicted to continue growing at an average rate of more than 3% per year.

Iron and steel is an essential ingredient to modern everyday life. Considering the climate implications of the associated CO_2 released during manufacture, it is imperative that new methods be developed to reduce carbon emission and improve efficiency, while continuing to provide a ubiquitous feedstock that drives the economy forward. The Iron and Steel industry employs more than 300,000 people in the European union across 30 integrated steel mills; as well as many more people in smaller scale facilities for speciality products, e.g. production of car engines (20 million manufactured in 2017); and even more people indirectly, such as in the construction and many value-added industries.

To meet the European goals of carbon emission reduction, solutions need to be offered to allow European steel businesses to keep their competitive edge, and not simply export the CO_2 emissions (and jobs) to other countries that have less stringent regard for climate. Technologies exist for thecapture of CO_2 andthey have been deployed traditionally in the petrochemical and chemical industries as cleaning and quality control steps. Compared to these industries, CO_2 emissions from Iron and Steel are substantially larger and require new, and more cost-effective ways of removing the CO_2. The STEPWISE project is a demonstration of one of these new methods.

Decarbonisation of the Iron and Steel Industry

The production of Iron and Steel is energy intensive, and is characterised by three overall energy uses: one third of the energy is needed for the reduction of the iron ore to pig iron; one third is required for the high temperatures which are necessary to run the process; and one third is released again in low calorific, low value residual gases which contain the majority of the carbon emissions, and today, these are used mainly to produce electricity.

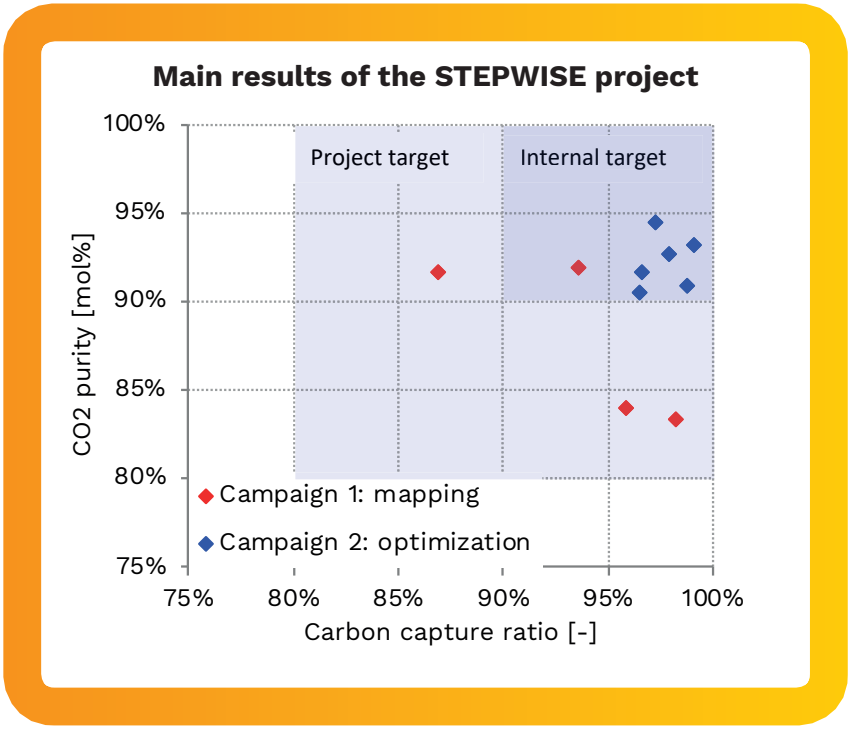
In the STEPWISE project, part of the energy content of these iron and steel works gases is used to power a CO_2 separation step, called SEWGS, Sorption-Enhanced Water-Gas Shift. SEWGS produces two gas streams: CO_2 is produced in a pure stream that is suitable for both sequestration, and utilisation by other industries; the remaining stream is a mixture of hydrogen and nitrogen that is suitable for both decarbonised heating (needed for many processes across the steel works) and decarbonised energy production.

How the STEPWISE and SEWGS process works

With the use of other capture technologies the amount of energy available in the off-gases is insufficient to drive the CO_2 separation step. This means that a choice must be made between either importing extra energy (that must be fossil-free) or capturing less CO_2. While this could be acceptable when only a small reduction of CO_2 output

is required, this becomes a burden when drastic reductions in CO_2 are required, as is the case.

The SEWGS process is a separation process that works at 400°C, the same temperature as in many industrial processes, and the gases do not need to be heated and cooled between the different process steps, saving an enormous amount of energy. The SEWGS process also integrates the conversion of carbon monoxide (CO) in the off-gases to CO_2, producing an H_2 by-product. Furthermore, SEWGS, as implemented in the STEPWISE project allows for a route to progressively decarbonise over 85% of all CO_2 emissions from the many processes that exist around a steel plant. In the first instance SEWGS can be implemented in the power plant, and later in various other units, e.g. the steel plant and the hot blast furnaces, and this enables it to meet the challenges of ever tightening CO_2 emission targets, while not building capture technology that becomes obsolete when the targets are moved up.



Headline Results of the STEPWISE project

In the STEPWISE project, a 600m pipeline was built to transfer off-gases from a blast furnace in Northern Sweden to an experimental demonstration equipment plant with a Water-Gas Shift system for CO conversion and a SEWGS system to produce a CO_2 and a H_2 stream. Three stages have so far been completed, adding to a total of more than 5000 regeneration cycles of the clay-based material that, when adsorbed, removes and releases the CO_2 from the off-gases. The SEWGS reactor is 10m high and contains several tonnes of the adsorbent material that has been produced on an industrial scale.

One of the main targets of the pilot stages was to develop the understanding of the heat management for the entire process, which is not possible at lab-scale. This understanding is has now been achieved, and it has allowed the design of a full-scale piece of equipment, which has also been costed. Additionally, a Life Cycle Analysis has shown that the STEPWISE implementation of SEWGS has a smaller environmental footprint than other carbon capture technologies.

The target for these early stages was to capture 80% of the CO_2 in the blast furnace gas and deliver it at a purity of greater than 80%. This is a suitable target for a single column SEWGS and it was easily matched with a low steam-use. Steam is synonymous with an energy input and is needed in almost all CO_2 capture technologies for the regeneration of CO_2. The STEPWISE project demonstrated that less than 1 steam per CO_2 captured was used, compared to other technologies that can use up to 3 steams per CO_2 captured.

The Next Steps

The next steps to bring the SEWGS technology to maturity will be the demonstration of a multi-column system that will allow more than 95% capture of the CO_2 in the off-gases, and produce a purity of more than 95% continuously, instead of in batches. Most of the utility equipment used for the STEPWISE project can be reused, which provides considerable cost savings. Also the productivity can be increased using the single column system, the final step before commercialisation. SEWGS will then be ready, as the legislation on CO_2 emission catches up with the requirements of a decarbonised society.

The STEPWISE project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 640769.

More information of the STEPWISE project and SEWGS technology is available at www.stepwise.eu

Advances and challenges in bioenergy and biofuels

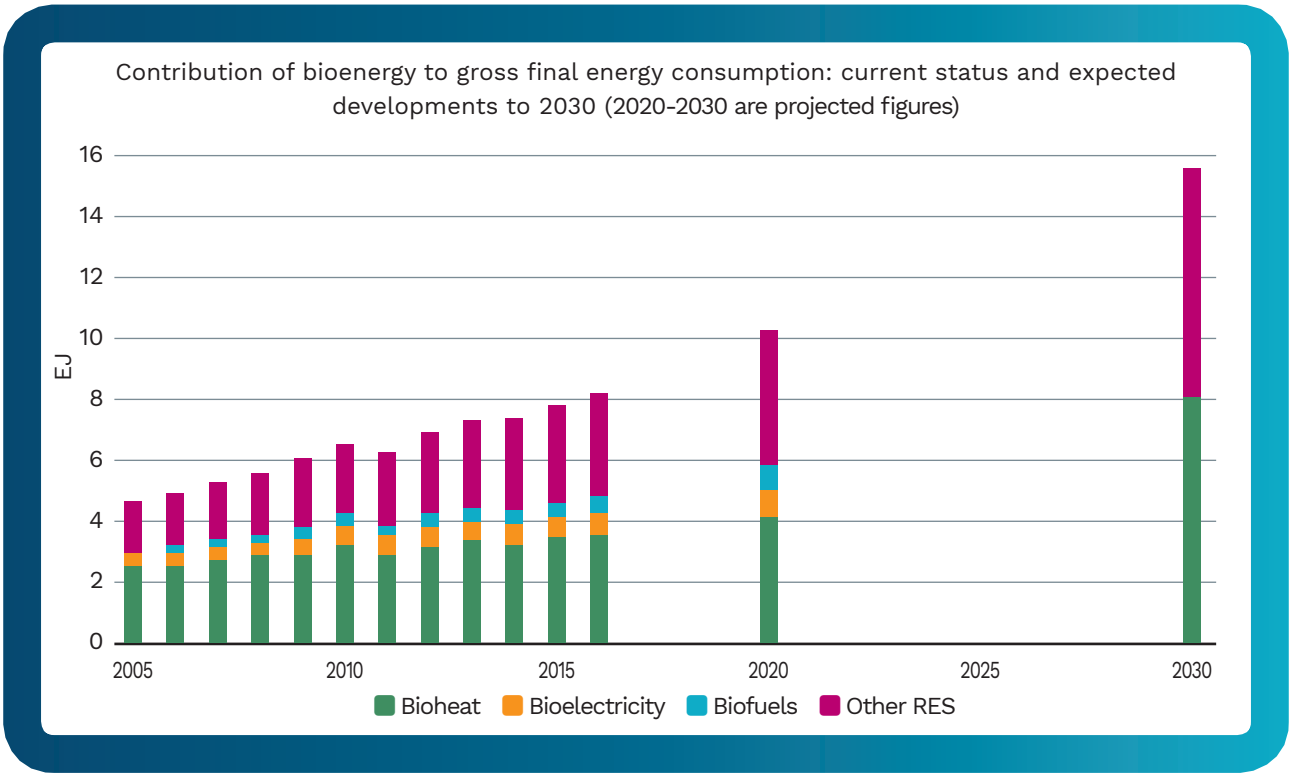
By Piotr Szymański, Nicolae Scarlat, Laura Lonza, Directorate C – Energy, Transport and Climate, DG Joint Research Centre, European Commission

Bioenergy is currently the main Renewable Energy Source (RES) in the European Union (EU), accounting for 65% of the EU renewable energy consumption. It's considered a key pillar for the achievement of energy and climate targets, both at EU and global level. As acknowledged in the "A Clean Planet for all" (COM(2018) 773 final) communication, sustainable bioenergy is expected to facilitate a net-zero GreenHouse Gas (GHG) emissions economy, with estimates of its use pointing to an increase of around 80% by 2050 compared to today's levels, up to 10.5 EJ (250 Mtoe).

Biomass can not only generate electricity, but it can also produce heat and transport fuels, as well as bio-based materials and bio-chemicals. Most importantly, bioenergy can play an important role in decarbonising sectors where other options are unavailable or are very limited, such as freight road transport, aviation and maritime transport. Besides contributing to GHG reduction, bioenergy brings additional social, environmental and economic benefits to agriculture, forestry and other industrial sectors driving rural development, in the context of sustainable development.

While there are legitimate concerns over the sustainability aspects and carbon emissions related to large-scale bioenergy expansion, most studies demonstrate that substantially lower GHG emissions, compared to fossil energy, are achievable if induced impacts on the use of land are avoided, biomass is produced with low (fossil) energy input (or derived from residue and waste streams) and if it's processed with high conversion efficiency using renewable process energy.

The recently adopted (Directive (EU) 2018/2001), regulating bioenergy and biofuels within the broader frame of Renewable Energy Sources includes a binding renewable energy target for the EU of 32% by 2030, with an upwards revision clause by 2023. The sustainability

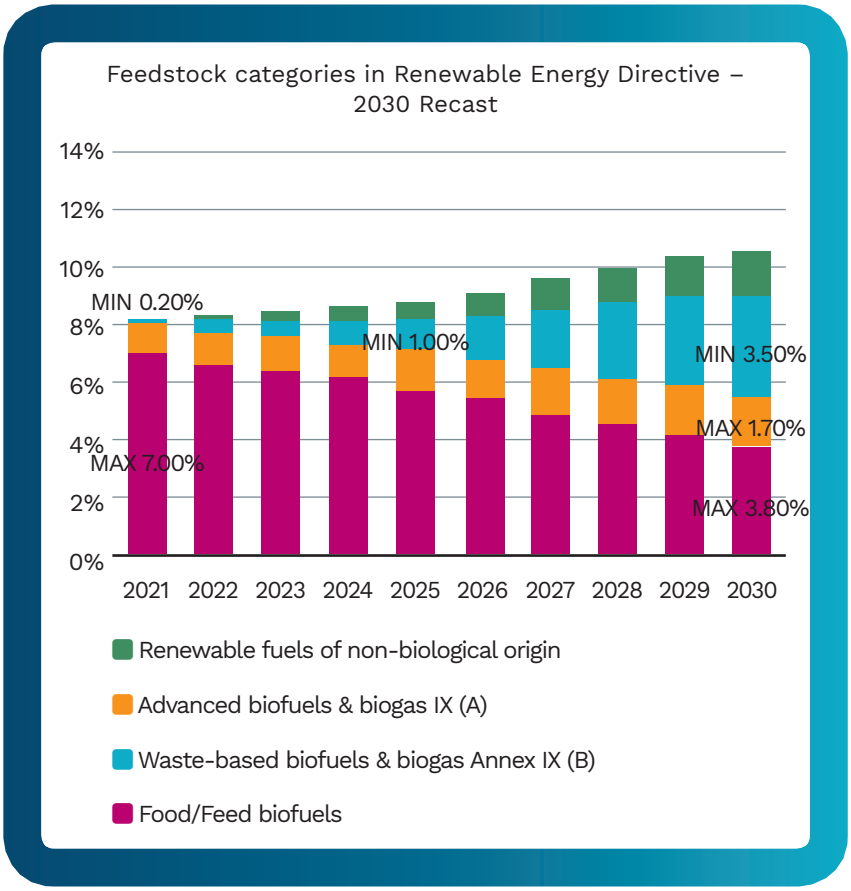


of bioenergy is of paramount relevance, i.e. it must deliver optimal greenhouse gas (GHG) savings and it must be produced according to strict sustainability requirements. These sustainability criteria include restrictions on biomass production in high biodiversity value land (primary forests, highly biodiverse forest, protected areas and highly biodiverse grasslands) and in high-carbon stock land, such as wetlands, forest land and peatland. Furthermore, forest biomass needs to comply with Land-Use, Land-Use Change and Forestry (LULUCF) criteria.

Combined heat and power (CHP) provides currently 11 % of Europe's electricity and 14 % of its heat. Biomass fuelled CHP had about 21 % from the total CHP market of in the EU in 2017. The Scandinavian countries with large forestry biomass resources have the highest penetrations rates.

As for biofuels, the Directive ensures that the share of renewable energy allocated for final consumption in the transport sector (road and rail) reaches at least 14% by 2030. The contribution of biofuels derived from food and feed crops is capped at 7%. Within the overall 14% quota, the contribution of the so-called advanced biofuels shall be equal to at least 0.2% in 2022, 1% in 2025 and increasing up to 3.5% minimum by 2030.

Bioenergy has a primary role to play on the road to a low-carbon energy system, by allowing higher integration of variable, intermittent sources of renewable energy (such as wind and solar) into energy systems. Biomass power production can be used to deliver continuous electricity or grid balancing, offering certain flexibility capability in operation. A number of bioenergy solutions are currently available and are applied at various size ranges to enable flexible power generation. Integrated bioenergy hybrids offer flexible solutions applicable to both energy supply and energy storage, including solar thermal systems, Concentrated Solar Power (CSP), geothermal, heat pumps, waste heat recovery, etc.



