THE EUROPEAN FILES

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ENERGY SYSTEM INTEGRATION IN EUROPE

Decarbonization of the European economy

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EDITORIAL

The current crisis brought about by COVID-19 has strongly impacted our economic activity and has put all sectors in dire straits. The green recovery put forward and advocated for by the Commission in May, focuses on speeding up the transformation of all economic sectors in such a way so as to ensure future growth will be sustainable and generate sufficient new jobs.

Within the framework of the Paris Agreement and in line with ambitions of the Green Deal, Member States have committed to curbing their carbon emissions and promoting fossil fuels alternatives in order to meet their energy needs, while securing reliable supplies of energy sources and ensuring the EU's autonomy.

But how exactly are we to increase the reliability of fuel supplies while reducing costs and minimizing environmental impacts of our energy systems? The answer should be looked for in the notion of "synergy" and "integration" as a guarantee for greater overall efficiency. This is quite a revolutionary perspective, and it seems like the European Commission has already embarked on this road. Indeed, the Commission will shortly bring forward a new strategy for energy system integration and a new hydrogen strategy aiming to lay the foundations for the European energy system of the future.

Energy Systems Integration (ESI) means linking the energy sector composed of various energy fuels and carriers – electricity, heat, cold, gas, solid and liquid fuels – with each other and with the end-use sectors where carbon consumption and emissions need to be reduced, such as buildings, transport, or industry. Linking sectors will allow for the optimisation of the energy system as a whole and generate essential synergies, while avoiding energy losses and waste

The transition towards energy systems integration will involve using various technologies such as ICT, smart grids, and meters to create a more flexible, more decentralised and digitalised energy system, in which consumers are empowered to make their energy choices and become active prosumers. It will rely on the direct and indirect electrification of those sectors, which are still reliant on fossil fuels. The latter will be progressively replaced by renewables gases, including green hydrogen.

The strategy will be essential for the heat sector, often overlooked or misunderstood. Technologies to increase the share of renewable energies in the heating sector within the strategy, including the use of biomass, solar thermal and geothermal facilities, heat pumps, power to gas-fired heating and power generation facilities, will guarantee optimised system flexibility and contribute to the competitiveness of the European industry.

In the Commission's view, this integrated approach is also necessary to make the most of hydrogen's potential, open up new markets for flexible storage systems, tap on the potential of waste heat and allow for cross-sectoral energy transfers in order to ramp up the full decarbonisation of various sectors.

This special issue will highlight the tremendous economic, technological and environmental potential of integrating various fuels, different energy carriers, parts of energy systems and sectors.

In this time of unprecedented economic crisis, Europe's ambition will be to shape a new decarbonised, resilient, and innovative economy, and we have no doubt that energy systems integration approach is part of the equation.

Editor-in-Chief
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DECARBONIZATION OF THE EUROPEAN ECONOMY

Creating the **energy system** of the **future**

KADRI **SIMSON**

EU Commissioner for Energy

The EU has made a political commitment to achieve carbon-neutrality by 2050, hence there is no doubt that Europe's energy future will rely on an ever-growing volume of renewable energy. The share of renewable electricity sources keeps increasing, with one third of our electricity already coming from renewables. At the same time, the costs of renewables continue to come down – frequently being more competitive than their fossil fuel alternatives. In addition, innovation and technological progress means that renewable energies are diversifying beyond the "traditional" renewable electricity sources such as hydropower, wind and solar.

At the same time, the Commission is also preparing a new initiative to maximise the potential for **offshore renewable energy** sources, due for publication before the end of 2020. Renewable gases, such as biogas and biomethane are already becoming more important elements in our energy mix. New fuels, in particular renewable hydrogen, are also expected to develop rapidly in the coming years. But in order to encourage their further development and to enable us to make the most of their potential, all of these renewable energy sources need to be included and integrated into the energy system at all parts of the energy supply chain, from generation to end-use. They need access to a system that links the different energy carriers, infrastructures, and consumption sectors. A system that works in a coordinated manner.

This is one of the key challenges that the Commission is going to address through a major new initiative due for publication on the 8th of July, called the **Strategy on Energy System Integration (ESI)**. In the coming years, the concept of Energy System Integration will guide us policymakers towards a wide-reaching reform of every aspect of the EU's energy system, all in support of our ultimate goal of becoming climate neutral by 2050. It is an integral part of the European Green Deal, and will result in a more efficient system that supports decarbonisation across multiple energy sources, building modern infrastructure, greening European industry, and allowing citizens to take decisions on the energy they use. A better-integrated energy system will not only help deliver our climate goals economically, but will also promote jobs and technological innovation. By making our economy more sustainable and resilient in the long term, the ESI strategy, like all other strands of our policy, constitutes another key building block of the EU's economic recovery from the COVID-19 crisis.

One principle benefit from energy system integration will be to facilitate the contribution that renewables can make in the decarbonisation of sectors that are difficult to decarbonise, such as transport, buildings or industry. For instance, renewable electricity for lightweight transport vehicles, biofuels for shipping, and hydrogen for some industrial processes. This process will not only link different energy carriers to end-use sectors, but it will also be done efficiently by attributing renewable energy sources where they are the most appropriate.

In this context, the versatility of renewable energy sources is expected to be an asset, making it easier to combine with innovative demand-side technologies and digitalisation. Indeed, this should enable a more efficient use of energy sources, while cutting primary energy demand. The potential for reducing consumption is huge, with the Commission's 2018 Long-Term Strategy scenarios estimating that a more efficient use of energy sources would reduce energy demand by a third by 2050[1], whilst supporting an increase in GDP of 75%[2]. Thus, by contributing to the decarbonisation of hard-to-abate sectors, energy system integration will facilitate the best combination of energy efficiency and conversion to renewables, thus reducing the environmental and climate impact of the energy sector while also supporting the economy.

Through the promotion of new and more efficient technology solutions across all sectors of industry, in particular in aiding the transition to renewables, the ESI strategy will also play a key role in strengthening the competitiveness of the European economy - and maintaining EU leadership in renewable technologies. A more flexible, better integrated system is expected to lead to the emergence of specialised enterprises that could provide energy services locally or regionally, creating more regional economic benefits. As new, more efficient, and complex technologies and processes are developed, they can rapidly be rolled out across the EU, and play an increasing role in energy systems worldwide. In parallel with the Energy System Integration Strategy, the Commission is also intending to publish on July 8 a separate, **Hydrogen Strategy** to find ways of boosting this sector.

Another area where energy system integration can combine with renewables is the evolution and deployment of **energy storage technologies**. Given the variable nature of many renewables technologies, many people see storage as the missing part of the puzzle. Storage can take various forms depending on the type of primary renewable energy, such as thermal storage, pumped hydropower, grid-scale batteries, and electrolysers. It is possible others will emerge in the years ahead. The changes from the ESI strategy will make it easy for these technologies to be developed and to be integrated into the energy system.

In the end, renewable energy will not enable the decarbonisation of the economy on its own. That will only happen by looking at the energy system as a whole and seeing how all the different elements can work together most efficiently – energy carriers, infrastructures, and consumers. This is why the forthcoming Energy System Integration Strategy is so crucial for enabling renewables to fulfil their potential in contributing to our climate neutral ambitions.

1 See COM (2018) 773 - A Clean Planet for all - A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy.

2 *Ibid.*

CRISTIAN **BUȘOI**
MEP (EPP Group),
Chair of the ITRE Committee

Gauging **Smart sector integration** impact: will it **help us reduce CO_2** emissions and improve industrial performance in Europe?

I welcome the upcoming strategy on energy system integration. The Commissioner assured us that the Strategy on energy system integration will focus on a more circular energy system, greater direct electrification of end-use sectors and increased use of renewables and decarbonised fuels including hydrogen. The strategy represent a fundamental factor for achieving Europe's CO_2 reductions targets and increase global competitiveness of our industry, in line also with the ambitions of the Green Deal.

The Strategy will rather boost the optimisation of the energy system as a whole, than decarbonising and making separate efficiency gains in each sector independently, and this has the potential to directly contribute to reducing costs of renewable energy, deployment of clean technologies, reduce network investment costs, enhance cross-border market access for renewables, open new markets for storage systems and hydrogen, allow greater amounts of renewables in the energy mix, and contribute to our digital transformation.

There has been an ongoing need for innovation in better linking our different energy carriers (electricity, gas, heat, cold, fuels) and following COVID-19 economic crisis, I find of outmost importance to use our recovery financial instruments to accelerate the transition towards a more integrated and decarbonised energy system in EU, in order to reduce the total of energy our industries need, their production costs, while ensuring security of supply, but also energy autonomy in Europe.

If the first objective of sector coupling will be to increase direct electrification of key industrial sectors from the current 20% to more than 15% (COM LTS 2018), the second will be represented by the indirect electrification, which implies using excess renewable electricity to produce hydrogen. This will require increased investments, as I underline that, in present, only 4% of Europe's hydrogen is produced from renewable sources despite the fact that Europe is a major global actor in the production of electrolysers. Consequently, I stress the need to better capitalize on our potential and strengthen our efforts to large-scale deployment of renewable hydrogen, increasing demand and providing necessary financial support instruments. Additionally, we need to scale up usage of this hydrogen in all industrial processes where electrification is not possible, such heavy industry, aviation, shipping and long-haul and heavy-duty road transport. For instance, the introduction of renewable energy in the production of cement could decarbonise one of the most energy-intensive European economic sectors, while creating new jobs at the same time.

As regards to hydrogen, the increased production will require enhanced generation of renewable energy, as well as consolidated public and private investments in development or transformation of infrastructure across the Member States, building storage capacities, as well as a developed and competitive hydrogen market. Where it cannot be entirely used near the place of production, we need to evaluate the options to let the flow of hydrogen across the EU through our existing pipelines, which also means investment in modernizing them, we need to invest also into other transportation means, as well as a well-established regulatory framework supporting the uptake of renewable hydrogen.

Energy system integration in Europe will also contribute to the competitiveness of European industry by promoting smart technologies, their standardisation and market uptake. A sound European strategy for system integration will need to ensure that all industries can reduce emissions while leveraging economic advantages of a decarbonised economy. Moreover, digitalisation of EU's industrial sector will further enable optimisation of our industries' energy systems.

A decarbonised European economy needs to be based on a decarbonised energy system. In this context, I highlight the importance to provide necessary financial incentives to support our industry to fasten deployment of Carbon capture and use or storage (CCUS) for those industrial processes with large emission rates. I underline the need to identify new ways to increase financial viability for CCUS projects, reduce their high upfront investment costs, and establish a correct ratio between investment on CCUS and CO_2 price, in order to encourage our industry to capture and store CO_2 instead of paying for emitting it.

In present, a large share of Europe's energy demand still dissipates as waste. An important step forward will be to apply circular principles to our energy systems, a process that can reduce significantly primary energy needs for industries. One of the principal solutions is represented by cogeneration, which can lead to energy efficiency levels of around 90%. Across European regions, small cogeneration facilities can also be an effective way to supply energy to remote industrial sites without the need for expensive grid infrastructure. One step further can be done by accelerating deployment of trigeneration plants to produce cooling, heat and electricity, simultaneously.

As policy maker, I finally underline the need to strengthen regulatory framework for the reuse of industrial and data centres waste heat, through appropriate revision of relevant legislation. The Energy Efficiency and Renewable Energy Directives already contain provisions targeting the reuse of waste of heat from industrial sites, but we still need to identify innovative ways and incentives for our companies to apply additional business models in this matter.

Building momentum for a **sustainable recovery**

DR FATIH **BIROL**

Executive Director of the International Energy Agency

Today, we are living through extraordinary times and facing tremendous challenges. As the world deals with the unprecedented health emergency triggered by the Covid-19 pandemic, the global economy is facing its biggest shock since the Great Depression. This is having a major impact on jobs and investment across all parts of the economy, including the energy sector.

Governments have taken the lead in providing urgent financial and economic relief to prevent the crisis from going into a downward spiral, but the damage is still severe. Today, attention is increasingly focusing on how to foster an economic recovery that repairs that damage while also putting the world in a better position for the future.

Since the scale of the economic crisis began to emerge, the International Energy Agency has been leading the calls for governments to make the recovery as sustainable and resilient as possible. This means immediately addressing the core issues of global recession and soaring unemployment – and doing so in a way that also takes into account the key challenge of building cleaner and more secure energy systems.

At the IEA, we quickly re-focused the work of our analytical teams across the Agency on the shocks caused by the crisis to global energy demand, assessing the impact across oil, gas, coal, electricity and renewables. We then quantified and examined the staggering effects in key areas, such as the unparalleled 20% plunge in global energy investment that is expected this year. And now, we are identifying the most effective measures available to governments as they consider their once-in-a-lifetime recovery plans. The Sustainable Recovery Plan proposed in our new World Energy Outlook Special Report is the result.

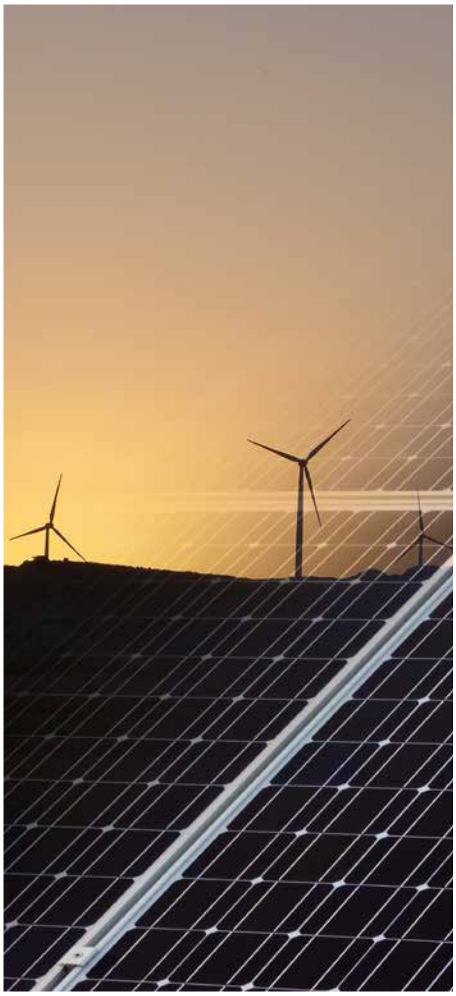
The Sustainable Recovery Plan is not intended to tell governments what they must do. It seeks to show them what they can do. Whether countries choose to follow the measures laid out in the plan remains their sovereign choice. Our plan – a combination of policy actions and targeted investments – offers a hugely encouraging picture of what the world can achieve despite the tremendous difficulties we face today.

As they design economic recovery plans, policy makers are having to make enormously consequential decisions in a very short space of time. These decisions will shape economic trends and energy infrastructure for decades to come and will almost certainly determine whether the world has a chance of meeting its long-term energy and climate goals. Our Sustainable Recovery Plan shows governments have a unique opportunity today to boost economic growth, create millions of new jobs and put global greenhouse gas emissions into structural decline.

Even before the Covid-19 crisis, cities across Europe were asking for sustainable investment, companies were planning for it, and people were out in the streets marching for it. The European Commission made the European Green Deal its top priority a few short months ago, and it is now aiming for a sustainable and resilient recovery.

In Europe, as in many other parts of the world, investing in clean energy technologies, clean transport and clean industries is the way to create well-paying local jobs that boost economic growth. Such investments will help the world move closer to meeting our international climate and sustainable energy goals and making economies more resilient to future shocks. This means putting resources into viable projects that bring both immediate and long-term gains, such as housing renovation, clean energy infrastructure and low-carbon transport.

To build momentum for these efforts, the IEA is bringing together top decision-makers from government, industry, the investment community and civil society for the IEA Clean Energy Transitions Summit on 9 July. A sustainable recovery is within our reach – I hope the grand coalition of global energy leaders we are assembling will seize this opportunity.

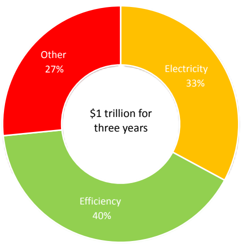


International Energy Agency

Sustainable Recovery

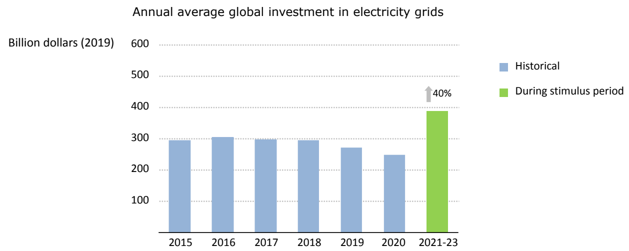
World Energy Outlook Special Report

A plan for a Sustainable Recovery post Covid-19



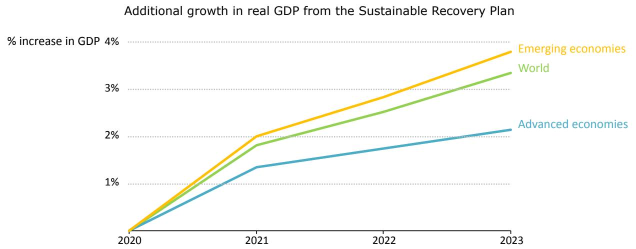
The Sustainable Recovery Plan provides an integrated approach to support economic recovery and jobs while improving the resiliency & sustainability of the energy system

Modern grids support robust and resilient electricity supply



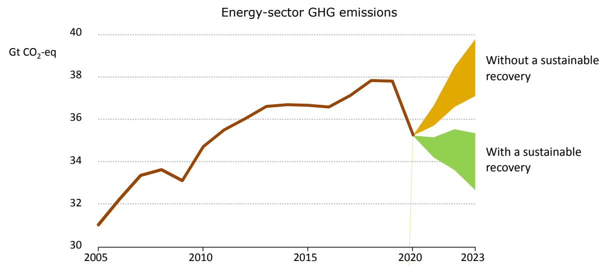
The Sustainable Recovery Plan would boost spending in grids, and so help to bolster electricity security, modernise grids, and enhance reliability, efficiency and flexibility.

The energy sector could be a major driving force for economic growth



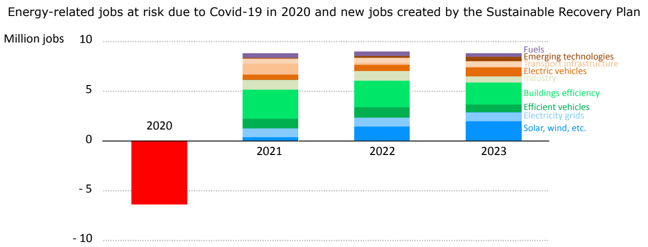
An assessment conducted in co-operation with the International Monetary Fund shows that the Sustainable Recovery Plan would boost average annual global GDP growth by 1.1% to 2023.

Energy systems would shift towards structurally cleaner ones



The plan would make 2019 the definitive peak in global emissions, reducing GHG emissions by 4.5 billion tonnes and putting them on a path towards achieving long-term climate goals, including the Paris Agreement.

A Sustainable Recovery Plan creates new jobs



With 6 million jobs that could be permanently lost due to the crisis, the plan could create or save some 9 million jobs in every year between 2021 and 2023 with most being in efficiency and in power.

Conclusions

- Governments are set to make major decisions that will shape energy infrastructure and industries for decades to come.
- Implementing the Sustainable Recovery Plan can achieve a range of significant outcomes. Our analysis, carried out in cooperation with the International Monetary Fund, shows implementing the plan can:
  - Boost global economic growth by an average of 1.1 percentage points a year
  - Save or create roughly 9 million jobs a year
  - Make 2019 the definitive peak in global emissions
- Direct government expenditure would be less than 10% of recovery plans announced to date, but it is crucial for governments to create the right conditions to materialise $1 trillion a year for three years.
- The IEA will hold a Ministerial-level Clean Energy Transition Summit on 9 July and the Sustainable Recovery Plan will be a key element informing discussions.

No green transformation without **sector coupling**?

MORTEN **HELVEG PETERSEN**

MEP (Renew Europe Group), Vice-Chair of the ITRE Committee

The current situation with COVID-19 is having a huge impact on the European economy. Even though the pandemic constitutes an immediate crisis, the climate crisis constitutes an existential threat towards future generations, thus staying the greatest challenge to overcome. Part of the solution to both problems may very well be sector integration.

In Brussels, sector integration has already become a buzzword. Sector integration is of utmost importance if we are to integrate renewable energy to the extent that we want – and have – to.

The expansion of wind and solar energy creates a need to utilise green energy in new ways. An option could be sector integration plants where green electricity is electrolysed to hydrogen or refined to other fuels.

Another important aspect of sector integration is district heating and cooling. District heating and cooling are technologies that increase the overall energy system efficiency by recycling energy or fuels otherwise lost and, at the same time, providing flexibility to the heating and cooling markets as well as the energy system in general. This is done by aggregating heat demands in buildings and industries through thermal networks and covering demands with a portfolio of supply options. By integrating district heating and cooling networks with other energy sectors, in particular electricity, their ability to thermally store energy can be utilised to enhance both efficiency and flexibility of these other sectors.

A large CO_2 reduction

The enormous amounts of money we need to invest now to get the economy back on track should be as green as possible and at the same time ensure job creation. A green recovery plan has the potential to create millions of sustainable jobs across Europe.

The so-called Power-to-X (PtX) can go a long way and become a crucial technology if we are to create more sustainable jobs and reach our goal of net-zero CO_2 emissions in the EU by 2050. However, to achieve this, we need a quick transition to a green and sustainable energy system. According to a new analysis from The Technical University of Denmark, PtX can for example save Denmark 22 million tonnes of CO_2 over the next 0-10 or 0-25 years. In other words: The potential is huge.

PtX makes it possible to intelligently integrate and connect the different sectors of the energy system. The various energy carriers in the energy system 1) the electricity grid, 2) the gas grid, 3) the district heating grid and 4) the district cooling grid have traditionally been viewed separately. But with PtX, the different energy carriers can be converted to each other so that the energy system becomes more coherent. The four energy carriers should therefore no longer be regarded as four isolated silos. Instead, one can link the different sectors and leverage their respective strengths to provide the flexibility needed in an energy system where the share of green energy becomes greater.

Flying CO_2 free

Basing the recovery plan on the conversion of green power to hydrogen or on to other products such as gas, methanol and ammonia has a number of advantages. The technology can help reduce CO_2 emissions from sectors such as heavy transport and industry. It is cheaper to store and transport the green energy when it is converted from electrons to molecules. As the conversion process can run very flexibly, it also helps to increase the value of wind and solar in times of excess production.

In the future, we must ensure that all our future energy is green and circular, and that the renewable energy is utilised throughout the community. It is crucial that we avoid wastage and can create value based on profits in production. For example, bio-waste from agriculture, industry and households can help produce green biogas, which can be used in our existing gas infrastructure.

The cost of PtX is constantly dropping, which makes it a viable alternative to fossil fuels in the future. The costliest part of the process is the electrolysis, which is constantly being streamlined because a number of large European energy companies are currently investing in very large green hydrogen plants. With a strong dedication to this technology, we may one day all be flying on holidays with aircrafts fuelled by CO_2-free, liquid aircraft fuel.

CHRISTIAN EHLER
MEP (EPP Group), EPP ITRE Coordinator

Energy system integration needs consistency with other policies and methodology for aligning targets

As part of the European Green Deal, in order to encourage this smart sector integration, the Commission will present an **EU Strategy for energy system integration** by June 2020. The new EU strategy - in synergy with a new dedicated strategy on hydrogen in Europe - will lay the foundation for the decarbonised European energy system of the future. By linking traditionally separated sectors of the energy system – like electricity and gas – the Commission hopes to create synergies that will allow integrating more renewables and decarbonise industrial sectors that are currently lagging behind.

First, several barriers still prevent energy system integration from fully materialising and allowing citizens and industry to embrace cleaner energy alternatives. The cross-sectoral links in the EU's current system need to become stronger in order to create the conditions, which enable and encourage further integration - where different energy carriers can compete on a level playing field and use every opportunity to reduce emissions. Better integration of the energy system is also necessary to achieve a cost-effective decarbonisation of the EU economies. It will build a more flexible, more decentralised, and digital energy system, in which consumers are empowered to make their energy choices.

Secondly, many of the technologies we need to drive forward decarbonisation and digitalisation are yet to be developed. What is also lacking fundamentally is a methodology that connects all the different initiatives into a functional system. As EPP ITRE Coordinator I am convinced that when assessing the need to adopt new legislative proposal revising existing legislation and policies, the Commission shall take into consideration regulatory consistency and stability to preserve favourable environment for future-proof investments. If carbon-free steel plants or carbon-free aviation are to see the light within the next decade, we need yet to see concrete EU plans to achieve this. More generally, the 10-year climate ambition which we are setting until 2030 should be embedded in an overall 10-year plan which defines research, innovation, infrastructure, industry, energy-efficient targets, digitalisation goals which all come together to achieve economic recovery and long-term growth and jobs. Europe still did not finalise its Industrial Strategy and key funding programmes. If there are 2030/2050 targets on CO2 reduction, they must be reflected in Horizon Europe and the related Joint Undertakings. There is also a need to set targets to create the necessary energy infrastructure as well as to provide an appropriate capacity building to have hydrogen available sufficiently as an important bridge technology to decarbonise energy-intensive energy sectors. There is currently an inconsistency between EU strategies/targets and the funding and toolbox in place to implement them. In the recovery package, we have reference to hydrogen alliance but we lack a clear plan on how to invest in the relevant infrastructure as well as the needed push for Member States to support investments in this area.

