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HOW CAN ENERGY SECTOR INTEGRATION HELP THE EU TO ACHIEVE OUR CLIMATE GOALS?

KADRI SIMSON COMMISSIONER FOR ENERGY

To fight climate change, the European Union, with Ursula von der Leyen at the helm, has pledged to turn Europe into the first climate-neutral continent by 2050. The sudden burden of the corona crisis has led some to ask whether our goals should be postponed or even scratched completely.

In my view, the reality is actually the opposite. The looming economic crisis means that now is the time to make smarter decisions and to make sure we fund a greener, more sustainable future.

First, we need to learn from the past and embrace this crisis as an opportunity, transforming our economy and society with the help of the European Green Deal. Second, it means increasing investment, creating jobs and innovating for sustainable solutions with the help of our recovery plan,Next Generation EU. It is also clear, that with 75% of our emissions coming from the energy sector, it is impossible to reach climate neutrality without addressing this sector.

SECTOR COUPLING AND HYDROGEN

Finalised in 2019, the Clean Energy for All Europeans Package addressed the three main priorities of EU energy policy: security of supply, affordability, and sustainability. Now, the European Green Deal continueson this path across all sectors and completes the transformation of our energy system into one that is not only carbon-neutral, but also more cost effective, energy efficient and secure.

Today, we still rely (for 86%) on converting coal, oil and gas to run our industries, drive our cars and heat our homes. New ideas are needed to rise to the challenge of reaching zero emissions.

While we are already at a rapid pace replacing coal, oil and natural gas with renewable forms of energy, this is not enough. We need to rethink the ways we produce, transport, convert and use energy, and the roles of all actors along the way. That is the reason why the European Commission adopted this week the strategy for Energy System Integration.

In an integrated system, we will use less energy by relying on more efficient processes, cars and homes and ensure that waste heat – for example from data centres or factories - is reduced and reused.

An integrated energy system supports electrification through renewable electricity, replacing the petrol in our cars and the heating in our homes. It introduces new forms of renewable and low-carbon gases (like clean hydrogen) for those industrial sectors or transport modes where electrification is not an option.

This strategy also looks at the enabling conditions to make these processes and the necessary investments happen simultaneously. In this respect, a transparent and competitive European market framework based on clear rules, an open market, and solid price signals is key. Digitalisation will play a central role in enabling producers and consumers to connect and ensure that the transition happens in the most cost-effective way.

Infrastructure is another important pillar for an integrated energy system. Whereas in the past, electricity infrastructure, gas infrastructure and petrol stations were planned in isolation, new methods are needed to ensure synergies across these different infrastructures and energy carriers.

Together with the Energy System Integration strategy, we presented a hydrogen strategy. Renewable hydrogen will be an integral part of our quest towards a cleaner future.

Hydrogen has been considered as a solution in the past, but it has failed to materialise in large quantities in our energy system. However, today's situation is different. First, the costs of renewable electricity have declined significantly, which makes clean hydrogen production cost-competitive in the next decade. Second, the technologies to convert electricity into hydrogen have been proven to work at scale. Third, our 2050 ambition sets us a definite timeline for when hydrogen is needed.

With our hydrogen strategy, we plot a pathway with three stages corresponding to the levels of maturity, and the different roles that we expect hydrogen to play in our decarbonisation process.

The first phase is from today to 2024, and our objective is to show how renewable hydrogen can be quickly ramped up to respond to current industry needs. The aim is to reach 6GW of electrolyser capacity and one million tonnes of clean hydrogen by the end of the first stage.

The second phase, until 2030, is about embedding hydrogen into an integrated EU energy system. We will have to demonstrate our economic case to reach out to new sectors. This is also the time when we expect hydrogen to start becoming more than merely a feedstock or a fuel and expand its uses as an energy carrier, contributing to reaching our increased 2030 climate target. By the end of the second stage, we need 40 GW of electrolysers and 10 million tonnes of renewable hydrogen.

The last two decades before our mid-century climate neutrality objective are the ones where we can make hydrogen an important part of our energy system. Policy makers rarely work towards such a long time horizon, but it is essential to establish bases to avoid lock-in effects, for instance as regards infrastructure. This strategy is not science fiction. It is an element of today's future-proof investment agenda for Europe.

We know that moving towards a climate-neutral green economy in three decades will be a challenging journey. The integration of energy systems will be an ongoing priority throughout this process. At the same time, we have an advantage: we are starting from the common foundation of the Energy Union and we are always more efficient and stronger by joining forces at EU level.

This is a real opportunity for Europeans. The European Green Deal is the EU's recovery and growth strategy: together with the digitalisation of the EU, we will increase our strength and resilience and be ready for future crises, whilst at the same time reducing our net emissions to zero by 2050.

THE ROLE OF POWER-TO-GAS IN THE ENERGY VALUE CHAIN

A TRUE CONTENDER FOR THE ENERGY STORAGE AND DEEP DECARBONISATION CHALLENGE

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Following the thought-provoking debate at the REKK Power-To-Gas Forum in February 2020 this brief explains how Power-To-Gas technology can be a viable solution for excess RES electricity and eventually allow natural gas infrastructure to have a second life in Europe's carbon neutral future. The main findings are the following:

- Remarkable advantage of the P2G technology is its capability to store low-carbon renewable electricity in the form of hydrogen (P2H) or synthetic methane (P2M).
- The Power-To-Hydrogen technology has widespread potential (transport, industry and even electricity production) but existing assets must be upgraded.
- The Power-To-Methane technology is equivalent to natural gas and could be injected into existing gas infrastructure without any conversion.
- Power-To-Gas processes are more expensive than producing hydrogen from fossil fuels or buying natural gas at TTF.

While Power-To-Hydrogen provides carbon-friendly energy solution in numerous sectors, the Power-To-Methane is well positioned to be a lifeline for future gas infrastructure in the European decarbonisation agenda.

ROLE OF POWER-TO-GAS IN THE ENERGY VALUE CHAIN

Climate ambitions of the EU dictate the long-term phase-out of fossil fuels including natural gas. This decarbonisation challenge has been largely met by technology gains in renewable energy production, which resulted in significant increase of renewable electricity capacity.

Exceptional growth occurred in photovoltaic and wind power plants, which are weather-dependent sources and difficult to predict. Therefore, a storage solution is needed for the quantity of electricity which could not be consumed at the time of the production.

We argue that besides batteries, network connected electric cars and pumped hydro, one of the most viable energy storage solution is Power-To-Gas.

THE BASIC CONCEPT OF POWER-TO-GAS (P2G)

The main idea of Power-To-Gas technology is that the electricity is used to transform water into hydrogen and oxygen via electrolysis. After the electrolysis there are two options:

1) the process stops with hydrogen as output (Power-To- Hydrogen)
2) CO_2 and hydrogen are converted into methane (called Power- To-Methane) (see Figure 1).

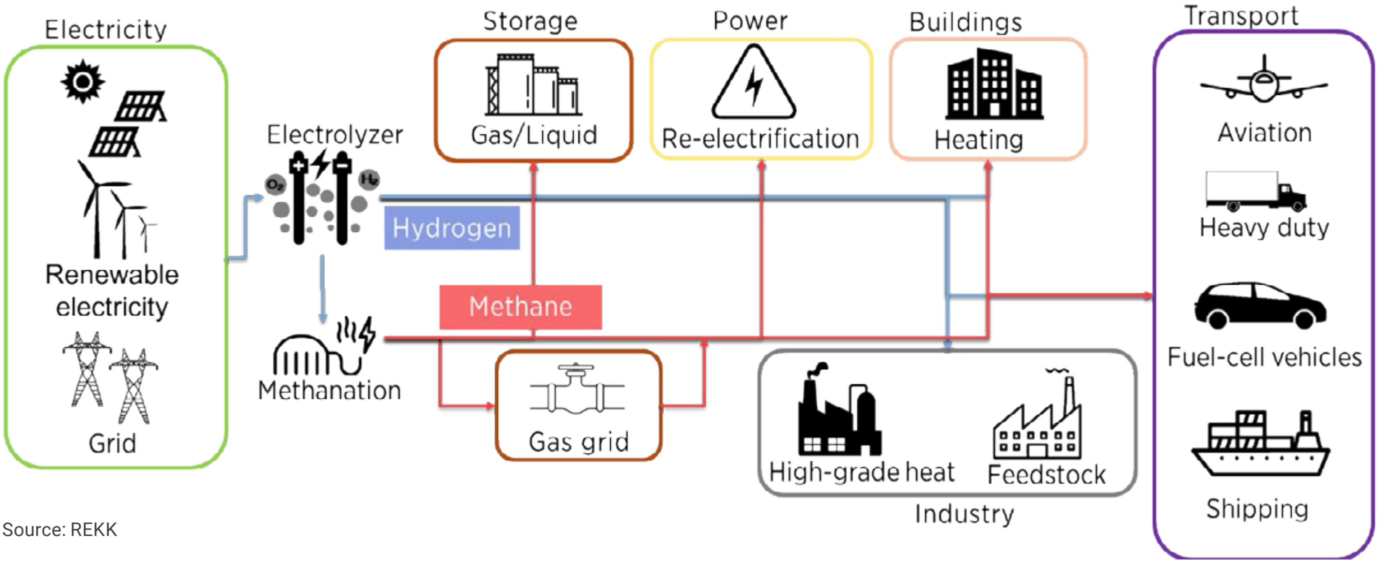
Hydrogen can be used directly as an alternative fuel in numerous sectors: it is feasible to use hydrogen as a fuel input in aviation, heavy duty railroad transport, railroad passenger vehicles (fuel-cell) and shipping. Moreover, it is technically also possible to use hydrogen in power plants or for heating, and it could be stored in gas or liquid form for future usage. These characteristics make hydrogen an alternative option for grid-balancing purposes, too. However, for traditional vehicles/plants to run on hydrogen as input fuel existing infrastructure must be upgraded. Furthermore, storing and transporting hydrogen in the current natural gas infrastructure is problematic, as the networks were built to accommodate methane-based natural gas. Network losses and other problems (e.g. hydrogen embrittlement, corrosion of steel pipes) limit the potential of non-site consumed hydrogen.