Bioenergy can be competitive in some cases, especially when cheap or even negative cost of biomass feedstock, such as waste and residues, is available. While a number of bioenergy technologies approach maturity, further technology development is needed to allow promising technologies to reach commercial production and to achieve cost competitiveness.

The main focus is to close the gap between research and innovation and industrial implementation of innovative technologies. In this respect, the European Commission adopted a Communication for an Integrated Strategic Energy Technology Plan (C(2015) 6317 final), which identifies ten priority actions aimed at accelerating the transformation in the energy system through coordinated or joint investments between EU Member States, private stakeholders (including research and industry) and the European Commission. The Implementation Plan (IP) of Action 8, Bioenergy and Renewable Fuels for Sustainable Transport, proposes to prioritise the execution of Research and Innovation (R&I) activities to achieve the SET Plan targets for renewable fuels for transport, other renewable fuels of non-biological origin, bioenergy intermediate carriers, renewable hydrogen and large-scale biomass CHP.

As the European Commission's Science and Knowledge Service, the Joint Research Centre supports EU policies in the field of bioenergy and biofuels, covering the entire policy cycle from research and innovation to implementation of regulatory acts.

A Call for Action in Horizon Europe on Advanced Materials for Clean Energy & Clean Mobility

Despite …

1. The role Advanced Materials play in enabling (driving costs down, increasing performance, increasing lifetime) clean energy & clean mobility technologies for the Energy Union and EU citizens' comfort & health

2. The share of Advanced Materials in the cost structure of clean energy & clean mobility technologies (beyond 50% today and trends will bring that share to 80+% making Advanced Materials a competitive factor for manufacturers of these crucial technologies)

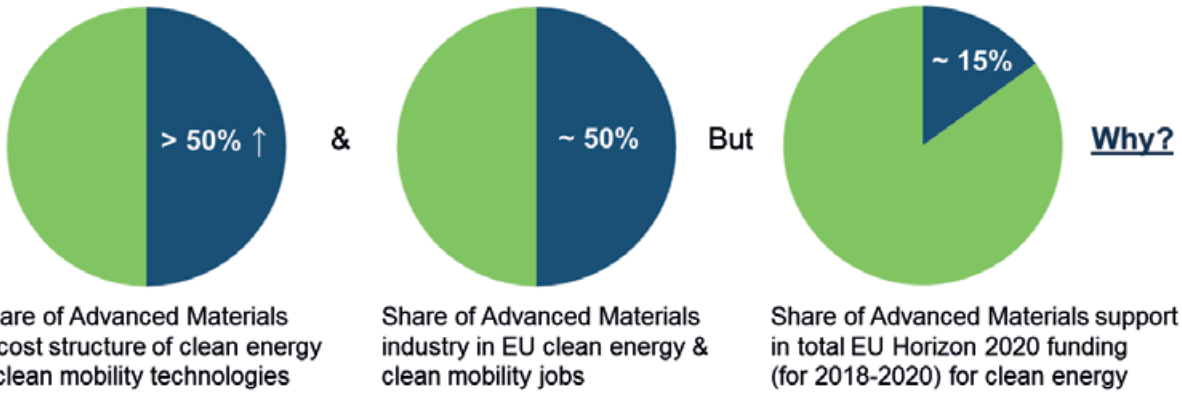
3. The need for risk-sharing policies & instruments at EU level to support the long, risky (market & technology) and capital-intensive development cycle of Advanced Materials

4. The contribution of EU-based industry of Advanced Materials to our economy (more than 30 billion euro, 500.000 jobs, 3 billion euro annual investment in R&D and facilities)

5. The share of Advanced Materials industry in EU clean energy & clean mobility jobs (at least 50%) and the importance for SMEs and start-ups to rely on a strong industry & research ecosystem to collaborate and co-innovate with

6. The excellent collaboration between EMIRI and EU DG R&I in Horizon 2020 (based on EMIRI strategic innovation roadmap called EMERIT) which led to increased EU support to Advanced Materials for clean energy & clean mobility

The share of support to Advanced Materials in total EU Horizon 2020 funding for clean energy is at a low 15% (in work programme 2018-2020) partly due to Horizon 2020 architecture & budget allocation.



Moreover, potential developments regarding EU Commission's forthcoming Horizon Europe could affect negatively the EU support to Advanced Materials and other Key Enabling Technologies. This would result in an impact on European industrial leadership … Europe is not in a position to afford such a development.

IN FIELD OF CLEAN ENERGY & CLEAN MOBILITY TECHNOLOGIES, ANY DETERIORATION IN EU SUPPORT FOR INDUSTRIAL LEADERSHIP IN KEY ENABLING TECHNOLOGIES SUCH AS ADVANCED MATERIALS WILL LEAD UNDOUBTEDLY TO EU NOT DELIVERING ON ITS ENERGY UNION PROMISES:

1. **Europe not generating the much-needed economic growth & jobs for citizens who strongly supported European transition to clean energy & clean mobility technologies**

   EU is losing leadership in clean energy & clean mobility techs leading to deindustrialization and job destruction (net loss of 100.000 jobs in 2013-2016) while China & USA are thriving. Moreover, without presence in EU of a globally exporting Advanced Materials industry, the job loss would have been worse (EU-based Advanced Materials industry created 40-50.000 jobs over 2013-2016 while the downstream part of clean energy value chains lost 140-150.000 jobs). Our industry is actually slowing down EU loss of leadership in clean energy & clean mobility techs and is undoubtedly the foundation on which EU can regain global market share in the field.

2. **Europe weakening its innovation ecosystem in technologies critical to climate change mitigation**

   With China spending more than 2.5 billion euro annually on clean energy & clean mobility technologies, EU is now challenged. The situation is worsened by fragmentation, unclarity and instability of European R&I support to its ecosystem. In China, Advanced Materials are among the 10 priorities of "China Manufacturing 2025" … This is not the case in Europe.

3. **Europe replacing dependence on fossil fuels from outside EU by dependence on imported clean energy & clean mobility technologies**

   Today more than 50% of industrial players in top 10 of manufacturers of wind turbines, solar modules, batteries, … are Asian (in most cases Chinese)… Leading to EU representing today less than 15% of jobs in the field in 2016 (1.16 million jobs) while China is already at 44% (3.65 million jobs). Without EU action, EU will pass below 1.000.000 jobs in clean energy by 2020 (10% of global jobs in the field) and market opportunities of fighting climate change will not benefit EU citizens.

WE CALL ON EU COMMISSION, EUROPEAN PARLIAMENT AND MEMBER STATES TO FURTHER SUPPORT ADVANCED MATERIALS AND OTHER KETS AND SHOW AMBITION IN HORIZON EUROPE TO PRESERVE EUROPEAN TECHNOLOGY DEVELOPMENT LEADERSHIP, RE-INDUSTRIALIZE EU IN CLEAN ENERGY & CLEAN MOBILITY TECHNOLOGIES, DELIVER ON THE ENERGY UNION PROMISES AND PROVIDE ECONOMIC OPPORTUNITIES TO CITIZENS.

EMIRI (the Energy Materials Industrial Research Initiative) represents more than 60 organizations (industry, research, associations) active in Advanced Materials for clean energy & clean mobility technologies. The association contributes to industrial leadership of developers, producers and key users of Advanced Materials by shaping an appropriate European innovation, energy and industrial policy framework. For more information, contact Philippe JACQUES at philippe.jacques@emiri.eu, visit www.emiri.eu

Want to reach climate neutrality by 2050? Then start with our buildings!

Adrian Joyce is Secretary General of EuroACE, the European Alliance of Companies for Energy Efficiency in Buildings, the leading industry voice on energy performance of buildings within the EU policy context. In this editorial comment he outlines why the EU cannot expect to achieve its ambition for a climate-neutral economy by 2050 without solving the energy waste crisis in our buildings.

A Clean Planet for All is the surprising start to the title of the recently launched Communication of the European Commission on the European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy in which the Commission sets out the actions needed to achieve climate neutrality by 2050. It describes eight potential pathways to achieve its aim, each one containing a different emphasis and different mix of technologies. The road to climate neutrality must, it says, be built on seven strategic buildings blocks.

The first, and for me most important, building block mentioned is to maximise the benefits from energy efficiency including zero emission buildings. I fully agree that putting energy efficiency first is right and I was pleased to see that it is the first building block mentioned in the Commission document. However, it is practically the only place in the entire Communication where energy efficiency gets the prominence it deserves.

My alarm at this lack of attention to the role that energy efficiency can and must play in getting the EU on the path to a climate-neutral economy by 2050 was further accentuated when I took a close look at the logo used by the European Commission in conjunction with the Communication (see picture). In all the icons used in the doughnut shape, there is just one building and it is a factory building used to make the observer think of industry. Practically all the other icons are ones that lead the observer to think of renewable energy supply or efficient products and none make you think of our buildings in which we all spend nearly 90% of our time!

The Communication, on page 8, correctly refers to the role that higher energy performance of buildings can play in decarbonising the EU. It correctly recalls that buildings use above 40% of all primary energy and that there is a huge potential to dramatically reduce energy use in buildings through higher renovation rates although it does not mention that the higher rates must be coupled with higher levels of ambition in renovation projects. The focus then changes to a long text on fuel switching and the use of sustainable renewable heating to achieve the decarbonisation objective.

From my perspective, the Communication has not accounted for the supporting analysis in an adequate manner. In the analysis (page 90), we see that the Commission acknowledges that the target renovation rate to achieve our ambitions should be at least 3% per year up to 2050. We then find that on page 102, the renovation rates used in the eight modelled scenarios are a maximum of 1.8% and then only in the residential sector! This clearly demonstrates that the full potential for energy savings in the buildings sector has not been considered, thus contradicting the analysis that accompanies the Communication.

The analysis of the buildings sector leaves the reader with an accurate appreciation of the challenge of achieving highly energy efficiency and decarbonised buildings as it describes an integrated approach that includes a narrative on improved energy performance of the building envelope that must be coupled with optimised technical building systems and appropriately designed building automation and control systems.

IN-DEPTH ANALYSIS IN SUPPORT OF THE COMMISSION COMMUNICATION COM(2018) 773

A Clean Planet for all
A European long-term strategic vision for a prosperous, modern, competitive and climate neutral economu

Is this a graphic illustration of how the role of buildings is overlooked in the long-term decarbonisation strategy?

It is now very clearly accepted that it is better, more cost-effective and more responsible to first reduce the demand of a sector, before exploring ways of supplying the sector with sustainable, decarbonised supply. This is because, the lower the energy demand that must be supplied, the broader the range of suitable sustainable sources that become available. However, this relationship where energy efficiency measures and renewable energy supply are harmoniously and optimally integrated, does not emerge from the Communication and this is a point of great regret.

Across the EU we are witnessing a collective realisation that the negative effects of climate change are no longer a distant threat. They are with us today as witnessed by the heatwave of 2018 and the incredibly long mild spell that most of the EU experienced in February 2019. In many countries we see school children skipping school to regularly protest at our level of inaction and our immaturity in the face of the gravest crisis that has ever befallen the human race.

The protests resonate very well with the scientific warnings included in the IPCC 1.5° Report that states we have no more than 12 years to take action to avert catastrophic impacts on our world from the effects of climate change. This clear and vivid scientific message coupled with a disenchanted but ready-to-act youth shows that we must take action and that we must take it now. In fact, the ground swell of opinion among out youth shows that we have societal permission to act.

For the buildings sector, the right EU-level legislative framework is in place as the revisions to the Energy Performance of Buildings Directive (EPBD) and the Energy Efficiency Directive (EED) have been agreed and published. The EPBD requires that all Member States adopt and implement a national renovation strategy that will transform their buildings to a nearly-zero energy stock by 2050. It puts the ball firmly in the court of national governments and I trust that they will seize the day and implement highly ambitious strategies that will lead to a rapid acceleration in both the rate of renovation activity and the depth of ambition for each renovation project.

The Member States should not shirk from their responsibility to plan this transformation correctly, despite the challenge that this task presents them. They will find that as the quality of buildings improves, large individual and societal benefits such as higher employment, greater general levels of health and higher public finances will flow from the works that are undertaken on the buildings.

Knowing that all the products, technologies and services that we need to achieve this huge societal task are already on the market, leaves me optimistic that we can achieve our goals. However, revisions to the long-term strategy of the EU towards a climate-neutral economy in which the central role of buildings is better included and fully modelled, will be necessary. I look to the European Parliament and to the Member States to ensure that when the choice of which pathway to follow is made that the essential corrections that I have referred to in this article are made before the final decision is taken.

In this context, not tackling buildings first is just too risky.

EuroACE 20 YEARS
THE EUROPEAN ALLIANCE OF COMPANIES FOR ENERGY EFFICIENCY IN BUILDINGS

About EuroACE

EuroACE represents Europe's leading companies involved with the manufacture, distribution and installation of energy saving goods and services for buildings. EuroACE members employ over 286,000 people in these activities in Europe and have around 1,200 production facilities and office locations. The mission of EuroACE is to work together with the EU institutions to help Europe move towards a more efficient use of energy in buildings, thereby contributing to Europe's commitments on climate change, energy security and economic growth.

EuroACE Members (March 2019) are:

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“Closing the gap”

Aggregators as Enablers of Prosumers and Consumers Active Participation in the Energy Markets

Aggregators should be intermediaries to put “Consumers at the heart of the Energy Union”. The regulations in the “Clean Energy for all Europeans” Package envisage a situation in long term prospective where the consumers and prosumers are more integrated in the energy market.

Currently, aggregators are mostly acting for industrial and commercial consumers. Domestic consumers, and prosumers, do not have means to trade directly in the energy markets and require the services of an aggregator. Aggregators are the enablers for an active participation of prosumers and consumers in the energy markets.

In that context, the European project BestRES “Best practices and implementation of innovative business models for renewable energy aggregators” made real the

implementation of business models for aggregators of decentralized renewable energy units acting to support the participation of prosumers and consumers in the energy markets.

Established in 2016 and funded by the European Commission, the BestRES project involved eleven European partners across nine different European Countries: United Kingdom, Belgium, Germany, France, Austria, Italy, Cyprus, Spain and Portugal. The main target group, the aggregators, were involved directly in the project as partners: Good Energy from UK, Next Kraftwerke Germany (targeting Germany, Italy and France), Next Kraftwerke Belgium targeting Belgium, oekostrom from Austria and EDP (targeting Spain and Portugal).

The Consortium included renewable energy experts 3E from Belgium and the Technical University of Vienna from Austria, as legal expert the Foundation for Environmental Energy Law - Stiftung Umweltenergierecht (SUER) from Germany, one dissemination-communication expert, youris.com from Belgium, and a research centre: FOSS from Cyprus. The project was coordinated by WIP – Renewable Energies, based in Munich, Germany.

In the last three years, four fundamental steps have been achieved with the aim to guarantee the implementation of the business models for aggregators of decentralized renewable energy systems and an active participation of prosumers and consumers in the energy markets:

1. Analysis of the existing business models
2. Improvement of business models and testing phase
3. Implementation of business models in real-life conditions
4. Identification of National and European enabling conditions for the uptake of business models for the aggregation of decentralized renewable energy systems

Thirteen business models have been analyzed and improved during the BestRES project. The analysis focused on technical, market, environmental and social benefits that aggregators bring to power markets and systems. The technical, regulatory, and legal barriers

preventing optimal deployment of current business models have also been defined. The business models were tested to define the feasibility for the real-life implementation. Eight of them passed the test and have been implemented under real life conditions with consumers and prosumers from several European Member States.

Silvia Caneva, the project coordinator from WIP, said: "The BestRES project is the proof that aggregators of decentralized renewable energy units can close the gap for an active participation of consumers and prosumers in the energy markets. Aggregators define a new era for renewable energy sources, since they make possible the access to new markets and services otherwise not accessible for decentralized renewable energy units. She highlighted that flexibility is the key to ensure the adaptation of the energy system to the rise of intermittent generation, decentralized power production and the regionalization of the electricity sector".