Thirdly, one of the most central questions concerns the conditions for the spending. There is an immanent risk that Member States will spend the funding on non-competitive industries which cannot lay the base for long-term recovery and sustained growth. The funding should focus on real transformation of the economy and this has not been addressed so far. This is even more important in the context of a new debt created to finance the recovery plan: we have to ensure that this will be an investment which will have for first priority the rebuilding of our productive capacity, to give also the future generations the possibility to pay back the debt we will transfer to them. Financial securities and the path for re-payment needs to be clearly defined for that. Another aim is the clear conversation over financial issues. A certain living standard has a certain monetarily value, that's why consumers must be aware of price signals. Taxes and levies will ensure a financial support of the decarbonization. The market also needs to be adjusted, to provide a secure environment to both the system and the consumers.

Fourthly, more renewables introduce challenges of their own, for instance because of the variable nature of renewable electricity generation and the need to balance supply and demand at all times. Energy system integration will require a more flexible power system, including storage and digitalisation. And low-carbon fuels like hydrogen could provide an essential piece of the puzzle when trying to link the dots. Central to energy system integration is the deployment of new fuel sources such as hydrogen into the system. This has the potential to be a game changer. It could act as an enabler, especially for the hard-to-decarbonise sectors like heavy industry and transport. Hydrogen today only makes up less than 1% of the European energy system, but the Commission believes it could unleash a new wave of decarbonisation in hard-to-abate sectors of the economy.

Finally, energy system integration is how we connect the missing links in the energy system. If Europe is to succeed, EU policies, strategies and programmes need to be adopted fast and be better interlinked. Existing tools and instruments need to be adapted to fit our climate targets. We must move towards smart sector integration, which will promote stronger integration of the electricity, heating and cooling, transport, gas, industry, and agricultural sectors. Electrification, low-carbon gases, digitalisation and storage all play a role in completing the picture.

NIELS FUGLSANG

MEP (S&D Group, Denmark), Member of the ITRE Committee

Perverse subsidies: Three policies to break with short-term **fossil investments**

As a member of the European Parliament's committee on energy, I am part of making sure that the policy we create are in line with the overall goal of a CO_2 neutral European Union in 2050. Even though we in the Parliament agree on the overall objectives, a common ground is rather rare once the policy discussion becomes tangible. Contradicting views between the political groups are especially evident when it comes to continuous subsidies for fossil fuels.

Every year, the EU member states lead billions of euros into investments in fossil fuels. Recently, the European Commission published a report, which concludes that a number of countries such as France, Ireland, the Netherlands and Sweden on average are using larger sums of money on fossil fuels than in support for renewables.

These subsidies are 'perverse' and as such detrimental to our overall and long-term interests, and arguably. Moreover, the economic arguments for maintaining such policies are highly doubtful. Continuing these subsidies employ contrary effects of both environmental and economic nature over the long run. They are detrimental to our common European interests. At the same time, the EU finds itself in a place of momentum to rethink exactly these policies as we are approaching a new budget cycle.

With the European Green Deal, the Commission has this year pleaded to introduce new legislation on which energy projects should be eligible for subsidies. The stakes are high, especially after the controversies over the Commission's 4th PCI list in February.

I believe that policy makers and the EU in general can learn something from the Danish tradition of state subsidies for renewable energy. After the oil crisis in the 1970s, the government introduced a state supported research programme for wind turbines, followed by a support programme offering 30 pct. in grants for citizens aiming to introduce privately owned wind turbines in their household.

In the 1990s, Denmark introduced a Public Service Obligations tariff, the so-called PSO, taxing electricity customers and directing private money to investment in renewables. This policy gave a boost to especially wind energy in Denmark.

These measures were initially not financially sustainable or immediately feasible in the short run, but this long-term attitude towards renewable energy and investments is exactly what we need throughout the EU to succeed. Today, the price of wind energy is lower than any other source of energy per kilowatt and wind turbines are sustainable on market terms.

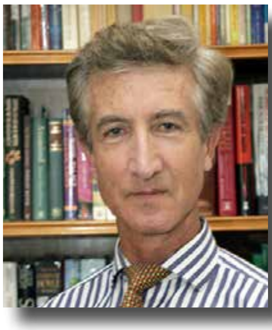
EU policy makers should change their attitudes to long-term investments in exactly this way and start the incremental change now in order to achieve climate neutrality in 2050. The EU has three policy responses that should all be implemented to move away from perverse subsidies to energy that does the exact opposite of reaching our common 2050 aims.

Firstly, the upcoming MFF and recovery package should be a chance to not only negotiate a budget but also to reform it. The MFF should not contain financial support for oil and gas. Simultaneously, within the budget the CAP should be revised to make sure that billions of euros are targeted towards sustainable agriculture and farming instead of anachronistic emission heavy production. The EU needs to embed a green contingency into all support programs in the future.

Secondly, we simply need to make it more expensive to pollute. Polluters need monetary incentives. Therefore, the EU should reform the ETS and raise the price of CO_2 quotas for all energy companies and industries. For too long, the ETS has been contradictory to its own aims. By reducing the inexpedient number of quotas, the price of polluting will naturally rise. Simultaneously, we need to reexamine the system's exceptions for heavily polluting industries perceived to be in danger of carbon leakage.

Lastly, the EU needs to set a deadline for the final phase out of tax-paid subsidies from member states to fossil fuels. In order to achieve our green objectives, it is adamant to turn the cash flow from black investments to green investments as soon as possible. And it is adamant that the EU can make a firm promise as to when.

This is the immediate playing field for policy makers to achieve a greener EU.



PETER STYLES
Executive Vice Chair
European Federation of Energy Traders

LORENZO BIGLIA
Coordinator for Energy System Integration
European Federation of Energy Traders

Harnessing markets in power, gas and related contracts to drive carbon neutral, joined-up **energy systems**

The intended EU Commission strategy for energy system integration[1], aimed at strengthening links between electricity and gas systems and energy end-use sectors across the EU economy, is a worthy initiative. However, the EFET analysis is that more emphasis is needed on using market-based mechanisms, if Europe is to achieve an efficient linking of the gas and power markets at wholesale level.

The objective of climate neutrality across the whole European economy by 2050, together with a tightened trajectory for emission reductions by 2030, justify stringent efforts to create an integrated energy system and to take a cross-sectoral approach to decarbonisation. Electrification alone is unlikely to deliver carbon emission reductions affordably on the scale and at the pace required. This is the case in particular for hard-to-abate sectors, such as heating, construction and some modes of transport, which ultimately must also contribute to Europe's decarbonisation objectives.

Policy priorities

In order for the future energy system integration strategy to facilitate Europe's energy transition and help reach ambitious climate objectives in a cost-effective way, it should be underpinned by the following policy priorities:

- Setting an ambitious, economy-wide climate neutrality objective at Union level
- Strengthening and expanding the EU Emissions Trading System (EU ETS)
- Utilising market-based mechanisms whenever financial support for new, low carbon energy sources is considered
- Ensuring pan-European coordination and cross-border implementation of any financial support schemes
- Insisting on a level playing field between power and low carbon gas systems, so that users face a cost reflective allocation of costs across both types of grid

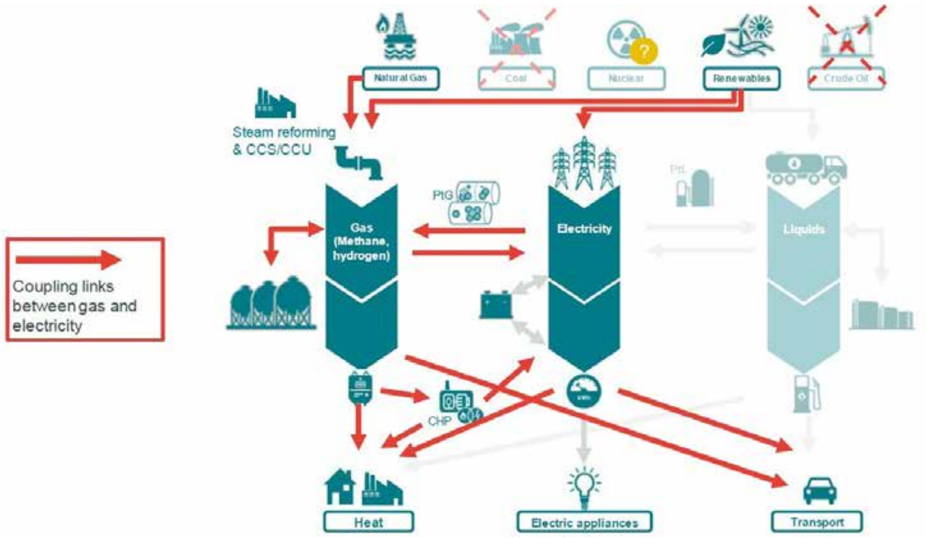
An energy system integration strategy worthy of the name must rest on a continuation and strengthening of the European Internal Energy Market. Especially the preservation of competition and liquidity at the wholesale level of energy commodity and energy derivative markets is essential.

The integrity and efficiency of current Europe-wide markets in energy products and energy contracts at wholesale level can best be protected by ensuring that any financial support for low carbon solutions is in turn market based. Allocation of such support must also respect the principle of strict unbundling between energy transmission and energy supply businesses, so that transmission system operators do not become producers or suppliers of energy by default. Ideally the EU should develop a coherent framework, which rewards carbon abatement using market instruments in a technology neutral way. A robust framework could eventually work across gas (renewable, decarbonised and low carbon), electricity (RES-E as currently defined in EU legislation) and other energy carriers (such as liquid fuels).

Carbon markets in the long run and market based financial support in the interim

In the drive to integration of power and gas systems with decarbonisation in mind, it will be increasingly important to distinguish between the carbon footprints of various energy sources. An expanded ETS, maturing into a wider European carbon pricing scheme, could in the long run facilitate energy system integration and encourage uptake of least

Growing links between electricity and gas



Source: Frontier Economics

1 https://ec.europa.eu/info/news/preparing-future-eu-strategy-energy-sector-integration-2020-apr-14_en

cost emission reduction technologies and solutions. We would expect this to happen, if EU policymakers are brave enough to tighten further the supply of emission allowances and spread the demand for them into all end uses of hydrocarbon fuels. It is reasonable to anticipate the tightening and expansion must proceed in lockstep with national prohibitions on certain end uses of hydrocarbons by stipulated deadlines.

Even if low carbon sources are not deemed to be priority renewable means of energy production under current EU legislation, there are two main market-based methods to encourage their uptake, pending expansion of the EU ETS to extra sectors:

a. The establishment of a voluntary market in low carbon certificates, whereby customers, in addition to or in parallel with buying energy, purchase a certificate from a supplier which guarantees derivation from a zero or low carbon production source; in the case of gases this method is untested, but experience on the power side suggests the value may only amount to around €1 or less per MWh consumed.
b. The introduction at EU level or by national governments of targets for carbon abatement in sectors outside the EU ETS currently, pursuant to which they then require suppliers of energy to meet low carbon quotas and set up a certification scheme for the fulfilment of those quotas; national governments need to ensure that any support schemes for technologies facilitating decarbonisation and energy system integration are strictly market-based, technology-neutral, open across EU borders, harmonised between countries as early as possible and aligned with the EU ETS.

A report commissioned by EFET from Frontier Economics and published earlier this year describes how a system of low carbon gas quotas might work across the EU. These quotas are seen as being allocated on the basis of either an EU wide target or coordinated national targets for carbon reduction in specified gas end use markets[2].

Whole system approach and a potential role for hydrogen [3] [4]

There are no proven efficient mechanisms for storage of electricity over weeks, months and seasons in the volumes that would be necessary in a fully carbon neutral economy entirely reliant on electrification. The European gas system is well-placed to help address both this storage challenge and the challenge of intermittency of electricity supply at higher levels of penetration of renewable generation. Additionally, the gas system provides a cost-efficient means of transporting large amounts of energy using already-invested assets, as an alternative to expansion of the electricity transmission grid or increased localised production. However, as already mentioned, gas must decarbonise in order to contribute.

Replacement of natural gas with hydrogen would allow the gas system to play an ongoing role in a decarbonised framework using existing assets in many cases. Ultimately, there will be dedicated hydrogen grids, but in the interim, opportunities may exist for blends or co-transportation, subject to design of new operational and end use frameworks. It will be hard to work out how to use or repurpose existing gas grids and establish new hydrogen grids; how to facilitate the production of renewable hydrogen; and how to recognise the sustainability benefits of hydrogen produced through reformation of methane in combination with CCS or through methane pyrolysis.

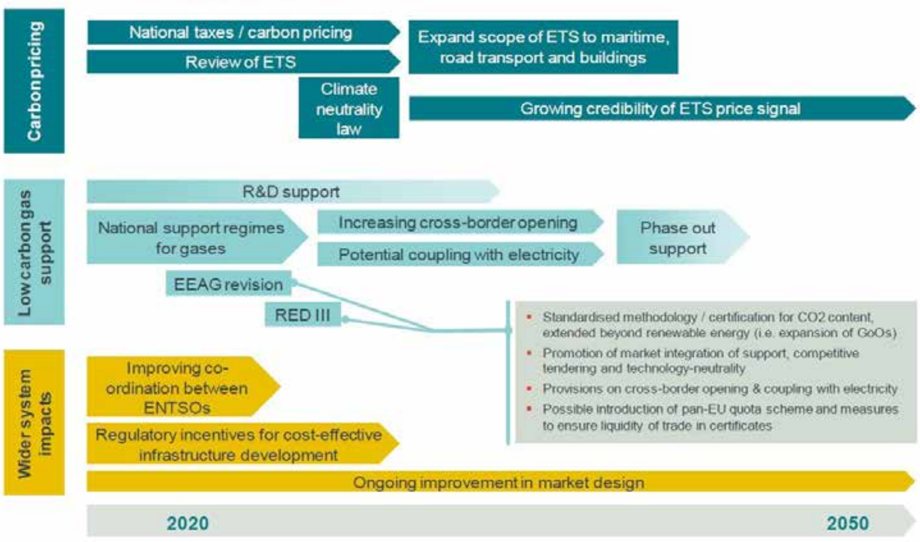
Nonetheless, the existing EU legislative framework could be adapted and new legislation to cover hydrogen markets and infrastructure could be introduced.

Regulators, TSOs and DSOs could in the meantime contribute through:

- Facilitating optimisation of grid infrastructure at transmission and distribution levels and increasing integration of power and gas infrastructure
- Ensuring that producers and suppliers using various technologies face whole system price signals reflecting the costs they impose on gas and power networks
- Not distorting decarbonisation incentives by misallocation of legacy gas system costs that have been irreversibly incurred
- Not permitting unwarranted expansion and reinforcement of electricity grids where use of an already built low carbon gas network provides a cheaper alternative

Further work is necessary to understand how flexibility markets in hydrogen could develop to enhance continuity and efficiency of energy supply to consumers. The roles of storage, demand side management and controllable production of sustainable hydrogen will likely be fundamental to producers' and suppliers' ability to contribute to our future European decarbonised energy system.

Potential pathway for future reforms to enable gas decarbonisation



Source: Frontier Economics

2 https://efet.org/Files/Documents/Short_Form_Report_A_market_based_approach_to_gas_decarbonisation_and_sector_coupling_Frontier_report_for_EFET.pdf

3 See also EFET comments on the Roadmap for an EU Hydrogen Strategy

4 See Germany draft hydrogen strategy https://www.bmbf.de/files/die-nationale-wasserstoffstrategie.pdf

CHRISTIAN **ZINGLERSEN**

Director of Department, respectively, at ACER (the EU's Agency for the Cooperation of Energy Regulators)

DENNIS **HESSELING**

Head of Department, respectively, at ACER (the EU's Agency for the Cooperation of Energy Regulators)

"The best of both worlds": **Efficient decarbonisation** through energy systems integration

The current rallying cry for sector integration is important to show the direction in which decarbonisation needs to move in the energy sector. On the other hand, visions that also factor in execution typically make for success in the long run. Hence, the aim of this short piece is to combine sector integration opportunities (the vision) with some of the dilemmas inherent to sound regulatory design (the execution).

Sector integration covers a wider context, not just electricity and gas, encompassing also heating & cooling, and extending into other sectors – buildings, transportation, industry, even agriculture. Here, we focus on the parts where energy regulators have most knowledge and experience: electricity and gas.

Building on what already works ...

European energy regulation has long promoted internal market integration and economic efficiency. Until now, it has been developed largely separately for electricity and gas, taking into consideration their inter-linkages but not in an integral framework. This approach made sense as long as the sectors functioned mostly independently, with energy flowing from gas to electricity but not the other way round. However, this is likely to change with a further growth in renewable electricity generation. Efficient solutions for long-distance energy transport, for tough-to-decarbonise industrial sectors and for seasonal storage of energy is where power-to-gas (or power-to-X) will play a decisive role. Thus, regulation needs to move from a primarily sectorial approach to a more integral energy or system-use approach.

So what might this mean for the integration between electricity and gas? And how to draw on the benefits of a fully integrated market?[1] In order to answer these questions in terms of regulatory design, three main elements can be distinguished: the design of a future hydrogen market, the incentives to promote the necessary investments to get there in an efficient way, and the regulatory treatment of the electricity – gas interfaces and energy flows.

Integrated markets, taking a cue from others ...

To start with the end in sight: sector integration will necessarily lead to significantly more storage installations, including power-to-gas installations producing (increasingly green) hydrogen. While the volume of a future hydrogen market is open for debate, the need for a sound regulatory framework for a European hydrogen market is beyond dispute. As long as hydrogen is blended into natural gas networks, there is no new market design question since it is simply treated as part of the current EU gas market. However, once we start to move to pure hydrogen networks we need to address that question. The current EU gas market design with its main elements unbundling and regulated third party access has proven to be very effective. From a market design perspective, it makes no difference if the molecules floating through pipes are methane or hydrogen; the

1 *See e.g. the political declaration of 11 May 2020 of the Pentalateral Energy Forum on the role of hydrogen to decarbonise the energy system in Europe; here hydrogen is foreseen "... to play a key role in an integrated future energy system in Europe based on sector coupling ...".*

same approach can be applied. Since the EU gas market design has brought significant benefits to EU consumers, it makes sense to take its best practices and lessons learnt as a starting point. To that, relevant experiences from electricity regulation can be added, such as how to deal with distributed generation and how to provide locational signals.

A necessary preceding issue is how to provide the regulatory incentives to construct such a market in an efficient way. The amount of hydrogen is expected to go up over time, while the amount of methane will likely go down. In the early stages, mainly industrial clusters will likely be served by hydrogen. With these projections in mind, it seems reasonable to assume that hydrogen and methane markets will coexist for some time. In fact, with the currently available double sets of pipelines in a number of important markets, they could even function side-by-side.

This raises new questions about the most appropriate regulatory design for such a transition period. First, repurposing of existing gas pipelines is often presented as one of the ways to accommodate the transportation of significant volumes of hydrogen. In such a set-up, a closer look at the regulatory asset base of the gas transmission system operators is needed to avoid end users paying twice for the repurposed assets that may already have been depreciated.

Second, given the uncertainty about the timing and scale of such future developments, as well as the likelihood about the decline of the gas market, a more flexible regulatory approach may be needed than what is currently applied to the gas market. Here, a look at EU's telecom regulation can be useful. The telecom framework has long needed to deal with potentially competing networks, namely copper, cable, optic fibre and mobile, with different set-ups in different geographical areas, which also changed over time. This regulatory framework requires the regulatory authority to perform a market analysis every 3-5 years in order to assess what kind of access regime is appropriate, with a consistency check at European level. This framework has proven robust throughout the significant changes the European telecom sector underwent over the last decade or more. For sure energy regulation could learn from that.

The approach to infrastructure becoming ever more important …

Specifically for energy infrastructure investment, the new possibilities offer more room for competition between various options to bring energy from production sites to consumption centres. Electricity

produced by offshore wind could be brought to consumers in the form of electricity, but this may require significant, and therefore expensive, reinforcements of the electricity network. Even cost-efficient electricity network enhancements may be constrained by planning limitations or local opposition. Besides, a high-voltage electricity line would carry maybe 1-2 GW of power, while many gas pipelines can easily transport 20-30 GW of power equivalent, providing larger economies of scale. This raises the question whether the conversion of some of the electricity produced to hydrogen and/or synthetic methane and then transporting it through (possibly already existing) gas pipelines could not be a more efficient alternative from a societal point of view, despite the energy conversion losses.

There is no universal answer to this question, and it will need to be assessed on a case-by-case basis taking into consideration scale, location and other factors that lead to system-wide effects. To compare "like with like", an integrated cost-benefit methodology will be needed to address the economic viability of the business case or to compare competing alternative business cases. Furthermore, the network development plans for both electricity and gas need to consider rather different feed-in locations than the traditional ones. The importance of "locational signals", known from power markets, to incentivise investments in those locations where they minimise overall energy system cost, will likely take on a new and important meaning in the context of sector integration.

Opportunities to codify the required ways and means for achieving the necessary changes exist in the foreseen revision of the TEN-E regulation. The range of such opportunities covers putting the right governance in place to ensure a neutral approach to the benefit of society, streamlining network plans and lists of projects, and developing integral cost-benefit analysis methodologies.

Don't ignore the tariffs …

Finally, with respect to the regulation of current interfaces between the electricity and gas systems, in particular the electricity tariffs and levies due by power-to-gas producers stand out. Since such producers are no regular end consumers of electricity, the current system may need a closer look. For starters, it would be advisable to see whether current tariff structures can be disaggregated, by identifying those system services that power-to-gas producers do not really rely on and thus may not necessarily need to contribute to, and setting separate tariff schedules for such cases.

Next to that, there may be opportunities to align more operational items between the two sectors, such as timeframes and capacity products, also with a view to balancing an energy system with more intermittent generation. Indeed, with increased power-to-gas installations, more aligned market operation rules would seem the way to go.

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To conclude, visions of a more integrated energy system are rapidly taking root in Europe. That is encouraging given the decarbonisation challenges at hand. Learning from current regulatory practices, looking at other regulated sectors for inspiration, adding a dosage or two of fresh thinking – and voila, the much-needed visionary thinking will more rapidly advance to the execution stage. It is our impression that most regulators are "*on the ball*", ready to support the vision and to start working on its implementation.

HERVÉ LAFFAYE
President of ENTSO-E

Electricity TSOs as key enablers of **smart sector connectivity** in Europe and beyond

The COVID 19 pandemic has once again underlined how crucial electricity security of supply is for our societies. We understood more than ever the importance of 'keeping the lights on'. Despite unprecedented circumstances, the transmission system operators for electricity, TSOs, have fulfilled their strategic responsibility of maintaining the security of operations of the power system - one of the most complex system ever build by mankind.

As unbundled, regulated entities TSOs fulfill their mission driven by the maximization of social welfare. They act locally but they also have a long and successful history of voluntary cooperation at regional and pan-European level, notably through ENTSO-E. Far from working in isolation, they are in close relations with a growing number of stakeholders and in particular distribution system operators and power exchanges.

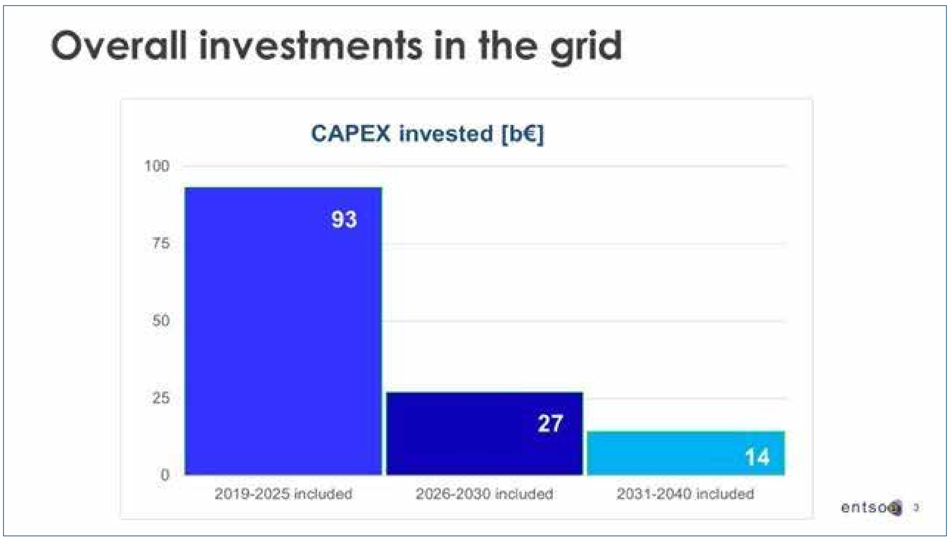
Under the Paris Agreement and with the objective of reaching climate neutrality by 2050, the role of electricity is going to become even more central. The future energy system is characterized by an **ever-increasing share of renewable energy** in the energy mix surpassing 80% and almost **doubling the electricity share** in final energy demand reaching up to 54%. The overall electricity demand is expected to rise from 3 200 TWh in 2025 up to 4 270 TWh by 2050. However, there will still be significant energy demand hard to electrify which has to be transformed to cleaner objectives.