A further (bio)chemical transformation of hydrogen will result another gas of high heat value: methane. This methanation process uses the hydrogen and CO_2 inputs to produce methane as an output. This can be injected into the existing gas networks as methane shares the same characteristics of natural gas.

TECHNOLOGY OVERVIEW USED FOR THE MODELLING

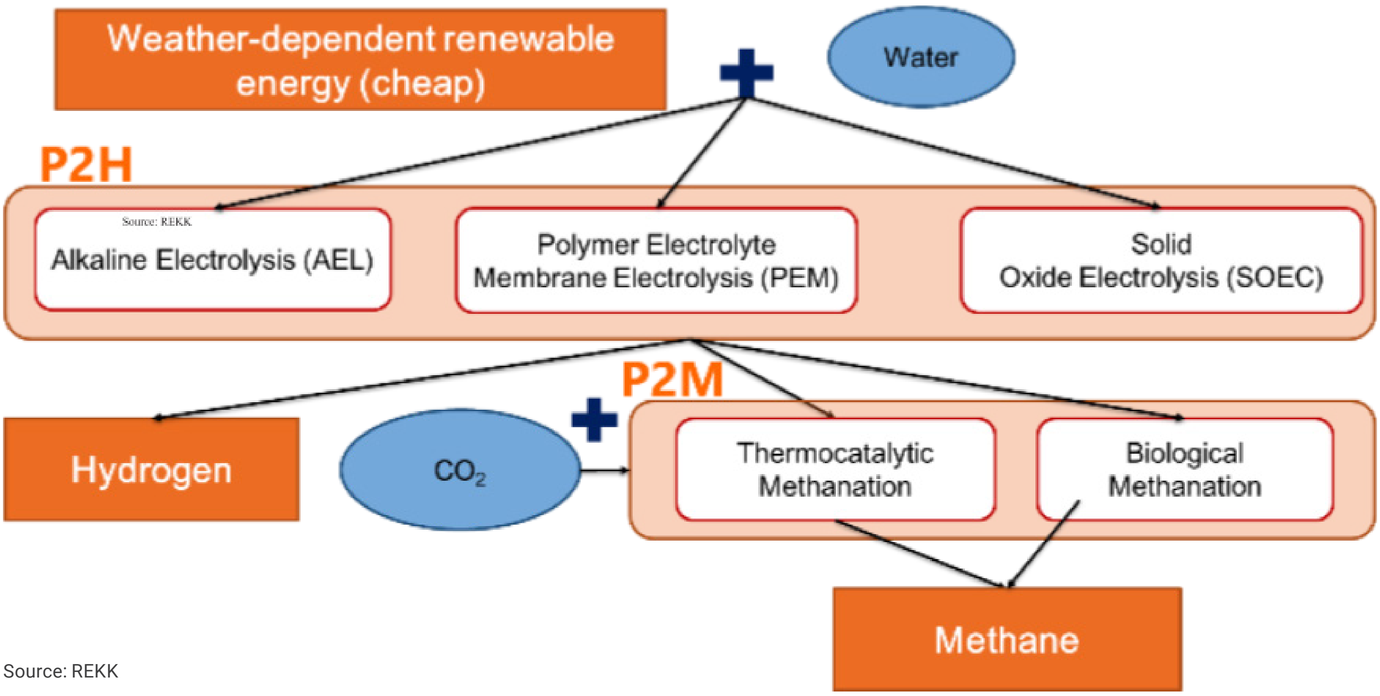
The calculations used to estimate the cost level of the process are summarized in Figure 2. Three prevailing alternatives for electrolysis which differ in their maturity and costs are described (AEL, PEM, SOEC). The methanation step considers two processes (thermocatalytic and biological) that also differ in maturity and costs. ▶

FIGURE 1: BASIC CONCEPT OF POWER-TO-HYDROGEN AND POWER-TO-METHANE (P2M)



Source: REKK

FIGURE 2: TECHNOLOGY OVERVIEW OF POWER-TO-GAS PROCESS TYPES



Source: REKK

POWER-TO-GAS USING METHANATION AS AN ENABLER OF SECTOR COUPLING

One of the key cost drivers is the wholesale electricity price and the availability of renewable electricity at low marginal cost. Thema et al. (2016) projects surplus electricity produced by weather dependent renewables in Germany to reach 60 to 100 TWh/annum by 2050 based on literature review while their modelling estimates 150 TWh/annum.

The concept of surplus electricity or excess RES electricity refers to electricity produced by weather dependent power plants that cannot be consumed at the source in real time – i.e. the price of electricity is zero or negative.

P2G solutions use the surplus RES-electricity and Power-To-Methane technology integrates renewable sources into the energy system with great potential for deep decarbonization goals.

European support for pilot P2G projects has increased in the recent years along with the share of the Power-To- Methane projects, reaching 70 MW by the end of 2018.

LEVELIZED COST OF ENERGY (LCOE) CALCULATION FOR POWER-TO-GAS SOLUTIONS

The current P2G projects rely heavily on public funds from green R&D programs because they are not yet mature and competitive. This section assesses the LCOE values that will ensure the technological competitiveness without public support.

Methodology

We used the LCOE calculation to compare the unit cost of energy production for P2G solutions using the following formula:

$$LCOX = \frac{\sum_{i=0}^{n} \frac{Costs\ in\ year\ i}{(1+WACC)^i}}{\sum_{i=0}^{n} \frac{Number\ of\ X\ units\ produced\ in\ year\ i}{(1+WACC)^i}}$$

Based on the ENEA study The potential of Power-To-Gas (2016), the three electrolysis and two methanation processes were compared (see Figure 2).

Results

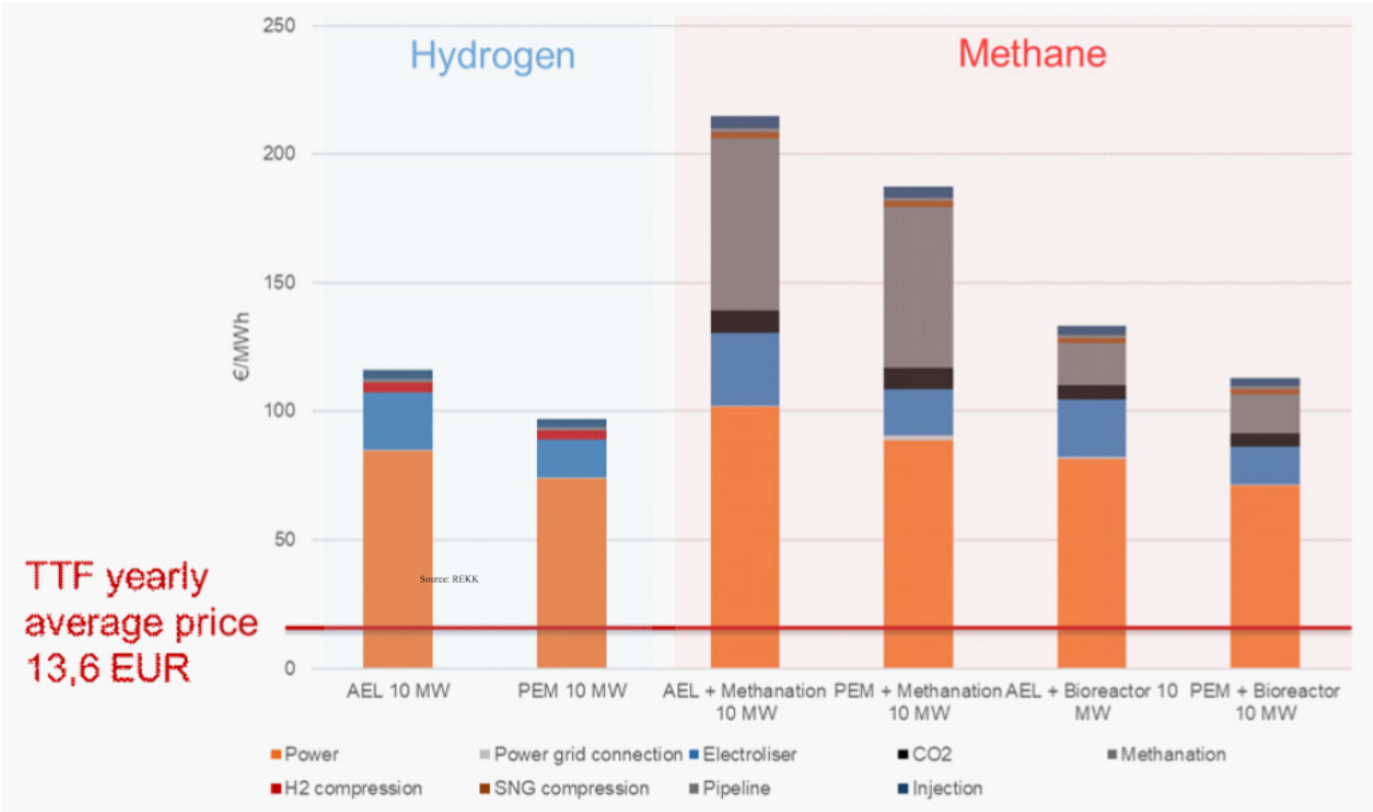
The LCOE is driven mainly by the technology (electrolysis, methanation) and input costs, e.g. wholesale electricity price. The cheapest processes are Polymer Electrolyte Membrane Electrolysis (PEM) and Biological Methanation process.