Elias De Keyser, energy & flexibility expert at Next Kraftwerke, said: "The key technology to ensure the provision of flexibility through decentralized renewable energy units is the virtual power plant (VPP), which is defined as technology platform that connects distributed energy resources to markets and services which they might otherwise not have access to (Reference: Bloomberg New Energy Finance). VPPs are the enablers since they cluster decentralized renewable energy units and automatically dispatch the generated renewable electricity".

Fabian Pause, legal expert from the Foundation for Environmental Energy Law (SUER), said: "The recently agreed Clean Energy Package with its new rules on market design and renewable energies recognizes that aggregators are important enablers for consumers and prosumers in the future. Aggregation is now clearly described as a function taken by a person that combines multiple customer loads or generated electricity for sale, for purchase or auction in any electricity market. To support this role, the development of a clear legal framework for decentralized market players like consumers and prosumers, both on EU and national level, is crucial.

The project results are available at the BestRES project webpage: www.bestres.eu

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Al-Bahar Towers, Abu Dhabi (© Abdulmajid Karanouh)

Adaptive Facades Network A key to harmonize green envelope on all future buildings

By Prof. Dr Andreas Luible, Professor, Competence Centre for Building Envelope, Lucerne University of Applied Sciences and Arts, School of Engineering and Architecture, Switzerland

Most of our facades today are passive systems and exhausted from an energetic point of view. A collaborative network brought researchers and industry together to develop, design and integrate next generation adaptive facades to reduce energy demand and carbon emissions of our future building stock.

The need to reduce energy consumption and carbon dioxide emission are the most important challenges facing the building industry. Half of the world's population lives in urban areas where they need home and shelters. One third of all end-user energy in Europe is consumed by space heating-cooling, ventilation and lighting of building which is governed by the efficiency of the building envelope.

Energy demand in building can be reduced by up to 13% by 2020 and up to 70% by 2050. Therefore, the energy performance of the future building envelopes will play a key role in meeting EU's Climate change and energy sustainability targets for 2020 and beyond.

Adaptive building envelopes are multifunctional, able to interact with the environment and the user by reacting to external influences. Behaviour and functionality will also change accordingly: the building envelope insulates only when necessary, it produces energy when possible and, it shades or ventilates when the indoor comfort requires it. Therefore, multifunctional and highly adaptive systems can provide significant improvements in the overall building performance.

This may be by means of materials, components or systems.

Several different adaptive facade concepts have already been developed, and an increase in emerging, innovative solutions is expected soon.

The overarching objective of COST Action, Adaptive Facade Network, which ended in 2018, was to harmonise, share and disseminate technological knowledge on adaptive facades at a European level.

This translated into several measurable objectives: organise knowledge-sharing activities between European research centres and between these centres and industry. Encourage the participation of established research centres as well as early-stage researchers from a broad range of European countries. Foster the development of novel adaptive facade concepts and technologies. And finally, disseminate the activities and achievements of the Action to the widest audience possible.

Networking activities organised by this COST Action have enabled considerable knowledge sharing and harmonisation of technologies between stakeholders from industry, research, and education to a wider audience.

14 working group meetings, two industry workshops, two training schools, 31 short-term scientific missions and two international conferences have been organised throughout the duration of the Action.

During the four years of the Action more than 210 experienced professionals from 28 countries were involved with the objective to support transnational cooperation between researchers and industry through science and technology network. Several of these activities were incubators for new research and the

COST TU1403 group

development of new collaborations in this field becoming very visible and respected globally.

In order to foster the development of novel adaptive facade concepts and technologies, the Action undertook a comprehensive review of adaptive facade case studies.

This was the first of its kind and used a simple and effective classification: materials, components and systems of state-of-the-art adaptive facades. In addition, useful details working principles, technology readiness, and economic aspects were also reported. The database includes 165 cases of adaptive facade systems, components, and materials and provides an invaluable resource for future teaching and research activities.

The high potential of adaptive facades can only be achieved if their performance can be reliably predicted in the design phase. The intrinsic complexity of the dynamic behaviour of these systems, when compared to traditional building envelope components, leads to the fact that conventional simulation tools, experimental assessment methods, and key performance indicators cannot be fully adopted in the case of adaptive facades. Therefore, several activities in the COST Action focused on a comprehensive review of simulation tools and experimental characterisation facilities. Specific know-how on selected cases was also presented. The adaptive facade sector is evolving rapidly, therefore the simulation and characterisation methods were presented in a manner which could remain relevant in the coming years.

Adaptive facades play a significant role in improving the productivity and wellbeing of its occupants. This Action has made several contributions in this area. Members have reviewed, developed and trialled post-occupancy evaluation methods that are vital for commissioning and assessing the performance of adaptive facades. Furthermore, a classification map was developed that captures the complexity of occupant-adaptive facade interaction that is essential for maximising occupant satisfaction with novel adaptive facades.

The outcomes of the COST Action are disseminated by means of numerous scientific journal publications at Elsevier and two special issues of the Journal of Facade Design & Engineering among other. Facade-related research and industry across Europe would greatly benefit from the network initiated by this Action as well as setting new standards for any new green buildings.

Ultimately, these outcomes of COST Action could lead to a more efficient use of energy and material resources in the built environment and help to improve human wellbeing in buildings.

Contact information:

View the Action: https://www.cost.eu/actions/TU1403/
View the Network website: http://www.tu1403.eu

The European Cooperation in Science and Technology (COST) 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.

cost
EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

A decision support tool to prioritise energy efficiency measures in public buildings

The PrioritEE project aims to strengthen the policy-making and strategic planning competences of local and regional public authorities in the energy management of Municipal Public Buildings (MPBs) in Italy, Portugal, Spain, Greece and Croatia developing replicable solutions suited to various regional contexts.

The project aims to gather the knowledge acquired in terms of decision support tools, good practices and strategies in one common platform, the PrioritEE toolbox, which can be used by local administrations to manage and monitor energy consumption, assess the cost-effectiveness of a predefined set of Energy Efficiency (EE) and Renewable Energy Sources (RES) measures, and prioritize investments. Moreover, it will release a policy document on common strategies in the MED area to develop local action plans to reduce the energy consumption of MPBs.

The PrioritEE toolbox

The PrioritEE toolbox has been tested on five pilots in the partner regions, focusing on a varied portfolio of local priorities and covering different key energy efficiency issues. The toolbox is composed by five main components which will be available in English, Italian, Portuguese, Spanish, Greek and Croatian:

A ***technologic analytical database*** which incorporates solutions to improve EE in MPBs split by end-use: lighting, space heating, space cooling, water heating and cooking. The database also includes measures to reduce the energy needs of the buildings structure as well as renewable electricity generation technologies providing information on technological characteristics, investment and operation and maintenance costs, energy savings, etc. It can also be used as a benchmark tool and for identification of different alternatives for improving EE in MPBs.

A ***Decision Support Tool (DST)*** to prioritize EE measures divided among nine areas of focus: external walls, external windows, roof, ventilation system, heating and cooling system, lighting system and integration of renewable energy (solar collectors and PV panels). The DST provides an overview of results ranked by savings, investment costs and return of investment for each building and building typology allowing also the evaluation of different combination of EE measures. Users can either fill only basic input which will be supplemented with a list of assumptions from the toolbox's database, or fill-in also advanced inputs for more accurate results. The DST is available in a spreadsheet version as well as in a user-friendly software application.

The toolbox is completed by: a set of ***How-to Briefs*** that are easy-to-use guides for the implementation of selected best practices for EE in MPBs; a ***Repository of Good Practices*** to enhance sustainable energy awareness and foster behavioural changes; and an ***Open data & knowledge access infrastructure*** which gathers all these components in a central point on the PrioritEE website in order to be easily and freely accessed.

Capacity building and knowledge transfer

Local Living Labs were carried out in each pilot area to engage target groups in the project's activities, foster energy awareness and implement selected good practices within the local communities. Moreover, Local Workshops were organized to involve key stakeholders and provide an effective transfer of knowledge with the final aim to develop local plans for improving EE in MPBs.

Contact details:

Project number: MED15_2.1_M2_205
Website: https://prioritee.interreg-med.eu/
Start date: February 2017
Duration: 30 months
Project coordinator: Monica Salvia, CNR-IMAA
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Interreg Mediterranean PrioritEE
Project co-financed by the European Regional Development Fund

The revised EPBD

The opportunity to unleash the multiplier effect of Building Automation and Control Systems

By Simone Alessandri (pictured), Director, Governmental Relations, eu.bac

2019 is a turning point for energy efficiency of Buildings. With buildings that are responsible for approx. 40% of energy consumption and 36% CO_2 emissions in Europe, actions are needed, more than ever before. In this regard, the European Union played its part approving an ambitious piece of legislation: the revised Energy Performance of Buildings Directive.

This Directive entered into force in July 2018 and the Member States have now time until March 2020 to transpose it into national legislation.

Among the most innovative elements introduced by this revision, the following amendments are of utmost importance:

- Definition of Building Automation and Control Systems (BACS) according to the European Standards in the Directive
- Mandatory requirements for installation and retrofit of Building Automation and Control Systems (BACS) in non-residential buildings (existing and new) with effective rated output of over 290 kWh, by 2025
- Incentives for installation of continuous electronic energy performance monitoring and effective HVAC controls in existing and new multifamily buildings
- Requirements for the installation of individual room temperature controls such as TRVs in new buildings and alongside the replacement of heat generators in existing buildings
- Non-residential and residential buildings equipped with BACS and electronic monitoring, respectively, are exempted from physical inspections of Heating and Air-Conditioning Systems
- Optimization of performance under typical or average (real-life) part load operating conditions including dynamic hydraulic balancing
- Reinforced requirements on optimizing the performance of TBS i.a. with controls

Let's take a look, for example, at two of the most important amendments listed above.

Art. 8 par.1 (bullet point 4 in the above list) claims that Member States shall require new buildings, where technically and economically feasible, to be equipped with self-regulating devices for the separate regulation of the temperature in each room or, where justified, in a designated heated zone of the building unit. In existing buildings, the installation of such self-regulating devices shall be required when heat generators are replaced, where technically and economically feasible.

These requirements are already successfully enforced only in few Member States: as of today 4 out of 10 radiators in Europe are not equipped with temperature control, leaving people out of control for their heating expenses. The full enforcement of this measure is therefore needed on a large scale and in short-term: it's a no-regret complement to longer-term road maps for decarbonized building, it is not invasive (installing TRVs takes 1-2 hours) and convenient: pay-back is 1-2 years and heating energy savings are proven to be at least around 20%.

While the measures on self-regulating devices are applicable both to residential and non-residential sector, the other important amendment applies only to non-residential buildings, but with wider-ranging ambition and effects. Art. 14 par.4 (bullet point 2 in the above list) claims that Member States shall lay down requirements to ensure that, where technically and economically feasible, non-residential buildings with an effective rated output for heating systems or systems for combined space heating and ventilation of over 290kW are equipped with building automation and control systems by 2025 (Art. 15 adds the same requirement for systems for air-conditioning or systems for combined air-conditioning and ventilation, with the same threshold: 290 kW). The EPBD text then continues specifying that

only certain BACS are able to fulfill these mandatory requirements, the ones capable of delivering enhanced functionalities (in the view of eu.bac easily identifiable with those at least level B class EN 15232).

These requirements are valid for all non-residential buildings above the threshold, including in particular the existing buildings.

One could say that it could be an ambitious challenge for the Member States to equip all the existing non-residential buildings above the threshold with advanced BACS by 2025, but the benefits that can be achieved with these measures (and with the other ones mentioned in the bullet points) are definitely worth the efforts:

- BACS ARE LOW CAPITAL INVESTMENTS, WITH FAST PAYBACK
  Investments in BACS are low capital investments (typically 30 €/m2 in non-residential buildings and 12 €/m2 in residential buildings), with fast payback period (average 3 years) highly cost-effective, with benefits being 9 times higher than the costs.

- BACS DELIVER HIGH ENERGY SAVINGS
  The annual energy savings that can be achieved by BACS are up to 20.3% of all EU service sector building energy consumption, while in the residential sector this figure goes up to 23.4%

- BACS IMPROVE COMFORT AND HEALTH, REDUCE COSTS
  In residential buildings, e.g. automatic room temperature controls complement metering and billing information; in their absence, citizens would know how much they spend, but remaining largely unable to take effective action, to reduce costs but also improve health and comfort.
  In commercial buildings, e.g. BACS monitoring and automation functions help maintenance staff to keep availability, lower consumption and ensure maximum comfort and productivity of the workers.

- BACS BOOST DIGITALIZATION
  An incentivizing policy framework for BACS would:

  a) create 200,000 and 300,000 direct jobs and 3.7 million indirect jobs by 2030;

  b) drive manufacturers' investments into R&D, innovation and manufacturing, in particular on smart digital technologies.

- BACS TACKLE ENERGY POVERTY

- Incentivizing policies for BACS, facilitating the access to affordable, reliable and sustainable energy will help these citizens to escape energy poverty.

All these benefits were achieved only in part, due to the existing market and regulatory barriers at EU level. These amendments, together with the future deployment of the Smart Readiness Indicator, can finally deliver these impressive results.

The European Institutions showed political courage and vision, it is now up to the Member States to translate these words into actions, integrating the current text with ambitious measures and fully implementing the Directive in the best interests of people and businesses. The European Building Automation and Controls industry is fully committed in providing its technical expertise in implementing the Directive and will soon publish its Guidelines on the text, providing Member States and Stakeholders with concrete, detailed suggestions on how to ensure a smooth and effective transposition and implementation.

eu.bac european building automation controls association

STUNNING Renovation Hub

EU platform for energy-efficient refurbishment technologies and business models

Today's measured rate of refurbishment is much lower than what should be observed to remain in line with Europe's 2050 ambitions. There is a need to accelerate the market uptake and large-scale implementation of energy efficient refurbishment solutions and increase the renovation level to 3% per year until 2030. The poor market acceptance of innovative refurbishment solutions is in most cases attributable to the lack of adequate business models. Innovative business models have already been demonstrated, but their replication is very slow: how can this replication be supported?

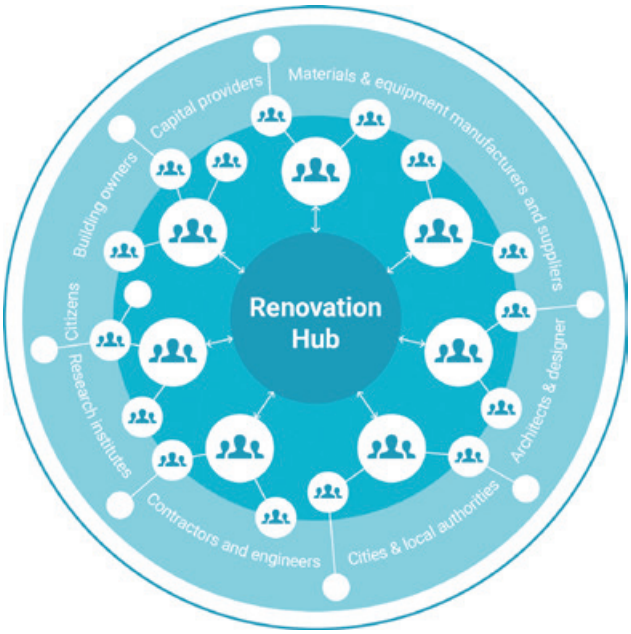
The EU H2020 project STUNNING (SusTainable bUsiNess models for the deep reNovation of buIldiNGs) has the goal to promote successful and innovative building renovation packages and business models around a virtual and collaborative knowledge sharing platform: the **STUNNING Renovation Hub**, so as to accelerate their adoption.

The Renovation Hub, launched in May 2018, **builds on the extensive studies carried out by the STUNNING project team**:

- Refurbishment packages are benchmarked based on factors such as required building characteristics, cost-benefit indicators, embedded technologies and technology readiness level.
- Results from the analysis of Europe-wide barriers for deep renovation are funneled through recommendations on how to overcome them.
- Promising and replicable renovation business models are mapped, analyzed and validated within case studies.