In this future, as electricity becomes the dominant vector for clean energy, the **electricity grids and the associated system operation will be the central backbone.** They will be at the **interface** of the main evolutions to clean the energy sector by helping to connect all levels of the value chain:

- **Energy production/conversion**: Energy will be predominantly produced in the form of electricity (more than 60% of primary energy in 2050) complemented with significant contributions of other primary sources such as green gases, biomass, biofuels, etc. Given that multiple energy conversions result in high losses of energy, higher electrification of end usages, such as electric vehicles, heat pumps, etc, becomes first choice. Where electrification appears no longer cost-efficient (e.g. in aviation, specific industrial uses, etc.) carbon-free production of synthetic fuels through conversion (when available and competitive technologies are available) of electric power is one of the alternatives.

- **Energy transmission**: As wind and sun are first converted to electricity and each additional conversion to other energy carriers adds costs and losses, the grid is the most cost-efficient way to connect renewable energy sources. As the development of wind and sun generation implies a move to new geographical locations and an increase of transmission capacity due to their variability, an increase in grid investments is expected (for example offshore). The coupling to additional sectors will probably amplify these needs as shown in the next figure according to ENTSO-E TYNDP.

- **Energy trading**: In a future energy system characterized by low marginal costs, flexibility and system services become critical products and therefore energy markets need to eliminate distortions across sectors to enable a cost-efficient operation. Products derived from smart sector integration should only be defined as green when CO_2 savings in one sector doesn't lead to increase of CO_2 somewhere else.



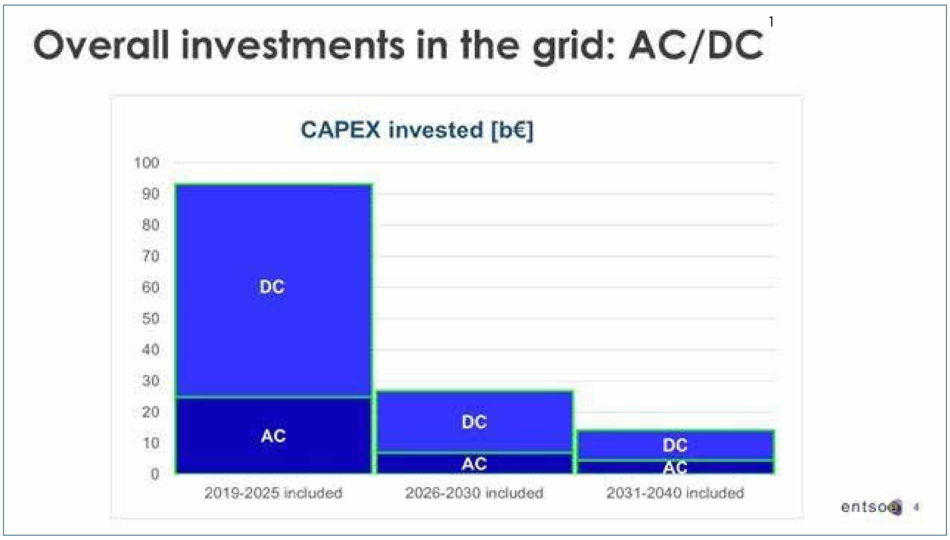
- **Energy consumption**: The high level of electrification in end demand is driven not only by electricity being the primary source of energy, but also by the higher efficiencies of the electric consumption by mature and available technologies (for instance electric vehicles or heat pumps). In addition, hybrid demand has the potential to further enable consumers to effectively participate in the cost-efficient operation of the energy system by providing demand side response capabilities, with an increasing share of the peak demand up to 25 % in some scenarios.

A paradigm shift is needed to enable such a smart sector integration:

- **Optimization of social welfare** should be applied at the design phase on the basis of holistic scenarios adopted at the European level with a neutral, inclusive, and transparent approach based on national and regional developments.
- **Technology neutrality**: Technologies such as power to hydrogen, power to methane, power to heat and power to liquids, as well as other technologies providing flexibility such as electro-mobility or batteries are complementary to each other and should be compared according to the value of the different services they provide.
- **Digitalization and new technologies** are game changers in terms of enhancing the potential of sector integration. Scaling up these technologies and stepping up R&D efforts are critical elements for proper implementation of innovations. For the electricity transmission assets, hybrid system is already on its way: with an increase of DC technologies coupled to the AC ones, and more generally with assets boosters using IT advanced technologies.

ENTSO-E and ENTSOG already cooperate on grid planning scenarios and modelling. But the needed sector interconnection goes far beyond just gas and electricity.

ENTSO-E member TSOs stand ready to be key facilitators for the future system of interconnected system with electricity as a main vector coordinating regionally, cooperating at European level, in close coordination with other sectors and stakeholders.



1 AC = alternate current; DC = direct current

JAN INGWERSEN
ENTSOG General Director

Energy Sector Integration – role and challenges for the existing and **future energy infrastructure**

As the old saying goes: a system is more than the sum of its parts, and that is certainly the case when it comes to the European energy system. A coordinated approach can result in a stronger energy system, building on both gas and electricity carriers' strengths. Combining our efforts will enable better efficiency and reliability, facilitate the meeting of the EU Green Deal commitments, and address the post COVID-19 recovery plan for a green economy.

As the debate further develops on how gas and electricity systems in particular can help the EU to meet its 2030 and 2050 climate and energy targets, ENTSOG (European Network of Transmission System Operators for Gas) recognises the changing landscape of the European energy market and consequently, the changing infrastructure needs for transporting increasing volumes of renewable, decarbonised and low-carbon gases, such as hydrogen and biomethane.

In ENTSOG's '2050 Roadmap for Gas Grids' – published in December 2019 – the European gas Transmission System operators (TSOs) make a number of recommendations on how to effectively combine well-functioning, liquid gas markets and established security of gas supply, with the commitment to reach decarbonisation goals. One of the recommendations specifically addresses the principles for sector coupling – that is, to allow for flexibility, storage options, cross-border transportation capacities and security of supply in a faster and more efficient way, whilst also meeting decarbonisation targets.

ENTSOG and ENTSO-E, as part of their Ten-Year Network Development Plans (TYNDPs) 2020, have jointly developed scenarios for the European energy sector up to 2050. This is the first important step to identify and assess the interlinkages and interactions between the gas and electricity systems. The TYNDP scenarios work is therefore paramount to deliver the best assessment of the infrastructure in a hybrid system. ENTSOG and ENTSO-E are also on concrete project basis further investigating the interaction between gas and electricity infrastructure projects.

In relation to the upcoming revision of the TEN-E Regulation ENTSOG suggests that for a cost-efficient decarbonisation, a coordinated and coherent interaction between electricity and gases is essential. Due to the intermittency of renewable energy, the power sector will need decarbonised gases to ensure security of supply and to reach climate neutrality. Power to Gas, for example, enables renewable energy supply in the form of hydrogen to be transported via gas grids to sectors difficult to electrify. This technology can help to alleviate local/regional congestion in electricity infrastructure, avoiding the curtailment of non-dispatchable renewable electricity. It would thus contribute to solving challenges in relation to balancing the power grid – for storage and flexibility. The challenge today is not that the individual technologies are not proven and ready, but that they need to be massively scaled-up in order to offer cost-effective climate benefits. We believe it is possible to realise the synergies between the existing gas and electricity infrastructures in evolving technologies.

ENTSOG believes that energy sector integration should be focussed on establishing mechanisms whereby energy sources and carriers are able to compete with one another on a level playing field - properly taking into account relevant 'externalities', and in particular CO_2 emissions. With this aim in mind, we consider that the establishment of a trustworthy EU-wide Guarantee of Origin scheme, which is fully recognised in the EU Emissions Trading Scheme (EU ETS) and which facilitates trade of certificates across energy carriers and across national borders, is essential in order to track and transfer climate value and ensure decarbonisation is achieved at the lowest possible cost.

On 23 June, ENTSOG will host a policy session titled 'Smart Sector Integration of gas and electricity infrastructure – opportunities and challenges in the context of the EU Green Deal', for European Commission's EU Sustainable Energy Week policy conference, along with GIE, ENTSO-E, Gas for Climate and GD4S. This session will not only address the integration of European gas and electricity sectors, but also the interlinkages and the interactions of the TSO and DSO infrastructures.

Since its foundation in 2009, ENTSOG, along with its Members, Observers and Associated Partners have helped to build a competitive and secure European gas market. In the next decade, ENTSOG will continue to contribute to the decarbonisation process, working not only on integration of the gas and electricity systems, but also on energy conversion technologies, and long-term energy scenarios. A progressively renewable and decarbonised EU gas market would promote competition/affordability, liquidity, transparency, and security of supply across EU to allow economic and environmental benefits to the end-users. We aim to continue to contribute to the discussions on the topic of energy system integration, now and into the future.

CHRISTIAN **BUCHEL**
Chair of E.DSO

From sector coupling to smart sector integration – DSOs serving as the backbone of an integrated and **intelligent energy system**

"Business as usual is no more. We will need to bounce forward and not bounce back."

Those words of Commission President Ursula von der Leyen encouraged us, the DSO Industry in Europe, to address our present and future challenges with new solutions and a new spirit. This is probably true for all economic sectors, but specifically for our industry which is positioned, by design as well as by regulation, to enable energy transition and customers' empowerment in the energy sector. The need to bounce forward is therefore much more needed.

In the wake of unprecedented challenges, including the economic and societal implications of COVID-19 and looming climate change, Europe is looking for new ways to build a sustainable, resilient and future-proof economy. With the new **MFF** and the **Next Generation EU**, we are looking at an economic recovery package that has the potential to contribute significantly to transform Europe's economy and put the "old continent" at the forefront of **global leadership in sustainability, digitalisation, green technology and innovation**.

There are currently several political construction sites to address this transformation and **smart sector integration** is a fashionable way, although a somewhat ambiguous one with several definitions, depending on who you ask. As an industry, E.DSO's members are not only able to provide a proper definition, they are currently experimenting what sector integration is.

Originally referring to the electrification of end-use sectors in order to increase the shares of renewables, **sector coupling** is a concrete strategy to broaden and include cross-vector interconnection of power, heat, and gas, thus the integration of their networks and the conversion of energy carriers into another. For us, a climate-aligned and cost-efficient decarbonisation is our main target. As distribution system operators, we connect both customers and decentralised renewable energy sources, facilitate exchanges between them especially at local scale to make the energy decarbonisation a common ground. The European regulation recognise our role of **natural proactive enablers**. Coping with flexibility on a local scale and alongside with territories and citizens is now possible thanks to the digitalisation of network and data transparency which are levers we develop with a fast pace.

Going further, **sectoral integration** refers to the integration of sectors across the energy system, e.g. of heating & cooling, industry, transport with the power sector to achieve EU decarbonisation targets. **Smart integration** refers to the need of ICT and AI layers towards this end. To make it a reality, the members of E.DSO massively invest in smart meters, ICT and AI layers in addition to classical grid investments,

Digital and energy infrastructures, modernised and reinforced by new investments and bold innovations, are key to make the development "new energy systems" possible. Combining the best of each lever: gas when there is no possible alternative, clean hydrogen for the optimised uses flexibility between heat, gas and electricity.

We, as the DSO industry, think that a regulation is needed to better coordinate and facilitate investments. We are also convinced, based on several demonstrators we developed all over Europe, that some principles of current regulations, especially on the tariff-structure, have to evolve quickly. Consequently, this will make the development of ICT and IA possible, which constitute another kind of asset different from the classical copper and transformers.

DSOs are ready to take up this role of **"System Integration Facilitators"** as part of their regulated business. Most importantly, this role must be clearly defined. At a very early stage of the crisis, E.DSO's members discussed what could be the contribution of DSOs to the European economic recovery. **Sector integration** is one of the key areas for DSOs to take an enabling role, as well as **investments into digital technologies, electro mobility networks and increased flexibility infrastructures.** And we are ready to take up these responsibilities.

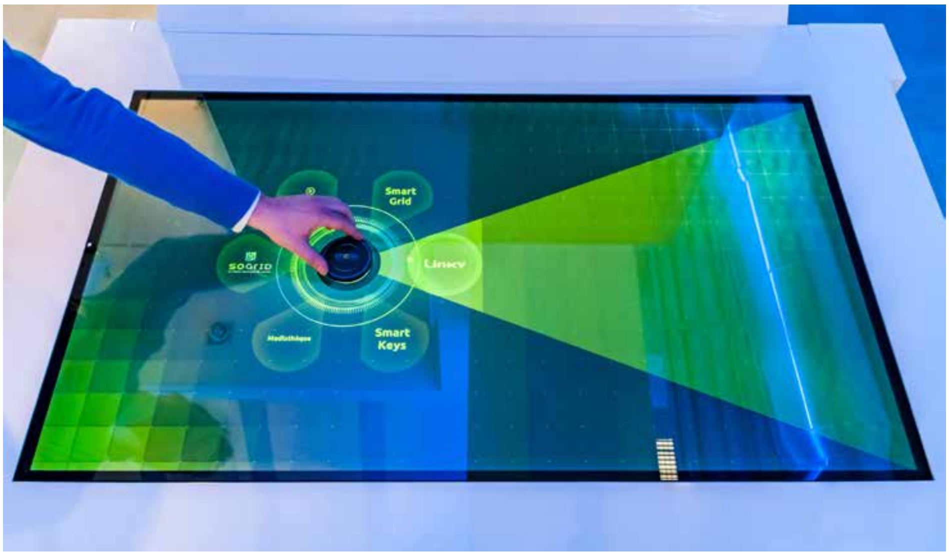
The local nature of DSOs, being spread across the municipalities, territories of all countries, means that our investments have an immediate impact on our communities and all stakeholders. Those **network investments equal EUR 27 billion annually**, but also **EUR 823,5 million in recent years for smart grid projects**, 70% of which private investments, making DSOs the largest investor in smart grid RD&I. Some of the key areas for us are **investments into digitalisation, rolling-out smart meters** and continuously investing into smartening our system, as well as **cybersecurity**.

As mentioned above, **digitalisation is the smart side of sector integration** as its enabling component. Digitalisation along with the cost-efficient development of physical networks provides an increased visibility over the infrastructure and a necessary tool to facilitate system coordination.

Digitalisation is a cultural move and a great opportunity for the European citizens if trust is there. As DSOs, our duty and responsibility is to provide customers, cities and market players with secured and certified energy data. These data, provided by the neutral enablers we are by design and regulation, are also **key sources to lever energy efficiency of buildings** and contributing to the **EU Renovation Wave**. In this field, also **coupling cross-sectoral data** will bring benefits to consumers and enhance their active participation to the energy transition. Some of our members, in the Netherlands or France among others, have created cross-sectoral data platforms.

E.DSO and all our members, legally unbundled, irrespective of their size or their ownership, are strongly committed to bring our strong and ambitious contribution to move Europe forward. Only a collective move can face the impressive upcoming challenges.

Our understanding, and I would say our hope, is that the EU's announced policies and legislative proposals are ambitious and strongly driven by a willingness to act concretely. The EU can rely on us, European DSOs, as key component of this ambition, for instance, by facilitating a smart sector integration and to make it a European success story.



Power-to-gas – a system's perspective

DR. KLAUS KLEINEKORTE

Chief Technical Officer
Amprion GmbH

Limiting global warming is key to mitigate climate change. However, this can only be achieved by reducing our greenhouse gas emissions and ultimately becoming carbon-neutral. That in turn requires a radical transformation of our energy system.

One essential cornerstone within this context is the smart integration of a hydrogen system into our overall energy system. Hydrogen is the promising energy carrier due to its ability to decarbonise applications that cannot be electrified directly (e.g. furnaces or chemical processes). In that regard, we need to identify how to maximise the CO_2-reducing effect of this new system, while minimising the cost to the European economies at large. However, an inappropriately designed hydrogen system can even increase an economy's greenhouse gas emissions.

If the European transformation proves its success in practice, the concept will contribute to the achievement of global climate goals. This will keep Europe at the forefront of the global energy transition. Henceforth, what do we need to accomplish?

Introducing a hydrogen system is not an end in itself.

First, we have to recognise that the goal of implementing a hydrogen system is necessarily subordinated to the overarching objective of decarbonising the European economy. If planned appropriately, the system can play a key role in bridging industrial production and climate protection. In fact, renewable energy sources (RES) will have to replace the use of fossil energy sources and feedstock in all sectors. Therefore, the introduction of a hydrogen system will only make any sense at all if the capacity of RES is consistently expanded.

From a systemic point of view, electricity which is suitable for use in electrolysers cannot be directly integrated into the electricity system. This can happen for two reasons: (A) there are no recipients for green electricity in the electricity system; (B) the electricity cannot be transported to users for technical reasons. At any given time, a decision needs to be made about the use to which green electricity should be put, in order to achieve the greatest decarbonisation efficiency – we refer to this concept as an electricity-gas switch. Applying this principle, an electrolyser can replace a conventional steam reformer, thereby decreasing the system's CO_2 emissions.

A kilowatt hour of hydrogen produced by using fossil-fuelled electricity in an electrolyser would result in at least twice as much greenhouse gas emissions compared to the alternative. We therefore always need to evaluate the effect on the entire energy system in consideration of substitution chains for both conventional and new technologies.

Conversion of infrastructure and end applications comes first.

A transformation pathway needs to be found that links the current separate transport systems for electricity and gas. Partially retrofitting today's gas infrastructure from natural gas to hydrogen will be beneficial: reducing the impact on the natural environment and on the population will boost social acceptance of the steps necessary for the energy transition. This transformation pathway has to be economically efficient and should reduce CO_2 emissions at every stage of the way. Therefore, the potential of electrolysis is limited at the beginning. Beyond 2030, we will need system-serving electrolysers in the gigawatt class. This technology is not yet available, so a technological ramp-up and therefore initial projects are required now.

Additionally, converting the natural gas infrastructure to the transport of pure hydrogen must begin at an early stage. This will be essential to enable CO_2-intensive industries to be capable of decarbonisation at all. In the transformation phase, already existing steam reformers should be connected to the hydrogen infrastructure and be used as hydrogen sources. In this way a hydrogen market can be established. Decarbonisation itself can then take place in sync with the expansion of RES and electrolysis, additionally with the import of green energy. Nothing else is currently happening in the electricity system. This approach should also be applied to the hydrogen system.

Converting end applications is as time-consuming as converting infrastructure, on account of long investment cycles. That is why end applications, like furnaces or chemical processes, need to be made H_2-ready or converted to using hydrogen as soon as possible. The transition will also provide an opportunity for industries to face their own decarbonisation and therefore survival.

Gradually, the system's capacity of electrolysis and storage increase.

The expansion of RES will steadily increase the quantity of suitable green electricity. At the same time, flexible technologies will be integrated into the electricity system. One of these is electrolysis that couples the electricity and gas systems. Subsequently, the gas system needs to become flexible because of the inalterable hydrogen supply from electrolysis. In analogy to the electricity system, conventional production and storage facilities are able to disengage energy demand and supply. As long as hydrogen demand exceeds the supply of green hydrogen, steam methane reforming can ensure security of supply within the gas system. Therefore, and in contrast to the past, steam reformers need to be operated variably and system-oriented – equivalent to conventional power plants within the energy sector. As the amount of green hydrogen in the energy system increases, steam reformers can gradually be shut down.

CLAIRE WAYSAND
Interim CEO ENGIE

For a **carbon neutral** and resilient energy system, the EU must take advantage of all its assets

The necessity to help relaunch the economy in face of the COVID 19 sanitary crisis provides a unique opportunity to set a path for Europe that is consistent with its objective to become the first climate-neutral continent by 2050. ENGIE supports this unprecedented ambition and is committed to continuing to fully play its part, fostering energy efficiency gains and greening its supply of energy.

The path towards carbon neutrality brings along significant opportunities for our economies, but also challenges. **The European economy has to decarbonize at the lowest possible cost for both consumers and companies, while ensuring security of supply which is vital for growth and prosperity in Europe**. Relaunch programs at national and EU levels are a unique opportunity to reconcile economic recovery with an acceleration of investments in decarbonization. And given the strain on public finances, it is more necessary than ever to use these massive financial means in the most sustainable, effective and efficient way.

Sector integration is in ENGIE's DNA

ENGIE's activities are quite diversified, comprising different energy carriers and end-use sectors. We clearly share the interest expressed by the European Commission in creating an integrated energy system that is optimized as a whole – instead of taking a separate, "vertical" view on energy generation, transmission, distribution and end-user supply for each energy carrier. Our key activities include the production of low-carbon electricity notably from renewable sources, the distribution, transport and storage of gas; we invest in district energy systems and provide integrated solutions around energy efficiency, mobility services and onsite generation to our customers. **Our target is to increase, by 2030, the share of renewable in our power generation mix to 58% and we have great ambitions in the development of renewable gases, primarily biomethane and green hydrogen.** In France, where we are number 1 in wind and solar, we committed to invest 800 million EUR in the coming years with our partners to develop biomethane, and this investment could be stepped up to 2 billion EUR by 2030. We are moreover involved in several flagship projects around green hydrogen, for instance the "HyNetherlands", "HyGreen" and "MassHylia" projects.

Decarbonization through electrification requires an appropriate market design

Electrification is a "no-brainer" in many circumstances. Public support and enabling regulatory frameworks have led to impressive cost reduction of wind and solar over the past years. Renewable generation today makes an important contribution to an increasingly decarbonized power mix. And this opens opportunities to decarbonize end-uses such as passenger cars, light commercial vehicles, parts of the heating sector, by electrifying them. However, wind and solar generations are intermittent by nature, requiring flexibility and back-up solutions to keep the power system in balance and ensure security of supply – especially during longer periods of "Dunkelflaute", when wind and solar power generation is unavailable. To encourage investment in such solutions and avoid that existing assets are decommissioned prematurely, **we need an appropriate market design which provides long-term signals to investors**. Notably, in addition to energy markets we also need market mechanisms for firm capacity and (local) flexibility mechanisms.

Gaseous energy carriers make electrification through renewables possible

Already today, gas plays a key role to integrate variable renewables in the power system. **Gas-fired power stations ("gas-to-power") provide capacity and flexibility** and their role will very likely increase in the future in the context of coal phase-out decisions. We expect that even in 2050, a significant CCGT fleet will still be needed. This fleet will

ENGIE biomethane project in France which valorizes 30 000 tons per year of agricultural and agro-food by-products. This represents a production of 22GWh/year of biomethane, which is equivalent to the annual gas consumption of around 1800 households.

operate on decarbonized gases. **"Power-to gas" will be a key technology for sector coupling and integration**. It will complement batteries, pumped storage, demand response as it has the unique advantage of providing long-term, seasonal storage of renewable energy by making use of existing gas infrastructures. **E-methane** produced from excess wind and solar, can be injected in gas pipelines and storage facilities and can either be consumed in gaseous form or converted back to electricity. In France, gas storage capacity is sufficient to store 133 TWh of energy which represents 1500 times the energy storage volume of existing electricity storage. **Hydrogen** can be blended in gas networks to a limited extent in a first phase of development. With increasing volumes, we could then see **the creation of more and more dedicated hydrogen networks, for instance by converting existing gas pipelines**.

The situation in Germany is an example where sector coupling through power-to-gas could help to deal with network congestions which lead already today to significant curtailment of renewable power production (6,5 TWh in 2019). Power network capacity is insufficient to transport renewable energy generated by wind farms in the North of the country to consumption centers in the South. The need for power network expansion and related cost and acceptance issues could be significantly mitigated by making use of the North-South gas network capacity which makes up around 75 GWh/h compared to a North-South power network capacity of only 1/4th.

Natural gas is a transition energy that helps decarbonization, and will progressively become greener

It is worth reminding that **natural gas makes up a significant part of energy consumption today, thanks on a well-developed, pan-European gas infrastructure, with excellent cross-border links**. This infrastructure is based mainly on underground facilities with minor impact on environment, land use and landscape.

Natural gas has an important decarbonization potential in the short term by replacing more carbon-intensive and polluting fuels such as coal and oil in power, heating and transport. It should clearly be recognized as a transition energy : replacing a coal plant by a new CCGT running on natural gas reduces greenhouse gas emissions by more than 50%. Not using such an immediate decarbonization potential would lock for longer periods of times carbon intensive countries into the coal option. In the transport sector, greenhouse gas emission savings of up to 23% can be achieved by switching to gas vehicles. These significant "quick wins" will be reinforced over time thanks to a growing share of renewable and decarbonized gas.