Based on Hungarian wholesale market in 2019, the wholesale electricity market modelling resulted in an average price of 39 EUR/MWh available for 6490 hours. A price of 50 EUR/ton was applied to the CO2 input and water was not priced because the unit cost is very low in most EU countries. However, it could be relevant in the future with large-scale P2G uptake.

The results show (Figure 3) that the LCOE value of the P2H process is around 100 EUR/MWh. The methanation increases LCOE for P2M technologies but makes it compatible with the existing infrastructure (gas pipelines, gas storages etc). Based on the Hungarian wholesale electricity market characteristics, the cheapest LCOE value of the P2M process is 110 EUR/MWh.

The LCOE of the methane produced by the P2M process is around 10 times higher than the TTF price (13,6 EUR/MWh on average in 2019), meaning it is not competitive.

FIGURE 3: LCOE VALUES OF THE P2H AND P2M PROCESSES USING HUNGARIAN MARKET (HUPX) CHARACTERISTICS, 2019



Source: REKK

Role of fuel costs on the LCOE

The same calculations applied to the 2019 German market resulted in P2G LCOE 10-15 EUR lower due to cheaper wholesale electricity (31 EUR/MW) and more available hours (7354). The P2M process is still much more expensive than natural gas at the TTF.

Role of technology cost on the LCOE

The potential technology cost reduction should also be carefully considered. The learning curve of the solar panel has demonstrated that R&D and economies of scale can result in a rapid fall in CAPEX. The Store & Go project report (2018) estimated that P2M technology costs are mainly driven by the CAPEX of methanation, with CAPEX expected to decrease 50% by 2050.

Thus, further support will be needed during the upcoming period to keep P2M in the game as a promising element of the green transition.

ROLE OF P2M IN THE EUROPEAN UNION'S DECARBONIZATION TARGETS

P2G technologies can become competitive in the longer term with technological improvements and demand driven economies of scale but in the near term support is required to keep them on track for deep decarbonization of difficult to abate sectors.

It is worth to have a wider look on the effects on climate goals. In the baseline case, the P2M process is mainly based on renewable electricity. However, it is also possible to source from nuclear or coal power plants which would raise environmental issues.

Moreover, the P2M process depends on a large amount of CO2 input which might accelerate the development of CO2-capture technologies. REKK calculations assumed CO2 was purchased on the market, but it is possible to capture CO2 from the air or from the emission of fossil fuel plants:

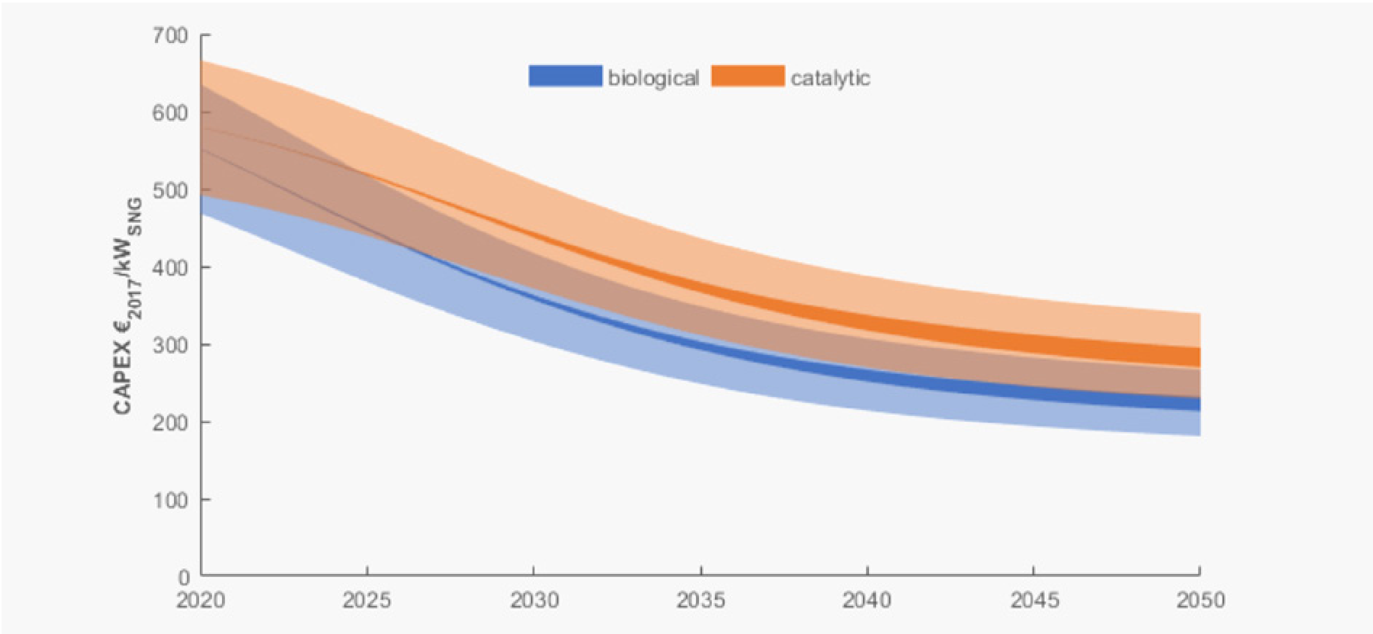
- CO_2 from fossil power plants: Carbon capture is considered the technology that can significantly reduce CO_2 emissions from fossil fuel combustion. Cebrucean at al (2015) finds that this solution reduces the net efficiency of a plant by up to 14% points and increase the cost of electricity by 30-70%.

- CO_2 from biomass: Schiebahn et al (2015) concludes that the fermentation of biomass to biogas or bioethanol offers an opportunity to create CO_2 free of charge as a waste product. However, the volume of CO2 is limited.

- CO_2 from industrial processes: CO_2 can also be captured from the emission of industrial processes; steel and cement have the greatest potential. Heela at al (2018) calculates the feasibility of capturing the 2,5 million tons of CO_2 from the cement industry in Switzerland to produce methane from renewable H2 via P2M.

- CO_2 from air: Technically it is possible to capture CO_2 directly from the atmosphere. A Canadian start-up claims (Carbon Engineering 2020) this can be done at a cost of about $100/ton.

FIGURE 4: LEARNING CURVE ESTIMATION FOR METHANATION SYSTEMS WITH AN UNCERTAINTY OF +/-15% ON INITIAL CAPEX



Source: Store&Go

CONCLUSIONS

The Power-To-Gas technology is a strong candidate for storing energy with a logical application to intermittent renewable-sources. Meanwhile, Power-To-Methane can be injected into the existing natural gas infrastructure. REKK derived the LCOE between EUR 110-210/MWh (based on technology type), and finds that a fall in the main cost drivers (CAPEX and wholesale electricity price) does not create much overall savings.

The advantage of the P2M technology might not be ensured by its standalone competitiveness but its integration and value added to renewable energy sources and the traditional gas sector.

P2G can conceivably be a major piece in the deep decarbonisation challenge. It ensures the possibility for renewable H_2 production and the rising P2M capacity might accelerate the development of CO_2-capture technologies.

Questions still to be answered:

- Future role of P2G: What is the future role of P2M in a decarbonized world? Is it the enabler of sector coupling? A solution for energy storage? Or the saviour of the gas companies' business model?
- Competitiveness of the technology: Shall we compare the LCOE value of the P2M to TTF gas price or to alternative storage options?
- Learning cost forecasts: What can we expect for the decrease of the P2G cost learning curve?
- CO_2 extraction from polluting sectors: Can the CO_2 from fossil fuel power plants or industrial plants or from the air be used in the methanation process?
- Decarbonization point of view: To what extent can we call P2M carbon-friendly? What is the carbon-footprint of the process along the whole value chain?

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1. https://rekk.hu/research-paper/109/the-role-of-power-to-gas-in-the-energy-value-chain