Designed to be collaborative, the Renovation Hub enables stakeholders from the entire value chain to gain and share knowledge through articles on innovative **refurbishment packages**, replicable **business models** and **case studies** on successful implementations. Interested parties can register with the following degrees of participation:

- **Follower** Access information through publicly available articles, our social media channels and our newsletter.
- **Expert** Get the additional ability to submit your own articles, validate articles from others and participate in workshops.
- **Ambassador** Get additional exposure in leading the validation of articles and disseminating STUNNING in your own community.



Visit the platform and register online at **renovation-hub.eu**

Project STUNNING is funded by the European Union's framework programme Horizon 2020 under grant agreement No 768287. It started on October 2017 with a duration of 24 months and is coordinated by DOWEL Management (France) with project partners CSTB (France), RINA Consulting (Italy), Solintel (Spain) and Steinbeis 2i (Germany).

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STUNNING

DOWEL MANAGEMENT · CSTB le futur en construction · RINA · STEINBEIS 2i · Solintel

Spanish Demo Site Building

The TESSe2b project is a European project, funded at €4.3 million under the Horizon 2020 programme, which began in October 2015 and lasts 4 years (www.tesse2b.eu). The consortium consists of ten partners, from 8 countries. The project is coordinated by the Polytechnic Institute of Setúbal (IPS, Prof. Luis Coelho).

The main objective of the project is to design, develop and demonstrate a modular and low cost system of thermal storage technology based on solar collectors and efficient heat pumps for heating, cooling and hot water production (DHW), thus contributing to the increase of renewables and provide flexibility for the electricity grid.

Aiming to evaluate the system's integration into building space, a demonstration and on-site monitoring evaluation of TESSe2b solution will be held in three pilot sites (Austria, Cyprus and Spain) to assess its impact in different climate conditions, and provide evidence about its overall technical and economic feasibility.

TESSe2b project developed and tested different solutions to operate with hydrated salts and organic based PCMs, and, in the end, organic base PCMs were chosen. For the TES tanks three paraffins were selected, and they can store thermal energy at three different temperature levels according to the application: A9 for the Cold energy storage tanks, A44 for the Hot energy storage tanks and A53 for the DHW tanks.

For the case of the demosite in Spain they were installed ten solar collectors, one DHW tank, four Hot TES tanks, two Cold TES tanks and the geothermal heat pump with PCM enhanced BHEs (four BHEs, 90 m depth). The layouts of the TESSe2b system are identical for the three demo sites, however each demosite has a customized solution for its specific needs, according with the building energy needs, climate conditions and soil characteristics.

Another TESSe2b project innovation is the development of a borehole heat exchanger (BHE) that can also be used for the storage of thermal energy, thus supporting the system to increase the geothermal heat pump performance in heating or cooling mode. The selection of PCMs for integration into the BHEs was made so as to take full advantage of the ground temperature. It was selected for Austria and Spain, a PCM with a freezing/melting point of three degrees Celsius lower than the ground temperature in order to stabilize the borehole temperature during the heating season. On the other hand, for the Cyprus demosite it was selected a PCM with a freezing/melting point three Celsius degrees above the ground temperature to stabilize the borehole temperature during the cooling season.

Another major TESSe2b innovation is the use of a self-learning management system that will use an algorithm combining a prototype model, a user profile database, weather forecasting and multi-variable controls. This makes it possible for the system operation to be adapted to the building user schedule and, with weather forecasting, to take maximum advantage of available energy that is or is going to be stored, while taking advantage of lower energy tariffs during night time. The control system will be managed according to the input of an array of sensors and actuators that will automatically change the system mode of operation according to the needs of the building.

During the current phase of the project, the TESSe2b solution is being validated and demonstrated in the three demosites and the results can be followed on the project website (www.tesse2b.eu).

After the conclusion of the project the consortium intends to find industrial companies that want to work in partnership towards implementing the solution in the market.

TESSe2b project has received funding from the European Union's Horizon 2020 Research and Innovation Programme, under the Grant Agreement number 680555. This article reflects only the author's view and the Commission is not responsible for any use that may be made of the information it contains.

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REHVA's viewpoint on the development of HVAC technologies in Europe

By Stefano Paolo Corgnati (pictured), REHVA President, Vice-Rector for Research at Politecnico di Torino (Italy), where he is Full Professor in Building Physics and member of the TEBE (Technology Energy Building Environment) Research Group.

The HVAC sector is called to play a crucial role in the main energy and environmental challenges of the European Union. The definition of strategic actions in this domain can indeed facilitate the European transition towards a post-carbon society. The practical implementation of the pillars of low energy buildings design - reduction of building energy demand, increase of systems energy efficiency and maximization of renewable energy sources use - sets a trajectory that is completely coherent with the mission of a community living with a reduced need of carbon-based energies, down to zero.

Wide and deep social acceptance of the zero-carbon concept is the biggest achievement Europe can get towards this much needed fast-paced change of paradigm. The role of building sector in this regard is to make energy efficiency desirable. That's why the recent developments of the HVAC focus on human-centred design, which means a design to maximize buildings occupants' wellbeing indoor, while decreasing energy consumption.

How to keep high comfort and high indoor environmental quality levels by a new design and operational approach for buildings based on "de-carbonization": this is the ambitious target in the HVAC sector for the next future.

The revised Energy Performance of Building Directive embraces this vision and suggests possible pathways to push building performances towards a new era. Indeed, the latest revision increasingly focus on Indoor Environment Quality of buildings linked to energy performance. Moreover, there is a clear focus on actual energy consumption and operational performance: the so called "performance gap", the difference between calculated and actual energy use in buildings, must be reduced. To do so, we need a better understanding of how occupants' behaviour influence building energy performance. To achieve this, the digitalization of the building and the HVAC sector is a fundamental step. To capture the capability of buildings becoming smart, the revised EPBD introduced the Smart Readiness Indicator (SRI). Defining the SRI assessment methodology is a challenge, and the HVAC community

WHAT IS REHVA

REHVA, the Federation of European HVAC Associations, founded in 1963, joins European associations in the field of building engineering services representing more than 120.000 HVAC engineers and building professionals in 27 European countries. REHVA is the leading independent professional HVAC organization in Europe dedicated to the improvement of health, comfort and energy efficiency in all buildings and communities. It encourages the development and application of both energy efficiency and renewable energy technologies.

www.rehva.eu

REHVA
Federation of European Heating, Ventilation and Air Conditioning Associations

JOIN THE REHVA FLAGSHIP EVENT: CLIMA 2019

CLIMA is the biggest international congress and exhibition held in Europe around the topics of HVAC, energy efficiency, smart buildings and cities, Net Zero Energy and Passive Buildings, renewables energy technologies. It is organized every three years by one of the REHVA Member Associations. The 2019 edition is co-organized by AIIR, the Romanian association, UTCB, the Technical University of Civil Engineering of Bucharest, and REHVA.

CLIMA 2019
Built environment facing climate change
REHVA 13th HVAC World Congress
26 - 29 May, Bucharest, Romania

This technical and international event was attended by over 1000 professionals from all over the world in the last years and the 2019 event has even higher participation targets.

Under the heading "BUILT ENVIRONMENT FACING CLIMATE CHANGE", the proposed main topics for the 13th CLIMA Congress will put into discussion the capacity of the new or existing refurbished buildings together with their technical systems, especially HVAC&S&R, to counteract in an energy efficient manner the climate changes in order to keep inside an optimum comfort, simultaneously with the security of occupants:

- Advanced HVAC&R&S Technology and Indoor Environment Quality
- High Energy Performance and Sustainable Buildings
- Information and Communication Technologies (ICT) for the Intelligent Building Management
- Sustainable Urbanization and Energy System Integration

must take a leading position in this issue. In case it is defined and implemented in a suitable way, the SRI could really help in facilitating people to understand the energy and IEQ dynamics inside a building.

Understanding building occupants' behavioural patterns, preferences and triggers towards higher energy consciousness can have a significant impact on the dynamics of building energy performance. If we want to increase our capability of interpreting users and the "users & building" complex system, we need data collection and data analysis.

The digitalization of buildings, and specifically of the HVAC sector, is a fundamental step to achieve this. Sensors in buildings measures quantities, collect and elaborate data, to analyse and investigate indicators, to provide the facility manager with information or to give feedbacks to occupants. Data science has penetrated the building energy sector.

The cross-fertilization between IT and construction sectors is a unique opportunity to create new products and services. Current market trends show a transition from selling HVAC equipment or energy towards selling a comfort-related service. This is a fully new model where those services can be directly sold to the end-user or building owner, which will have a big impact on the HVAC industry and our society.

Data analysis is useful also to open opportunities for interaction among buildings as parts of energy communities. Day by day, we move our boundaries of energy investigations from single buildings to districts of connected buildings, where different energy vectors can be selected to feed different energy equipment and to cover different energy needs by users. The transition to an all-electric, digitalized, connected and interactive smart buildings community is coming, as it is happening in the mobility sector.

The key take-away for the HVAC sector from the new European panorama is to be smart and innovative to grab all the chances that the ever-evolving technologies offer to our HVAC sector: the opportunity is there, we must be there too.

The IMPULSE project

Practical guide and tools for public-buildings' energy efficiency plans

By G.M. Stavrakakis and M. Damasiotis, Division of Development Programmes, Centre for Renewable Energy Sources and Saving (CRES), Greece

Energy transition to a low carbon economy in the horizon of 2030 goals starts indeed at local level. According to the directive 2012/27/EE, public buildings should be exemplary in terms of energy upgrading projects. To that direction Regions and Municipalities are expected to conduct reliable and affordable energy efficiency plans for their public buildings. While the regulatory framework is already in place, the development and implementation of such plans is still in its infancy especially in the Mediterranean. Indeed, in most Countries there is no common methodology or guide specifically dedicated for local authorities to conduct such plans. Combining the latter with other technical, financial and administrative barriers (lack of technical data, absent energy management, pending property issues, lack of funding, etc.), delays are observed in conducting the required plans and eventually implementing projects.

The IMPULSE project introduces a practical methodology accompanied with user-friendly computational tools to generate realistic and affordable energy renovation plans for public buildings. The methodology is consisted of the following steps and tools:

- Classification of building stock: A practical guide has been developed for clustering the initial building stock into representative Typologies, based on classification criteria affecting energy performance such as construction year, building use, construction type, systems, etc. From each Typology a representative building can be selected as the "Ambassador" building with available technical information for further energy analysis.

- Energy analysis: Based on the assumption that similar buildings present the same energy-related Key Performance Indicators (KPIs) per sq.m., an excel-based platform has been developed which automatically extrapolates KPIs for various retrofitting scenarios from the "Ambassador" buildings to all buildings of each Typology. The approach presumes the availability of KPIs for the "Ambassadors" e.g. obtained by energy simulations. The approach is very cost-effective, at least for planning purposes, as it skips time-consuming calculations for each building separately. The platform estimates also economic indicators (such as payback period, weighted investment cost), thus facilitating bankability assessment of projects for entire groups of buildings.

- Gradual renovation planning: Finally, an excel-based decision-making tool is developed which allows the user to select and bias decision criteria by means of which KPIs to optimize as well as to impose the % of floor area of the building stock to be renovated each year. The tool processes the KPIs' database from the previous step and returns which buildings and what projects to take place each year, accompanied with the duration of the plan (in years), the expected energy saved, the avoided CO2 emissions and energy-related cost savings.

The methodology has been successfully applied in six Mediterranean Cities, namely Heraklion-Greece, Elche-Spain, Cannes-France, Ravenna-Italy, Osijek-Croatia and Mostar-Bosnia & Herzegovina. Through the pilot applications the following major conclusions were drawn:

- The introduced protocols and platforms facilitate significantly energy renovation planning for large public-buildings' stocks at local level.

- Detailed energy audits are triggered, thus formulating a reliable energy baseline for public buildings which is a prerequisite for attracting innovative financing schemes.

- Bundling of buildings and of intervention scenarios increases the bankability of the foreseen projects.

- Energy managers and other technicians of public administrations are trained through a learn-by-doing process in planning, implementation and management of energy upgrading projects of public buildings.

Interreg Mediterranean IMPULSE
Project co-financed by the European Regional Development Fund

For further information please contact:
Email: gstavr@cres.gr
Web: https://impulse.interreg-med.eu/

There's now a web app that helps you cut energy bills

An EU's Horizon2020 project has developed a free web app that allows consumers to compare and choose the most energy-efficient home appliances and cut energy bills.

PocketWatt is a new web app that tells consumers how much an appliance costs to run, enabling them to compare both the running costs and the energy savings of similar models.

The tool covers refrigerators and freezers, washing machines and driers, dishwashers and air conditioners, and it is currently available in the Czech Republic, Germany, Italy, Spain and the UK.

Try PocketWatt here

Consumers can access the app via the PocketWatt website and use their smartphones' camera to scan the QR code on a selected product both online and in-store. The tool will then tell them how much it would cost to run that model, and they can search to see if more efficient models are available. This way they can make comparisons between models, identifying the best option for their household and lifestyle.

The aim of PocketWatt is to encourage consumers to buy more energy-efficient appliances, and make the energy label easier to understand and more readily available.

Energy-efficient appliances help cut carbon emissions by preventing wasteful energy use. These appliances also help consumers cut their energy bills, performing the same services such as cleaning clothes and dishes, but doing so with a lot less energy.

PocketWatt was developed by the Digi-Label project, a consortium of eleven organisations across Europe, and is funded by the European Commission. A number of retailers and manufacturers are working with the consortium to enhance and expand the impact of the project, including Whirlpool.

Karim Bruneo, a Corporate Responsibility and Government Relations manager at Whirlpool, had previously said of PocketWatt:

"In line with our commitment to developing high-performance appliances that conserve the earth's resources and help homeowners do the same, we're glad to support the Digi-Label consortium in driving the consumer awareness about energy efficiency and sustainability."

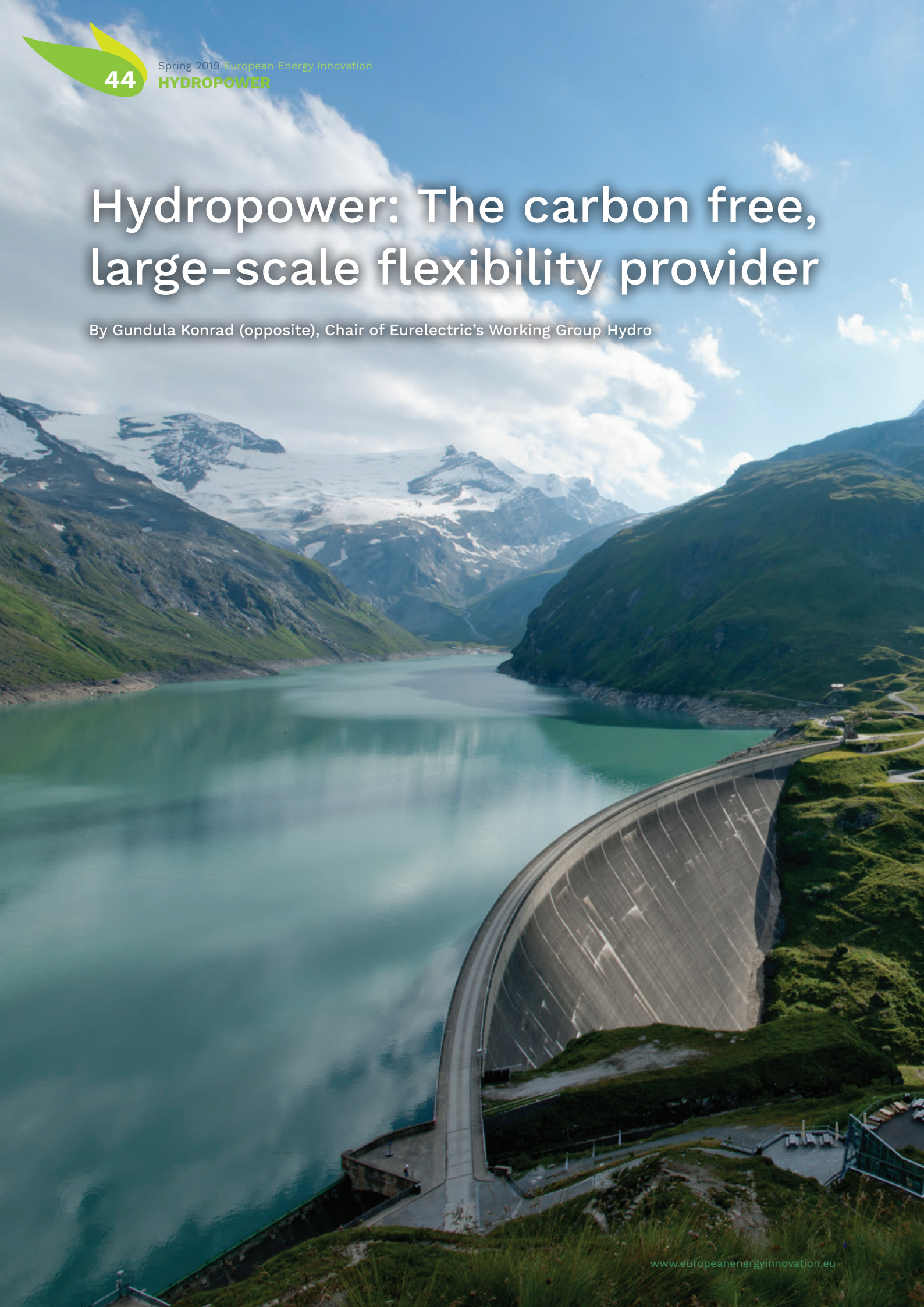
According to the European Commission, every home in Europe is projected to save nearly €500 per year by 2020 thanks to more efficient products. PocketWatt is here to help facilitate and accelerate this transition, and generate even more savings for consumers.