Let's set the course for the future development of renewable and decarbonized gases

Renewable and decarbonized gases such as biomethane, renewable and decarbonized hydrogen or e-methane, are emerging technologies and still **at the beginning of a learning curve which promises substantial cost reductions**. To achieve these, we need to scale up capacities. This requires the creation of a favorable regulatory framework and financial incentives – just as it has been provided for renewable power years ago. We also need to find a way to reward the positive externalities of biomethane production (like contribution to employment in rural areas, creation of biological fertilizers, treatment of waste)**. Players along the value chain need long-term visibility through a binding European target for green gases** which enables Member States to be free to develop their own strategies and define their contributions to this target. A robust and sustained CO_2 price signal across sectors and energy carriers is paramount to provide the right signals to operators and consumers. Moreover, national support mechanisms, EU Funds and possibly also sector-specific objectives will help reaching this target. A dedicated approach for green hydrogen might be necessary, due to its lack of maturity and specific virtues, while blue hydrogen will be needed as well, at least during a transition period. Finally, a market has to be created based on an EU-wide classification of renewable and decarbonized gases and interoperable Guarantee of Origin schemes.

Tractebel Engie Platform model containing a complete plant for the industrial production of CO_2-neutral "green" hydrogen from offshore wind energy

District energy systems as a showcase of circular economy and sector integration on local level

A more sustainable energy system is also more circular. District energy systems play a key role in this regard as they are re-using waste or excess heat, such as heat from power plants, industrial process or waste incineration. But the benefits of district energy systems go beyond capturing and utilizing waste heat. Making use of a wide range of energy sources and technologies (including also bioenergy/biogas, solar, geothermal, etc.), district energy systems connect the dots between local resources and local demand, thus strengthening the local economy. They can play a key role in decarbonizing heating and cooling, enabling high levels of energy efficiency, integrating intermittent renewables in the system and capitalizing on sector coupling. Such systems are particularly efficient and competitive when deployed within dense areas, making them major levers to reduce the carbon footprint of cities.

Complementarity is key

In addition to energy efficiency in order to consume less energy, electrification and the use of renewable and decarbonized gases are complementary solutions to ensure a competitive decarbonization, together with further solutions such as local energy systems. Many studies, covering western Europe and specifically Germany, have demonstrated that a multi-energy carrier approach will ensure the most resilient and cost-effective transition to carbon-neutrality, avoiding the enormous risks which would come along with a strategy of "putting all eggs in one basket". Massive investment is needed to achieve our targets and for this to happen. A clear and realistic taxonomy, which recognizes the need for a transition and takes a broad view on the complementarity of various decarbonization solutions, would provide investors with the right incentives.

Batteries are closing the loop of **Europe's climate** and industrial leadership

DIEGO PAVÍA

Chief Executive Officer of EIT InnoEnergy

Batteries are the crux to achieve Europe's climate-neutrality, providing the flexibility needed to operate an energy system largely based on renewables, decarbonising road transport, while capturing a sizeable market and creating millions of jobs for Europeans.

Flexibility: the cornerstone of a renewable-based society

The unrivalled ambition of the European Union, to reach climate-neutrality by 2050, goes much beyond climate and environment. It is the new growth strategy of the Union, and embeds a strong transformative power, in all the sectors of our economy and areas of our lives. Although there is not a single way to become climate-neutral, the destination is unquestionable. On this journey, there are two main drivers for the energy system: **to reduce our energy consumption and to decarbonise all our energy carriers**. In this perspective, the EU coined the "efficiency first" principle in the Clean Energy Package, and the long-term strategy published in November 2018 puts renewables at the centre, with around 80% of the electrons produced from renewable energy sources in 2050.

The rise of renewable energy sources in the power sector has been facilitated by a dramatic cost reduction of the various technologies (-82% for PV, -39% for onshore wind and -29% for offshore wind over the period 2010-2019 according to IRENA). With the accelerating penetration of renewables comes the imperative to shift the way the system operates to accommodate this variable generation. The gradual liberalisation of the power system combined with the rising penetration of small scale non-dispatchable generation assets imposes to shift to a system where the demand will increasingly have to accommodate the supply, **and where flexibility will become critical.**

This profound transformation implies to shift from a system limited in stock but almost unconstrained in flow, to a system limited in flow but unlimited in stock. Hence**, to make up for the loss of the storage function that was inherent to fossil fuels, "synthetic" storage like batteries must be developed**.

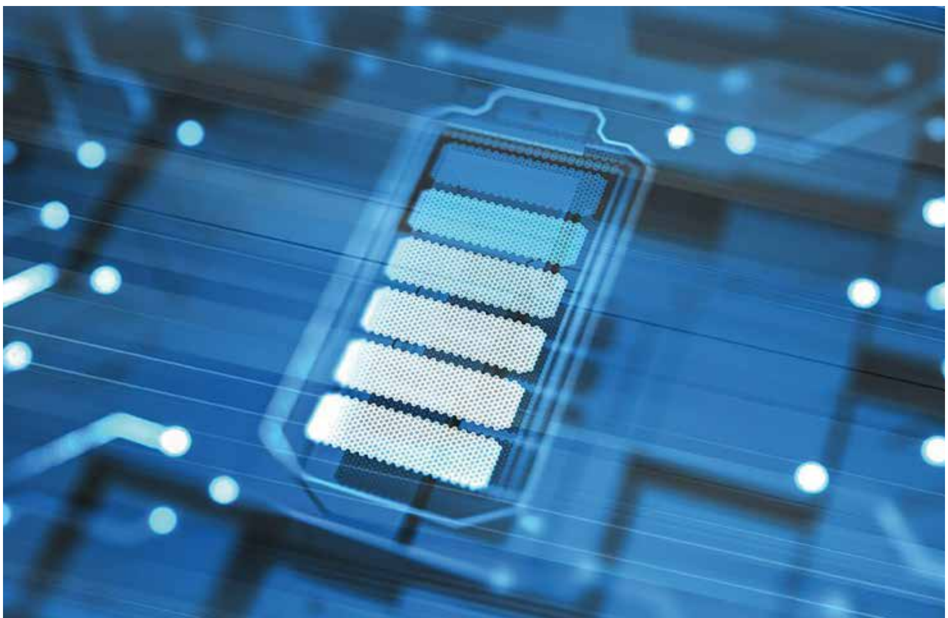
Transport: a belated decarbonisation

On the way to climate-neutrality, all sectors of the economy will have to decarbonise. A special attention has to be dedicated to transport for two reasons. Firstly, looking back at past emissions per sector in the EU-27 between 1990 and 2018[1], we realise that transport is the outlier, with an increase by 23.1% of the emissions over the period, compared with a reduction by 28.9% from electricity and heat generation, or with a reduction by 38.9% for manufacturing industries and construction. **Despite the increasingly tight EU legislation on CO2 standards for vehicles, tangible improvement is yet to materialise.** Secondly, road transport (which represents 93% of transport excluding international aviation) is based at 94% on oil of which 96% are imported in the EU-27. The urgency to move away from fossil fuel in transport is thus not only a climate and environmental concern, but also **an imperative for trade, resilience and strategic autonomy of Europe**.

Fortunately, electric powertrains are rapidly penetrating the automotive industry, mainly with Battery Electric Vehicles (BEV) in Europe while some other regions are promoting Fuel Cell Electric Vehicles (FCEV). In both cases, this electrification of transport is part of a climate-neutral future provided that the corresponding energy carrier is produced in a GHG-free manner. Given the comparison between the overall efficiency[2] of a BEV (77%) and of a FCEV (30%) and recalling that "efficiency first" should be a guiding principle of

1 The figures in this paragraph comes from the EEA and Eurostat.

2 According to T&E



our energy and climate policies, **promoting BEV for the applications where the range is not a critical element is a no brainer**. Besides, despite the additional emissions related to the manufacturing of the battery, the entire lifecycle emissions of a BEV in any of the countries of the EU-27 is at least 29% lower than for a comparable diesel or petrol car[3]. As a consequence, **there is little doubt about the merit of BEV to decarbonise road transport in Europe**.

Looking at BEV as electricity storage on wheels, the rising penetration of BEVs can contribute to accommodate the penetration of renewables and provide the synthetic storage missing to intermittent renewables: **electrification of road transport is an essential piece of the Energy Systems Integration**. This implies a systemic transformation, including the rapid adoption of smart charging and Vehicle to Grid solutions[4], the continuous upgrade of power grids and the deployment of a dense charging infrastructure (around 20 Bn€ by 2030 in public charging infrastructure), and first and foremost, an acceleration of the manufacturing capacity of electric powertrains and of batteries in Europe.

Battery: a strategic imperative

The automotive industry represents 13.8 million jobs in Europe including 2.6 million of direct jobs in manufacturing of motor vehicles (up to 42% of manufacturing employment in Bratislava), and exhibits a positive trade balance of more than 80 Bn€. The prompt alignment of this industry with a climate-neutral pathway is thus a clear socio-economic imperative. Some European manufacturers have already initiated an irreversible transformation towards electric powertrains: while in 2017-2018 China had invested 7 times as much as Europe in e-mobility with 21.7 Bn€, in 2019 this was reversed as **60 Bn€ have been committed in Europe, more than 3 times as much as in China**[5].

A battery cell is not a commodity: the performance not only depends on the type of cell, as the quality of the manufacturing process and of the advanced materials employed could also impact the use. On top of that, the safety concerns impose to Original Equipment Manufacturers to have an unwavering trust in their suppliers. For this reason, cells cannot easily be sourced anywhere as commodities.

3 For further detail, the reader can consult the explanatory note of T&E online

4 According to IEA Global EV Outlook 2020, V2G could provide in the range of 163 GW of peak capacity by 2030.

5 More information in T&E's report.

Besides for BEVs, the battery itself could represent 35% to 50% of the cost structure of the vehicle, creating a clear incentive for manufacturers to have, at least, a geographical proximity with their cells' suppliers. **There is thus no doubt about the strategic imperative to accelerate the development of domestic manufacturing capacities of sustainable batteries in Europe**.

Besides, the plummeting cost of this storage solution (-13% in 2019 and -87% from 2010-2019, on the way to be below 100$/kWh for a battery pack in 2024, and around 61$/kWh in 2030[6]) opens new avenues beyond mobility, like in utility-scale storage for ancillary services, or innovative business models involving behind-the-meter storage.

European batteries: a one-off opportunity for Europe's green and resilient recovery

The European Battery Alliance launched in 2017 by Vice-President Šefčovič should keep leading the way of the EU industrial policy. It has demonstrated its merit in federating the industrial ecosystem along the entire battery value chain and in shifting our mindset regarding our capacity to compete on the global stage, relying on our unique competitive edge. **We are now starting to think at the scale of the continent**.

The recovery must be the occasion to gear up this process, from lab to large-scale deployment to build our industrial competitiveness while developing our future leadership in new technologies. The Union should rapidly mobilise its existing instruments, such as Horizon Europe and notably the EIC and the relevant KICs for start-ups and scale-ups, the Innovation Fund, and the Connecting Europe

6 According to the BNEF EVO 2020

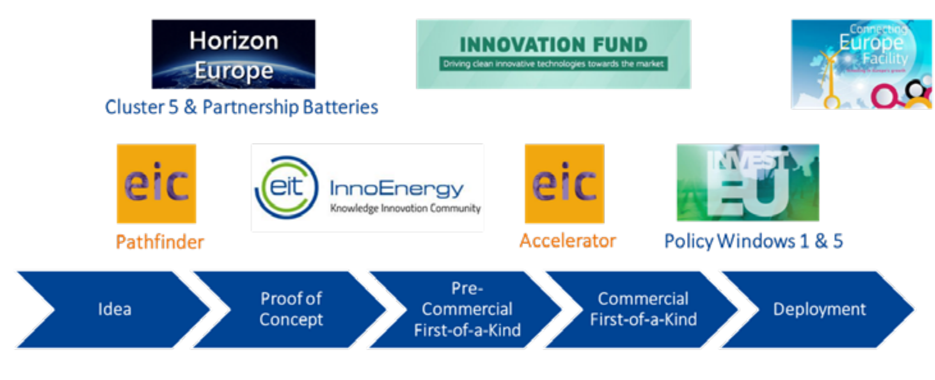
Facility for the charging infrastructure. Beyond that, the new policy window of InvestEU for Strategic European Investment will be essential to **unleash private investments contributing to build the 420 GWh of battery manufacturing capacities** representing around **15 gigafactories** needed to meet the European demand by 2030.

Member States could also power this transformation with the Recovery and Resilience Facility, including through reskilling, infrastructure and scrappage schemes. In these times of economic recovery, on top of safeguarding and upgrading most of the employment in the automotive industry[7], the Union could create one million jobs in the European Battery ecosystem **worth 210 Bn€ by the end of 2022**.

The Union must unlock this tremendous value creation contributing to a green and resilient recovery and delivering jobs for Europeans. This is a moment of truth for Europe and for our green industry.

7 According to IEA, 0.5 million jobs in direct manufacturing are at risk in the automotive industry in Europe due to the crisis

Main European Instruments Supporting the European Battery Ecosystem



Source: EIT InnoEnergy

THIERRY **TROUVÉ**
CEO of GRTgaz

Energy System Integration: What role for gas infrastructure and **renewable** and **low carbon** gases?

Europe is placing the Green Deal at the core of a major recovery plan with the ambition to restore and rebuild but also to invest to prepare a more resilient, more sustainable and fair future.

Achieving this ambition triggers many challenges for the society in all of its dimensions and the Green Deal is built with the prospect of implementing a holistic approach ensuring a full contribution from all sectors. While these challenges are even more exacerbated by the recent crisis stemming from the Covid-19 pandemic, it also unveiled the critical role played by several sectors such as agriculture, industry and energy in the functioning of the society. The forthcomings energy system integration strategy and hydrogen strategy of the European Commission are expected to deliver on this holistic approach. GRTgaz is convinced that the gas infrastructure will be a key enabler of a deep decarbonisation of the energy system and some of the most high-emitting sectors. Gas infrastructure allows to integrate more renewable energy sources into the energy system while maintaining a high level of flexibility and security. In this respect, renewable and low carbon gases will play, together with electricity, a critical role to reach the EU's decarbonisation and energy transition objectives in a smart and cost-efficient way.

Energy System integration: two sides of the same coin

Energy System integration entails two dimensions that need to be considered in a comprehensive way. On the one hand, the integration of networks or sector coupling which raises the question of optimised management of electricity and gas infrastructure. On the other hand, the sectoral integration underpinned by a concerted management of different sectors (mobility, industry, agriculture, waste, etc.) that raises questions regarding which energy sources and vectors are best suited to facilitate the decarbonisation of the various sectors implicated.

Gas infrastructure, across Europe, is already well developed. The history of European gas supply, based almost exclusively on imports, has led to the development of major trans-European corridors offering large capacities for energy transportation. To manage seasonal and daily flexibility of consumption without oversizing the networks, large storage capacities have been developed near consumption zones. Electricity infrastructure has been developed on a very different model, based essentially on facilitating national production, resulting in much lower interconnection capacities than gas grids. The growing integration of renewable electricity is thus challenging for the power system: congestion on the large transport and distribution networks (eg. SüdLink in Germany), increased flexibility needs as production methods and uses are evolving, absence of an electrical technical solution for seasonal flexibility, and long lead times. A concerted approach to the development of the two infrastructures - a hybrid energy system - is likely to optimize the costs of developing networks and integrating renewable energies. Numerous studies highlight the cost-effectiveness of a substantial role for gases alongside electricity in the transition, such as the study commissioned by the Gas For Climate consortium which indicates a cost difference of ca. €215 billion/annum between an optimised gas and a minimum gas scenario. Major investments have already been done into the European gas network with a view to ensure the security of supply making it resilient and strong enough to fully play a part in the transition as a connecter between energy carriers and sectors.

In France, the recent case of the Landivisiau power station exemplifies the benefits of this approach. The concerted analysis by the electricity and gas transmission system operators (TSOs), under the umbrella of the French Energy Regulator (CRE), made it possible to identify the strengthening of the gas network in Brittany as the most economically efficient technical solution, compared to the construction of a new electricity power line.

In the future, Power-to-Gas (P2G) could constitute a solution for managing excess electricity, produced by renewables and/or nuclear. With the massive development of renewable electricity and the reinforced push in favour of the electrification of certain variable uses over the year, it could constitute a flexible solution in the long term. Last February, our project Jupiter 1000, the first French power-to-gas demonstrator at industrial scale, injected its first hydrogen molecules in the grid.

Renewable and low carbon gases in sectoral integration

Developing the biomethane industry in France is a low hanging fruit considering the importance of Agriculture and Forestry sectors domestically. In addition to its economic benefits for the agricultural sector, biomethane perfectly illustrates sectoral integration. Biomethane can decarbonise the grid, reduce our reliance on imports while also contributing to the circular economy: reduction in chemicals used on farmland for fertiliser, providing an additional source of income for farmers, and improved waste management. Gas grids are ready today to transport large quantities of biomethane. Very limited adaptations of the network are required, such as the development of reverse flows from distribution grid to transmission grids to maximise biomethane injection.

Anaerobic digestion is today a mature process in France, with more than 139 biogas plants currently injecting biomethane into the gas grids, this represents over 2,5 TWh of capacity. We expect a strong growth in the coming years: more than 1100 projects are in the portfolio representing 25,1 TWh of capacity. Other technologies such as thermal gasification allow to convert waste (wood industry, solid recovered fuels) which would not fit into more traditional management channels.

Clean hydrogen is also poised to play a central role in reaching the Green Deal objectives, with a contribution that will probably not solely be limited to decarbonisation of hard-to-abate sectors. While production of clean hydrogen is expected to develop in industrial clusters in the short term, its deployment at large scale depends to a great extent on the availability of an adequate infrastructure, to transport, distribute and store large quantities of hydrogen, connecting production areas to consumption as illustrated by 2*40GW initiative from Hydrogen Europe. Europe can actually re-use its well-developed gas infrastructure and convert part of it at reasonable cost to accommodate hydrogen. Such hydrogen backbone would allow to transport across Europe large amount of renewable H2, produced from solar and wind as well as low carbon hydrogen produced from fossil fuels combined with carbon storage solution, at a cost 10 times smaller than electricity transport.

For this purpose, French gas operators have established a roadmap for preparing stakeholders to accommodate hydrogen into the French energy mix and established technical and economic conditions for injecting hydrogen into natural French gas networks. GRTgaz is also working with Creos Germany on the *MosaHyc* project aiming at the conversion of an existing gas infrastructure to pure hydrogen. *Mosahyc* would make it possible to develop a hydrogen valley between Saarland Luxembourg and France fostering clean hydrogen in mobility and transport as well as for industrial applications. GRTgaz is also preparing its infrastructure to be "hydrogen ready" through several R&D initiatives such as *Fenhyx*, a R&D open platform for the futureproofing of grids and equipment in cooperation with the German TSO ONTRAS, and *Hyblock Coating*, aiming to develop an exclusive surface treatment for steel pipelines to protect them from impacts of hydrogen.

Leveraging the experience from biomethane development in France, some basic features can foster the uptake of clean hydrogen and other clean gases at European level. A science based taxonomy of renewable and low carbon gases and EU wide system for guarantees of origins would give legal clarity and visibility to consumer. Incentives to stimulate market development including quotas/targets, dedicated programs and support schemes will also ensure that technologies that are promising today reach maturity soon enough to fully contribute to the transition. Above all, an inclusive approach comprising all production technologies, and the adoption of a life cycle analysis for the calculation of the CO2 content are central to reap the full benefits they offer. For infrastructure operators to support and play their part in the transition will require a flexible and forward looking legislation. In this context, it seems relevant to explore an easing of some unbundling rules to allow them to engage in the development and operation of bioGNV refuelling stations, development and operation of biogas collection networks with a view to pooling its injection into the transport networks and achieving economies of scale. Scaling up hydrogen and paving the way for a liquid hydrogen market require a transparent and non-discriminatory access to the infrastructure operated and rules that should be inspired from the best practises and lessons learnt from electricity and gas.

We are at the very beginning of an exciting journey to shape a future integrated energy system that places Europe on a sustainable, inclusive and cost efficient path towards carbon neutrality. European Gas infrastructure is a strategic asset and it should continue to be considered has such. Spurred by research and development, new energy solutions and technologies are evolving rapidly. We at GRTgaz are already embracing this new reality. We see ourselves at the heart of the energy transition and key enablers of the future energy system. Now more than ever, we are both ready and committed to putting our infrastructure to good use in service of the energy transition.

JENS GEIER

MEP (S&D Group), Member of the ITRE Committee

Integration of the **energy** and industrial sectors: Speeding up the transition towards a **low-carbon economy**

Climate change is an imminent threat to our society, economy and environment. It is our duty as politicians to lead the fight against this threat in order to save our planet and our society. As socialists and democrats, we therefore welcome the Paris Agreement, the European climate goals and especially the target to become the first climate-neutral continent until 2050. We also believe that it is our responsibility to leave no-one behind in this transition to carbon-neutrality. This claim has become even stronger during the COVID-19 crisis, as we will now need a fresh start for our society and economy. We should seize this opportunity to recover in a sustainable and future-proof way.

In order to achieve these goals, we need an energy transition moving away from the use of fossil fuels towards the use of renewable energies. We further need to decarbonise other important emitting sectors like the industry sector. The decarbonisation of the energy and industry sectors will not only contribute significantly to a reduction in greenhouse gas emissions, but it will also allow us to make these sustainable in terms of employment and competitiveness.

I am convinced that the energy and industry transitions are inextricably linked. We cannot look at these separately, but need to ensure that they are mutually reinforcing and beneficial. Especially now, that COVID-19 has slowed down the transition in the energy and industry sectors and the European solar and wind market is expected to decrease by 20-33% this year, we need to find effective means to get back on track, and fast! This is where sector integration, i.e. the integration of the energy and industrial sectors, comes into play. The use of renewable energy through direct and indirect electrification in industrial processes through, for example, electric furnaces and the use of renewable energy carriers like hydrogen, can help industry to decarbonise. For this, industry needs significant amounts of renewable energy. Hence, the faster the energy transition goes forward, the faster industrial decarbonisation is possible. At the same time, I believe that industry can speed up the energy transition and decrease its cost by increasing demand and new markets for renewable energy. Through demand-response, it can also help to stabilise the electricity grid that has to deal with increasing intermittency. Industry can for example offer flexible consumption of energy through flexible production processes or feed electricity and waste heat back into the grid.

At the European level, the sector integration between energy and industry has only recently started to gain the attention it deserves. For too long the transitions of both sectors have been looked at separately. Now the time has come to break the silos and to address both transitions together.

In this respect, I welcome the planned Energy System Integration Strategy and the references to sector integration in the New Industrial Strategy for Europe. It is indeed true that industry needs sufficient, affordable and secure energy for its transition to make it a viable business case. We need to step up the deployment of and investments in renewable energies. We also need sufficient sources of green hydrogen in order to make the industrial decarbonisation possible and affordable. We should start to think about an import strategy for these renewable energy carriers, as industry will advance to the biggest energy consumer. It will increase its energy demand through direct and indirect electrification to an extent that will be impossible to satisfy solely through domestic production. Furthermore, we need to address missing energy infrastructure. Grids need to be better interconnected. We also need to find answers to the following questions: Which infrastructure do we need to make large amounts of hydrogen available to industry? To what extent can we use the existing gas infrastructure?

The announced offshore strategy, the review of the TEN-E Regulation to support renewable infrastructure, the Fuel Cells and Hydrogen Joint Undertaking and the European Hydrogen Alliance are important steps in the right direction. With the European recovery plan, the Commission has further announced an upgrade of the InvestEU programme and its additional enhancement through the Strategic Investment Facility to accelerate the deployment of renewables, energy storage, energy infrastructure, hydrogen and low-CO_2 emission industries. Even though this is a promising proposal, the Commission could have seized the opportunity of the recovery plan to propose more concrete measures for a more sustainable and climate-neutral pathway because more remains to be done:

- Taxes and levies on the industrial consumption of renewable energy should be minimised to incentivize the industrial transition to clean production processes. Subsidies for fossil fuels need to be abolished. An industrial electricity price should be considered.

We cannot expect the industry to make a transition as long as the use of fossil fuels instead of electricity from renewables is financially more attractive.

In order to make sector integration possible from the industry side, we need to step up investments, research and development in clean production technologies and demand-response mechanisms in order to make clean solutions available and affordable to industry. Affordability is crucial in order for industry to remain competitive and to maintain its current level of employment. Important Projects of Common European Interests (IPCEIs) can play a significant role. I am looking forward to the revision of the state-aid rules in 2021 and I hope that this revision will clarify the conditions for IPCEIs, including for industry and energy transition projects. Furthermore, the EU Strategy for Clean Steel and Chemicals announced by the Commission should address sector integration. In addition, flexible production processes and the feeding in of heat and electricity back into the grid for grid stabilisation purposes need to become financially attractive to industry. Even though waste heat is included in the review of the Renewable Energy Directive, a clear and strong regulation on the reuse of heat and sufficient demand for waste heat is necessary.

We can see that sector integration of the energy and industry sectors can speed up up our transition to carbon-neutrality and decrease its costs. Thus, the transitions of both sectors have to be aligned. With the Clean Energy Package and the European Green Deal and its therein-announced strategies, the European Union kick-started this process. Nonetheless, it is evident that we are only at the beginning of smart sector integration. I am looking forward to advancing it over the course of this legislature, as the time has come to think outside the box. Climate change is complex. Our answer to complexity should be smart creativity.

What is a **smart sector-integration**?