SECTOUR COUPLING AND THE ROLE OF ELECTRIFICATION

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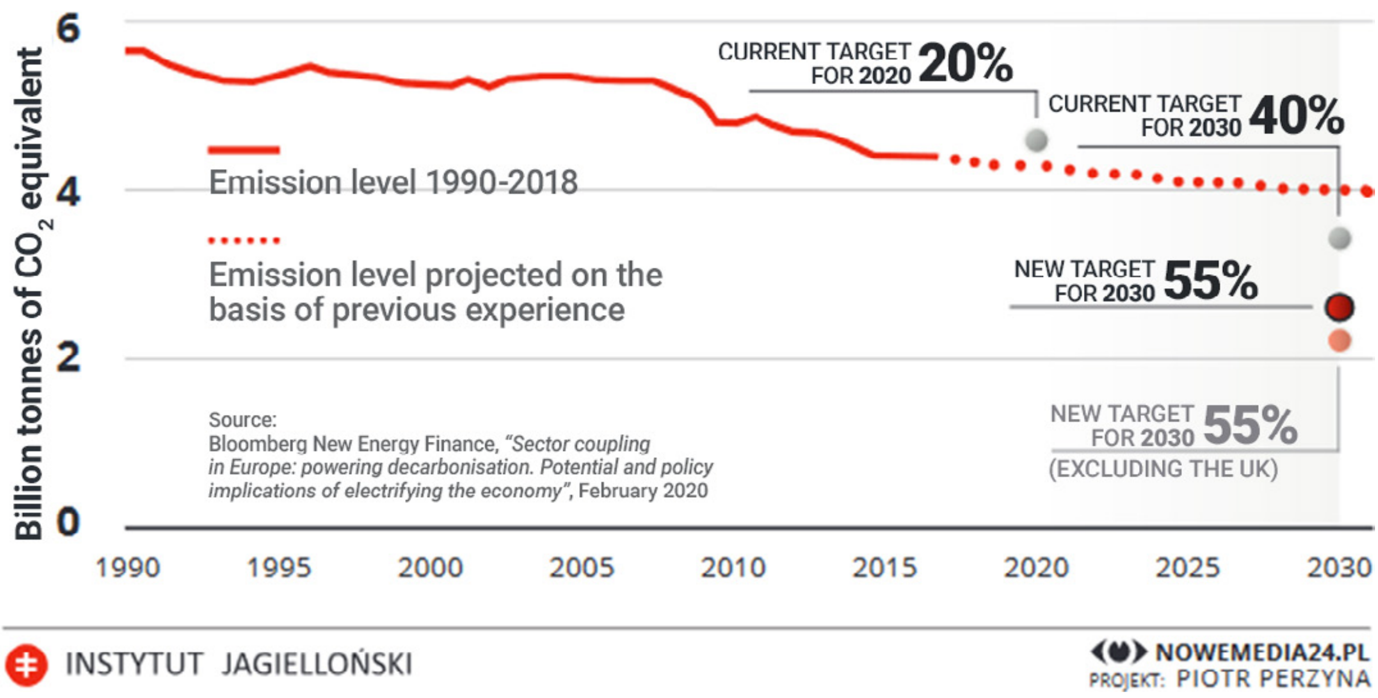
For many years, the EU energy and climate policies have consistently sought to create the conditions for sustainable social and economic growth of the Community, based on mutual respect, improvement of the environment, rational use of resources, innovation and competitiveness. The European Green Deal[1], published in December 2019, aims to accelerate the pace of the Community's transformation towards, inter alia, a zero-emission economy without fossil fuels. One of the possible implications of the European Green Deal is that the greenhouse gas emission reduction target for 2030 is revised up, from the current level of 40% to about 55% (compared to 1990).

In this context, the concept of **sector coupling** seems to be of key importance. It plans to increase the use of electricity from the cheapest forms of energy generation, i.e. wind power and photovoltaics[2], to supply specific sectors, such as transport, various industries and the heating of buildings, with a view to minimising dependence on fossil fuels which contributes to greenhouse gas emissions. It should be stressed that the European Green Deal intends to obtain electricity predominantly from renewable energy sources (RES). ▶

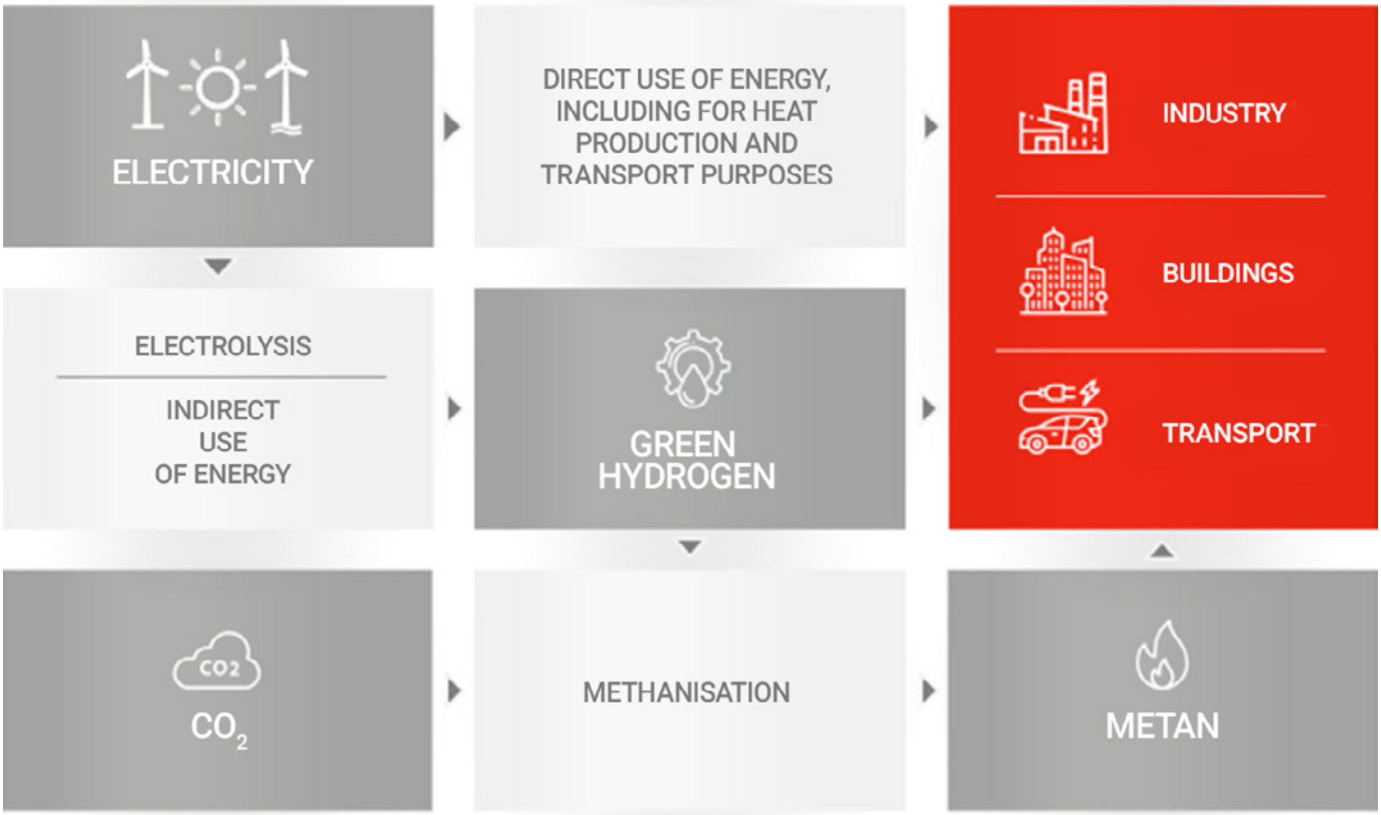
FIGURE 1: GHG REDUCTION TARGET FOR 2030 SET BY THE EUROPEAN GREEN DEAL



Source: Bloomberg New Energy Finance, "Sector coupling in Europe: powering decarbonisation. Potential and policy implications of electrifying the economy", February 2020

1. https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_pl
2. IRENA, Renewable Power Generation Costs in 2018, 2019

FIGURE 2: BLOCK DIAGRAM OF THE SECTOR COUPLING CONCEPT



Source: Bloomberg New Energy Finance, "Sector coupling in Europe: powering decarbonisation. Potential and policy implications of electrifying the economy", February 2020

According to estimates by Bloomberg New Energy Finance (BNEF) presented in the report "Sector coupling in Europe: powering decarbonisation. Potential and policy implications of electrifying the economy" of February 2020, the electrification of the transport, industry and construction sectors represents a potential to reduce greenhouse gas emissions by 2050 by about 60% compared to 2020 - equivalent to about 71% compared to 1990. The coupling of the energy, transport, industry and heating sectors, should raise this potential by 2050 to about 68% against the 2020 level and 83% compared to 1990.

It should also be underlined that while the concept of sector coupling contributes significantly to achieving the European Green Deal 2050 objectives, these may not be possible without the involvement of sectors with significant GHG emissions, such as aviation, maritime transport, long-distance road transport and high-temperature industrial processes (e.g. steel or cement production).

While the above concept will result in increased demand for electricity, the deep decarbonisation, as indicated earlier envisaged in the European Green Deal, will require that zero-carbon electricity, free of other harmful substances, becomes the main energy source in the economy.

It can be assumed that solar energy, as well as onshore and offshore wind power will be the prevailing means of electricity generation. Thus, it should not be forgotten that dispersion (decentralisation) as well as variability and irregularity/ discontinuity of production due to weather conditions are not only the essential characteristic, but also the challenge of a system where the electricity supply is based on wind and solar power. Appropriate technologies and market structures and mechanisms will be therefore needed to coordinate (aggregate) and manage the system, as well as to obtain the flexibility necessary to meet the challenge of volatility of production in wind and solar power plants.

In summary, the information provided above emphasizes the growing role of the electric power industry in the concept of sector coupling and the need for supporting it in achieving the goals of the European Green Deal. It is then crucial to foster discussion and research on the development model, taking into account its structure and functioning. Given this, it is important to bear in mind the context, which will be shaped for the most part by the EU energy and climate policies, as reflected in the European Green Deal concept.

This article was first publish as a part of Jagiellonian Institute report on Sector coupling in June 2020 and is republish here with a permission.[3]

3. http://jagiellonski.pl/news/722/laczenie_sektorow_zielonej_energii_co_to_oznacza_dla_polski_raport

ENERGY SECTOR INTEGRATION
KEY TO BECOMING CLIMATE-NEUTRAL BY 2050

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The future energy mix will be dominated by renewable energy sources (RES) with zero production costs, such as wind farms and photovoltaics. The abundance of cheap electricity will allow for the replacement of fossil fuels, both in heating and transport sectors. Effective integration of these sectors, within one energy system, will also help to solve the problem of weather-dependent RES production.