PocketWatt
YOUR ENERGY EFFICIENCY GUIDE

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 696081

Hydropower: The carbon free, large-scale flexibility provider

By Gundula Konrad (opposite), Chair of Eurelectric's Working Group Hydro



Hydropower plays a major role in meeting Europe's ambitious energy transition goals and it will continue to do so. Not only it provides carbon-free electricity, it also enables the energy transition with its increasing share of variable generation from wind and solar, thus avoiding the destabilisation of power grids.

To reach the climate objectives set by the Paris agreement, the European power sector is undergoing major structural adaptations. By 2045, renewables – including wind, solar, hydropower and biomass – will represent over 80% of the energy supply. A high-renewables future requires increased flexibility, firm capacity and the ability to balance variable generation. Hydropower has all these capabilities and can provide these services in a sustainable way.

The power system is one of high technical complexity, as supply and demand have to meet in every second. The European people and businesses rely on the power sector to ensure stability and security of supply; the overall

goal of maintaining stable provision of electricity is undoubted. In the future, the challenges in keeping the high level of security of supply and grid stability will be even higher, as a result of a large deployment of variable renewables such as wind and solar.

With rising shares of wind and photovoltaics in total electricity generation, the need for different types of flexibility in the power system increases. A mismatch between variable generation and consumption can lead either to an excess or a shortage of supply (wind does not always blow and the sun does not always shine).

Flexibility sources are therefore paramount for ensuring optimal system operation. All types of hydropower can provide reliable flexibility on all timescales. Depending on the size of the plant and where it feeds into the grid, hydropower plants are able to address congestions at both transmission and distribution level. As much as it can be used to ramp up and down within milliseconds to respond short-term system needs and it can also provide electricity over days and weeks (e.g. using water reservoirs) in times of no wind and sun. Last but not least, hydropower can even contribute to ensuring seasonal shifts.

Hydropower operates on all timescales supporting:

- power quality (monitoring and regulation of voltage fluctuation, frequency disruption and harmonic distortions);
- power management (short-term power supply for critical demands);
- energy management (energy storage for extended periods of time – retail energy shift).

It is often overlooked that run-of-river hydropower plants are relevant sources of flexibility, thanks to their potential as energy balancing capability within hydro power plant systems. Such systems consist of two or more hydropower plants that are situated along the same river. Coordinated operations of these systems can stabilise flows as well as maximise power generation. In addition, big run-of-river hydropower plants offer large amounts of rotating masses being able to stabilise grid frequency.

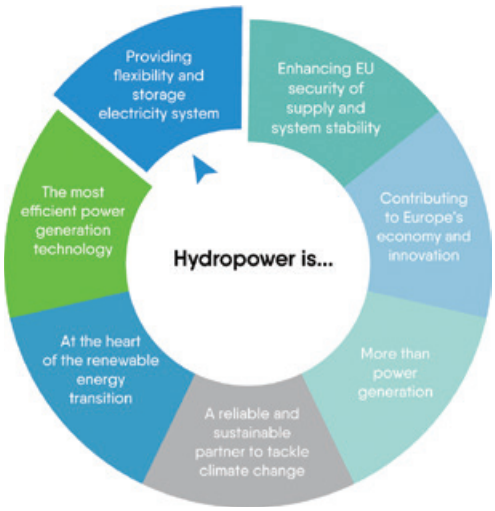
Pumped storage hydropower plants - combining pumps and turbines in a single plant - are the perfect enabler for a higher share of variable renewables. At times of high generation from wind and solar, there is a particular need to store the electricity surplus and make it available to consumers only at a later stage when supply is low. This is done by pumping water from a lower to an upper reservoir, and turbining it in the moment needed to meet demand. These reservoirs may be natural or artificial, they may have natural inflow or not and they may be used for other purposes, too, such as irrigation, flood control or even recreational purposes.

Different energy storage technologies can take different roles in the power system. A mix of complementary technologies is and will be necessary to meet flexibility needs on all timescales in sufficient dimensions. In this context, it has to be pointed out that hydropower technologies offer storage possibilities that are not always obvious at first glance. Besides pumped storage, storage hydropower constitutes a unique technology as well: Potential energy is stored for a later moment, even though, electricity is neither converted nor stored. Instead, storage plants collect water from natural inflows within reservoirs, for a later conversion into renewable electricity. Thus, storage hydropower (without the ability to pump) can serve flexibility requirements thanks to storing water, i.e. potential energy, and releasing water to meet changing electricity needs.

What does hydropower need to ensure it continues to deliver these essential services to all of us also in future?

- Better integrate energy policy regulation with climate protection and environmental regulation;
- Provide a clear and stable regulatory framework, including clear-cut definitions;
- Consider storage facilities as part of the competitive market;
- Ensure a level playing field for all technologies providing flexibility and storage, including support schemes, grid fees, R&D funding, etc.;
- Define system responsibilities and labelling of system services products;
- Eliminate policy barriers for construction, upgrade and operation for hydropower plants.

Figure 1 Hydropower Factsheets

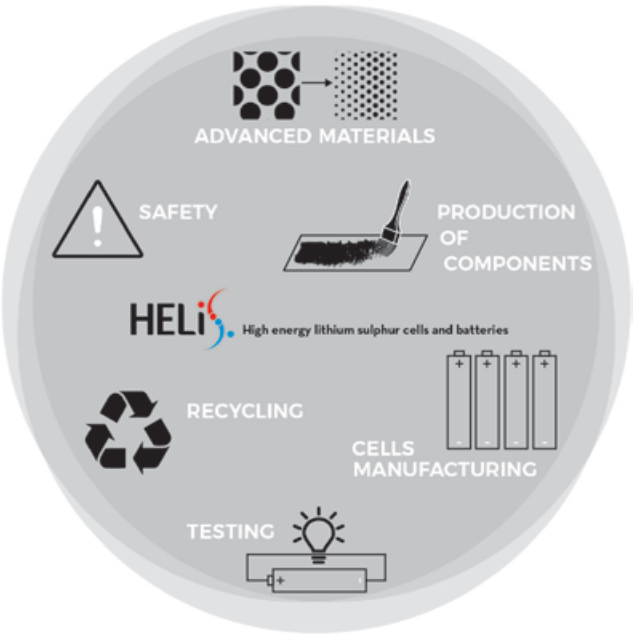


1 https://cdn.eurelectric.org/media/3177/hydro-facts_sheets-web-28052018-2018-030-0371-01-e-h-8DD82949.pdf

HELIS project

High energy lithium sulphur cells and batteries

By Dr Sara Drvarič Talian and Prof Robert Dominko



Lithium sulphur batteries are a viable candidate for commercialisation of post Li-ion battery technologies due to their high theoretical energy density and cost effectiveness. Despite many efforts, there are remaining issues that need to be solved, providing the direction of lithium sulphur batteries' technological development.

Instability of the lithium metal in most conventional electrolytes and formation of dendrites due to uneven distribution of lithium upon the deposition causes several difficulties. Safety problems connected with dendrites and low coulombic efficiency with a constant increase of inner resistance due to electrolyte degradation represent main technological challenges. From this point of view, stabilization of the lithium metal has an impact on safety issues. A stabilized interface layer is important from the view of engineering of the cathode composite and separator porosity since this is an important parameter for electrolyte accommodation and volume expansion adjustment. Finally the mechanism of lithium sulphur batteries ageing can determine the practical applicability of the batteries in different applications.

The HELIS project (funded through European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 666221) is addressing the remaining issues connected with the stability of lithium anode during cycling, engineering of the complete cell and questions about lithium-sulphur batteries cell implementation into commercial products. The consortium involves a joint collaboration with multi-disciplinary and complementary experts coming from 14 partners and 7 different countries: Slovenia, France, Sweden, Germany, Finland, Spain and Israel.

The work in the project is divided into 10 work packages and bundled into three major activities:

- coordination, management and dissemination
- lithium sulphur cell raw and advanced materials development, testing, scale up and modelling
- cell and battery pack characterisation together with research of ageing, safety and recycling.

The 4-year long project is finishing in May 2019. Before the end of the activities, three different series of lithium sulphur cell prototypes will have been produced, each with improvements suggested from research on the materials development. More specifically, larger quantities of novel carbon host matrices were produced, providing materials with characteristics required for production of prototype cells, while different analytical techniques were used for determination of favourable electrolyte composition. Several approaches for lithium metal protection against continuous degradation by modification of Li metal surface or separator were proposed and evaluated. The materials and components development was continuously supported by multiscale modelling of cell operation.

On the battery pack level, a battery management system (BMS) was developed and the lithium sulphur cells assessed through several safety tests. A life-cycle analysis was conducted, while also an efficient recycling process of Li-S batteries was developed in order to meet the European legislative requirements and the economic expectations of industry and consumers.

Together, the project resulted in 9 open access publications and few patent applications. The public deliverables and scientific publications that derive directly from the outputs of the project are available and downloadable at https://www.helis-project.eu/.

Acknowledgement: HELIS project has received funding through the European Union's Horizon 2020 research and innovation program under (Grant Agreement No. 666221)

Renewable jetfuel pathways

By Jeffrey Skeer (pictured), International Renewable Energy Agency (IRENA)

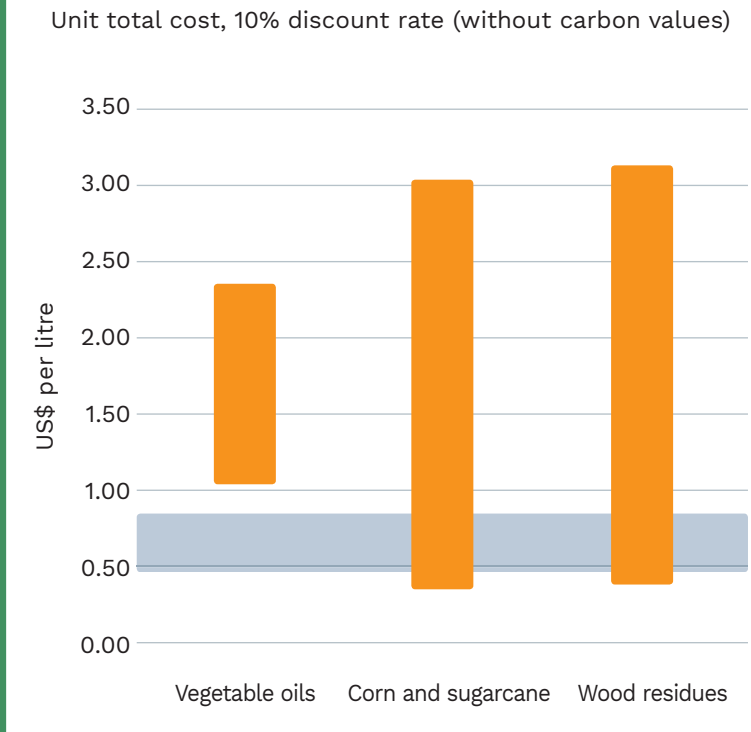
There are two main ways to reduce carbon emissions from aviation – better efficiency and better fuel. The International Civil Aviation Organisation (ICAO) has found that to cut aviation emissions in half by 2050 (from 2005 levels), half of the lifting can be done by efficiency improvements (in technology, operations and infrastructure). But the other half will have to be done by renewable biofuels.

IRENA analysis shows that biofuels can sharply reduce carbon emissions if they are produced from sustainable feedstocks on existing farm land or existing managed forest, so that no increase in greenhouse gas emissions arises from land-use change. The associated resource potential is very large – from sources like greater use of agricultural residues, restoration of degraded lands with wood crops, and freeing up land for energy crops by raising food crop yields, raising livestock on less pastureland, and reducing waste and losses in the food chain. While fossil kerosene emits 3 or 4 kg of CO_2 per litre, biojet emits just 1 or 2 or even less.

There are several promising biojet feedstocks and technologies. First there are oilseed crops, such as neem seed in India, rapeseed in Europe, and possibly oil palm – a very high yielding plant – provided it can be certified as sustainably grown on existing farmland. Next there are wood residues – such as tree tops and branches from logging ("slash") and sawdust from processing the lumber which is extracted from forests to displace use of cement in buildings; it is better to convert them to fuel than to have them decay to carbon dioxide uselessly. Finally there are carbohydrate crops, such as maize, sugar cane and high yield energy cane, which can be converted by a mix of conventional and advanced processes to ethanol and then upgraded to jet fuel in an extra process step.

Feedstock costs are potentially very low for energy crops – due to their high yield per hectare – as well as for wood residues of which large amounts are left in the forest because they have low value. But oil crops have many alternative uses, which tends to keep their costs somewhat higher. Feedstock costs are very important, since they account for up to 80 percent of total fuel cost when conversion technologies are mature. So we need to consider which feedstocks are cheapest in each place, and allow for jet fuel to be traded.

Comparative Costs of Renewable and Fossil Jet Fuel with Crude Oil Prices of $50-100 per barrel



Several technology pathways for biojet production from such feedstocks have been certified by the ASTM (American Society for Testing and Materials). The newly certified alcohol-to-jet pathway seem quite promising since there are many different ways to produce ethanol, and potential economies of scale from combining advanced and conventional conversion technologies. For example, first generation technologies for making ethanol from the sugar in sugar cane and second-generation technologies for making ethanol from the straw in sugar cane can share equipment for heat and power supply, harvesting, crushing, distillation, dehydration, upgrading, and storage.

In terms of technology readiness, the conversion pathways for oil and wood feedstocks are somewhat more mature than those for alcohol to jet. But all the pathways can well be commercial within the next couple of decades, provided there is sufficient investment in pilot and demonstration projects.

Each pathway already has pilot plants which are showing it is practical. For oleochemical pathways, there are Altair and Neste plants. For thermochemical pathways, Red Rock is using wood residues and Fulcrum is using municipal solid waste. For alcohol to jet, companies are applying a mix of first- and second-generation technologies to make ethanol from maize or sugarcane, while Pacific Northwest National Laboratory has a process for upgrading ethanol to biojet.

The costs can be expected to come down over time, provided we get from first of a kind plants to nth of a kind plants at scale. In economic terms, biojet will have to compete with petroleum-based jet fuel. In recent years, crude oil prices have fluctuated widely, but mostly between $50 and $100 per barrel. If oil prices continue in this range, biojet plants at commercial scale should eventually be able to compete.