ERKKI MAILLARD

EDF's Senior VP European and International affairs

Interview

Mr Maillard, a highly topical issue of 2021 is going to be sector-integration. What are your views on its role in the energy transition?

Let us look at the big picture, to start with. The big picture is that the European Union has decided to decarbonise its economy because it is a winning strategy for both environmental and economic reasons. Decarbonising the economy: this is the end. And you must regard the whole process as an investment: you have to spend money at the beginning and your gains will be growth and jobs, all the more necessary after the covid crisis. So the central issue is to find a trajectory that is as cost-effective as possible. This implies organising fair competition in the markets between different technologies, and not picking winners right at the beginning. Sector-integration is an important means to the end of cost-effective decarbonisation. It includes many technologies integrating energy and economic sectors like transport and heating, and organising conversions from a vector to another, power-to-heat, power-to-gas and gas-to-power, for instance.

What is the role of electricity in sector integration?

A very simple –and central- one. The basic process in cost-effective decarbonisation is electrification. The reason is that electricity is easy to decarbonise at an affordable cost. More than half of European electricity, and more than 90% of French electricity are already carbon-neutral. Furthermore, using electricity directly is very efficient: both electric engines for mobility and heat pumps are about 3 or 4 times as efficient as their thermal counterparts.

From this perspective in my view the first pillar of sector integration is about generalising the use of electricity in sectors where it is not very much developed yet: power-to-mobility and power-to-heating. Don't worry, I am not going to tell you we need a 100% direct electrification. I am not, because what Europe is looking for is the most cost-effective technology in every application, which may be a non-electrical solution. And here is the second pillar: using decarbonised gaseous or liquid fuels, or storing power as heat or hydrogen so as to differ consumption, whenever it is more efficient. Then of course you have to transform an energy vector into another, and power-to-gas is an important example.

Where do you believe e-fuels are relevant?

This has been clarified by many recent studies and reports, starting with the Commission's "strategic long term vision" for energy and climate until 2050. Some industrial processes, such as industrial heat up above 400°C and feedstock, and most of heavy transport, maritime or aviation, will be better dealt with if hydrogen and e-fuels are used rather than electricity, just because there is no cheaper electrical technology available, or even none at all. Furthermore, when you need to store power for some time, that is when the load profile cannot be in line with generation, sometimes the best solution is to store it as electricity, but not always: storing heat may be more appropriate, possibly also converting power to hydrogen.

We must prepare for an approach whereby you start from the uses and imagine a combination of energy vectors that answers

the users' needs in the most efficient way, direct use of electricity being dominant but not hegemonic: possibly 50 or 60% of total energy demand in 2050 to reach carbon-neutrality. Smart integration is precisely about finding such meaningful combinations.

Which sector integration technologies do you expect to play a major role?

To answer this question, you must address two issues: the intrinsic efficiency of a combination of energy vectors and their technological roadmap from now to 2050.

Power-to-heat as well as electricity storage as potential energy, in dams, or as chemical energy, in batteries, is highly efficient. Power-to-gas requires a conversion that inevitably wastes energy, about 30% of the input. Power-to-gas-to-power is really inefficient: about 70% of the energy input get lost in the double conversion. If there is no better solution you may use less efficient combinations, but they cannot be the first choice.

Regarding the roadmap, you have to make a clear difference between technologies that are fully mature today, those that are rather for tomorrow, that is close to economic maturity, and some that make sense for the day after tomorrow only, that is neither scalable yet nor economically mature. Storing power as heat, in batteries or in pump storage is mature. Using electric vehicle batteries to support the power system with vehicle-to-grid solutions is close to economic maturity. Many uses of hydrogen, in particular as storage, cannot be expected to be commercially viable before the 30s.

Your company is well-known for being a leader in nuclear and renewable generation. To what extent are you interested as investor in the new markets emerging with sector-integration?

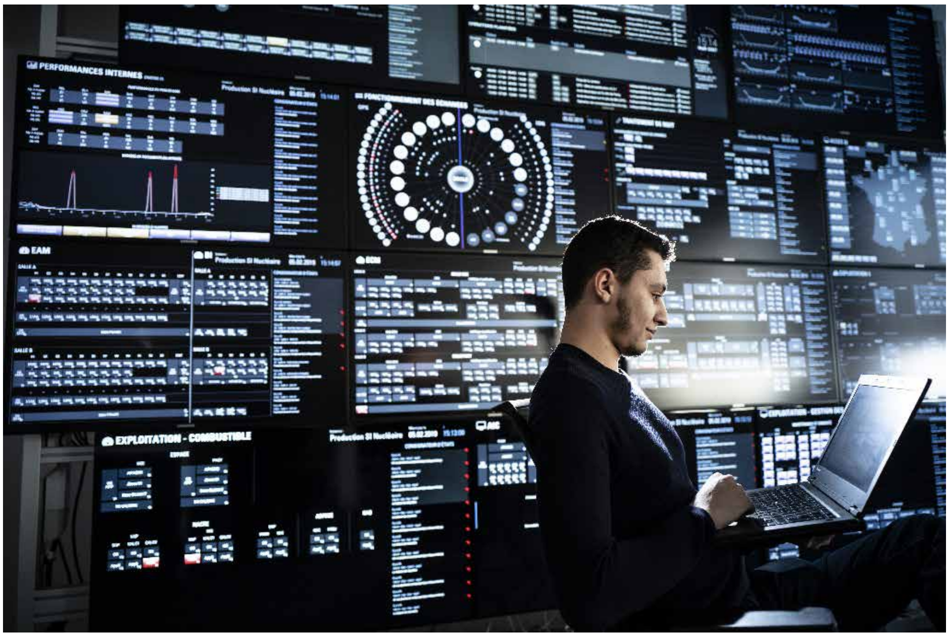
Our strategy is clearly to be present in every, or close to every promising technology of the energy transition. Thanks to a very strong R&D&I department with a staff of about 2000 people and investing half a billion euro a year we are able to be at the forefront of innovation. Before giving examples from today, let me remind you that EDF a few decades ago was a pioneer of sector-coupling when we introduced at large scale a simple but very efficient power-to-heat technology: French households and companies currently operate about 11 million hot-water tanks that store cheap power produced at night as hot water available at any time of the day.

We are currently investing in quite a few sector-coupling technologies. Let me give just three examples. We are one of the main shareholders of McPhy, a company that manufactures equipment for the hydrogen value-chain like electrolysers or charging stations. We created from scratch Hynamics, a company that provides hydrogen and connected services to sectors where hydrogen has a bright future. We believe in coupling mobility with power systems through vehicle-to-grid. Through Dreeve, a company created in partnership with a Californian start-up, our ambition is to be one of the leaders of this technology that will play a key role in delivering flexibility alongside with the deployment of electric vehicles.

And what do you expect from the upcoming European legislation?

Basically three main orientations. 1. Foster the development of efficient electric solutions and of the infrastructure for low carbon mobility. 2. Ensure a level-playing field: competition should be fair between solutions using different energy vectors; in particular taxation and regulations should take into account their respective greenhouse gas emissions. 3. Create a framework conducive to the development of the most efficient gas- or liquid-based processes in sectors where it makes sense, in particular through hydrogen produced by electrolysis from low carbon electricity.

In a sense the upcoming recovery from the covid crisis is a huge opportunity. The EU has taken the bold decision of investing a tremendous amount of money in recovery. If the EU really focuses on efficient decarbonisation we as industry players are eager to innovate and will deploy the most performing solutions.



Hydrogen: The fuel of the new era needs funding and infrastructure

MARIA **SPYRAKI**

ND-EPP MEP, Shadow Rapporteur at the report: A comprehensive European approach to energy storage (2019/2189 (INI), Member of the ITTRE Committee

Hydrogen has the potential to become one of the major energy carriers of the 21st century and therefore, we need to incorporate its production-transport-distribution into the energy planning of the EU and the Member States in a timely manner, starting with the enhancing of research in order to provide accessible technologies in affordable prices.

The European Union is already supporting Research and Development programs and support further scaling up of P2G (Power to Gas) as well as separation technologies. The new Horizon Europe has many opportunities for advanced and applied research in this field. However, it is important to upgrade hydrogen support at European level. One of the ways to achieve that is through the launching of a hydrogen initiative as an Important Project of Common European Interest (IPCEI), which will increase the availability of EU funds and the interest of the private sector to participate. Moreover, the potential additional cost of blending hydrogen into the natural gas grid must be considered in order to facilitate the end-users consumers and industry.

The coordinated steps of the EU including this sector can proceed on the basis of a strategy that will proposed by the Commission taking into account its actual potential production of hydrogen in the EU, the existing gas infrastructure is gas pipelines, underground storage and liquefied natural gas (LNG) terminals, as well as in end-use appliances. The same strategy will present the costs and benefits of retrofitting, where necessary, gas infrastructure and end-use appliances for the use of hydrogen either in pure or blended, gaseous or liquid forms.

It is essential to upgrade the existing infrastructure for the transmission of larger quantities of renewable gas and hydrogen. In addition, the construction of new infrastructure needed for the transportation of pure hydrogen is obviously too expensive. In order to move from the injection of hydrogen to pure hydrogen, EU needs strong and credible financial instruments.

In the political field it is necessary to recognise without rejoicing that European gas infrastructure has an important role to play in the energy transition towards a climate-neutral economy in 2050. The significant existing storage potential of European gas infrastructure can contribute inter alia to seasonal storage and mass-balancing of the energy system, ensuring security of supply, system integrity and providing adequate flexibility as more variable renewable electricity enters the energy system.

We must also agree that ensuring the futureproofing of EU gas infrastructure and utilising its storage potential can significantly reduce the cost of the energy transition. The existing gas infrastructure has an important role to play in integrating renewable gases such as locally produced bio-methane and hydrogen into the energy system.

In the meantime, we should also deal in advance with the issues related to the transportation and distribution of pure hydrogen. The existing natural gas infrastructure can be integrated into new hydrogen networks by transforming today's natural gas network operators into "combined network operators" as these can operate both mixed gas and pure hydrogen networks. The current rules for network operation only refer to natural gas networks, which may not yet be a problem for mixed gas networks. Hydrogen is fed into the natural gas network with a percentage varying per Member State, which does not go beyond the 15% safe limit. However, pure hydrogen networks are a major challenge for the energy transition. The development of pure hydrogen networks is limited because the current regulation framework neither allows such a network expansion nor it's financing with network fees.

In parallel, the upgrade of existing infrastructure needs huge investments. In this regard it important to have clear rules in order to stabilize and facilitate the market starting with the legislative framework.

The Taxonomy Regulation will establish an EU-wide classification system intended to provide firms and investors with a common framework for identifying to what degree economic activities can be considered to be "environmentally sustainable".

However, the Taxonomy Regulation leaves many short-term and mid-term gaps concerning the role for natural gas as a transition fuel and the infrastructure needed. Therefore, further clarification shall be provided to this topic because it is obvious that it is fully related with the future of transmission of renewable gas and hydrogen.

Moreover, a few months ago the EIB announced its new lending policy phasing out support to energy projects reliant on unabated fossil fuels. This implies that the Bank will phase out support by 2021 to (i) the production of oil and natural gas; (ii) traditional gas infrastructure (networks, storage, refining facilities); (iii) power generation technologies resulting in GHG emissions above 250 gCO2 per kWh of electricity generated, averaged over the lifetime for gas-fired power plants seeking to integrate low carbon fuels and (iv) large-scale heat production infrastructure based on unabated oil, natural gas, coal or peat.

Taxonomy as well as the EIB's decision create a new investment environment that needs immediate clarification in legislation.

COVID-19 pandemic also highlighted the impact of climate change, leading us to implement the Green Deal without deviations and to accelerate the change in the energy model in the EU. The EU Commission should develop a coherent and concrete strategy for Hydrogen in order to streamline its regulations and to prevent fragmentation of European markets. Standards are varying in the Member States as regards the blending of hydrogen with natural gas and therefore, the EU Commission should develop minimum blending standards for hydrogen both for the gas grid and end uses, considering each country's specificities as well as the specific interests of end-consumers on the basis of impact assessments.

In the same strategy, it is necessary to clearly include the upgrade of infrastructure.

Hydrogen can guarantee the energy future of the EU with safety, adequacy and affordable prices for consumers and industry, as long as we ensure that the terms and conditions of operation of the single energy market are met, taking into account that the energy mix is a national competence.

GABRIELLE GAUTHEY

Senior Vice President
Carbon Neutrality Businesses, TOTAL

Clean hydrogen: the enabler for smarter integration of energy systems and deeper decarbonation

A few months after the European Green Deal was presented at the end of 2019, and as the Recovery Plan for Europe is being developed, the new European Commission is preparing a strategy dedicated to hydrogen. This strategic plan and the resulting regulatory framework will be of utmost importance to successfully develop the hydrogen sector. Hydrogen can become one of the pillars of both the deep decarbonisation and the recovery of the European economy. Indeed, as a clean energy vector and as chemical feedstock, clean hydrogen has the potential to accelerate the decarbonisation of our energy system and of our industrial production pathways on many levels.

First, hydrogen as an energy vector is the missing carbon-neutral link between the power and gas systems. It enables smarter energy system integration and deeper decarbonisation of energy networks through "power to gas" technologies, which couple the gas and electricity sectors (sector coupling). These technologies should provide a cost-effective solution for large-scale, long-duration energy storage and grid service that will be needed to handle the high levels of renewable power generation which are necessary to achieve the energy transition.

Second, in the transport sector, thanks to its high energy density, hydrogen (as well as hydrogen-based fuels) stands out as some of the most promising solutions to decarbonise heavy-duty or intensive-use road vehicles (trucks, buses, utility vehicles) as well as trains and ships. Thus, like other renewable gases or biofuels, clean hydrogen is emerging as a fitting solution to complement battery-electric vehicles.

Third, the development of clean hydrogen is also an opportunity to decarbonise the European gas grid and the use of energy for heating in buildings. Indeed, most recent studies from European gas infrastructure operators[1] show that the existing gas grid could carry a proportion of blended hydrogen without any major upgrade. This decarbonisation of the European gas infrastructure is necessary to deeply decarbonise heating and ensure the global resilience of our energy system.

Finally, in the industrial sector, using clean hydrogen could decarbonise the large amounts of hydrogen currently used as feedstock for refining, for the production of chemicals (ammonia and methanol), and for metal processing. Today, these processes use hydrogen that is mainly produced from natural gas. Using clean hydrogen instead does not require any changes to these industrial processes. It would also create an opportunity to scale up technologies such as electrolysis and CCUS[2]. Clean hydrogen can also open the path to a circular economy using the CO_2 captured and producing materials and chemicals

For all these reasons, TOTAL strongly believes that developing clean hydrogen can massively contribute to the European Green Deal, and we are ready to be part of this adventure. At the group level, developing clean hydrogen is already a priority because it is both a means to decarbonise our own industrial activities and a new solution to provide cleaner energy to our customers. We combine it with the other low-carbon solutions that we offer, such as renewable power, natural gas and biogas, and biofuels. To accelerate the development of clean hydrogen, both within TOTAL and for our customers, we have created a new Hydrogen Business Unit dedicated to the implementation of hydrogen solutions this year, as part of TOTAL Carbon Neutrality Businesses.

TOTAL has already been active in the hydrogen sector since many years, both as a producer, as a consumer and as a distributor. We are also developing clean

1 As an example, see the public report issued by French gas infrastructure operators « *Conditions techniques et économiques d'injection d'hydrogène dans les réseaux de gaz naturel* »

2 Carbon Capture, Use and Storage

hydrogen solutions. In the transport sector for instance, we operate a network of more than 30 hydrogen refuelling stations in Europe (mainly in Germany) and we have invested in the largest gas & hydrogen mobility companies in the USA. We are also studying how to deploy hydrogen within our network of NGV stations in Europe. In the industrial sector, we are tackling the decarbonisation of our own hydrogen consumption through a series of ambitious projects. One of them aims at supplying green hydrogen to the biorefinery in *La Mède (France)* by developing and integrating an entire industrial system combining renewable power generation, storage, and green hydrogen production. We are also part of a project to test a new electrolysis technology to produce synthetic methanol through a combination of clean hydrogen and captured CO_2 in one of our refineries in Germany (E-CO2MET project). Indeed, CCUS technologies can also provide relevant solutions to produce low-carbon hydrogen. Consequently, they should constitute an integral part of the European hydrogen strategy, in a technology-neutral approach that ensures that all low-carbon hydrogen technologies can realize their full potential.

Whatever the technology used, developing clean hydrogen requires the implementation of complex ecosystems all along the value chain, from production to end uses. This, in turn, requires smart system integration capability. Through its various activities and commitments along the hydrogen value chain, TOTAL is well-positioned today to support this development and deliver the integration part. But developing clean hydrogen is not a one-company job. Therefore, through the new hydrogen strategy, Europe must seize the opportunity to develop a strong, competitive, and high value-added European industry, that is fully integrated along the whole hydrogen value chain. This will be key to ensuring that Europe remains self-reliant, at the cutting edge of technology, and thus able to compete worldwide to develop hydrogen.

Of course, to trigger this development, it is essential that the upcoming European strategy provides the right policy framework with ambitious targets and support for low-carbon hydrogen technologies (through a technology-neutral approach) to remove the current barriers hindering a large-scale deployment of hydrogen in the European economy.

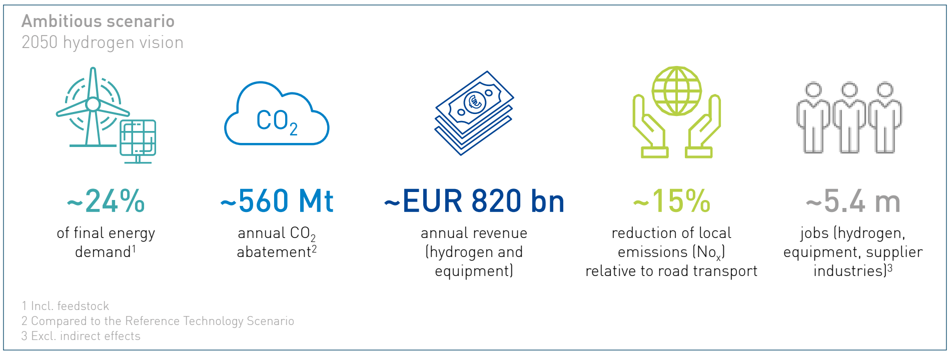
JORGO CHATZIMARKAKIS
Secretary General at Hydrogen Europe

The role of hydrogen in enabling energy system integration and the vision for a **global hydrogen economy**

Meeting the EU's long-term climate and energy goals and realising the promise of the Green Deal means carbon free power, increased energy efficiency and deep decarbonisation of industry, transport and buildings. Achieving all this will require both electrons and molecules, and more specifically: renewable and low-carbon hydrogen at large scale. Without it, the EU will not achieve its decarbonisation targets. As such, hydrogen and hydrogen-based fuels are set to play a systemic role in the transition to renewable sources by providing a mechanism to flexibly transfer energy across sectors, time and place. It can also be the bridge that unites the gas and electricity sectors, including their respective infrastructures while also acting as a link pin between the traditional energy sector and other demand sectors.

Hydrogen and hydrogen technologies are enablers of energy system integration, contributing to improving the overall efficiency of the system and cost reductions in the energy sector and across the economy. Both hydrogen and electricity grid infrastructures together with large scale seasonal hydrogen storage and small-scale day-night electricity storage, in mutual co-existence, will be essential to realise a sustainable, reliable, zero-emission and cost-effective energy system. Hydrogen can also help the renewables industry continue to grow since more renewables will be needed for hydrogen production. As such, renewables and hydrogen, "HydroGenewables", are the perfect partners in the energy transition.

Hydrogen is a versatile, clean and flexible energy vector that will play a crucial role in this process of energy and ecological transition. It can be used as a feedstock for industry, a carbon-neutral fuel for transport (land-use, maritime and aviation), and an energy carrier in the power sector as well as for heating in buildings and heavy industry. Hydrogen and hydrogen technologies will drive decarbonisation through innovation, boosting the EU economy and competitiveness via EU industrial leadership and the creation of highly skilled labour. By 2050, we expect 2,250 TWh of hydrogen in Europe, which represents roughly a quarter of the EU's total energy demand in 2050[1].



A scaled-up industry could deliver hydrogen for a benchmark cost of $2/kg in 2030 and $1/kg in 2050 in many parts of the world[2]. Our *2x40 GW Green Hydrogen Initiative* elaborates further on how to enable and realise the large-scale production of renewable hydrogen[3]. The *2x40GW Green Hydrogen Initiative* presents concrete next steps to underpin a concrete industrial roll-out. A roadmap for a 40 GW electrolyser capacity in the EU by 2030 shows a 6 GW captive market (hydrogen production at the demand location) and 34 GW hydrogen market (hydrogen production near the resource). Furthermore, A roadmap for 40 GW electrolyser capacity in North Africa and Ukraine by 2030 includes 7.5 GW hydrogen production for the domestic market and a 32.5 GW hydrogen production capacity for export. If a 2×40 GW electrolyser market in 2030 is realised alongside the required additional renewable energy capacity, renewable hydrogen will become cost-competitive with fossil (grey) hydrogen. By realising a 2×40 GW electrolyser capacity, producing green hydrogen, about 82 million-tonne CO_2 emissions per year could be avoided in the EU.

Hydrogen supplies could come from a mix of sources. While the exact split of production methods could differ among applications depending on cost assumptions and developments related to the different technologies: electrolysis, pyrolysis and steam methane reforming/autothermal reforming with carbon capture and storage (SMR/ATR with CCS) will most likely play key roles. Scenarios relying on only one of these three production pathways seem unrealistic and would fall short of the required deployment. In addition, hydrogen carriers (e.g. ammonia, synthetic methane, liquid organic hydrogen carriers (LOHC)) may be used to effectively transport and distribute renewable energy over large distances without having to handle large quantities of hydrogen. This is paramount because Europe will need to import renewable energy from the best wind and solar spots worldwide to meet its decarbonisation target. Their production

1 Hydrogen Roadmap Europe, FCH JU, 2019, P.50

2 Bloomberg, 2019, P. 4 https://data.bloomberglp.com/professional/sites/24/BNEF-Hydrogen-Economy-Outlook-Key-Messages-30-Mar-2020.pdf

3 2x40 GW Green Hydrogen Initiative Paper, April 2020 https://hydrogeneurope.eu/news/2x40gw-green-hydrogen-initiative-paper

requires a further conversion, but they potentially offer advantages such as much higher energy density, better compatibility with end use applications and lower cost.

To make the hydrogen economy a reality, we estimate total investment needs of around €430bn over the next years[4]. Most of this money is set to go to wind, solar and infrastructure e.g. conversion of existing natural gas pipelines to 100% pure hydrogen transport. By making these investments, the transition and disruption from a fossil-fuel based economy to the energy system of the future can materialise. Out of this €430bn, we expect around €150bn to come from public financing and the rest from private investment. Within the current context of the health pandemic and European economic recovery, the European Commission should also consider waiving state aid rules for projects submitted under the Important Projects of Common European Interest (IPCEI) label, provided that the project be submitted during the course of 2020.

In conclusion, our vision is the development of a global hydrogen economy, with Europe as it's launching pad. European laws for gas and electricity markets can provide inspiration for the development of a hydrogen market design; however, given its unique characteristics, hydrogen will require its own market design. As a first step, the European Union is set to unveil its communication on a Hydrogen Strategy in July 2020 with legislative initiatives aimed towards the development of a hydrogen market design expected next year in 2021. It is imperative that Europe maintains its industrial leadership in hydrogen technologies as global competition is quickly catching up. As a *Union*, we have the opportunity to shape a new industry while respecting and achieving our climate commitments under the Paris agreement. In addition, strengthening our leadership in hydrogen can present opportunities to export European technological and legislative know-how. Our industrial leadership can reinforce the EU's climate diplomacy and neighbourhood policy, while the "*Brussels effect*" can help path the way for the development of a global hydrogen economy based on European rules, norms and standards. Finally, to consolidate the EU's position as a global leader in hydrogen, it is also important that in economic terms, the price of hydrogen be denominated in Euros.

4 More information in our Green Hydrogen Investment and Support Report https://hydrogeneurope.eu/sites/default/files/Hydrogen%20Europe_Green%20Hydrogen%20Recovery%20Report_final.pdf

Solutions for a **hydrogen economy**, from 'valleys' to islands

BART BIEBUYCK

Executive director of the Fuel Cells and Hydrogen Joint Undertaking (FCH JU)

Technological breakthroughs have put hydrogen firmly at the heart of the European Green Deal. What is sometimes missing is the big picture of its place in a smart low-carbon economy built on smart energy integration. Hydrogen valleys address this lack, offering insights into how the puzzle might fit together and meet communities' needs.

Hydrogen is a priority in the EU's Green Deal proposal. The transition to a carbon-neutral society by 2050 requires a major shift in how our society and economies operate, switching to renewable energy sources, greening industry and shifting to a low-waste, circular economy.

Fuel cell and hydrogen (FCH) technologies offer solutions to these challenges, and more. For example, hydrogen buses and ferries are currently being used in our cities and island regions, while "green" hydrogen from renewable sources is becoming more affordable, more accessible and more sustainable.