ENERGY MARKET: INEVITABILITY OF CHANGE

It goes without saying that the energy industry is entering a disruptive phase. The centralised model, based on a one-way energy flow (from producer to consumer) is replaced by a dispersed pattern with multi-directional energy flows. The existing buyers are gradually ceasing to be passive energy consumers, becoming instead active market participants who take part in system balancing and energy supply (as prosumers).

Change is inevitable as it is driven by strong underlying fundamentals such as:

- Climate change and environmental pollution with resulting social pressure for change.
- Digitalisation and new technologies reducing the competitiveness of a large-scale energy industry.
- Political risks related to the availability of dwindling fossil fuel resources, forcing the search for alternative energy sources.

An era of a dispersed market of energy producers using available renewable energy is dawning. Greater dynamics of energy price fluctuations, as a consequence of the prevalence of uncontrolled sources such as wind power or photovoltaics, will certainly be an overriding feature of this new market model. These energy sources offer the advantage of operating at zero cost, but, on the other hand, production is dependent on weather conditions. However, sector coupling will help to mitigate this problem and take full advantage of unlimited access to cheap energy.

ELECTRIFICATION: GOOD ENERGY DRIVES OUT BAD

The Gresham–Copernicus law states that bad money drives out good. One could say that this rule applies to many aspects of life, but, fortunately, not to energy. In this case, the rule is completely reversed. Good energy drives out bad. Since the dawn of man, from the moment he made the first fire, mankind has been making use of new, more efficient and cleaner sources of energy. Today, we are in a new stage of civilizational transformation. Electricity, as better energy, enters all areas of life one after another, replacing the energy contained in fossil fuels. In recent years, it has become clear that this process is gathering pace in the heating and road transport sectors. We are just at the beginning of the journey, but the "electrification of heat and transport" is gaining momentum.

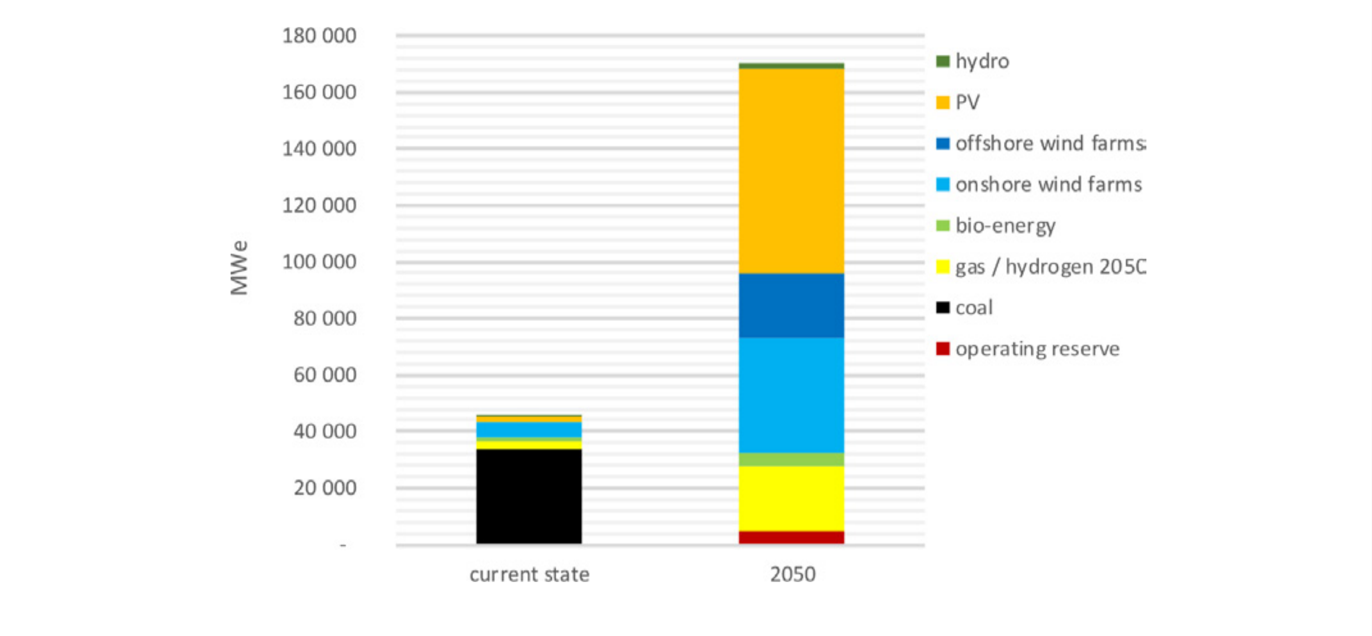
As analyses of Forum Energii show[1], electrification will boost demand for electricity in Poland by about 70 TWh (50TWh in e-transport and 20 TWh in heating) in 2050. When we add to this the increased demand from other sectors of the Polish economy, domestic energy consumption will rise from the current 170 TWh to about 295 TWh.

Let's take a look at a possible capacity mix in Poland in 2050, capable of meeting future energy needs, and compare it with the present one (Fig. 1). The annual electricity production of 295 TWh will require a fourfold increase in the capacity of generation units within the electric power system. Those accustomed to a centralized model of energy market may find it impossible. Indeed, it is not possible if only a few huge current players of power generation are involved. Let us remember however, that the paradigm of the sector's functioning is shifting. The era of a dispersed power generation base is coming. Hence, it is not only the four national giants who will build the future energy sector, but also millions of potential investors, driven by different priorities and business models. If we look at Figure 1 this way, we will see that it can work.

▶

1. https://www.forum-energii.eu/public/upload/articles/files/analiza%20-%20Polska%202050%20neutralna%20klimatycznie.pdf

FIGURE 1: STRUCTURE AND SIZE OF GENERATION CAPACITIES IN THE POLISH ELECTRIC POWER SYSTEM



Source: Forum Energiion the basis of Navigant analysis

SECTOR COUPLING AS A KEY TO DECARBONISATION

It is worth defining the eponymous 'sector coupling'. It is a close connection between the electrified heat and transport sectors and the energy system. Flexible interoperation and response to emerging surpluses in energy supply and temporary energy shortages, enable stabilisation of the entire energy system. In a nutshell, we can say that all energy consumers take part in balancing the electric power system. This is the main advantage of sector coupling. But it has other important assets such as lower operating costs, expenditures on extension of energy infrastructure and reduction of CO_2 emissions.

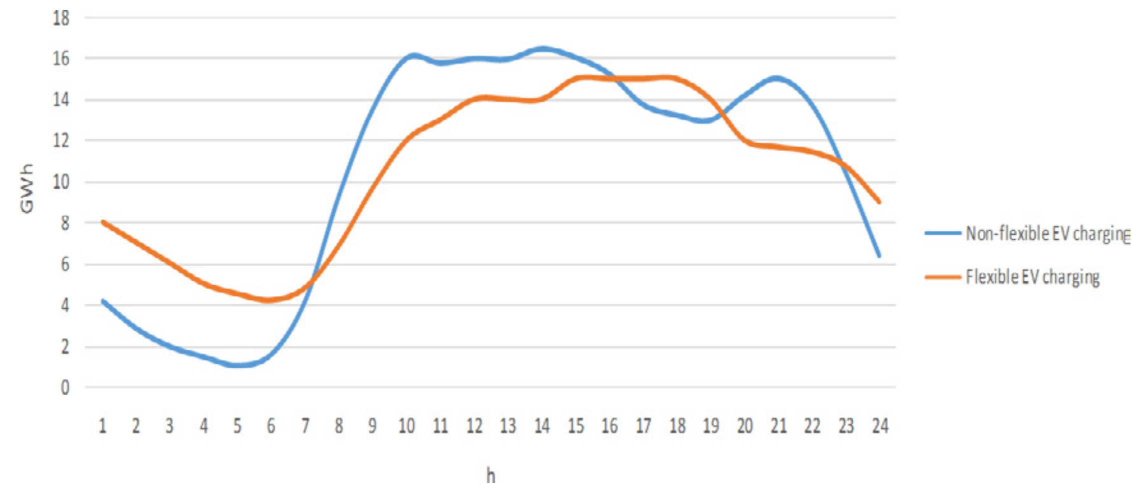
The power balance, such as presented earlier, guarantees Poland's energy security in 2050 and energy supply in line with current needs. The analysis of energy production capacity shows that with such a large installed capacity, when there are periods of excessive sunshine or wind, too much energy will be produced. The amount exceeds what consumers need by about 52 TWh, equivalent to almost 17% of the annual national consumption. The emerging surplus of electricity should be used somehow: it can be stored in another form, e.g. as "green hydrogen" from electrolysis, in the form of heat obtained via heat pumps or as electricity temporarily stored in electric vehicle batteries. Calculations indicate that up to 31 TWh of hydrogen energy can be derived from this surplus electricity, which covers about 42% of the national demand for this fuel by all the gas CHP plants in the electric power (and heating, at the same time) system.

The other side of the coin is that despite such high installed capacity, there are moments when volatile RES are not able to deliver enough energy. Although it is far from being significant as the risk of undersupply is of about 0.8% of annual consumption, it does occur and must not be underestimated. A flexible energy system, well integrated with other sectors, can be a solution. It is at such moments that stored energy is released and, simultaneously, the demand for electricity is reduced by slowing down the charging of electric vehicles, switching off heat pumps or using thermal inertia of buildings. The system operator may, of course, resort to further remedial measures, such as inter-system energy exchange or activating peak-load units.

Figure 2 illustrates how the need for instantaneous charging power for electric vehicles can be adjusted in a situation of flexible demand, responding to stimuli in the form of variable energy prices which reflect the level of supply and demand on the energy market. As can be seen, the level of energy demand can be changed significantly, provided adequate economic incentives are proposed (cheaper or more expensive energy at a specific moment). However, the infrastructure for charging electric vehicles should be sufficiently developed so that consumers react according to the needs of the electricity system operator.