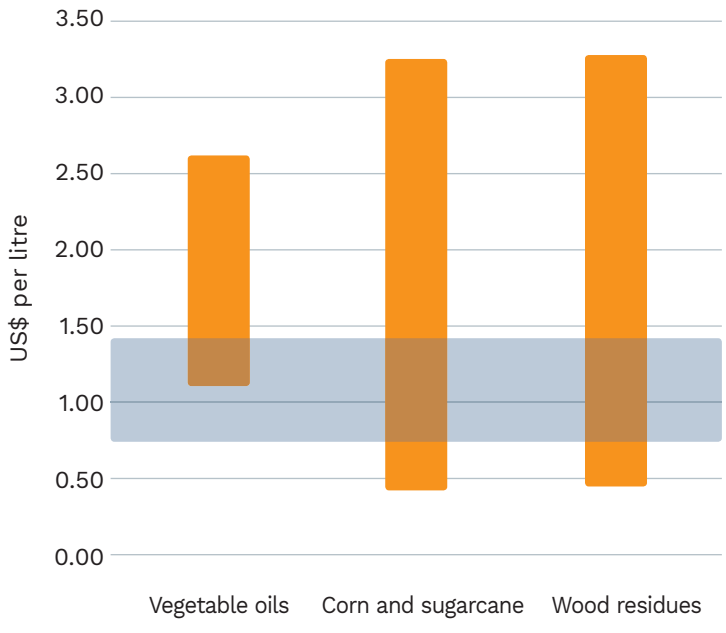
Pathways using wood residues and carbohydrate crops may be quite promising over the long term due to their lower feedstock costs, even though pathways using oil crops have lower costs today.

We should support technology development and demonstration for the conversion pathways that appear most promising. And we should put in place policies that let the market choose the most cost-effective feedstock and technology pairs at any given place and time. These could include a higher market value for carbon, limits on average fuel carbon content, mandates for renewable fuel, or a combination of these.

Carbon prices may not be enough to do the trick if oil prices are weak, which they could well be if shale oil supplies keep growing and automobiles start going electric. So regulations may be the most effective approach – to require a growing share of renewable jet fuel over time, or better yet a reduction in carbon emissions per passenger-kilometre and freight-kilometre to give equal credit to greater efficiency.

Comparative Costs of Renewable and Fossil Jet Fuel with Crude Oil Prices of $50-100 per barrel

Unit total cost, including carbon value of US$80-160/tonne



Innovation in the gas industry paves the way to low-carbon future

By Marco Alverà, President of GasNaturally

Meeting the long-term greenhouse gas (GHG) emissions target of the COP21 Paris Agreement will require extraordinary measures.

On current trends, the world is set to miss the Paris goals; however, a radical shift towards innovative and affordable gas technologies could make a real difference in achieving global climate goals in a sustainable way.

This is especially relevant in the context of growing energy demand: according to the International Energy Agency's (IEA) *World Energy Outlook 2018*, global demand is set to grow by more than 25% by 2040.

Marco Alverà, President of GasNaturally.

The members of GasNaturally are: International Association of Oil and Gas Producers (IOGP), Eurogas, Gas Infrastructure Europe (GIE), European Gas Research Group (GERG), the Technical Association of the European Natural Gas Industry (MARCOGAZ) and Natural & Biogas Vehicle Association (NGVA)

To meet this challenge, gas companies are pulling their weight by improving the efficiency of their own processes and increasingly investing in decarbonised and renewable energy ventures.

As the CEO of SNAM, Italy's leading gas infrastructure operator, I am honoured to represent also the GasNaturally partnership of six Associations throughout Europe. Having served the gas industry for almost two decades, I can see clearly how vital it is that the industry pursue innovation in order to remain relevant in the long term.

GasNaturally's membership covers the entire value chain, from upstream to transmission, distribution, wholesale and retail operations, as well as gas utilisation including in maritime, road and rail transport. This diversity is our strength: we support research and development (R&D) and are investing in the implementation of a full range of promising new technologies with long-term potential to reduce carbon dioxide (CO_2) emissions, such as power-to-gas (P2G), natural-gas-to-hydrogen, carbon capture and storage (CCS), and carbon capture use and storage (CCUS).

The gas industry today can partner and support the clean energy of tomorrow

Extensive existing gas infrastructure throughout Europe can be used to provide the flexibility needed to meet seasonal variations and peaks in energy demand and to transport increased quantities of renewable and low-carbon energies to final customers – a key feature that the electricity network is unable to deliver.

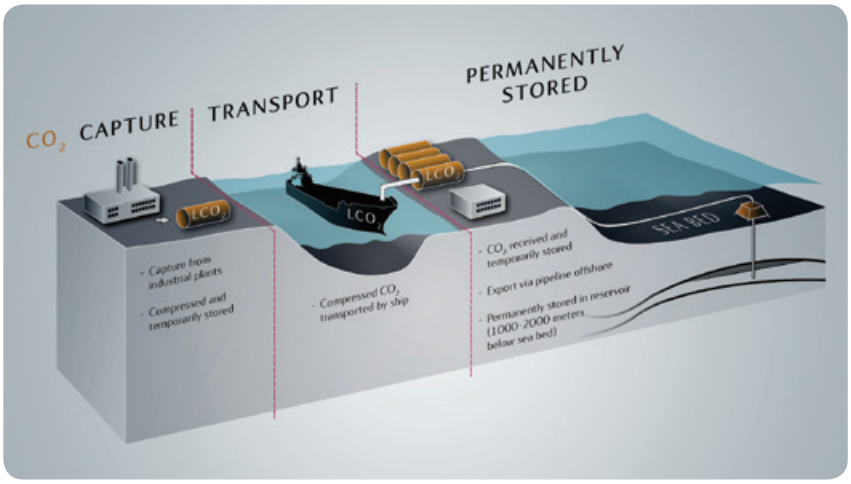
The most common renewable gases, such as biomethane and synthetic methane, have compositions similar to natural gas, which means that existing consumers can convert to low-emission fuels without further investment.

At the end of 2017, there were more than 17 000 biogas plants and more than 500 biomethane plants in Europe, and further development of the sector is planned in the coming years.

In Spain, the SMART green gas project, led by one of our members, is developing new generation technologies to obtain high-quality, low-cost biomethane for industry, transport and households. In parallel, the Power2Biomethane project aims to develop a fully renewable biomethane generation system through advanced bio-electrochemical process.

In Italy, SNAM places decarbonisation and smart energy at the core of our company strategy. We invest in biomethane and energy efficiency and support the vast potential of hydrogen as a sustainable energy technology.

Source: GRTgaz



Northern Lights project. Source: Equinor

The gas industry is best placed to launch a hydrogen revolution

Cutting-edge P2G technology can convert excess electricity from renewable sources into hydrogen. Recent examples of the gas industry's ventures into this type of renewable gas in Europe include: the world's first demonstration plant for storing wind energy in the gas grid at the WindGas Falkenhagen project in Germany; trial injections of hydrogen into the natural gas distribution network in Dunkirk under the GHRYD project; and the conversion of surplus renewable power into hydrogen and synthetic methane for storage by the French Jupiter 1000 project. Across Europe, the gas industry is developing more hydrogen projects.

According to the UN Intergovernmental Panel on Climate Change (IPCC), use of CCS will be needed to deliver the negative emissions required in 101 out of 116 possible scenarios for limiting global warming to below 2°C. Similarly, in its projections for GHG mitigation, the IEA ranks CCS as a key technology, alongside energy efficiency and renewable energy.

The gas sector has vast expertise in CO_2 management, which can benefit other industrial sectors through a broader process called CCUS, applicable both to pre-combustion and post-processing. Post-processing solutions are being championed in the Netherlands and Norway. These projects aim to capture CO_2 from industrial processes – such as refineries, cement factories and chemical plants – to either supply it to other industrial users or to store it safely and permanently in depleted oil and gas fields.

The CO_2 can be transported in two ways: by pipeline, as in the Porthos project under development in the Port of Rotterdam, or by ship, as in the Northern Lights project. The latter project aims to establish the world's first large-scale 'open source' infrastructure for receiving and storing CO_2 from multiple industries in Norway and other industrial regions in Europe.

Currently, approximately 50% of hydrogen is produced from natural gas using steam methane reforming (SMR) processes. Pre-combustion capture technologies use SMR to strip CO_2 from natural gas and can facilitate this revolution by producing 'hydrogen fuel', which can serve as a clean industrial feedstock or fuel for industry and households.

The UK leads the way on hydrogen use in the H21 City Gate project, which aims to switch natural gas household heating infrastructure in the city of Leeds to 100% hydrogen produced from natural gas through SMR with CCS. In the Manchester-Liverpool Hydrogen Cluster, SMR will produce hydrogen for local car manufacturers, refineries and households while the CO_2 will be safely stored beneath the Irish Sea. In the Netherlands, our members are repurposing the Magnum natural gas power plant to run on hydrogen. The CO_2 from the repurposed plant will be contained in a North Sea storage facility to be developed by the Northern Lights project.

Political support is vital to making the EU long-term vision a success

The best way to foster a cost-effective approach to cleaner and more innovative energy is to concentrate resources on R&D of the most promising non-mature technologies, including renewable gases, and to facilitate their large-scale deployment. This is among the key 'asks' addressed to policymakers in our recently published *Manifesto of the European Gas Industry* (link).

To achieve the COP21 Paris Agreement objectives, markets and R&D laboratories need to work effectively, creating competition among technologies to deliver the most beneficial solutions, both socially and economically. It is clear that investment to the tune of trillions of Euros will be needed to deliver the Paris targets. To make informed decisions in the near term, policymakers must also consider the cost of failing to meet the long-term targets already agreed upon.

Zero Carbon Hydrogen Green Energy to the World

By Prof Dr Robert Steinberger-Wilckens (pictured), Centre for Fuel Cell and Hydrogen Research, University of Birmingham

Many governments have today recognised that hydrogen technology is key to reducing emissions. A typical example gradually making it into public perception is the use of hydrogen as a fuel for Fuel Cell Electric Vehicles (FCEV). These vehicles are electric but do not only rely on a battery storage but add a fuel cell that will continuously be fed by a fuel, most often hydrogen. Refuelling is done in minutes and the range of these vehicles is comparable to cars with internal combustion engines. The tremendous advantage on top of this is that there will be zero pollutant emissions from the tailpipe of FCEV – the only thing that is produced in the fuel cell is water.

Nevertheless, hydrogen is no resource that can be mined anywhere. Although it is the substance the universe is made of, estimated 90% of interstellar mass being hydrogen, on earth, it is part of many chemical compounds such as water, ammonia, methane and all other hydrocarbons, cellulosis, sugar etc. Energy is therefore needed to separate the hydrogen from the other parts of such compounds. Typically this would be electricity to split water in so-called electrolysers, or heat to crack methane molecules. Roughly 15 to 35% of energy are lost as heat in such processes.

The market for hydrogen is vast today, although the general public is little aware of the many uses of hydrogen even today. Just as a few examples, refineries employ hydrogen for cracking crude oil, margarine as well as fertilisers are made with the help of hydrogen. So the question immediately arises: if energy is needed to produce hydrogen, where does this come from and are we simply shifting emissions and pollution from point-of-use (for instance the vehicle travelling around a city) to the production site of the hydrogen gas? This is a very valid concern. As it stands, the hydrogen used today is 'black' and is produced from natural gas or by regular grid electricity, including the specific CO_2, NOx, SO_2, particles etc. emissions and pollution from gas and electricity production and processing.

The use of electricity is gradually becoming 'cleaner' as renewable electricity is inevitably making its way to supplying the major share in power markets. Producing hydrogen from renewable electricity offers an interesting option to turn a form of energy that is difficult to store (electricity) into a substance (gas) that is easily stored and has a two-century-long history of safe handling, storage, and transport. This process has been labelled 'Power to Gas' (P2G) and is rapidly developing into one of the 'silver bullets' to building zero carbon energy systems, providing ample storage capacity and flexibility in gas usage for the heating, power or transport markets.

The current gas pipelines in many cities still stem from the times of town gas – which to around 50% consisted of hydrogen – used from the early days of the 20th century up until the 1960ies, when it was replaced by natural gas. Producing hydrogen from green electricity and adding it to the natural gas grids will therefore replace some of the methane and thus cause less CO_2 emissions at point-of-use, e.g. heating boilers or gas turbines, since burning hydrogen only produces water. To the extreme, hydrogen could even completely replace the natural gas and the gas grid would be converted to a 100% hydrogen network, building a 'Hydrogen Economy' based on hydrogen alone. The so-called 'admixing' could help gradually phase in hydrogen by stepwise increasing the hydrogen concentration in the pipelines.

Unfortunately, burning hydrogen in a jet flame, internal combustion engine or turbine produces pollutants such as nitrous oxides (NOx) simply due to the high temperature reaction with air. Thus, though production might now be emission-free, pollutants are produced at point-of-use. Large-scale employment of fuel cells

will prevent this since the fuel cell reactions produce none of the typical atmospheric pollutants. Most fuel cells in use today – typically the ones employed in vehicles, the Polymer Electrolyte type, PEFC – require very pure hydrogen and will not be happy with the natural gas-hydrogen mixture mentioned above.

On the other hand typical gas appliances such as boilers do not condone high hydrogen concentrations in the fuel gas mixture. Therefore all gas appliances would need to be switched over in the case of more than about 20% or even 100% hydrogen replacement of natural gas in the gas grids. This is a difficult and logistically challenging task.

There is one other option to produce a zero-carbon gas, which is synthesising methane from hydrogen and carbon dioxide. This 'Sabatier' process has a high efficiency. CO_2 is captured from the atmosphere, reacted with hydrogen, and injected into the gas grids as 100% compatible substitute for natural gas, even producing a higher quality gas than the variable fossil resource.

This gas is often labelled 'synthetic natural gas' (SNG) although it is just methane and has nothing to do with natural gas itself. Since capturing CO_2 from the air is energy intensive, we can pull the trick of using biomass to do the job for us. CO_2 from biogas could be used for the synthesis and thus delivers fully 'carbon free' methane – which admittedly sounds odd, but emphasises the fact that no fossil carbon is released to the atmosphere and the use of this SNG will not contribute to greenhouse gas (GHG) emissions. This would be completely 'green' fuel gas compatible with today's gas supply infrastructure and not requiring any additional investment in transport, handling, and at point-of-use. Using the SNG in high temperature fuel cells, such as Solid Oxide type (SOFC), is possible and results in a release of water and CO_2, which are then both recycled through the atmosphere.

CO_2 can of course also be obtained from any industrial process or power plant running on coal, oil or fossil gases. In this case the carbon would be captured and recycled, making the product SNG 'grey'. No new CO_2 would be emitted when the SNG is used, but still, there would be an effective release of fossil carbon, therefore only part-addressing the issue of GHG emissions and not qualifying for zero-carbon methane.

Green hydrogen and green SNG are the two components of a true 'Hydrogen Economy' based on hydrogen as the main component of an emission-free energy economy. SNG offers more versatility in combination with the existing gas grid transition to an emission-free future, whereas hydrogen offers more advantages for transport and vehicle fuels. The combination of carbon-free production and gas use in fuel cells will deliver both a zero-emission energy system with a dramatic reduction in point-of-use emissions, for example a substantial improvement of air quality in cities.

Figure 2 Scenario Analysis Results for CCUS (carbon capture, usage, storage)

Slovenia as trend-setter of technological breakthrough in energy transition

By Alenka Bratušek (pictured), Minister of Infrastructure, Republic of Slovenia

Our future strongly depends on our common ability to respond and adapt to new energy trends and climate change challenges. Transition to a low-carbon society is challenging for all stakeholders, and Slovenian energy sector is no exception. Our domestic production is currently based on a balanced mix of energy sources (one-third hydro, one-third thermal, one-third nuclear), and that balance gives several advantages that we can use to support the competitiveness of our economy. In spite of its small size, Slovenia has achieved enviable results in the field of energy. The World Energy Council ranks Slovenia as 10th in terms of energy security, energy equity, and environmental sustainability.