Here at the FCH JU, we are taking these innovations a step further by promoting hydrogen valleys to demonstrate how a hydrogen-based economy could work.

We coined the term "hydrogen valleys" in 2019 to describe self-contained areas which are in various stages of developing hydrogen technology to achieve sectoral integration.

These do not have to be valleys in the geographic sense. However, the integration of hydrogen technologies is typically made in a limited area, such as an island, city, region or industrial cluster, hence their other common name of "hydrogen territories".

The most complete hydrogen valleys cover the whole hydrogen supply chain, from production to final use, and a range of impacted sectors, such as manufacturing, mobility and energy storage.

Compared to reviews of individual applications, a large-scale integrated system provides clearer insight into how to develop a hydrogen economy. And because the areas consume large amounts of hydrogen, costs are also typically lower, and more realistic.

In short, we see the development of hydrogen valleys as an important step in scaling up hydrogen-based technology and making it a viable part of the greener economy so vital to our future.

A growing trend

The complexity and cost of a hydrogen valley might seem daunting to planners. It is therefore reassuring to know that countries and regions are already adopting the concept.

In Germany, the national government is supporting regions and municipalities in their adoption of hydrogen and fuel cell technology to decarbonise economies, its "HyLand" concept. It speaks volumes that one of Europe's most successful economies is already pushing ahead with hydrogen.

In France, a "Zero Emission Valley" is being developed around Chambery and Aix-les-Bains, piloting a larger plan to decarbonise the Auvergne-Rhône-Alpes region.

Europe's largest-scale hydrogen valley is in the Northern Netherlands, funded in part by the FCH-JU. In 2019, we held our first hydrogen valley call and awarded €20 million – our largest ever single grant – to the HEAVENN project, which combines over 60 hydrogen projects across the region. The funding complements a €70 million contribution from industry and other organisations worldwide, indicating the scale of the project and its importance.

People-focused regeneration

Hydrogen can also be a game-changer in islands, driving locally led green regeneration. Because of their remoteness and climate, islands often have unreliable, expensive energy supplies. Economic factors complicate matters as demand surges in the tourism season then falls sharply later in the year.

Hydrogen can help to balance the local energy system, boost growth and -- as the current pandemic makes all too immediate -- strengthen resilience to economic shocks.

For example, the BIG HIT project in the Orkney Islands in the north of Scotland, to which we contributed, has expanded the islands' low-carbon economy and boosted incomes.

Local communities guided partners on how to step up their existing use of hydrogen to manage the high levels of energy the islanders produce from wind, waves and tides.

Excess energy now splits locally sourced water into hydrogen to heat two schools and supply fuel cells powering a harbour area, ferries and small fleet of fuel-cell vehicles.

A trading and distribution model completes the strongly replicable project, which won third place in the 2019 EU RESPonsible Island Prize.

Another island, Martinique in the West Indies, illustrates hydrogen's value for a more circular economy. The ClearGen project, is recovering waste hydrogen from the islands' oil refinery to power a 1 MW large-scale fuel cell. This increases islanders' electricity supply with no increase in CO_2 emissions and keeps production costs low, essential in a community vulnerable to climate change and with modest average incomes.

New project support

With these successes in mind, the FCH-JU has focused its 2020 call for applications for funding on projects for hydrogen islands. We will foster bottom-up initiatives supported by targeted programmes and guidance to develop more sustainable communities. The winner will be announced by the end of July 2020.

We are also bringing information for projects under one roof – our new hydrogen valley website. The platform will provide an overview of leading hydrogen projects, offer support ranging from best practice information to a business case tool, and contact with other hydrogen initiatives for advice.

Hydrogen valleys are important for the climate, economy and our energy security. Join us in shaping the hydrogen economy.



JEAN-LUC BOHIC

Director at Business Support & Performance Department in charge of Local Loops of Energy, VEOLIA

FRANCISCO SILVERIO MARQUES

Director at Business Support & Performance Department in charge of Energy Services for Buildings, VEOLIA

KAMILA WACIEGA

Director at Public Affairs Department in charge of Energy and Climat, VEOLIA

Taking a district approach to **energy transition**

With the Recovery Plan published by the European Commission on May 27th, the European Commission has presented its vision for a new energy transition the European Union and its member states need to embark immediately on in order to reach the objectives of the Green Deal. There is new money but there also needs to be a new paradigm for policy design and implementation.

On July 8, the European Commission will unveil such new blueprint in the form of its Smart Sector Integration Strategy. At Veolia, we have been developing expertise in fostering local energy loops and **working right in the sector integration nexus making the links between energy, waste and water** management sectors. We learned to do this by exploring resources such as refuse derived fuel (RDF) from non recyclable waste, waste heat from industries, data centers or wastewater, and biogas from landfills and sludge processing. Hence, this new approach to energy planning and policy-making is already part of our DNA and makes us all the more excited about the new path the EU is taking.

This new strategy should deliver on many fronts: it should lead to the creation of truly integrated and highly flexible systems, linking energy carriers or forms of energy (electricity, thermal energy, including heat and cold, secondary chemical fuels including gas and liquids,) with each other as well as with the end-use sectors (buildings, transport, industry, agriculture). Those systems should be distributed and capable of integrating a myriad of low-carbon energy sources. The new system should also ensure an active participation of all stakeholders, in particular through an easy access to information about the energy mix, and flexibility options (including demand response mechanisms, aggregation services, and storage options) available to all participants of the system. But above all, such strategy should be guided by the imperative of enhanced overall efficiency. For this precise reason, the **Energy Efficiency First should be the first guiding principle of the new communication**, to guarantee that energy is being saved when planning for new investments both on the supply and demand side. In our view, **all of the above can be achieved in particular when we take a local, district approach to energy planning.** Although the ideal is to have a truly integrated energy system at the EU level, this can only happen if we aggregate locally integrated energy systems. Hence, a local, district-based approach to energy planning should be fostered to identify and maximise synergies among differents parts of energy systems on a given territory.

Maximising the potential of the buildings sector through district approach

Buildings are a centerpiece of both energy transition and the Recovery Plan. **The building sector is also a strong facilitator of the sector integration** and an example of how this process can generate significant efficiency gains.

Increasing the integration of buildings with a power producing sector relying more and more on renewables will trigger significant final energy consumption reduction and GHG emissions decrease. At the same time, a bigger share of renewables in the system will also require increased efforts to deal with intermittent energy. This will call for a more distributed and flexible energy system. **Buildings have a critical role to play in this new configuration, as they can also participate in distributed energy systems** by providing renewable electricity production, storage and demand response (through production of electricity and heat on site which can be also injected into the grid, interactions with the transport sector through charging points for electrical vehicles, and smart features enabling interaction, communication and exchange of flows among buildings situated nearby). These three strategies are not only complementary, but even enforce each other[1].

1 The active role of buildings in a transforming energy market, BPIE, 2015, see here: http://bpie.eu/wp-content/uploads/2015/10/BPIE_discussion_paper_buildings_in_the_energy-market_2015.pdf

To play such a role buildings will need to be renovated and become smarter. Both Smart Integration Strategy and the Renovation Wave Communication will be an opportunity to link our efforts the speed up and deepen the renovation rate across Europe, but also to accelerate the process of digitalisation of the existing building stock. **Energy Performance Contracts will be essential in making buildings smarter: they are an efficient tool to finance the implementation of digitalization programs.** Also using digital tools to enhance human capacity in monitoring and managing the energy efficiency of the building allows to guarantee higher savings, and therefore a faster payback for the energy conservation measures.

All of those efforts can be speeded up and facilitated considerably if we adopt a district approach to energy planning and deploy renovation and digitalisation efforts on a given territory rather than proceeding gradually, building by building, in a less than coordinated manner. This will also be a means to better explore the potential of high efficient heating solutions that can deliver low carbon heat, cold and electricity to renovated and smarter buildings.

Enabling deployment of district heating and cooling networks

Sector integration is already a reality and part of the decarbonisation blueprint of heating and cooling. **This is the sector with the biggest energy efficiency and cost-efficiency potential through system integration. District heating and cooling (DHC) networks enable sector integration by creating linkage between different parts of the system and provide flexibility through the means of technologies, which are both already technically and commercially available**. DHC networks connect the local level with EU level electricity and gas infrastructure, making it possible to look at sector integration well beyond a simple coupling between gas and electricity sectors. In particular, district heating integrates multiple renewable and waste heat sources, while coupling points with the electricity and gas systems via heat pumps, Combined Heat and Power (CHP) plants and renewable gases produced from waste streams, such as municipal sewage water, or renewable electricity. Furthermore, district heating connects waste heat sources (from industrial and tertiary sectors) to buildings and other consumers. District cooling also contributes to sector integration by utilising waste heat, ambient energy and geothermal energy to meet ever-increasing demands for cooling and reduce electricity grid strains and heat island effects in cities.

Heat Roadmap Europe shows that a 50% district heating share (up from today's 12%), together with sector integration, can lead to 13% primary energy savings, compared to a conventional energy system. It could also reduce the total energy-system costs by approximately EUR70 bn per year[2]. Only by looking and analysing the heat and electricity needs of a given territory as whole, there is a possibility for adequate planning for construction, extension or renovation of a district heating systems.

Optimizing the circularity of resources

The local approach to energy planning also enables us to identify alternative energy sources, which would not be used or optimized otherwise. **Waste heat recovery is a prime example of a circular and integrated approach to resources management,** as recovered heat that would otherwise be lost is put to use, enabling primary energy and CO_2 savings, as well as connecting various sectors and stakeholders/partners around a territorial project. In an integrated energy system, there is also a need for affordable treatment options for the non-recyclable fraction produced by sorting/recycling plants. Indeed, high treatment costs lead to higher prices, thereby decreasing the competitiveness of SRM. In accordance with the waste treatment hierarchy, energy recovery should be the preferred option, which is also in line with the overall climate and energy goals of the EU. **Refuse-Derived Fuels thus represent an obvious alternative to fossil fuels** as their calorific value is high and they avoid emissions linked to extraction and refining of fossil fuels. Waste-to-energy plants should also be considered to treat residues from recycling processes. This will contribute to strengthen the circularity of newly formed and reformed energy systems. Last but not least, **planning for transition from fossil fuels projects on the level of territory facilitates the optimization of resources such as recycled and collected wood,** helping to avoid the use of biomass which does not meet the sustainability criteria.

Concluding remarks

Smart sector integration can only happen at level of a territory. However, the absence of a systematic local energy planning prevents local stakeholders from linking their mapping and planning for available energy supply and demand (in virtue of article 14 of EED) with buildings renovation strategies (according to article 2 of EPBD). **Taking a district or a neighborhood as a starting point for energy planning will create a chain of opportunities to identify potential synergies that can emerge on the local energy market** (for heat, electricity and gas production) with and within the renovated building stock, as well as **spur a genuine dynamic for a systematic research of synergies and benefits in terms of saved primary energy, natural resources and greater circularity.**

2 https://vbn.aau.dk/ws/portalfiles/portal/316535596/Towards_a_decarbonised_H_C_sector_in_EU_Final_Report.pdf

What **strategy** for **electrification** in **Europe**?

KRISTIAN RUBY

Secretary General of Eurelectric

The COVID-19 outbreak has shown how fragile our economies can be, and how valuable it is that certain critical sectors can react swiftly to provide uninterrupted services. Power sector utilities have proved their reliability throughout this period, even when faced with protracted lockdowns.

What's more, the decarbonisation process has continued. This year, renewables have covered over 40% of the EU electricity generation, while the share of especially coal has plummeted.

The electricity industry is committed to provide Europe with fully decarbonised electricity, well before 2050, and lead the transition to a climate neutral economy. How do we get there?

In 2018, Eurelectric published a major piece of research, which showed how Europe's energy system can transition cost-effectively to carbon neutrality by mid-century. In all scenarios, renewables assume a key role in power generation – at least 80% of all electricity will come from renewables.

With increasing shares of renewables in electricity, increased uptake on the demand side will be critical. In other words, electrification of end-use sectors, notably transport, buildings and industry will be mission critical in order to integrate higher shares of renewables.

As the power mix progressively decarbonises, direct electrification will be the most efficient way to reduce emissions in end-use sectors, since conversion into other energy carriers inevitably comes with losses. Thus, electrification is not only a decarbonisation strategy, but also an energy saving strategy.

Electric vehicles and heat pumps are more efficient than their fuel-based combustion counterparts, even when accounting for power transformation losses. For instance, battery electric vehicles have a conversion efficiency of 80-90% from tank to wheel, compared to 20-30% for internal combustion engine. Similarly, compared to green methane used in conventional boilers the efficiency factor of heat pumps is 7 or 8 times higher.

Nevertheless, emerging energy carriers, such as renewable and low carbon power-to-gas fuels, will play an important complementary role in decarbonising specific segments of the industrial activity, and heavy-duty transport, where no electric alternative to fossil fuels exists.

There is no doubt that a smart sector integration strategy, driven by electrification, is now needed to fully benefit from positive synergies among various sectors of the economy. This strategy is critical for the establishment of predictable, stable and market-based framework which ensures investments in a clean and cost-efficient energy transition.

As policy makers mull over the "EU strategy for energy system integration" it is essential to seize this opportunity to tackle some remaining barriers, such as the heavy taxation of electricity, the coordination between electricity and gas grid operators, and the carbon pricing.

Today, almost two thirds of the electricity bill consists of taxes, levies and network tariffs. Lowering the levels of taxes and levies, while introducing cost-reflective network tariffs will contribute to an affordable and inclusive energy transition for all customers.

The strategy for energy system integration should be an opportunity to address the energy taxation and ensure that taxes and levies provide efficient and stable decarbonisation signals, while being fairly set across carriers.

Similarly, it is time to ensure that all part of the energy system contribute and are exposed to clear carbon price signals. The maritime sector is currently not exposed to any carbon pricing, while parts of residential heating have no or an insufficient CO_2 price. While there is no one size fits all approach for carbon pricing, it is important to find the most efficient tool that paves the way to climate neutrality.

Last but not least, there is a growing need to strengthen the electricity grids. In an integrated system with more renewables. The importance of distribution grids should be duly reflected in the sector integration strategy as well as European spending on energy infrastructure.

Plenty of things still need to be tackled, yet one thing is certain: for Europe's decarbonisation there is no way around electrification.

DR. MOHAMMED CHAHIM

MEP (S&D Group), Member of the ENVI Committee

The energy system integration of the different energy production and end-use sectors is at the heart of **Europe's decarbonisation strategy**

Between 1998 and 2018, emissions within the EU decreased by 23% while our economy grew by more than 60%. Indeed, it has been an EU ambition to become climate neutral by 2050 at the latest, however, to reach our climate neutrality target on time we need to step up our game. This article calls for the development of new technologies and a further integration of our energy systems.

We can boil down the decarbonisation of the EU energy market into the following four steps: (1) Decrease energy demand, (2) Increase the share of electricity, (3) Create affordable renewable fuels, and last but not least (4) Energy system integration. This article will elaborate on all four of these points and show the essential role that system integration will play in decarbonizing the EU energy market.

The first two steps speak for themselves. The first step is regarding a decrease in *energy use*. A decrease in *energy demand* means a decrease in our *total energy use*. The EU has already taken steps in this direction by introducing the EU Energy Efficiency Directive. Under this directive, all EU countries are encouraged to use their energy more efficiently throughout the energy chain (production, transport, distribution, and consumption). Combining the reduction in *energy use* with an annual reduction in *national energy sales* will further decrease the total energy use.

The second step is regarding the *type* of energy used. We need to increase the share of electricity in *total energy use*. Currently, electricity amounts for around 22% of the *total energy consumption* in the EU. To reach our climate neutrality target, this needs to increase to (at least) 40%. An added advantage of using electricity is that the process of decarbonizing electricity only requires a renewable energy source (e.g. wind-, hydro-, or solar power) making it relatively easy.

Diving even further into the technicalities of *total EU final energy use*, roughly speaking around 40% (or more) should consist of so-called 'energy electrons' (electricity) by 2050. The other 60% will then be non-electrical, or so-called 'energy molecules'. According to Eurostat data, the total share of *renewable energy* in 2019 was just below 18%. For electricity specifically, currently around one-third comes from renewable sources and projections show that the share of renewable energy will increase to more than half by 2030. This means that the decarbonisation of our 'electricity electrons' for 2050 is feasible. Moreover, projections show that we are currently on track to produce more renewable electricity than we would actually need if we keep investing in it.

On the other hand, if we focus on '*energy molecules*', we conclude that we need more efforts from the EU. For example, in the Transport sector, only around 8% of energy came from renewables as an energy source. The production of renewable *'energy molecules'* consists mostly of biogas and biofuels, which currently represents less than 5% of the total energy used. For this, we arrive at step three and four as mentioned above: (3) creating affordable renewable fuels and (4) integrating our energy systems. Since renewable energy is mainly converted into electricity e.g. 'energy electrons', expectations are we will have an oversupply of 'green electrons' compared to 'green molecules'. This excess energy is relatively easy to convert into new green fuels (or energy carriers), such as hydrogen. To make this strategy succeed, the EU needs to create a market for these energy products and subsequently prioritise the sectors based on available solutions to decarbonize. In concrete terms, this means that sectors that cannot electrify (part of) their production process should be prioritized in receiving green '*energy molecules*'.

In the figure below, we describe a simplified version of our desired energy system. Ideally, we produce renewable electricity which we then consume directly in order to limit the loss of energy. The excess electricity can then be stored (e.g. batteries) or converted e.g. green hydrogen. Green hydrogen can be stored in large amounts for extended periods, and is suitable as a raw material to produce chemicals like methanol, ammonia and methane. We use these types of chemicals as feedstock in the production of industrial chemicals, fuels, plastics, and pharmaceutical goods.

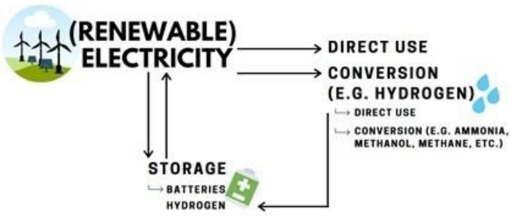


Figure 1: Simplified energy system

It is important that the EU takes a leading role in creating a roadmap to transform and integrate its energy system. In our future energy system, energy carriers like hydrogen will play a major role. To this end, we need to create and launch a hydrogen economy. Taking into consideration the different solutions sectors have to decarbonize, and by creating a clear roadmap, the EU can take away the insecurities of investing in new technologies, such as hydrogen. To accelerate the creation of this new energy market, we call upon the European Commission to prioritize which sectors are eligible to use 'energy molecules' and which sectors can undergo (further) electrification until the production capacity of hydrogen fulfils the total demand. However, this strategy can only succeed when aligned with further integrating of our energy system.

Solar power and **sector coupling**

AURÉLIE BEAUVAIS

Policy Director & CEO ad interim of SolarPower Europe

Under the European Green Deal, the European Commission aims for Europe to become the first climate-neutral continent by 2050, pioneering the fight against climate change globally and entering the race for industrial leadership in clean energy technologies. Climate neutrality will require slashing emissions through the decarbonisation of the economy and industries; a decarbonised energy system not only requires the massive deployment of renewables, but also strong sectoral integration to enable the growth of renewable beyond electricity, towards the entire energy system.

Sectoral integration refers to connecting different energy production and end-use sectors, with the goal of optimising the synergies that come from an increasingly electrified system. In a report from SolarPower Europe and LUT University published in April 2020, high-level modelling proved that it is entirely possible to achieve a 100% renewables scenario in which Europe meets the climate-neutrality target before 2050. The report also found that a 100% renewable energy system is the most cost-efficient way to become climate neutral in Europe by 2050, with levelised costs of energy 5-6% lower than in a less ambitious scenario.

Importantly, the report illustrated that sectoral integration is a crucial ingredient to achieve these goals, with efforts needed to increase electrification and battery storage, and to decarbonise the heating and transport sectors. Increased electrification and battery storage are the principal means of reaching the necessary level of decarbonisation. An electrification rate of around 85% will result in significant efficiency gains for the European energy system – with the power, heating, and transport sectors all contributing to the climate neutrality target. Further, this can pave the way for renewable hydrogen to contribute to the full decarbonisation of the heat and transport sectors by 2030 as the second largest energy carrier – this is essential for hard-to-abate sectors such as marine and aviation, as well as heavy industry and chemicals.

The study further shows that a decarbonised energy system in Europe will be primarily a solar story. Solar PV and wind represent the two main pillars of the energy transition, supplying over 90% of power demand in the long term. Due to its unique versality – capable of being installed in any size for distributed and centralised applications – and combined with its strong cost-competitiveness, solar will generate over 60% of the electricity in both 100% renewable scenarios modelled for 2040 (high ambition) and 2050 (medium ambition). At this penetration level, solar would employ over 4 million people in Europe by 2050 – providing high-skilled jobs, particularly in regions most affected by the energy transition.

A result of renewables-based electrification is enhanced sectoral integration. Direct and indirect renewable electricity usage in the power, heat, and transport sectors will increase through the transition. While the direct and indirect electricity needs are likely to be the highest in transport, up to 10,000 TWh in our most ambitious scenario; the possible maximum is up to 7,000 TWh in the power sector and up to 3,000 TWh in the heat sector.

Indeed, the transport sector is the most difficult to decarbonise and will become as of 2020, Europe's prime source of CO2 emissions. While electric vehicles will drive the way for the full decarbonisation of road transport, renewable electricity-based hydrogen emerges as an essential energy source for the complete transition of the transport sector, providing a sustainable solution for heavy transport modes such as aviation and shipping. Here, electrolysers are a key technology, which not only have a vital role in the production of synthetic fuels, but also in enhancing the flexibility and integration of the energy system. In 2050, installed capacities of electrolysers will be well distributed across Europe, with the higher capacities operating in Spain and Turkey. Overall, in our most ambitious scenario, we project 2,825 GW of electrolysers installed in 2050. A detailed cost comparison has shown that synthetic fuel production in southern Europe in 2030 will not be more expensive than in North Africa, and that obviously there is a gain in energy security since the energy will be produced in Europe – this not only enhances sectoral integration, but further advances Europe's energy autonomy.

Sectoral integration is a key priority of the Commission, which is set to present a strategy on 'smart sector integration for a future integrated European energy system' in early July 2020. The strategy aims to maximise efficiency of an integrated system, focusing, for example, on increasing the roll-out of electric vehicles and heat pumps – both of which add to the level of electrification of their respective sectors. Also important is the development of a more circular economy, where energy efficiency is a guiding principal. For instance, the 'waste' heat from industries can be used to heat buildings, through a district heating network.

There are still many impediments to reaching this vision. In particular, there is the need to strengthen links across sectors, which today often operate in isolation of each other. Further, there is the need to develop a more decentralised and digitalised energy system, where solar energy and consumers can play a more active role. It will take a cross-sectoral dedicated commitment to achieve the ambition of the European Green Deal, but together and today more than ever, a climate-neutral Europe is possible.

Towards net-zero emissions: Which role for Wind-to-X?

GILES DICKSON

Chief Executive Officer, Wind Europe

Europe has set out to become the first climate neutral continent by 2050. While this objective is necessary in the face of global warming and international climate agreements, it is nevertheless highly ambitious. Climate neutrality means the conversion of all energy uses from fossil fuels to electricity generated by renewable energy sources, mainly wind and solar. Today the energy system is responsible for more than 75% of greenhouse gas emissions, calling for new technologies and a change in the way we produce and consume energy. What's the role of wind energy in this? How can wind-to-x technologies contribute to the system integration of renewable energy sources?

The UK's Daily Telegraph recently published an article with the headline "Electrify the hell out of everything". While the phrasing might seem absurd, the essence of the headline is more than accurate. These simple six words illustrate several things. Firstly, direct electrification is the fastest and most efficient form of using renewable electricity. Secondly, direct electrification will deliver the bulk of decarbonization. Thirdly, there are very few limits to electrification. With battery storage technologies falling in costs and increasing in scale, many sectors such as power generation, light-duty transport, rail, pulp and paper, aluminium, buildings, and agriculture will be electrified with renewable electricity. And finally, the blunt phrasing illustrates that decarbonisation by 2050 requires determination and endurance, radically rebuilding our economies in accordance with the EU Green Deal and phasing-out fossil technologies. In some cases, against the resistance of European leaders and established interests.

Today wind is 15% of Europe's electricity. It is expected to grow up to 50% by 2050. At the same time, the share of electricity in the energy mix will increase from 24% today to over 50% in 2050.

But the Telegraph headline misses one important point. **Even in the wildest energy transition phantasies electrify-all strategies do not work.** We cannot electrify the hell out of *everything*, for the so called harder-to-abate sectors, like heavy industry (cement, steel, and chemicals), heavy-duty road transport or large parts of aviation and shipping we need other solutions.

Renewable gases as well as gases or liquid fuels produced from renewable electricity, are key to decarbonising these harder-to-abate energy uses. They will also play an important role in storing electricity for times without wind and sun, creating a more flexible energy system. It remains crucial that those gases are produced from renewable electricity and without upstream greenhouse gas emissions or potentially dangerous carbon capture technologies. Today, over 95% of hydrogen production is fossil-fuel based. Only around 4% of global hydrogen supply is produced via electrolysis. By 2050 100% of hydrogen produced needs to be renewable hydrogen.