A similar phenomenon of demand shifting to off-peak periods occurs in the heating sector. It is possible to switch off heat pumps without affecting thermal comfort, using the thermal inertia of buildings or the heat accumulated in batteries (if installed). ▶

FIGURE 2: POWER DEMAND PROFILES FOR ELECTRIC VEHICLES IN POLAND IN 2050



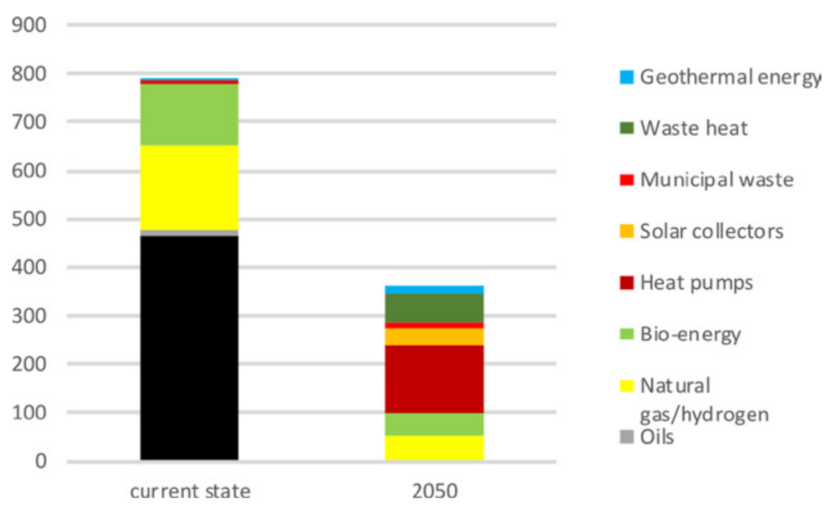
Source: Forum Energii on the basis of Navigant analysis

In conclusion, the higher the flexibility of energy demand from the transport and heating sectors and the ability to temporarily absorb electricity surpluses and refrain momentarily from consuming electricity without consumers losing comfort, the greater the stability of the entire electric power system.

ENERGY EFFICIENCY: A KEY STEP FORWARD

In Poland, heating consumes about 1/3 of the total primary energy stream. 26 million tonnes of coal, 4-5 billion m3 of gas and 9-10 million tons of biomass are used each year. These are huge amounts of fuel and energy. Electrification of the heating industry will only make sense if it is accompanied by thermal insulation of buildings. Analyses[2] show that by 2050 the energy consumption of existing buildings may decrease by about 50% provided a more ambitious strategy of thermal insulation is implemented. The rate of thermal insulation should be tripled to 3% of the total number of buildings per year and, at the same time, an effort has to be made to achieve the energy effect as foreseen by the regulations for new buildings from 2021. Lower heating needs means lower demand for electricity for heat pumps, which eventually will be the major source in individually heated buildings, as well as in district heating (Fig. 3).

FIGURE 3: STRUCTURE OF SOURCES AND ENERGY CONSUMPTION IN DISTRICT AND NON-DISTRICT HEATING SYSTEMS



Source: Forum Energii on the basis of KAPE analysis

2. PL https://forum-energii.eu/public/upload/articles/files/strategia%20dla%20cieplownictwa_pl_net.pdf
EN https://forum-energii.eu/public/upload/articles/files/strategia%20dla%20cieplownictwa_en_net.pdf

CONCLUSIONS

The analyses made by Forum Energii show that the integration of electrified transport and heating with the energy system using RES, may bring numerous benefits to Poland, such as:

- Reducing total operating costs of energy sectors by €75 billion/year.
- Cutting CO2 emissions by about 250 million tonnes per year.
- Reducing dependence on gas and oil imports.

As the objective of decarbonisation of the country is closely linked to electrification of the transport and heating sectors, legislative and organisational measures should be taken to accelerate this process.

Planning the development of the grid infrastructure should be driven by the priority of maximizing sector coupling. This will have a synergistic effect in the form of lower operating costs and investment expenditures.

Improving the energy efficiency of existing buildings is the cornerstone of electrification of the heating industry. A national strategy for building should be completed urgently and measurable targets should be adopted to reduce the use of non-renewable primary energy for heating and cooling purposes.

HYDROGEN SEEN AS A CATALYST FOR SECTOR COUPLING
- CLEAR EU GAS MARKET FRAMEWORK NECESSARY

ROLANDAS ZUKAS
CEO OF EPSO-G, LITHUANIA'S HOLDING OF ELECTRICITY AND GAS TRANSPORTATION SYSTEMS, CEEP MEMBER

The share of renewable energy resources is consistently rising in the global energy supply, with countries mapping out increasingly ambitious plans to produce up to 100 percent of energy from renewables dominated by solar and wind by 2050, on their way towards climate neutral energy sectors and economies as a whole.

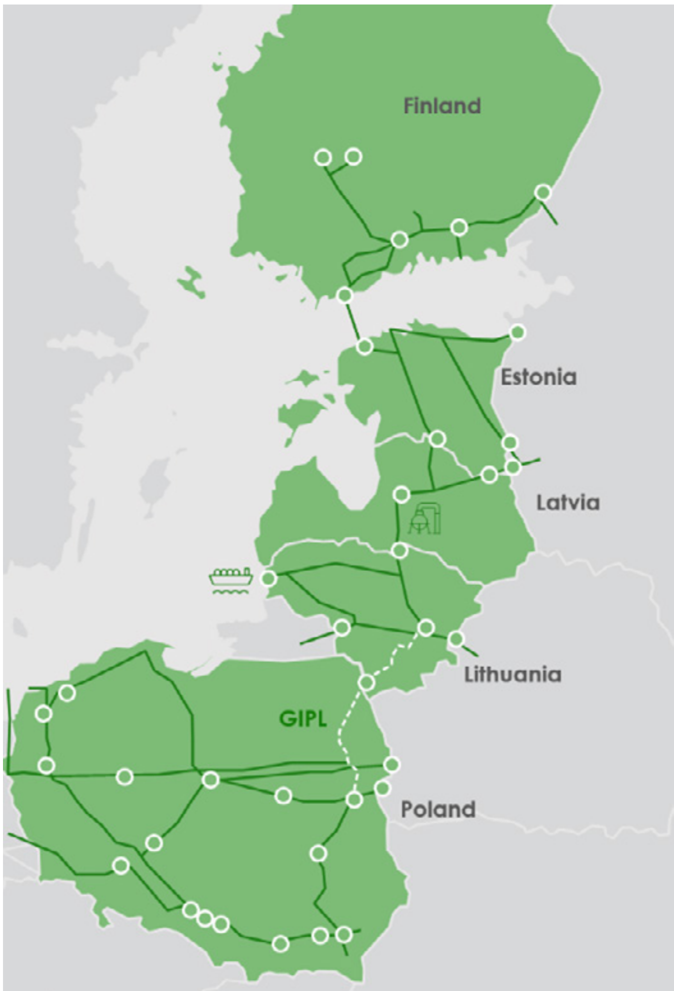
In this respect Lithuania is no exception – according to the National Energy Independence Strategy, the country aims to feed 45 percent of its total energy appetite from renewable resources by 2030, before heading to 100 percent green power within the next 30 years.

With breakthroughs in new technologies and the public mindset leaning towards renewable energy resources, the energy sector, including in Lithuania, is actively looking for options to come out with economically viable energy storage solutions to facilitate the large-scale integration of renewables to enable power grid balancing and seasonal storage, as well as the decarbonization of the gas sector through utilization of innovative technologies.

EXISTING INFRASTRUCTURE TO SERVE THE FUTURE

Power-to-gas technology is seen as a tool to feasible mid-to-long term storage of surplus intermittent renewable electricity, with hydrogen integration representing a pragmatic and cost-efficient solution for the decarbonization of hard-to-abate sectors of the economy such as transport, heating and cooling, and energy-intensive industries in particular. ▶

PICTURE. EXISTING AND GAS INFRASTRUCTURE UNDER DEVELOPMENT WILL BECOME ONE OF THE PILLARS OF CLIMATE NEUTRAL ECONOMY.



In the majority of studies on decarbonization in Europe, the decline of natural gas usage suggests a subsequent reduction of gas infrastructure utilization. However, with the switch to renewable green and low-carbon blue hydrogen (among other sustainable gases), such assets can be adopted and used for a cost-effective decarbonization across Europe.

The key role of hydrogen as a decarbonizing agent in gas grids is to reduce the carbon footprint of the gas being consumed by customers across the various end use applications (industrial, buildings, refueling, etc.).

In addition, the conversion of gas grids to hydrogen is the fastest way to fully decarbonize as it can be achieved via central and decentralized actions which tend to materialize rapidly as soon as they become commercially viable.

We believe that development of Power-to-Gas technology in the form of utility scale electrolysers and subsequent hydrogen integration can ease the transition towards a deep decarbonization, thanks to the ability of the gas grid to integrate varying geographies and scales, as well as admixtures of hydrogen into the grid.

Pipelines have a great advantage over other means of energy transmission – it can transport large energy volumes over large distances at a fraction of the cost, while doing it an efficient, safe, reliable, discreet and climate friendly manner.

While the overall hydrogen demand and renewable power supply will dictate the extent of gas grid decarbonization, hydrogen itself can be injected in the form of an admixture to the natural gas grid or used to produce synthetic methane for injection, or injected directly into a hydrogen grid.