Slovenian electricity production is already today one of the least carbon-based in the EU. In 2016, 71% of domestic electricity production came from low-carbon sources (the EU average is 58%). The Slovenian electricity system is also highly integrated with the neighboring electricity systems (almost 84% of electricity interconnection level) and flows that pass our territory are twice the amount of energy consumed. Consumption of gas is lower than EU average, while on the other hand we consume more oil than EU average. All this gives us a very specific framework for the development of smart grids infrastructure and the control mechanisms for the use of final energy especially in sectors with a large share of total energy consumption, which will inevitably play a very important role in the overall energy transition challenges.

Today, Slovenia already has several recognized projects in terms of smart networks, cities and local communities, and let me just name a few. The SINCRO.GRID is a smart grid investment project of European significance and an EU flagship project in the priority thematic area of smart grids deployment. The project is actually a virtual cross-border control center that facilitates new electricity generation from renewable energy sources in Slovenia and Croatia and its safe and efficient integration into the grid. Several other pilot projects recognized by the relevant EU programmes are also being conducted, for example GOFLEX (grid integration of renewables) and FutureFlow (TSO cooperation). All of the above are project with a high level of domestic knowledge, which has to be recognized and nurtured in the future. Electromobility is also becoming a strategic focus for the increasing part of the Slovenian economy. In the field of "blockchain" technology, Slovenia has proven to be a very encouraging environment for the introduction of new technologies, which will also leave a mark on developing energy technologies. The “blockchain” technology is particularly useful in the field of trade of electricity, as the share of active market participants is increasing.

Due to its small size, geographical position and international recognition of its know-how, Slovenia has proven to be an excellent polygon

for various development projects in the field of smart grids, efficient use and renewable energy sources. Our internationalization is actually being transformed by new energy platforms and business models, all dictated by the ongoing digital transformation. Today, Slovenian companies offer true innovation opportunities – in particular in the areas of processes, semi-products and final products. According to the innovation index, Slovenia is classified as a group of countries of the so-called strong "innovators" and is just below the EU average.

Our ambition in the field of renewable energy and energy efficiency targets by 2030 is yet to be determined in the ongoing process of National Energy and Climate Plan adoption, due by the end of 2019. Efficient use of energy will remain one of the key priorities for Slovenia, as there are many unused opportunities in this area, especially in the field of energy renovation of buildings and energy efficiency in industrial use. In the field of building renovation, Slovenia wants to reduce energy consumption by 60% by 2025 compared to 2015. Slovenia has therefore established a comprehensive system for the renovation of public buildings in accordance with the requirements of 3% of the necessary renovations of public buildings each year. However, it is fair to say, that while the heat sector is already contributing significantly to the energy transition goals, the transport sector remains a challenge, a true potential yet to be properly addressed.

Another challenge that will need to be addressed at the EU level is the compatibility of spatial and environmental protection policies with our energy and climate goals. Spatial planning of further use of renewable energy, especially in the field of electricity production, in areas that are protected by the EU environmental laws, has proven to be very challenging in Slovenia. It might be time to find a European answer to this challenge.

At the end, let me offer some thoughts as an active policy-maker. We do not only live in the time of energy transition into a low-carbon society but also in time of exponential growth of new technologies and innovations. In the future we can expect greater and faster changes in different technological areas as digitisation, nanotechnologies, ... A large part of the community accepts these changes almost unconscious. Many people are unaware that we are some sort of pioneers at the beginning of a technological revolution. This revolution will fundamentally change the way we live, work and relate to each other.

The greatest challenge for us, policy-makers, will be how to recognize on time the magnitude, scale and complexity of the energy transition trends already in the making, in order to make proper regulation and decision-making for innovative and transformative approach to be used by the companies and consumers alike.

Comprehensive Energy Management Solutions

We address the following Business Challenges

Energy management is no longer an engineering issue, but a question of infrastructure which is based on information and communications technologies. The ultimate success depends on the ability of system and devices to securely and reliably interconnect via a network.

Based in Slovenia, our company is a leading expert in energy monitoring and management; over the last 16 years, our solutions have been recognized by energy efficiency specialists, as well as prominent corporations such as Knauf Insulation, Henkel, ETI, Goodyear, DS Smith, DUOL, and others.

Solvera Lynx's solutions

Solvera Lynx offers innovative solutions for smart energy management (EM) based on in-house developed Software (GemaLogic) and Hardware (ComBox) solutions, also we include in our portfolio wireless LoRaWAN technology. This technology is a better alternative to the classical wired networks due to its long range, unique penetration capabilities, flexibility, easy operation & maintenance, safe & reliable data transfer. **So, we focus on energy saving instead of investing in a wired network.**

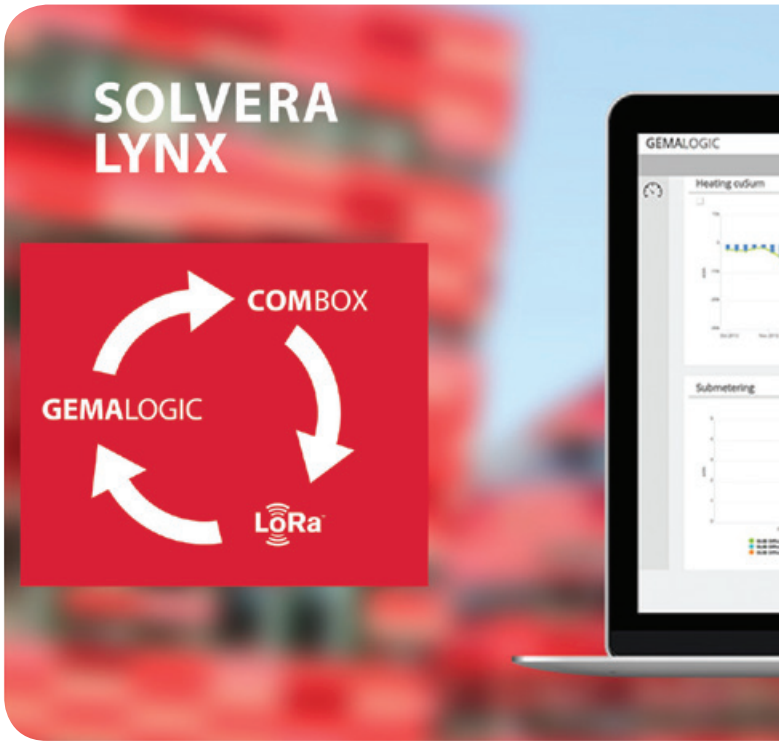
Our software solution is multi-sites, multi-languages, multi-utilities, and fully integrable with production and building management systems; they empower energy managers to fully benefit from Big Data applied to their installations, with advanced analytic techniques, predictive models, and state-of-the-art interfaces.

How does it work?

Transmission of the data from devices, sensors, actuators is done by our innovative wireless long-range ComBox.L® equipment, which has long battery lifetime and suitability for the harsh industrial environment. ComBox.L® sends data to the advanced software platform GemaLogic®, where all the data is gathered, processed and analyzed.

Benefits of implementing Solvera lynx's solution

Implementation of our solution allows companies to accomplish primary EM goals: holistic monitoring of



energy efficiency performance and reduction of energy consumption. Due to the introduction of new energy management system and usage of our innovative software (GemaLogic®) and hardware (ComBox.L®) solutions, the following benefits can be achieved:

- Energy consumption reduction in the 1st year of solution implementation up to 7%
- Analytics to identify consumption patterns, compare historical data, and predict future energy needs
- Reduction of energy losses
- Protection from unexpected energy consumption and alarming in case of energy consumption increase
- CO_2 emission reduction
- Support in ISO 50.001 implementation

Competitive advantages

- Developing software and hardware solution in-house, so we are ready for almost any EM challenge, which requires custom-made, unique, future-oriented solutions.
- The real experience of working in the hardest industrial environments - inhospitable, with high moisture rate, extreme temperature conditions and far-spread production areas

Who can benefit from our solutions?

A wide range of business applications can benefit from our solutions: Energy & Utilities, Telecom, Oil and Gas, Factories, Building and Facilities, Industry, Agriculture, Smart City, Transport, and Logistics.

We have already provided tailor-made solutions for the following projects: smart metering (electricity, gas, water, air renewable energy), volume monitoring (fuel tanks/containers), different types of analyses (air quality, temperature, humidity), tracking/localization and machine status monitoring.

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SOLVERA LYNX
ENERGY MANAGEMENT

The future of the Slovenian energy sector

Decarbonisation, digitisation and democratisation for greater accessibility and competitiveness

By Franc Bogovič (1), MEP, former Minister for agriculture and environment of Republic of Slovenia and former Mayor of Krško, Municipality with Slovenian sole nuclear facility.

With Danijel Levičar (2), MBA, Member of the Management Board of GEN-I and former Director General of the Energy Directorate at the Ministry of Infrastructure of Slovenia

The World Energy Council (WEC) published its 2018 World Energy Trilemma Index[1] end of last year. The index ranks 125 national energy systems on their ability to provide sustainable energy. Slovenia scored as high as rank 6 in this global index, and even ranks 2nd in terms of energy security.

This score is above all a result of a favourable design of the country's energy systems – electricity, heating and gas – which historically come from the decisions of the Slovenian political leadership in the late 1960s and the 1970s. Projects like the Krško nuclear power plant, completion of chain of hydro plants on the Drava River, high-voltage power lines, a gas transmission system, the combined thermal power and district heating plant TE-TOL in Ljubljana, and the electrification of railways set the groundwork for modern national energy systems that still offer a high level of security and affordability of energy, ensuring competitiveness for the economy and accessibility to citizens.

In the almost three decades since Slovenia became independent, four new hydro plants were built on the Sava River, and another is to be set up in the next four years. In the next decade, three more hydropower plants may be erected on this river. Each of these plants covers a notable share of the annual energy consumption. This way, Slovenia is increasing the share of renewables in its energy mix. On the other hand, the recent construction of a new, sixth generator at the coal-fired thermal power plant in Šoštanj (TEŠ) was a big mistake because of its negative impact on competitiveness and environmental parameters. The plans for this project were made before the global financial crisis, when energy prices were growing and coal was relatively cheap. Unfortunately, the project was not stopped or at least scaled down despite numerous warnings that the economic circumstances had changed substantially. TEŠ accounts for about a third of Slovenia's power supply, at high production costs and with a large impact on the environment. If Slovenia intends to meet the required emission reductions, the thermal plant will need to be shut down before the end of its life cycle in 2053. At the same time, it is worth noting that the share of wind power in Slovenia is negligible, and other renewables (solar and biomass) account for 3-4% of power production. Moreover, planned projects often encounter delays due to complications in acquiring environmental permits.


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After fifty years of maintenance and gradual modernisation of energy systems, Slovenian politicians face important decisions, since Slovenia still has not adopted a long-term concept for energy. The good news is that the existing state of the energy sector offers a realistic opportunity for a positive outcome that could also give Slovenia a new visionary drive.

Several scenarios until 2050 have

been prepared. The reference scenario envisages no major new power plants despite the winding down of both the Krško nuclear plant and TEŠ, which today account for around two thirds the country's electricity production. This would substantially increase the need to import electricity. The green renewable energy (RE) scenario envisages a 100% replacement of the lost production capacity with renewable sources, while the RE + nuclear scenario includes a new generator at the nuclear power plant and replacing the rest of the fossil fuel–based production with renewables. The expected result can be found in the tables below.[2]

On the national level, Slovenia has committed to increase the share of electric cars to 15% by 2030. Moreover, the EU's commitment to an 80% cut in greenhouse gas emissions by 2050 as compared to 1990 also requires Slovenia to do its part in pursuing this target.

So, what do we do next?

IT, transport and energy are the three key infrastructure sectors that greatly define the way and quality of life for individuals and a given society. We live in an extraordinary time when all three sectors are changing greatly. These changes are reflected in megatrends that indicate where the sectors are headed. In IT, new technologies are bringing ever new upgrades to the internet, and with them a shift in centres of trust. At the same time, advanced IT platforms open the door for the development of autonomous vehicles. And already today we are witnessing an electrification of transport. Behind all these transitions lies electrification. Electricity is gradually taking over from oil and is becoming the most important energy vector of the future, which will define the policies of the transition to a low-carbon society. And so, electricity is becoming the link between the three crucial infrastructure sectors.

Energy security, energy equity (accessibility and affordability) and environmental sustainability constitute the so-called energy trilemma and represent the main orientations for a sustainable energy sector, providing a framework for defining the energy concept. The right combination of these three sustainability dimensions enables stable and sustainable energy systems, which are also key to sovereignty.

Decarbonisation

A transition to a low-carbon society should be a priority for mankind, as the success in this transition will determine our survival on this planet. Energy sector is the main force leading this transition, and the mentality in this sector and the technologies that have been tested here also offer solutions for the transport sector, as well as other industries. The transition can be led by those parts of the energy sector that are already low-carbon and see the transition not as a problem but rather a solution bringing added value, quality jobs for a highly educated workforce in Slovenia and a competitive edge for the Slovenian economy. Given the growing need for electric power, the crucial role in the decarbonisation will need to be played by carbon-free sources like renewables and nuclear energy on the production side, and the electrification of traffic on the consumption side.

Democratisation

The end user is no longer merely a recipient and consumer of energy, but is also assuming a more and more active role with the introduction of advanced systems in smart homes. The awareness of citizens regarding energy issues is growing, and with it their need to express and participate in shaping the energy future.

Although households only make up for a quarter of the total energy consumption, the growing use of heat pumps, air conditioning and e-mobility indicate a trend of additional growth in electricity consumption. As a result, it will be necessary to invest more in production and distribution systems.

Digitisation

New technologies for electricity use, dispersed production and the shift in the transport sector herald changes in production, but even more so in energy use itself. Mankind is developing new technologies, such as the internet of things, blockchain, artificial intelligence, mobile devices and big data. Digitisation, the driver of technological progress, appears to be a particularly appropriate basis for further development in energy. Digitisation offers an opportunity to change habits and thereby the

Electricity prices (taxes excluded) for households by scenario (in €/MWh)

TODAY	2050	
125	Reference scenario	?
	Green RE scenario	240
	RE + nuclear scenario	150

Dependency on energy imports by scenario

TODAY	2050	
49%	Reference scenario	65%
	Green RE scenario	36%
	RE + nuclear scenario	27%

efficiency of energy consumption. New technologies allow energy systems to become more robust and economically efficient. This way, energy systems also maintain reliability of energy supply as their top priority.

Accessibility

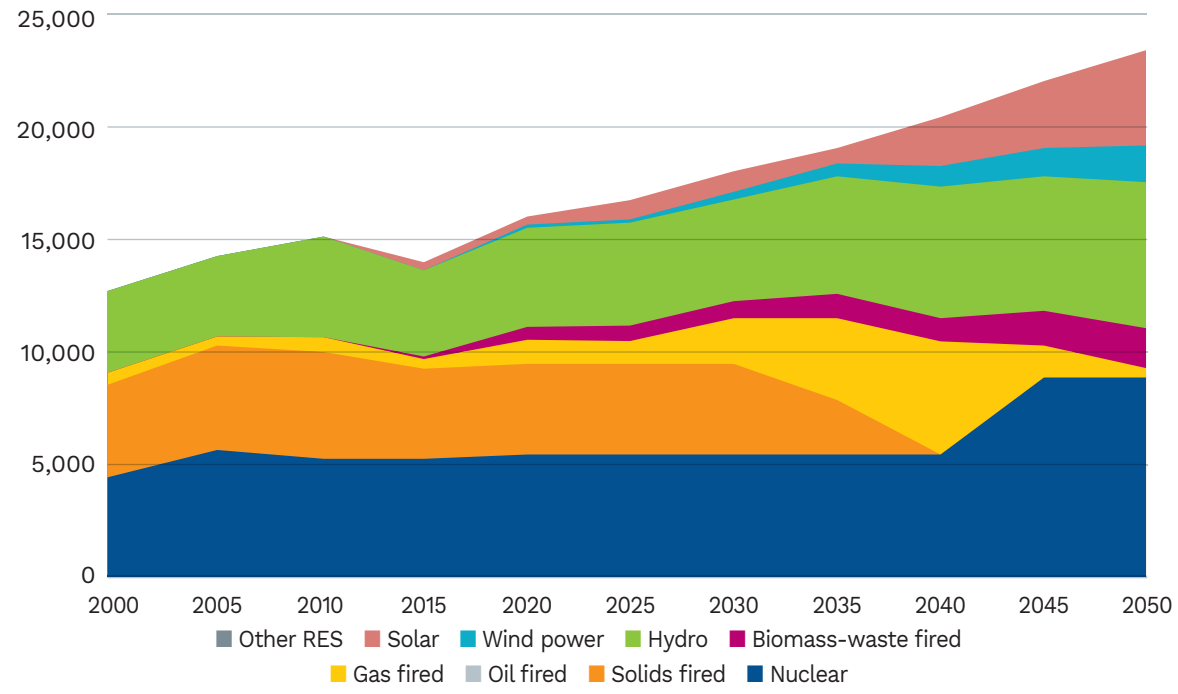
Energy sources are not only commodities but also social goods. For a society to function normally, it is essential that citizens and the economy have reliable, sustainable and affordable energy sources. This is why every decision in the energy sector must be taken with consumers' bills and competitiveness of the economy in mind.