This poses a major challenge but also offers huge chances for the European economies. **The EU Commission has understood the potential of renewable hydrogen in delivering a green recovery, creating future-proof jobs and tapping international markets for green tech.** Hydrogen plays an important role in the EU Industrial Strategy and the Recovery Strategy. The European Hydrogen Strategy presented in July will further strengthen the role of renewable hydrogen. The EU aims to make renewable hydrogen cost competitive with fossil-based hydrogen within the next few years and start a massive scale-up of electrolysis capacities from 2024 onwards.

Germany has been the first member state to present a hydrogen strategy. They want to make hydrogen produced from offshore wind energy a centrepiece of their upcoming EU Council Presidency.

As WindEurope we believe that Europe can become a technology leader for renewable hydrogen, if we get the policies right. Economies of scale and efficiency improvements will reduce costs. In parallel, the EU must tackle main drivers of the additional costs. These are of regulatory nature in the use of electricity, which represents 65-80% of the operational costs of electrolysers. Tariffs and levies on electricity account for 30% on average of the total electricity bill across the EU.

The next package of legislative proposals for the gas sector should avoid locking-in Europe with fossil gas but rather create the conditions for zero-carbon gases to be technical and commercially viable. Alongside the right definition and taxonomy for renewable hydrogen, an enhanced traceability through Guarantees of Origin and further investments in European infrastructure are necessary. While there is room for the optimisation of the existing power grid, the EU and Member States should step up the grid build out significantly.

Finally, any ambitious strategy for wind-to-x technologies will fail without a continuous and predictable expansion of wind energy capacities in Europe. According to the EU Commission's scenarios, wind energy needs to increase from 200 GW today to 1200 GW in 2050, with onshore wind remaining the bulk of the capacity but offshore wind accelerating rapidly. To deliver on this promise, Europe needs to simplify the permitting of new renewables and ensure a revenue base for them that minimising financing costs. Europe also need to continue to expand and upgrade its electricity transmission and distribution networks. The National Energy and Climate Plans have been a good starting point. They offer visibility for new installations up to 2030.

ALIX CHAMBRIS

Vice President Group Public Affairs and Sustainability, Viessmann

How to exploit the full potential of heating and cooling in EU buildings for **sector integration** and the **EU green recovery**?

Heating and cooling systems cover fundamental human needs: heat, comfort and health. In times of corona, this has never been more important. Yet, heating and cooling is even more than that, it is the gold mine of energy policy that still remains to be exploited to its full potential. Heating and cooling is the glue between electricity and green fuels, between buildings and mobility, between cities and the entire energy system.

Heating and cooling is responsible for half of the EU's final energy consumption. To date, significant progress has been made: The share of renewables almost doubled from 10.3% to 21% between 2004 and 2018[1] and the share of heat pumps increased more than fivefold to reach about 10%[2]. Yet, the speed and scale of changes, even pre-corona are still far behind what is necessary to meet climate goals. After corona, there is a serious threat that the transformation of heating and cooling is put on hold - threatening jobs and innovations, and locking-in CO_2 emissions for decades to come.

The challenge in times of corona is twofold: how to leverage the full potential of heating and cooling for growth and job creation, and how to make a leapfrog into a fully integrated, decarbonised and connected heating and cooling sector. Here are 5 recommendations on how to exploit the full potential of heating and cooling for sector integration and the EU green recovery.

1 - Create jobs and modernize heating and cooling at the same time

With more than 2-3 million people (direct and indirect jobs) providing goods and services, the heating and sanitary sector is labour-intensive and local by nature. The import of space heaters from (non-EU) third countries is estimated to be lower than 10%[3]. A renovation wave targeting heating and cooling benefits jobs, SMEs (most installers are small entities) and the local economy across EU Member States. In addition, it is a no-regret. A study run in Germany shows that every €1 invested in subsidy schemes for buildings leverages €6 to €8 in investments across the supply chain and €1,17 revenues back for public finances[4].

Buildings account for 40% of the EU final energy consumption. 85% of this consumption is used for heating and hot water production. This is not surprising: the average age of space heaters is around 25 years. If they had an energy label, it would indicate class C, D or lower. In most countries, 40- or 50-year-old boilers being still in operation is not uncommon. Their consumption is at least 20% higher than a standard space heater today. Prioritizing their modernisation reduces quickly CO_2 emissions and supports the local economy.

2 - Minimize costs of decarbonization with a system approach

With the right approach, we can minimize the costs of a decarbonized energy system. What counts is the overall system efficiency. System efficiency is optimized by mutually reinforcing electricity, gas, district energy, communication networks and building infrastructure. Electrification via heat pumps will be a backbone, as they generate 3-4 units of heat output from one unit of electricity. This is important from a system perspective: the lower the annual electricity and peak load demand, the lower the costs of electrification (incl. the costs of electricity generation, network expansion and back-up generation capacity for security of supply). In a well-insulated houses, with four times lower heat demand, low-capex direct electric heating combined with PV and battery are also an option[5].

1 Eurostat 2020

2 European Commission 2018

3 EHI own estimates

4 https://www.geea.info/fileadmin/Downloads/Jahresberichte/geea_Jahresbericht_2011.pdf, p. 11

5 ITG study, Energetische Effizienz und Wirtschaftlichkeit der elektrischen Direktheizung, June 2019

Integrated energy systems for the home enable climate-friendly and cost-effective production of electricity and heat, including the charging infrastructure for electric vehicles.

Viessmann

The use of green molecules in existing gas networks parallel to electrification reduces system costs and enhances the reliability of the energy system. A study by Navigant (2019) found that maintaining gas infrastructure generates €217 billion in annual energy system cost savings.

In short: heating and cooling technologies and energy carriers will differ, from building to building, depending on the availability of grid connections and energy carriers, and on the financial capabilities of households.

3 - Secure access to green fuels for buildings

From the perspective of the end-user, green fuels can help to decarbonise homes with limited investments. In a significant part of the building stock, it is difficult to replace heating with gaseous fuels by electricity based solutions, either because it would require significant investments in insulation, either because it is not possible in practice. Decarbonized gases for heating help people to cope with the decarbonization agenda, increase acceptance and reduce the risk of populism and anti-EU sentiments.

Gas-using technologies are getting ready. With minor technical modifications, highly efficient gas boilers and CHP are already capable of processing up to 30% hydrogen admixtures to methane. First pilots exist that are capable of processing pure hydrogen. Fuel cells also offer the additional advantage of producing heat and electricity at the same time - including during electricity demand peaks - and their "natural" fuel is hydrogen anyway.

Building laws and product rules should be adapted in order to synchronize investments across the gas value chain. Forward-looking building codes should be ready to recognize green gases e.g. in primary energy calculation methods, with suitable verification systems. Such an approach is currently established in Germany. Ecodesign and energy labelling regulations should ensure that the installed base of gas-using heaters is transformed towards models that are capable of processing hydrogen. A requirement to process methane-hydrogen blends is a no-regret for end-users and is achievable at costs close to zero.

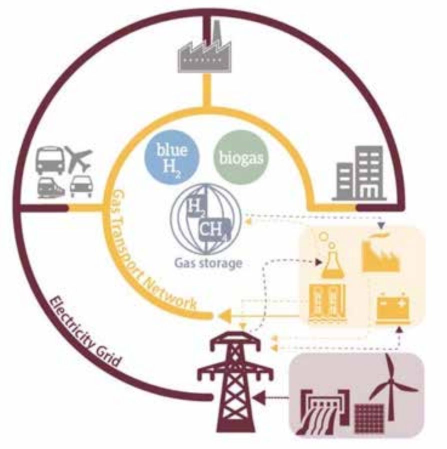
4 - Exploit the full potential of hybridization

The electricity system must be up and running also when the wind is not blowing and the sun is not shining - but electricity demand peaks. Electricity in such situations can be supplied by dispatchable power plants such as a gas or coal power plant, MWh-scale batteries, or interconnections. The electrification of heat and transport at the same time as the phasing out of dispatchable coal, and in some countries nuclear, capacities will increase security of supply concerns. Clearly, new solutions are required - such as hybrid heat pumps.

Hybrid heat pumps, a combination of a heat pump and a boiler, deliver the heat demand at all times, selecting either electricity, or gas, or both. In times of peak electricity demand, very low outside temperature, and/or limited availability of renewable electricity, heat is generated from renewable gases; in times of sufficient supply from renewable electricity. The market uptake of hybrid solutions in the EU building stock reduces the need for back-up capacity and hence reduces overall system costs - a vivid example of what sector coupling means in practice.

5 - Accelerate PV self-consumption and digitalisation in heating and cooling

Digitalisation is transforming buildings, and cities, into an extension of our central nervous system. The sale of sensors in homes increased 3 fold in the past 5 years alone and the sale of digital vocal assistance systems increased tenfold in the past 2 years. By 2030 the number of connected devices will reach 125b worldwide, up from 25b in 2017.



Sector coupling involves:

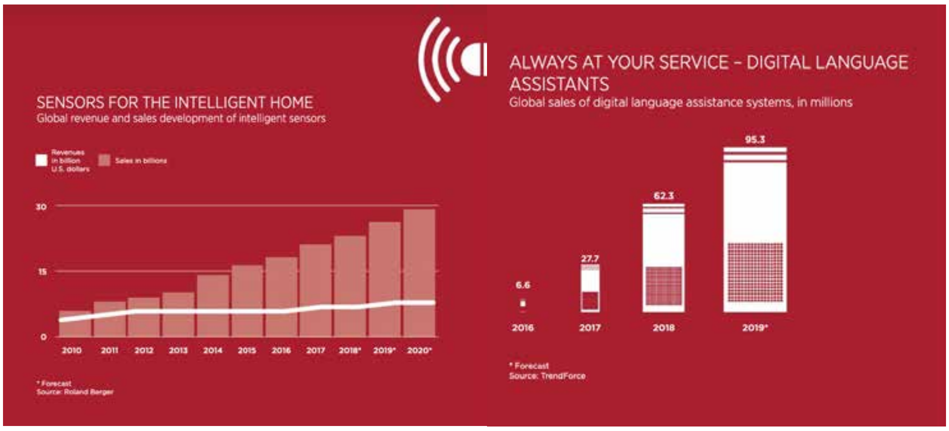
- the electrification of transport, industry and households through the electricity grid,
- production of gases such as hydrogen (H_2) and methane (CH_4) from renewable electricity,
- storage of energy in pumped hydro, batteries and as gases (H_2 and CH_4),
- supply of end-use sectors with renewable gases, and
- electricity production from hydrogen through fuel cells and from gas with thermal power plants.

Source: European Parliament, EPRS.

Source: European Parliament

This opens up complete new opportunities to increase the well being and comfort of home-owners and office buildings. Buildings will be the charging hub for e-vehicles, the heat and power plant for self-consumed rooftop PV, and the provider of flexibility to gas and district energy networks via demand-side-management - for example by aggregating the flexibility of residential heat-pumps, or using commercial heat-pumps to heat-up large water storage tanks in district heating.

With the right focus, heating and cooling makes the energy transition people centric, sharing the benefits among people and increasing the acceptability of the energy transition. With these 5 recommendations, we put the EU on track to exploit the full potential of heating and cooling for optimized sector integration and the EU green recovery.



Source: Intelligent living. From Toy to True Solution, a publication by Viessmann, Miele and Grohe

Sector integration and decarbonisation of heating and cooling

PAUL VOSS
Director EHP

The emergence of 'sector integration' as a major theme of European energy policy has been one of the most exciting features of President von der Leyen's new administration. The core idea is delightfully simple: by taking advantage of synergies between the constituent elements of our energy system, we can find a smoother, faster and cheaper route to achieving the EU's ambition of making Europe the world's first carbon neutral continent.

A cursory glace at a pie chart is enough to tell us that this cannot be done unless the heating and cooling sector (which continues to account for more than half of energy consumption in Europe) shifts from a model dominated by natural gas (and, to a lesser extent, oil) to one which embraces the potential of renewables and waste heat. The good news is this is one of the areas in which sector integration can make a major difference.

Given their history as the twin pillars of the EU's internal energy market, it is understandable, even inevitable that many observers perceive the concept of sector integration at European level as nothing more than the coupling of Europe's gas and electricity markets. But sector integration can and indeed should be based on a much richer and more comprehensive vision of the energy system and the wider economy in which interaction and symbiosis across the power, heat, transport, industry and even the tertiary sectors allows them to become more than the sum of their parts.

For district heating and cooling (DHC) networks, this process has already developed well beyond the 'vision' stage. It is a proven concept that plays a major role in a number of Member States and has the potential to emerge as a key feature of the European energy transition as a whole. The concept is remarkably simple. In a European electricity system which will increasingly be dominated by intermittent production from the wind and sun, flexibility will be of the utmost importance. When such production outstrips demand at a given moment, the 'surplus' electricity can easily be channeled into large heat pumps or electric boilers and stored in water at a cost roughly 100 times lower than that of a comparable electric battery. Not only does this 'power-to-heat' process provide a precious route to market for RES electricity which might otherwise need to be curtailed or 'sold' at a negative price, it also serves to decarbonise the supply of the DHC network itself allowing our sector to take an important step towards making good on our commitment to decabonise our networks in Europe before 2050.. It's a win-win for both the electric and thermal grids, all made possible by the power of sector integration.

Similarly, DHC networks can help to literally bridge the gap between industrial/tertiary installations and the heating sector by connecting sources of waste heat such as steel production, data centres and even supermarkets with the buildings in which they are needed. Making use of these widely available heat streams means would mean far less reliance on the combustion of oil and gas and the establishment of a more circular and energy efficient model that will make Europe's wider climate and energy ambitions far easier to achieve.

For all its statistical significance, the decarbonisation of the heating and cooling does not need to be particularly difficult to achieve. Achieving room temperature in our built environment without the use of fossil fuels is already well within Europe's capability given sufficient political will and the establishment of an appropriate regulatory framework. Indeed there will be other areas of the economy, not least heavy industry, aviation and shipping, which look likely to pose a far greater challenge. The more rare, exotic and precious fruits of the coming sector integration revolution, notably green hydrogen, should be directed towards these hard to decarbonise sectors where they are likely to be desperately needed.

In urban areas, where the density of demand makes it possible to benefit from economies of scale, DHC networks can deliver, particularly if the EU is able to acknowledge embrace their status as more than *'just'* local heat supply infrastructure. Modern, smart thermal networks can emerge as a major strategic asset, not only for the communities they serve directly but for the wider European energy infrastructure puzzle. The publication of the forthcoming European Commission Communication on Smart Sector Integration should serve as a significant milestone in this process. The European district heating and cooling industry looks forward to working closely together with policy-makers in Brussels and in cities all across Europe to deliver on the obvious potential of this important and intriguing concept.

The integral role of buildings in **smart sector integration**

OLIVER **RAPF**

Executive Director, BPIE

The European Commission will publish a Strategy for smart sector integration *(expected for summer 2020) and a Renovation Wave initiative (September 2020), which has been named as a key priority not only within the context of the EU Green Deal but also within the EU Recovery Strategy. Tight coordination between these policy strategies is necessary to ensure an efficient, decarbonised energy system.*

Europe is standing at the threshold of a paradigm shift: the transition from a centralised, fossil fuel-based, and highly consuming energy system towards a digitised and decentralised, interdependent and consumer-focused system that is powered by renewable energy. The European Commission will shortly deliver its strategy for a smart sector integration, which will link sectors from buildings, transport, and industry in order to accelerate decarbonisation and improve living conditions for all Europeans. But how important are *buildings* to smart sector integration? The answer in short, is, *very*.

Micro energy-hubs: Catalysing energy system integration

Buildings are responsible for 40% of Europe's energy consumption and 36% greenhouse gas emissions; in addition, they are also crucial for our comfort and well-being as Europeans spend 90% of their time indoors. Buildings have a central role in enabling the transformation towards achieving an integrated energy system while providing better living conditions for citizens across Europe.

Traditionally, buildings have been designed and understood as static and high energy consumers , connected in a unilateral way with the energy system. In an integrated, decarbonised system, however, the role of our offices, hospitals and homes will no longer be static: they are already transitioning towards becoming active *micro energy-hubs* that are flexibly connected and synchronised, able to produce, store and consume energy efficiently.

Micro energy-hubs contribute to the stabilisation of a cleaner energy system through reducing overall energy demand and therefore the size of the energy system, making it easier and cheaper to decarbonise. At the same time, they increase storage capacity and flexibility, enabling a larger uptake of renewable energy and electric vehicles, while decreasing fossil fuel dependency. Very low energy buildings also allow the integration of the most promising renewables-based supply decarbonisation technologies such as heat pumps or the latest generation of district heating and cooling, therefore contributing to a smart integration with the power and heat networks.

Micro energy-hubs also carry huge societal benefits. By empowering end-users with the control over their own home's energy, smart business models and cost-effective solutions will arise and will be a key element towards greening the economy with reduced energy bills and improved working and living conditions for citizens.

Implemented integrated energy planning while putting efficiency first

While buildings are the catalyst, achieving this overall vision of an integrated, decarbonised energy system requires tight integrated energy planning, with an eye to exploiting synergies between different areas including supply and mobility at the local, or district, level. Buildings are the key construction components of urban areas: smartening and interconnecting them within a district perspective increases resilience for shocks in demand or supply overall, and can provide a boost for the economy, encouraging new, innovative business models and job opportunities.

The starting point of this integrated planning is the principle of *efficiency first* (E1st), as an enabler for long-term energy, resources and investment planning, ensuring effective energy system integration and decarbonisation. Originally enshrined in the Clean Energy for All package in 2018, E1st means recognizing that demand is not bound to increase, and supply should not automatically be scaled up to meet it[1]. In the context of the smart sector integration strategy, the principle of E1st should inform energy infrastructure decisions by requiring the consideration of demand options as alternatives for investing in generation.

Integrated policymaking for an integrated energy system: Coordinating smart sector integration with the Renovation Wave

We have known for a long time that tackling climate change requires monumental system change. The Strategy for smart sector integration is paramount to decarbonisation, as linking sectors will allow optimisation of the energy system as a whole. We are working towards achieving a veritable paradigm shift, with buildings at the heart of this transition.

It is therefore crucial that policies work together. Just as the energy system should no longer be viewed as a series of disparate parts working in isolation, our policymaking requires tight coordination. Considering the urgency of decarbonisation, we must prioritise close alignment between the Strategy for smart sector integration and the Renovation Wave initiative with the principle of *efficiency first* at the foundation.

Within this context, the Renovation Wave provides the opportunity to take a holistic approach, by proposing measures that reduce energy and emissions in the building sector through accelerating the rate of deep renovations, but also by ensuring that buildings become energy-system responsive. The Renovation Wave must be the catalyst for the transformation, and it is a unique chance to drive innovation and create new opportunities in the building sector while making European buildings fit for climate-neutrality and creating better living conditions for all Europeans.

1 Enefirst, 2020, Defining and contextualising the E1st principle. Available at https://enefirst.eu/wp-content/uploads/D2-1-defining-and-contextualizing-the-E1st-principle-FINAL-CLEAN.pdf https://enefirst.eu/wp-content/uploads/D2-1-defining-and-contextualizing-the-E1st-principle-FINAL-CLEAN.pdf

Chemelot – The place to be

LOEK RADIX

Executive Director, Chemelot

Basic chemistry forms the fundament of many economic value chains, just as plankton does within many food chains. Fertilizer, clothing, medicine... none of these would exist without the raw materials that chemistry provides.

The Dutch Minister of Economic Affairs and Climate declared the basic industry to be "crucial" in his vision of sustainability, published recently. The Minister emphasized the indispensable role that the chemical sector plays in the Netherlands, which is factored into his economic policy accordingly. The Dutch Government aims to become – in its own words – "the place to be" for sustainable primary industries in the future.

This is great news, because one of those places to be is the Chemelot chemical complex in South Limburg, the geographical heart of the Meuse-Rhine Euregion and the Antwerp-Rotterdam-Rhine-Ruhr Area (ARRRA). The region is already one of the most highly concentrated areas of chemical companies in the world, accounting for around 40% of Europe's chemical production. In view of the Dutch Government's firm ambition, we should aim to maintain and strengthen that position. Chemelot is a global-oriented chemical site; about 90% of all products produced here are for export.

Chemelot is uniquely positioned to transform into a circular, sustainable, and completely climate-neutral chemical site. Historically the 60+ plants at Chemelot are highly integrated. A product produced in one factory is used as a raw material in another – reducing energy loss and boosting efficiency at the same time. Integration and intense cooperation are key to achieving sustainability and circularity.

The role of chemistry is undisputed; society needs the primary chemical products, both now and in the future. To continue to play this vital role in a socially responsible way, there are two challenges that we face: 1) the raw materials (input) must be renewable (non-fossil), so that the products (output) are also green, and 2) we must electrify all chemical processes, and use electricity from renewable sources.

These two challenges are enormous, but they certainly can be overcome. Currently, raw materials are still being widely produced from fossil fuels at Chemelot; roughly 4 million m^3 of natural gas and about 93,000 barrels of naphtha (distillate of crude oil) are consumed each day. Electricity consumption is around 2 million MWh per year. Yet, Chemelot can become 100% sustainable and circular by 2050. There is still a lot of work to be done, and we are on our way.

A prime example is the new factory being built by SABIC and Plastic Energy on the Chemelot site. This new plant will chemically recycle plastic waste and will be in operation in 2021. Plastic Energy has developed a special technology as part of this collaboration, which melts plastic waste and breaks it down into pyrolysis oil in an oxygen-free environment. This plastic waste oil is then used by SABIC as a raw material in the existing naphtha crackers, and converted into ethylene and propylene.

This new technology creates a cycle by transforming plastic waste into high-quality raw materials for the production of plastics independent of naphtha. This innovative development will reduce the waste being incinerated, and offers a more environmentally friendly alternative for processing mixed plastic waste.

The use of chemical recycling is a great example of how to make value chains circular and increases cooperation within the circular chain. In this case, companies like Unilever have been actively involved from the outset, as these plastics can be used for food packaging.

We are very proud of this development, which eliminates the need for naphtha originating from fossil fuels, replacing it with a circular alternative. This technology is very progressive and way ahead of other sustainable developments in the world.

But there is a lot to be done before we can apply these and other technologies on a bulk industrial scale. One day Chemelot will run out of space for storage and processing plastic waste, municipal waste, and biomass. However, all recycling factories do not necessarily have to be built on Chemelot; they can be built elsewhere. After the recycling process, renewable raw materials such as pyrolysis oil are transported via existing or new pipelines, water, rail, or road to Chemelot.

Chemelot is a natural hub for various types of infrastructure: pipelines, highways, waterways, rail tracks, and electricity lines. This infrastructure plays a crucial role in developing a sustainable chemical site, because the pipelines are needed not only to supply the pyrolysis oil, but also to replace the other important raw material: natural gas.

Naphtha and natural gas will slowly but surely be replaced with renewable alternatives. Chemical processes need heat, which is now often generated by burning natural gas. High temperatures will still be necessary for processes in the future, but the heat will need to be generated from a sustainable electrical source. This means electricity consumption will increase approximately four-fold by 2050.

Within the wider climate debate, Chemelot and the companies on site are certainly not just part of the problem, but they are absolutely an indispensable part of the solution. Chemelot is seeking partnerships on several fronts with relevant companies, knowledge institutes, and governments to help achieve its ambitions – from building infrastructure and obtaining a sufficient amount of green electricity, to creating a level playing field in Europe and across the world. For a chemical site that sells 100% of its products on the world market, the importance of a level playing field cannot be understated.

Optimising power networks to accelerate the energy transition

MICHAEL WALSH
Managing Director Europe, Smart Wires

The last twenty years has seen a major change in the energy landscape. Decarbonising our energy systems and economies to protect the planet is now the primary long-term target for European energy policy. The Green Deal sets clear and ambitious targets for Europe, with 50 or even 55% GHG reductions in 2030, up from the current 40%. The electricity sector has shown remarkable innovation and technical excellence in the successful development and safe integration of large-scale, cost-effective renewables into a reliable grid.

Electricity can continue to play a leading role in the energy transition and can support the decarbonisation of other sectors. However, three challenges will need increased focus:

- Affordability and competitiveness for consumers and industries competing in a global marketplace.
- Minimising impacts on sensitive environments and communities.
- Dealing with complex technical challenges arising from a system with very high levels of renewable generation.

Radically increasing the efficiency of the power grid using modern technology offers the opportunity to address all of these issues. The value available from a truly efficient network is the ability to transport enough additional renewable energy to power ten or more large cities across Europe using today's poles, wires and substations. This is many times more impactful than the incremental efficiency measures applied to networks in today's regulations.

Over the past century, the power network has performed remarkably well and has enabled large volumes of energy to be instantly transported from producers to consumers. However, with the rapid growth in renewable generation, the power network has struggled to keep pace. In many parts of Europe, the speed at which renewables can enter the market is constrained to the speed at which new electricity networks can be built. It will continue to be necessary to add more traditional grid infrastructure, but this process is slow, expensive and impacts the communities and the environment where it's built.