However, at EPSO-G we see a lack of pan-European and third-party rules considering different gas mixture compositions which would determine allowed hydrogen concentration at interconnection points.

The upcoming revision of the gas market design, currently being prepared by the European Commission, to our belief should aim to provide a clear framework for the uptake of renewable and low-carbon gases and the hydrogen market.

HYDROGEN AS A CATALYST FOR SECTOR COUPLING

In these rapidly growing markets, the development of hydrogen technologies is evolving in differing manners, notably via sector coupling and sectoral integration.

Indeed, it is key to acknowledge the different roles that power-to-gas plants can have in linking the gas and electricity infrastructures, by alleviating stress on the power grid and thereby increasing renewable integration (sector coupling), or by efficiently integrating various sectors through the creation of increased market competition with the purpose of decarbonization (sectoral integration).

At EPSO-G we are in a perfect position for integrated development as both gas and power transmission system operators are part of the group.

Hence, with the help of consultants DNV GL, Lithuanian electricity TSO Litgrid is carrying out a study that links ambitious national energy goals with possible technical solutions to integrate a growing fleet of renewable energy generators, one of which is power-to-gas solution.

A survey carried out by Lithuania's gas TSO Amber Grid has found that even in a single market, different locations have a varying degree of acceptability to hydrogen concentration, both due to gas infrastructure elements and gas consumption facilities; and it might be that more complex dispatch solutions will have to be employed to maximize hydrogen content within the gas mix. There will be further analysis to ultimately define allowed content of hydrogen.

An important thing to consider is ownership of power-to-gas facilities. Having in mind the urge to become climate neutral and the relatively high construction and operation costs of such plants, the market could be stimulated by allowing TSOs to make regulated investments and auction the energy conversion capacities on transparent and equal terms.

With a view to 2050, we consider that a significant cost-effective decarbonization can only be achieved through an integrated sectoral approach, using both electricity, gas, transport and heat infrastructures.

GREEN HYDROGEN IN THE ELECTRIC POWER SYSTEM
- RESEARCH PROJECT OF LOTOS GROUP AND PSE

WOJCIECH LACH GRUPA LOTOS
WOJCIECH LUBCZYŃSKI PSE

The EU's European Green Deal policy sets new climate objectives, including zero greenhouse gas emissions and promoting the integration of all economic sectors. It poses numerous challenges to many countries, such as Poland, which are about to reshape their electricity generation portfolio. The ongoing shift in electric power systems due to the development of renewable energy sources, the long-term increase in demand for electricity, and a gradual phasing out of conventional sources because of their age and high level of carbon dioxide emissions, make it necessary to adopt a new approach to power system management.

A way to meet these challenges is to promote green hydrogen production technology with the use of electricity (Power 2 Hydrogen - P2H), which, according to the "Study on energy storage - Contribution to the security of the electricity supply in Europe"[1] commissioned by the European Commission, is to become a leading technology supporting the transition to a zero-carbon economy by 2050, allowing full use of energy generation potential by large-scale RES installations.

Accordingly, LOTOS Group, one of the two largest producers of liquid fuels in Poland, has launched a research project that will enable it to gain first experience in the use of P2H technology and investigate its impact on the national electric power system. The project is partnered by Polskie Sieci Elektroenergetyczne S.A., a transmission system operator, which, as a technical advisor, will assess the opportunity for using electrolysis installations to provide system services.

PROJECT DESCRIPTION

The project assumes the construction of the first large-scale hydrogen production installation in Poland and the use of hydrogen for refinery and sale to consumers from the transport sector, especially the public one. In the second stage of the project, LOTOS Group intends to make use of domestic fuel cells to produce electricity using hydrogen as a fuel (P2H2P - Power to Hydrogen to Power technology). For PSE, the crucial thing will be to gain knowledge about the possibility of providing system services by P2H installations and, in the long run, producing electricity and providing system services by P2H2P installations.

The project also explores the opportunities for using hydrogen from electrolysis to produce traditional motor fuels, which will contribute to the fulfilment of the National Indicative Target and the RED II requirements. The project will also provide technological know-how concerning the interoperation between RES, with time-varying characteristics of energy production on the one hand, and an electrolysis installation, a hydrogen storage and a production unit, on the other.

The project is split into two phases. The first will be a pilot, divided into two stages. Apart from preparing a feasibility study, the first stage will consist of implementing an electrolyser connected to a photovoltaic source and the power grid, as well as developing software to manage the installation. In the second stage, the extension of the electrolysis installation and its connection to the PSE transmission grid will allow an increase in its capacity.

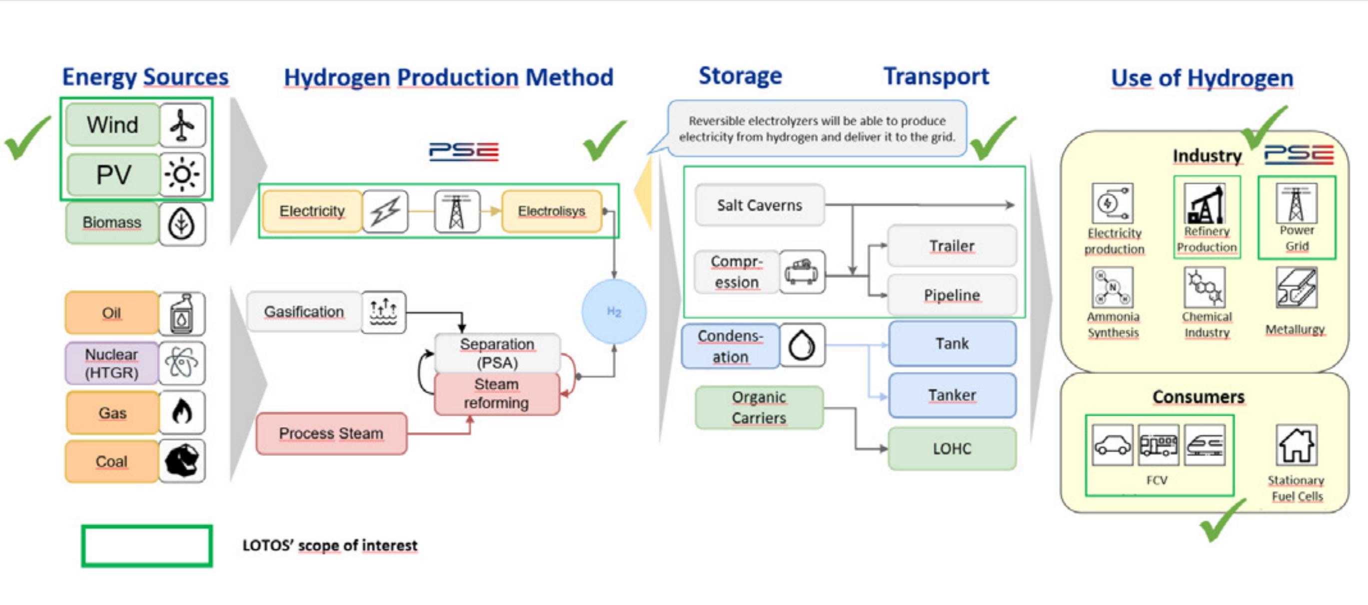
The second phase involves the use of caverns to store hydrogen and then feed fuel cells or turbines producing electricity in P2H2P technology. At the same time, the installation management software will be expanded with new functionalities.

The project will explore the possibilities of interoperation between various parts considered as one system. The aim is not to develop components of the solution, such as electrolysers or fuel cells. The installation is recommended to be built on the site of the LOTOS Group refinery. Reasons for this include the opportunity to use on site all the products of the electrolysis process (hydrogen, oxygen, heat) and provide access to utilities, including water presenting appropriate characteristics and steam derived from other technological processes at the refinery.

One of the assumptions of the project is to increase knowledge (including of procedures), in order to create similar installations in areas with high need for hydrogen. The electrolysis technology is favoured by its scalability, allowing dispersed hydrogen production according to local demand. ▶

1. "Contribution to the security of the electricity supply in Europe", https://op.europa.eu/en/publication-detail/-/publication/a6eba083-932e-11ea-aac4-01aa75ed71a1/language-en (Accessed 23 June 2020).

FIGURE 1: THE HYDROGEN VALUE CHAIN



Source: PSE and Grupa LOTOS

INTEROPERATION WITH THE ELECTRIC POWER SYSTEM

Different possibilities of using the electrolyser as part of the National Electric Power System will be tested in both phases of the project. Currently, electrolysers are able to provide demand response system services for the electric power system. For this reason, they can participate in the capacity market by providing services directly (and participating in electricity auctions as a generation unit owner), or through one of the aggregators operating in the market.

After the implementation of a new model of balancing services market in Poland, which is expected in 2021, electrolysers will be able to take part in this market. The Commission Regulation (EU) 2017/2195 of 23 November 2017 (establishing a guidelines on electricity balancing), provides that services increasing the power input to the system and those increasing the power output from the latter should be obtained separately. The project will investigate the possibility of using an electrolysis installation to provide FCR[2], aFRR[3] mFRR[4] balancing services (primary, secondary and tertiary reserve) and RR[5] services.

Full implementation of the "Clean Energy for All Europeans" package will in turn attract players capable of ensuring demand response in the flexibility market. In addition to the transmission system operator, using the potential of balancing service providers, flexibility services will also be purchased by distribution system operators, primarily for congestion management purposes.