A competitive energy sector is therefore a precondition for a competitive economy. Furthermore, energy sources are also strategic goods. The interests of superpowers have always given energy flow projects priority status. Slovenia has no major oil or natural gas deposits, nor refineries for that matter. But it does have a robust and balanced electrical power production mix that is strongly integrated in transmission networks. Given that electricity is the energy vector of the future, this provides an excellent basis for further development of the energy sector, and with it the society in general.

The third scenario - with continued use of nuclear energy alongside a shift to renewables - can ensure affordable energy for consumers and competitive prices for the economy. Having served for 13 years as mayor of Krško, which is home to the only nuclear power plant in Slovenia, I support continued use of nuclear energy, as I am well aware of the safety measures in place and that if the waste is handled appropriately the environmental risk is minimal. Apart from affordability, this scenario provides greater stability of the energy system and lower dependency on imported energy. At any rate, something will need to be done. The only question is whether Slovenia is ready to accept substantially higher energy prices if it chooses to switch to renewables only, or whether it will do better with a different mix, such as the one mentioned above.

It is up to Slovenian politicians to decide and outline the direction of energy policy for the next 30 years. This is a sector of strategic importance for Slovenia, so decisions should not be delayed much longer. Long-term planning is crucial for a successful transition to a low-carbon society.

Net electricity generation by plant type (in GWh) - scenario with a new nuclear power plant launched in 2045[3]



1 https://trilemma.worldenergy.org/
2 KONČNO POROČILO - priprava dolgoročnih energetskih bilanc do leta 2035 in okvirno do leta 2055, stran 75, 100: http://www.energetika-portal.si/fileadmin/dokumenti/publikacije/eks/razprava_jun_2017/eks_priloga2.pdf
3 KONČNO POROČILO - priprava dolgoročnih energetskih bilanc do leta 2035 in okvirno do leta 2055, stran 84: http://www.energetika-portal.si/fileadmin/dokumenti/publikacije/eks/razprava_jun_2017/eks_priloga2.pdf

The Clean Energy Partnership
On the move with hydrogen

The Clean Energy Partnership (CEP) in Germany offers a protected framework for cooperation between competitors in order to advance hydrogen mobility. Since 2002, when the CEP took up its work, the partners have already produced essential and internationally acclaimed results. “Since the beginning of the project, the CEP partners have put their know-how and experience to work in a unique, cross-industry cooperation,” says CEP Chairman Thomas Bystry. The market activation of hydrogen mobility in Germany has begun.

On the move with hydrogen

In 2017 the CEP has started a new phase. Bystry: “In Phase IV of what originally started as a research and development project, we are now working on the market activation of electromobility with hydrogen and fuel cells. Hydrogen will make a major contribution to a successful energy transition – on the road, on rails and on the water – we can see that it works, every day, on Germany’s roads.” The CEP vision has become a reality: fuel-cell vehicles are on the road, the infrastructure is growing, and hydrogen production is up and running. We are on the move with hydrogen – but there is still a lot of work to be done.

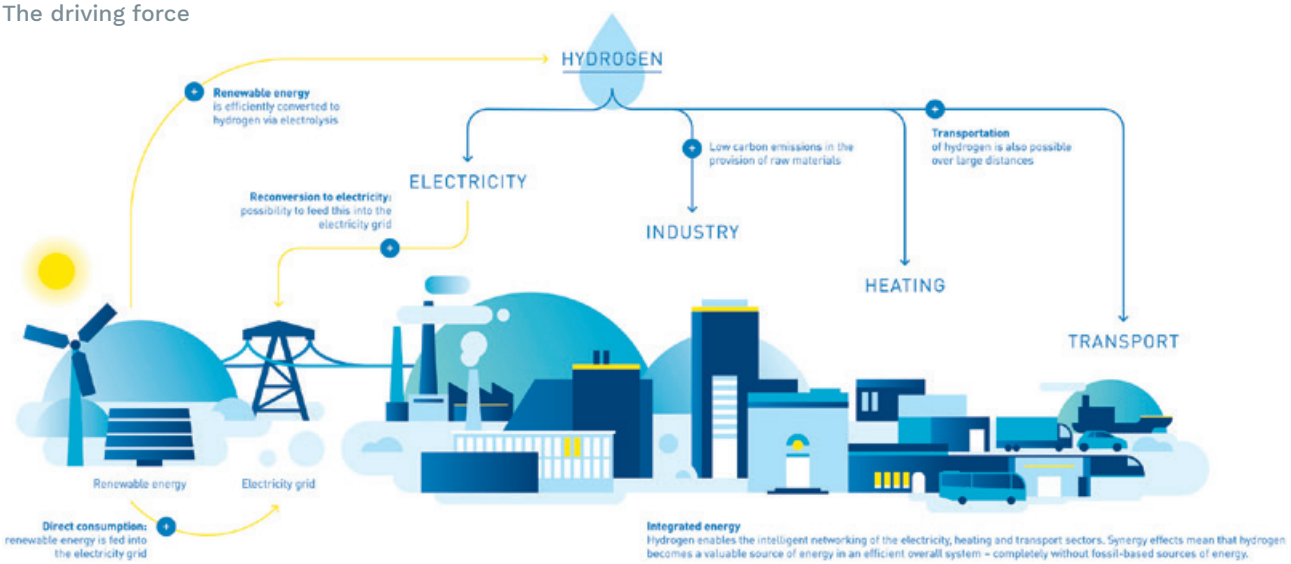
Goals of the CEP

- Market activation of H_2 mobility, across various modes of transport
- Demonstrate road capability of high-performance vehicles (cars, buses, trains)
- Use of fuel-cell vehicles in fleets
- Cross-sector development and expansion of ‘green hydrogen’ production capacities
- Support the linking of sectors
- Assist with establishing supply logistics for green hydrogen
- Demonstrate the systems capability of accompanying technologies
- Standardise interfaces and protocols
- International exchange at expert level

Working groups: The core of the CEP

In the CEP experts from thirteen companies – Air Liquide, Audi, BMW, Daimler, H2 Mobility, Honda, Hyundai, Linde, OMV, Shell, Total, Toyota and the Westfalen Group – have organised themselves into task forces to optimally leverage resources and synergies. To support the establishment of an integrated hydrogen mobility concept in the market, these task forces concentrate increasingly on technology, product, business and market development. Specific questions that the partners are dealing with include: How can the use of fuel-cell vehicles be accelerated, for example in fleets? How can we achieve greater visibility for the technology? What measures are needed to make it easier for customers to buy vehicles? Currently the partners of the CEP are focussing on the H_2 electrification of the heavy-duty sector, the production and logistic of green hydrogen, and the development of a platform for regulations, codes, and standards.

The driving force



Integration of renewable energies: Green hydrogen

For things to get better, something has to change. In the case of the energy transition, a lot has to change. A quick reminder: the goal is to reduce CO_2 emissions by 80-95 percent, by 2050 (compared to 1990). Hydrogen has the unique potential to play a key role in the energy transition. CO_2 emissions can be reduced to a minimum through sustainable hydrogen production – which is why the CEP is urgently advocating the use of 'green' hydrogen.

As a storage medium, hydrogen can increase system stability and enable the large-scale integration of renewable energies. So one important focus of the CEP is the development of solutions for the production and logistics of 'green hydrogen' in the terawatt-hour range.

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The green hydrogen used by the companies meets all the criteria and requirements of TÜV Süd (CMS 70 standards 'Production of green hydrogen' in the version dated 11 December 2017).

In addition, it also essentially corresponds to the European CertifHy project's definition of 'green hydrogen'.

Heavy-duty logistics with hydrogen

Studies show that hydrogen can play a key role in reducing CO_2 emissions in the heavy-duty sector. In the logistics sector in particular, there is already great demand for emissions-free vehicles.

The CEP is in international dialogue with major players in the H2 industry. Some manufacturers are already developing production-ready hydrogen-powered commercial vehicles. The expertise that exists in the CEP will help them to reach an agreement on a global refuelling standard.

Platform for regulations, codes and standards

The CEP itself also sets important standards, such as a definition of 'green hydrogen' as a basis for the repositioning of the industry that is needed in this context. In the field of filling station approval, the CEP has made an important contribution to shaping ISO standardisation (TC 197): The partners contributed to specifying the acceptance protocol and implementing a uniform acceptance report. This established the basis for having all H_2 filling stations throughout Europe assessed according to the same criteria by independent third parties – an important step towards improving the safety and performance of filling stations. The industrial partnership is currently focusing on developing an 'RCS (Regulations, Codes, Standards) Platform' that will serve to involve even small and medium-sized companies from the H_2 sector in regulatory decisions in Germany, Europe, and worldwide.

The Clean Energy Partnership (CEP)

The partners in the Clean Energy Partnership (CEP) are working across multiple sectors towards the market activation of hydrogen and fuel-cell mobility as part of a sustainable energy transition. Air Liquide, Audi, BMW, Daimler, H2 Mobility, Honda, Hyundai, Linde, OMV, Shell, Total, Toyota, and the Westfalen Group are all involved in the project.

In order to make optimum use of resources and synergies as the partners work together towards their goals in the spirit of a shared mission, the project is organised into working groups: Market Activation & Modes of Transport, Car Filling Stations, Green Hydrogen & Logistics, Regulations & Promotion, Strategy Circle, and Communications, with their respective subordinate focus groups.

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Energy from waste as part of the circular economy concept

By Prof. Mario GROSSO, Department of Civil and Environmental Engineering, Politecnico di Milano (Italy)

Despite energy recovery from waste not being formally acknowledged as part of the circular economy paradigm, but rather a "leakage to be minimized", at the same level of landfilling, there is mounting evidence that if properly managed it can play a crucial role in achieving the ambitious targets set by the EU Circular Economy Package.

Let's start with some facts: to be honest, not all forms of energy recovery are excluded from this paradigm, in fact biogas from biogenic sources is included, despite potentially generating emissions into the atmosphere. It is acknowledged that such emissions are climate-neutral, since they compensate for the uptake of CO_2 during the growth of the plants, but a certain release of methane is always possible, being a much more powerful greenhouse gas, whether it is biogenic or not.

What is missing from the discussion is that the recovery of energy from the residual waste (which still accounts for the majority of the municipal waste generated in many European countries) is on the one hand unavoidable if we need to get rid of landfilling, on the other hand functional to some further material recovery activities.

The new Circular Economy Package issued by the European Commission in 2018 is ambiguous in that sense, because it shows a great emphasis towards avoiding landfilling of waste ("A binding landfill target to reduce landfill to maximum of 10% of municipal waste by 2030"; "A ban on landfilling of separately collected waste"; "Promotion of economic instruments to discourage landfilling"), while at the same time it excludes the contribution of energy recovery in achieving the very ambitious targets of "recycling" (not "recovery", in fact, that would include also energy recovery). There is a clear embarrass in the legislator, that prefers to even avoid mentioning such topic, paving the way to the mounting popular and political opposition to any type of energy recovery activity.

It worth briefly discussing the reasons that stand behind such an opposition, which have evolved during the past decades. The first and oldest concern is the one related to the potential emission of toxic substances that might impact the human health.

While it is true that mixed waste is the dirtiest (and most difficult to process) type of solid fuel, this has prompted a huge effort in improving the performances of flue gas cleaning and of combustion optimization.

Emission limits at the stack of WTE plants are not only extremely strict when compared to other industrial sectors, but also strictly controlled and generally publicly available on the real time. While the "dioxin issue" has been tackled back in 1997, by cutting the emission limits by about 800 times, a more recent considerable effort has been put in decreasing NOx and HCl emissions well below the EU emission limits, and the new targets widely discussed and recently set by the revision of the BREF on waste incineration are putting further pressure to the plants designers and operators. Also the emission of fine dust has been targeted, especially in Italy, where a campaign on the risk of nanoparticle emissions by incineration plants had mounted and generated widespread concern.

A comprehensive research carried out by the LEAP Laboratory and Politecnico di Milano has then showed the effectiveness of fabric filters in capturing also very fine dust, with typical measured stack number concentration being of the same order of magnitude (or sometimes even lower) of the baseline presence in ambient air.

Following the acknowledgment of such progresses in controlling the stack emissions, a second point of discussion is targeting the solid residues generated by the incineration process, i.e. bottom ash, fly ash and flue gas cleaning residues. Again, in recent years a lot of efforts have been put by the operators in achieving high levels of material recovery especially from bottom ash, where ferrous and non-ferrous metals are present in interesting amount and can be easily extracted and sent to recycling. Especially the non-ferrous stream, which is dominated by aluminium and copper, has proven to be rich in precious metals such as silver and gold, that concentrate in the fine fraction. Also the inert components of bottom ash can be used in civil engineering application, as well as in the cement and concrete industry. More complicated is the recovery from fly ash, but some possibilities are envisaged especially for Zinc. In any case such (minor) flow of material is the one where toxic elements are concentrated, which means it is the "final sink" needed to safely isolate them from the environment.

A last and more mature point of discussion regarding WTE plants is their lack of flexibility, i.e. the fact that they will represent a "rigid" element in the whole waste treatment chain, that on the contrary has to be flexible in order to accommodate the envisaged increases of source separation, as well as the waste prevention policies. This is probably the most robust claim, which has to be seriously targeted with a proper design of the treatment capacity of new plants, taking into account that more source separation will generate more sorting and recycling residues that should be routed to energy recovery. Avoiding any construction of new plants where there is a lack of capacity simply means to guarantee a long and prosperous life to landfills and/or huge and easy earnings to the waste transport sector. At the detriment of the environment.

Mario Grosso is an environmental engineer graduated at Politecnico di Milano. He holds a PhD on the topic of dioxin formation and destruction in waste incineration plants. He is currently Associate Professor at the Department of Civil and Environmental Engineering of Politecnico.

He coordinates the AWARE (Assessment on WAste and REsources) research group, aimed at researching on waste prevention, technologies for recovery and disposal of solid waste and of residues, integrated waste management, flue gas treatment technologies for industrial plants, definition of scenarios for emission reduction, as well as Life Cycle Assessment (LCA).

european energyinnovation

Connecting Europe's Stakeholders in Energy and Transport

EUSEW Special Issue
Summer 2019 Edition

Sustainable Energy Week (EUSEW) is organised the European Commission (Directorate-General for Energy and the Executive Agency for Small and Medium-sized Enterprises). This year it will take place in Brussels on 17-21 June.

EEI are press partners to the event and the Summer issue will focus on the EUSEW themes of renewable energy and energy efficiency. With informed viewpoints from EU Commission officials, Members of the European Parliament and industry experts, we showcase current thinking.

We will also feature a wide range of topics: from smart cities, ICT and building efficiency, to smart grids and transport decarbonisation.

Our energy country profile will feature Belgium, with a focus on its technological advances in energy efficiency, research, and innovation.

In addition to our regular European distribution, the Summer issue will also be freely available to all delegates and visitors for the entire duration of the event.

We look forward to welcoming you at our stand at EUSEW.
For further information: www.eusew.eu

View our publication online at
www.europeanenergyinnovation.eu

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