Smart Wires' technology enables power flow to be digitally controlled on the grid. This means that power can be diverted away from congested paths on to lines with spare capacity available. Recent examples in the UK and Germany have highlighted the substantial amount of spare capacity on the existing grid – often enough spare capacity to meet the needs of a large city can be released in one year.

This technology can be quickly installed within the existing network to utilize spare capacity – allowing significantly faster access for new renewable connections. It can also be relocated if the needs of the system change which minimizes the risk of stranded or underutilized assets. This delivers new capacity much cheaper than traditional solutions, reducing costs for consumers and industry.

As a digital technology, it is highly complementary to other new smart grid solutions like dynamic line rating and distributed storage. These solutions identify additional spare capacity on the grid and provide additional flexibility around when and where power is required. By adding the ability to control power flows in real time and respond to changing circumstances, the overall impact will be transformational for our power grid.

This offers the possibility of a truly controllable, digital power grid for Europe where the network can be used to its full potential for the benefit of European citizens. The range of control available will help tackle the technical challenges that will only grow in a highly renewable grid. It will also enable fast access for new renewables at lower costs to consumers and with less intrusive new infrastructure. It is important that project developers and regulators fully weigh all these factors in detail when considering the construction of new electricity infrastructure.

Many of the difficult technical issues in this transformation will require careful work and consideration from experts. Thankfully, the European grid operators have the best talent in the world and have repeatedly shown their ability to solve the hardest problems. When it comes to the uptake of new solutions, regulation can be either a powerful accelerator or a roadblock. We recognize it will take time to streamline legacy regulatory and procedural hurdles that were designed for a world where new projects were built of steel and copper and took ten years to deliver compared with today's solutions built from silicon and software and available in weeks.

The Clean Energy Package for all Europeans and now the Green Deal have set a bold direction towards a renewables-based, low-carbon energy system. This year, there is an excellent opportunity to adapt the existing policy frameworks and procedures to enable a more efficient and faster delivery of the Green Deal, including the update of the TEN-E regulation, the Energy Efficiency Directive, and the Smart Grid Indicator. Platforms such as the Copenhagen Infrastructure Forum also play a key role in ensuring transparency and a collaborative approach of all stakeholders. This will support the uptake of new, proven solutions that contribute to a more flexible greener and future proof grid.

With ambition and leadership Europe can deliver vast volumes of new, fast, clean power with less environmental impact. Europe will also confirm its place as the world leader in renewables and modern power systems.

PATRICK **CLERENS**
EASE Secretary General

Energy Storage Technologies: Key Drivers for **Smart Sector Integration**

The European Commission's strategy for smart sector integration is a cornerstone in the transition to a greener energy system and in the European Green Deal, as it can link up different economic sectors and unlock synergies in an integrated energy system through direct and indirect electrification.

To achieve a truly integrated and greener energy system in a cost competitive way, the upcoming strategy must be tied to clean and smart solutions that allow for the cheapest route to decarbonisation, and the transition to a greener energy mix, while supporting the competitiveness of European industry. In this scenario, energy storage technologies are key drivers for smart sector integration.

Energy storage technologies allow us to store excess energy and discharge it when there is too little generation or too much demand and provide flexibility at different time-scales. Renewable energy sources essentially become dispatchable, which greatly facilitates their integration into the energy system, and ensures maximal use of renewable energy. Energy storage deployment facilitates direct and indirect electrification of different sectors, helping decarbonise and interlink, among others, transport, Industry, and heating and cooling. It can reduce CO_2 emissions, contributes to meeting the climate objectives, and guarantees secure and affordable energy for consumers.

Energy storage has already proven its cross-sectoral success

There are many interesting examples of how energy storage can enable smart sector integration.

EASE is one of the actors behind TSO 2020, one of the key projects funded under the EU Connecting Europe Facility mechanism. In this project, electricity obtained from renewable energy is used to produce hydrogen that stored and used in different applications. For transport, i.e. to power busses, trains, and other vehicles. But some of the hydrogen is also given to industries, e.g. for fertilisers' production. These industries need to get rid of CO_2 emissions, and this is optimal: by combining it with hydrogen, it is possible to obtain methane, which is then injected into the gas system, and used by consumers and industries. That's how different sectors get interlinked.

Thermal storage technologies also can play an important role in the integration of the heating and cooling sectors. For instance, in the food industry: heat pumps at the industrial scale can supply heat and cold at the same time. So, these food plants are powered by renewable energy through energy storage; rather than fossil fuels.

A final example: electrification of transport based on renewable energy sources will play a pivotal role in decarbonising the transport sector. Through Vehicle-to-Grid solutions, vehicles can release electricity, actively working as storage systems and solving grid management issues. Besides, energy storage coupled to electric vehicles chargers enables multiple vehicles to be charged at the same time, with power being supplied both by the grid and local renewable energy sources. Without storage, this could not be possible.

Intelligent storage solutions for smart sector integration

When we talk about "sector integration", we often use the phrase "smart sector integration". But what's smart about it?

The current power grids rely only to a limited extent on digitalisation and automation. But new software and hardware solutions allow for a cost-efficient, secure, and consumer-centric energy system. In the future, we will not have any more only centralised energy generation with no connection between economic sectors. But a smart, decentralised, integrated system that will allow for the growing penetration of distributed generating and flexibility sources, such as energy storage.

Many barriers are yet to be overcome

Let's start with the economics. At the moment, a well-functioning market for flexibility services doesn't exist. And tariffs are not aligned with the actual cost that storage solutions induce to the grid. In other words: storage stabilises the system, reduces costs, and guarantees security of supply; nonetheless, all these contributions are not properly taken into account in the grid fees, tariffs, and levies system, meaning that energy storage needs often to pay twice for the services it renders. Besides, costs of storage technologies are decreasing. But they still often remain high, hindering the creation of a developed value and supply chain and hindering the business cases.

The legislation: with the Clean Energy Package, the EU has introduced key, innovative pieces of legislation. But the road ahead is long: storage-related regulation still lags behind, and it is in some cases contradictory. EASE did publish quite some recommendations regarding the next steps.

Finally, end-users are often not fully aware of the services that storage can provide; and EU research funds don't sufficiently focus on energy storage.

To conclude, electrification through energy storage can lead to decarbonisation in several sectors and is key for smart sector integration. The EU must continue the implementation and modernisation of policies to a.o. mainstream the deployment of renewable electricity, electrification and energy efficiency measures. In light of the ongoing Europe-wide recession and plans for recovery, it is important to make decarbonisation a priority and explore innovative, cost-efficient solutions. The EU has the opportunities to be a world-leader in the energy transition: it should rise to the challenge.

ANTONELLA **BATTAGLINI**
CEO of the Renewables Grid Initiative

10 years of experience in RGI: The dignity of compromise can bring a great opportunity for **smart sector integration**

We live in a world which is increasingly fragmented, polarised and divided. The European project is struggling to find vital new strength and determination or it risks succumbing to criticism and discontent of citizens whose daily life is too far-removed from Brussels to see what it is in it for them. However, one task which can, and indeed must unite all Europeans is the fight against irreversible climate change and for a liveable, sustainable and equitable future. Here, the transition to a fully decarbonised economy in Europe and the world is an essential step. Already, impacts are being felt in every sector and corner of the world, often bringing huge economic damage with them. Despite that, measures to reduce emissions and protect the environment are described as costs. Under this paradigm, we, society and industry alike, ask ourselves if we can afford these costs. I would like to argue that we need a radical change in our mindsets. We should start framing political decisions and actions to reach climate neutrality not as costs but as **investments** to foster and deliver prosperity at local level, to increase resilience to local and global crises and to enable the creation of sound opportunities for the future.

The Renewables Grid Initiative (RGI) was set up 10 years ago and it brought together, as I often say, former "enemies": transmission system operators (TSOs) and NGOs from across Europe. These two important stakeholder groups of the energy transition have learned to respect each other and appreciate the value of challenging each other's beliefs and positions. Over the years, they have worked together more closely on the ground, with the objective of finding solutions to common problems. This may not seem ground-breaking at first sight, however, there is no other organisation in the energy sector, that I am aware of, that has achieved such a level of trust and regular engagement, while dealing with a such broad range of topics and diverse group of Members. RGI's work is highlighting the "**dignity of compromise**" – something we urgently need nowadays.

The paths to climate neutrality are diverse. There is no one way that brings about change. It is often a trial and error process, but we cannot make too many mistakes. Therefore, we need to pool knowledge, perspectives and aspirations to enable a path which is less vulnerable and more suited to enabling a future desirable for broad society. RGI Members, with all their diversities, have learned that we cannot, and need not agree on everything. But RGI Members also know that we have many things in common, among them the commitment to a sustainable future and to relevant action that prevents irreversible climate change. When you focus on what you have in common, rather than what divides you, you can find **solutions based on the possible and not the past** . Currently, the most used approach is to think back and extrapolate a path for the future. This is considered, by many, the only way to overcome the uncertainty posed by the future. However, even though the future is indeed informed by the past and present, it is also the result of daily choices and aspirations. This, after all, is the fundamental principle behind innovation.

The ongoing discussion on sector integration can form the base for innovative solutions and new collaborative approaches, and deliver opportunities for local communities as well as Europe as a whole.

Indeed, sector integration is one of the most critical current issues in energy and one of the biggest opportunities ahead for all of us. It opens the way to fundamentally changing our way of thinking and to moving beyond the established sectors or 'silos' of society, economy and environment in a collaborative way. When Commissioner Simson took office, she spoke about Smart Sector Integration. At the time I asked myself what does "smart" mean, is it a marketing label or something more? Over time, I have concluded that indeed the "smart" part is a fundamental element of sector integration. Sector integration is nothing new, especially in the field of electricity and gas. But what we are aiming for now is much bigger and more challenging: we need and want to integrate sectors in a way that delivers benefits to citizens, the economy, the optimisation of resources and the decarbonisation of the entire system. Sector integration can only be smart if it addresses a variety of policy objectives in parallel. This also makes it a massive opportunity for optimisation.

Currently we are facing multiple challenges: the looming economic crises due to the COVID-19 pandemic, the climate and biodiversity emergency, the societal disparity that currently finds one vocal outlet in the "Black Lives Matter" movement. The opportunity we have is to listen to the voices of those directly affected by these crises and create fairer policy responses for all of them. When thinking about sector integration, we should not limit ourselves to the energy system, but rather use the transformation of the energy system as an engine for a more profound overall transformation. Smart sector integration therefore requires collaborative integrated planning across the different dimensions and a very strong attention to the creation of tangible local value. The trustful relationship we have built in RGI can serve as inspiration on how to overcome narrow individual perspectives for a stronger and long-lasting common good.

DAVID DONNERER
Covenant of Mayors Office – Europe

Leveraging on the key role of cities in the EU **strategy on energy system integration**

The Commission strategy on energy system integration can be a game-changer in putting the EU on track to reach climate neutrality by 2050. In order for this to happen, it should leverage on the key role of cities as its central conductor in a holistic European integration approach.

In this approach, the traditional relationships between electricity, heat and gas networks on the supply side, and their links with key sectors on the demand side (e.g. buildings, industry, transport) would be overhauled, thanks to the development of local district heating and cooling (DHC) grids. This low carbon energy network could provide energy storage and balancing services and serve as an integration platform. It would maximise the potential for renewable energy (both thermal and electricity), energy efficiency, use and recovery of waste heat and other waste resources - thereby contributing to the circular economy - and cost-effectiveness. It would also address the flexibility and balance issues of the current energy system, and help deliver a just transition that involves local communities and leaves no one behind.

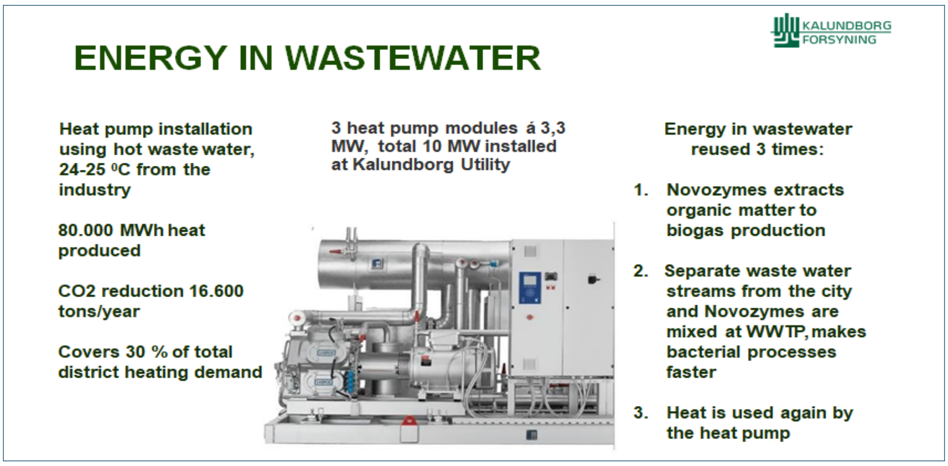
The case for local renewable DHC networks

Cities have proven experience in implementing energy system integration, through their collective, often citizen-owned DHC infrastructure. Therefore, they have a key role to deliver an EU strategy for energy system integration anchored in this approach. The cities in the Covenant of Mayors community that have made the most progress in their long-term transition towards climate neutrality, tend to be those in which efficient, decarbonised local DHC networks are widely developed and integrated into the wider energy system.

In Denmark for example, this approach to energy system integration has been a success. Thanks to local DHC networks, they could match the electricity surpluses from wind with the country's heating and cooling needs. These networks have also effectively linked up with electricity systems, by cogenerating clean electricity and heat, and through power-to-heat production in large-scale heat pumps. The Danish Covenant city of Kalundborg went even further in the integration, by linking up its DHC network with its water and waste water sectors, to reuse energy in wastewater three times (as shown in the picture below).

As DHC suppliers, cities can also respond to price fluctuations in the electricity market and help balance the grid by producing or consuming more electricity. They can also use thermal energy storage, which is generally less expensive than electricity storage, to provide further flexibility in an integrated energy system. Considering that energy consumption patterns for electricity and heat are also different, having cities' DHC networks work in concert with electricity and gas grids, allows for a better optimization than a full electrification approach.

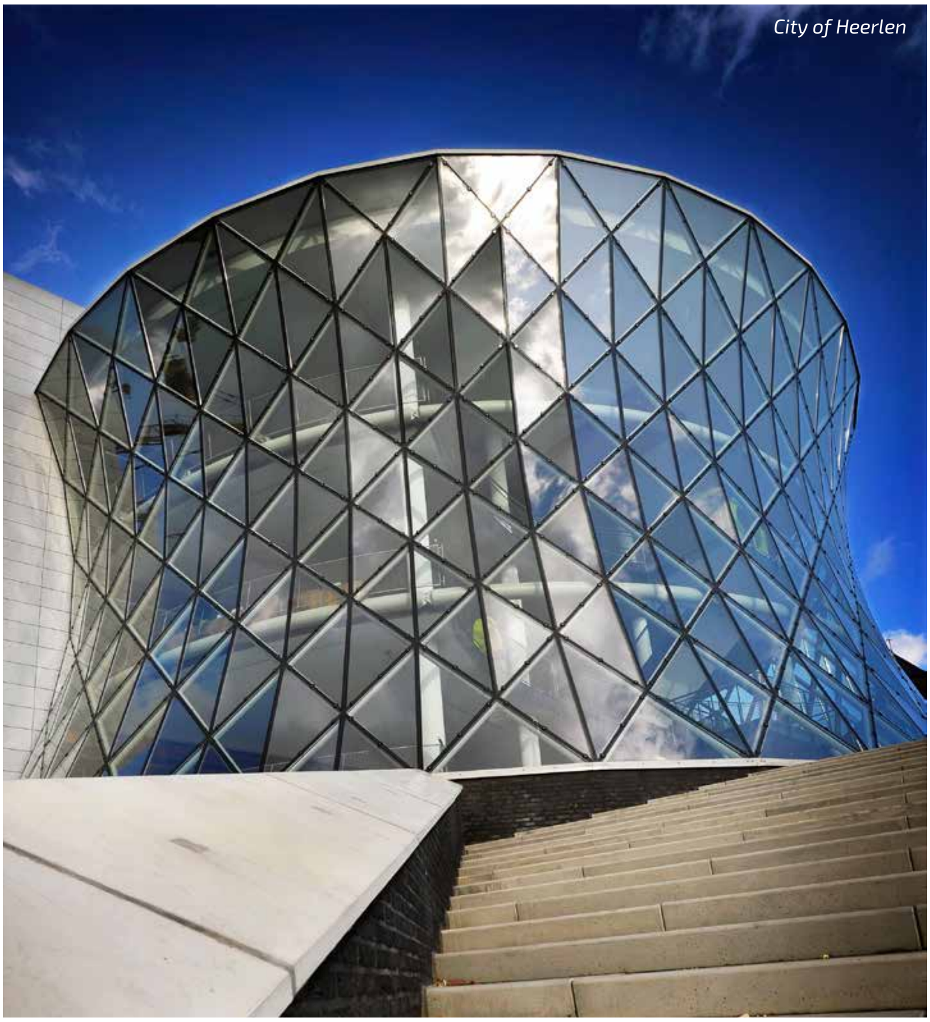
Cities can also leverage on the use and recovery of waste heat and other waste resources for energy system integration, as they are best placed to evaluate the cost optimum and trade-offs between energy efficiency and energy production, based on their local resources and contexts. They are already widely using waste heat recovery, as it is mainly carbon-free, increases the efficiency of the entire system and it is cost-effective. Moreover, it integrates different renewable and residual energy sources in one system, with sources such as solar thermal, geothermal or excess heat from sewage water. Local authorities can enhance synergies between different energy carriers and technologies, thereby increasing energy efficiency and enabling the deployment of renewables, while ensuring the system's balance and stability. In order to foster this potential even more, the costs of running this integrated system should be calculated in an aggregated way and not separately for each of its components.



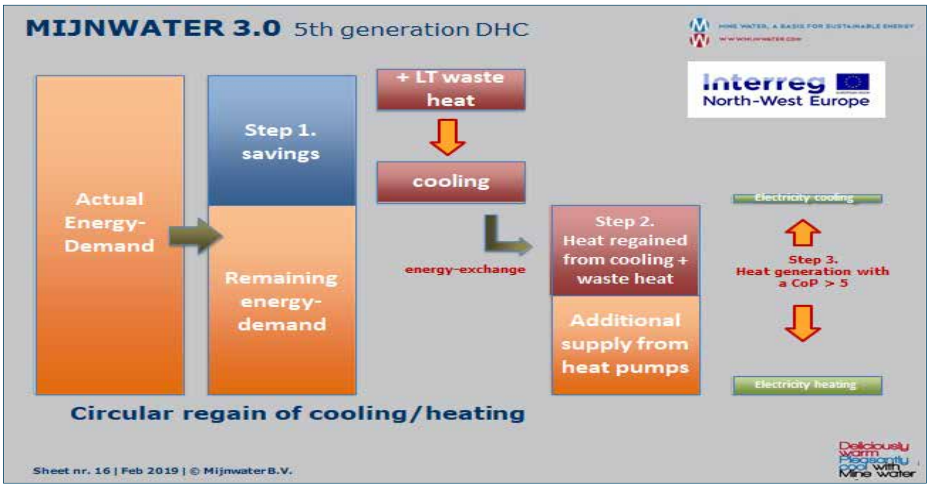
Energy system integration for a just transition

Finally, cities have shown that implementing energy system integration with local resources can breathe new life into coal regions' just transition paths. The Mijnwater project in the Covenant city Heerlen, located in a former coal-mining region in the Netherlands, is a success story in this regard. After the closure of its coalmines between 1965 and 1974, the old mining tunnels filled with groundwater, which was heated by the earth naturally. The mines became a water reservoir, unused for many years, until the city stepped in, with support from the EU and the governmental agency Agentschap NL, to drill five wells and build an underground water piping system. In 2008, the first mine water geothermal plant in the world, Gen Coel in Heerlerheide, became operational, and the first connections to the Mijnwater grid were established. Currently, the Mijnwater Company provides renewable energy to offices, schools, gyms and supermarkets in Heerlen. The system combines a low-temperature DHC grid, with seasonal geothermal heat storage, and the use of reversible heat pumps providing cooling and heating to buildings. The heat pumps are highly efficient and are currently supplied by green electricity procured from the wholesale market (but they plan to produce it locally in the future). Storage is guaranteed by water tanks along the DHC networks. Heerlen's project also involves some consumers as producers, as the network recovers heat from some connected buildings, such as industries, datacenters and supermarkets. Heerlen's Mijnwater project could be replicated in other European coal regions, by using thermal pits or geothermal drillings as seasonal storage options.

The European Covenant of Mayors' community, with its 10.000 signatories, can provide many additional examples and success stories. Visit the European Covenant of Mayors' website to know more https://www.eumayors.eu/support/library.html



City of Heerlen



Smart integration requires and favours new business models

PROFESSOR JEAN-MICHEL GLACHANT

Economist, Director Florence School of Regulation

We are entering a new world and doing so at accelerated speed to ensure recovery from Covid-19 crisis. It is a critical moment to rethink what physical assets we invest in, the technology and operational rules activating them, the alternative usages of intermediate or final outputs, as well as our individual or collective related behaviours. It means, in other words, rethinking our business models, knowing that those emerging now may differ from those that will appear in 2030.

The old world was based on 'silos': everyone taking into account only her own energy needs and costs. The new world will be different: systemic, consciously interactive, integrating all supply chains into a general "system of systems" which must be sustainable and accountable for our global carbon budget. It is why integrating electrons and molecules into a smart response to climate change challenges has the same innovative nature as integrating all industries and sectors into a global EU Renew. Ending silos is a duty for EU Recovery & Green Deal. And a smart digitalisation of the economy and society will be of great help.

All industries and sectors will have to move and adapt, to be ready in 2030 for the final and hard push to "net zero" by 2050: from steel, cement & chemicals, to construction & transportation, agriculture & food industry, or home equipment. All of them will have to consciously review what assets, technologies and operational rules they use and why. How they influence each other vis-à-vis our general carbon constraint. How reactive, flexible, adaptable they are vis-à-vis much smarter individual or collective behaviour.

Seen from 2030, the smart energy integration world we are entering in today will look like a game with four corners:

1. The manufacturers, who determine what assets can do, exchange and react to;
2. The assets transaction space (Internet of Things, proprietary Operating Systems, etc.), which defines how different sets or classes of assets can dialogue and interoperate;
3. The sellers of final products, who decide what product characteristics to promote and guarantee to final users;
4. The delivery loop operators (handling or not the final settlement process), who are putting these products core characteristics into the hands of final users.

However, seen from 2020, that game still looks more limited as most manufacturers have not yet reached the critical mass production of 'smart assets' (think of the still early development of self-driven cars, smart home appliances, etc.). The race for EU Green Deal's new business models has just started, while we are conceiving our EU Covid-19 crisis recovery paths.

Sellers of final products' characteristics play a key role today as, in the 'light assets' world open by digitalization and big tech corporations, there are plenty of ways to redefine products' characteristics, even for existing ones. We all know "organic milk" and "fair-trade coffee". We are eager to learn how "green electricity" could be guaranteed to electric car charging; how much "green or blue hydrogen" might be used by the chemical supplier of our preferred 'Farm to Fork" local food supplier; and so on. Consumers will pay the price for characteristics that do make sense in a sustainable "knowledge-based" society. Several types of sellers will compete to convince us as buyers and users; be they our peers, in a typical "Peer2Peer" relation, or brand new intermediaries, like aggregators, young start-ups and promising SMEs. Alternatively, they could be firms already transformed into unicorns, nurtured with rich resource flows from financial markets; or even our old suppliers, having created in-house new business units or acquired smaller and innovative companies.

However, sellers of newly defined final products' characteristics cannot act without intermediary services of the related "assets transaction space". A space interconnecting producers' assets with those of the users. That space can be a "platform". We already know platforms can be extremely performant and trigger new forms of trade, notably for "peer-2-peer" exchange. We even know platforms ending into fully closed "ecosystems". A kind of "private resorts": fully dominated by the entity running the platform. As Apple Store, Google Play, Alibaba and WeChat actually do. In the EU, we are promoting an opposite kind of resorts, energy communities, where the transaction space between producers' and users' assets is managed by another type of governance having users at its centre. Other relevant forms of "assets transaction space" are Blockchain networks, or individual prosumers.

Renewal of business models in today's 'energy sector integration' does not end with sellers of new products connected to new transaction spaces. Electricity, heat, or gases (i.e., natural gas, biomethane, hydrogen, etc.) circulate mainly within dedicated infrastructures, frequently controlled by a regulated monopolist managing how products flow to feed individual users. New products' sellers as well as new transaction space operators have to coordinate with this mandatory "delivery loop". Most of these "delivery loops" are regulated today to deliver "old" products, within a regulatory framework centred on traditional products' characteristics and a conservative equilibria of cross-subsidies among infrastructure users. It will not be easy for new business models to expand into this deeply regulated world. Some new projects can be found here or there, as pilots being tried out or operational sandboxes. However, they are only spots for testing, not entries into a fully open new territory. Public policy and regulation can do much more to welcome innovations that new business models may create to reach our 2030 milestones and, later, our final 2050 net zero objective.