The most important role to be played by electrolysers in the electric power system will be to deal with surplus energy generated by RES and in particular, planned offshore wind farms. The electricity produced by these sources during low demand periods will feed electrolyser installations in order to produce hydrogen to be stored and then used by fuel cells, to generate electricity when needed (P2H2P). Classic pumped storage power plants work in a similar way. Such a new value chain will contribute to the development of a zero-emission economy and facilitate the improvement of electric power system management by increasing its flexibility.

2. Frequency Containment Reserve
3. Automatic Frequency Restoration Reserve
4. Manual Frequency Restoration Reserve
5. Replacement Reserve

HYDROGEN AND SECTOR INTEGRATION: A TOPIC GAINING TRACTION IN ROMANIA

MIHAI BĂLAN AND RADU DUDĂU ENERGY POLICY GROUP

With last December's European Green Deal, the EU has firmly embarked on the pursuit of ambitious decarbonization targets for 2030 and carbon neutrality by 2050. Against that background, this year's pandemic crisis and the global economic breakdown it caused, brought to the fore the need for a green recovery, promising a complete overhaul of the EU economy and industrial strategy. In this context, new opportunities arise for the further development of sector integration and value chains for clean hydrogen, deemed essential for putting Europe on track for reaching net-zero carbon emissions by 2050, based on its applicability in hard to abate sectors, such as transport and industry.

Growing signals from public and private stakeholders, as well as politicians, indicate an awakening to the opportunities that are likely to arise in the next period, in a striking departure from the rather conservative approach towards the energy sector in past decades.

From the perspective of the Romanian National Energy-Climate Plan (NECP), in addition to the existing 4.5 GW of wind and PV capacities, Romania plans to add by 2030 almost 7 GW of renewables as part of its decarbonation efforts. However, the most important challenge is related to the flexibility of the grid and its capacity to use the power produced in the country's south-east (where most of the renewable capacities are installed), alongside the Cernavodă nuclear power plant (with existing 1.3 GW and plans to double it in the next decade).

Apart from reaching a RES share of 49.6% in the electricity sector by 2030, the NECP envisages that renewables will also have a key role in the decarbonization of the heating and cooling (H&C) and transport sectors in Romania, where it will have to reach 33% and 14.2% respectively, in the next ten years. Whilst direct electrification is the more efficient and cost-effective pathway, it can only be achieved up to a certain level. Therefore, a significant share of the market will require indirect electrification, opening up to hydrogen's potential for sector coupling.

While hydrogen-based technologies are given attention in the NECP, it is rather from a general and theoretical perspective. Aside from calling for a general study to assess hydrogen's potential in the Romanian energy mix, the NECP sets no clear targets or measures, and certainly no roadmap for sector integration.

The massive development of offshore wind capacities in other parts of Europe led to an advancement on the learning curve and substantive cost reductions of this technology. While previously largely ignored, the offshore wind potential of the Black Sea coast might become economically attractive for developers in the near future. There are already signals from private companies willing to assess the opportunity to invest in offshore wind capacities, on top of the recently published investment strategy of state-owned Hidroelectrica, the largest power producer in Romania, which includes between 300 and 500 MW of offshore wind in the Black Sea. In addition, the company is considering expanding its portfolio with green hydrogen production and storage capacities.

Taking into account the possibility of offshore wind developments in the Black Sea, combined with the high concentration of clean energy production capacities (renewables and nuclear) in the SE part of Romania (Dobrogea), and the limited grid capacity to evacuate this variable energy profile, there are clear prospects for hydrogen to become a much-needed alternative energy carrier in the region, also benefitting from the key role the Port of Constanța can play.

In the conventional power generation sector, there are plans for investments in at least 1.6 GW worth of gas-fired power generation in the next five years. Such costly assets, along with any new piece of gas infrastructure, should better be designed as "future proof" in terms of blending into a decarbonized gas industry of the future. Making them able to also work based on hydrogen is a way of securing an economical lifetime for them, thus avoiding the palpable risk of turning them into stranded assets.

One such initiative is the recently announced plan to build a gas-fired power plant along with wind and solar PV capacities to power the country's largest steel plant in Galați, a project that will transition to hydrogen use in its second phase. There is already convincing evidence from viable business cases globally that, apart from the steel industry, petrochemistry is also a suitable candidate to sector coupling. ▶

Although little attention has been given to it in Romania so far, hydrogen has recently become a hot topic, not only in the energy sector, but also at governmental level, with the Ministry of European Funds announcing a large-scale investment in an R&D hub aimed at accelerating the national implementation of hydrogen technologies. Before that, in 2018, a council reuniting multiple ministries was formally established to develop the infrastructure for alternative fuels. Just recently, the Parliament voted an update to the Energy Law that includes specific references to hydrogen and delegates responsibilities in the field to the Romanian energy regulator, ANRE, including those related to hydrogen injection.

Even more so at present, when the design of the green recovery takes place, hydrogen is expected to play an important role in making H&C, transport and industrial processes more sustainable. Therefore, it is important to attract investments to kick-start the development of the needed technologies, and hence create a smart and stable legislative and regulatory framework.

The sudden interest for hydrogen in Romania is lacking though a robust foundation in policy analysis and planning, having been fueled almost entirely by the momentum that the topic has received at EU and international levels. Indeed, other European countries such as France, Germany and Norway have already published national energy strategies, as have Australia, Japan and Korea.

Finding economically viable opportunities for sector integration, based on international cooperation in R&D and commercial projects, will be imperative to the development of a hydrogen industry in Romania. It must all start from solid business cases for hydrogen's value chains and expanding them once funding opportunities become available and technology costs decrease. This calls for a Romanian hydrogen strategy, that should involve public and private stakeholders, with a strategic roadmap of development steps and potential funding sources. It should also be anchored in the upcoming EU hydrogen strategy and coordinated with the strategies of other member states, in order to create strong business cases for the needed investments.

There are, indeed, key strategic choices to be made for the long-term regarding hydrogen's production, location of sites, and transport infrastructure, which are likely to create commercial winners and losers. Will the strategy favor massive investment in renewables and electrolysers, hence an electrification of the hydrogen production, or will it also make space for "blue" hydrogen, produced on methane steam reforming with carbon, capture, utilization, and storage capacities (CCUS)? The latter may give a lease of life to the gas sector, which is well developed in Romania, but would have to rely on the gas industry's own decarbonization plan to address the issue of residual CO2 emissions and methane leakage.

And then, for the "downstream" part, hydrogen can be transported and used either as a pure molecule, or converted into other synthetic gases such as methane, methanol or ammonia, or in synthetic fuels such as diesel, gasoline or kerosene. All these options come with their own value chains, which, on the one hand, open up more commercial opportunities but on the other hand, risk causing market fragmentation and diminished investors interest.

To conclude, it is high time, on the back of the current exuberance about the prospects of hydrogen, that Romania takes the next step towards a more systematic and mature reflection on the design of a hydrogen roadmap that is best tailored to its natural and economic specifics, while fully aligned with the EU strategies and developments.

DEVELOPMENT OF H2 SECTOR IN CROATIA

ANTUN DUJMOVIĆ THE INSTITUTE FOR DEVELOPMENT AND INTERNATIONAL RELATIONS (IRMO)

Placing the development of the H2 sector in Croatia in its legal framework and European context, it is striving to be a part of key EU initiatives for hydrogen. The following is important to be pointed out at an EU level, as the Ministry of Environment and Energy of Croatia is involved in all key initiatives of the European Union connected to hydrogen.

Croatia joined political declaration "the Hydrogen Initiative", launched at the Informal Meeting of Energy Ministers in Linz in Austria in 2018; Croatia signed the declaration on "Sustainable and Smart Gas Infrastructure for Europe" in Bucharest in 2019; Croatia also joined the Hydrogen Energy Network. On a national level, Croatia adopted "The strategy for the energy development of Croatia in the period until 2030 with an outlook for the period until 2050", which envisages a much higher share of energy from renewable sources, greater energy efficiency and a reduction of greenhouse gas emissions. The strategy indicates the importance of H2 production, and although the strategy envisages large scale introduction of hydrogen after 2030, it is of high importance as this strategy is the key document for the development of the energy sector in Croatia. The Croatian energy strategy envisages 25 hydrogen refueling stations by 2030, 50 by 2040, and 75 by 2050.

New technologies including hydrogen, are also an integral part, along with biofuels of Croatia's Integrated Energy and Climate Plan. In the foreseeable future, Croatia will also have a strategy for hydrogen.

The system of H2 production stands on three main components – solar energy, water and equipment – with an abundant source of the first two in Croatia.

Considering H2 projects, Croatia has the potential to introduce hydrogen in transportation, especially buses fueled by hydrogen in the capital Zagreb or/and other bigger cities. For that purpose, Zagreb needs to introduce hydrogen refueling stations and secure the supply of hydrogen. Hydrogen run busses in Zagreb could be from natural gas (grey) or even more favorable from renewable (green). In order to achieve this, Zagreb needs public private partnership, including from industry and the academic community. The introduction of hydrogen in public transportation for eight major cities in Croatia could cost between 160 and 300 million euros and the key obstacle here is the lack of the required infrastructure.

The other locations where hydrogen could be introduced are Croatian islands. The "Clean energy for EU islands initiative", which was launched on Croatian island Hvar in 2017, aims at energy independence of islands in Europe; hydrogen could be a good solution for Croatian islands which are home for more than 100,000 Croats. Although hydrogen is not included in this initiative, H2 could be the vital element to achieve energy independence of Croatian islands, through storing energy surpluses, and for transportation to and on islands.

Introducing H2 technology in Croatia in the everyday life of citizens, including transport, will not be without obstacles, as it requires participation of both producers and distributors of hydrogen, producers of equipment and vehicles, and users, with the appropriate regulatory framework. That means introducing significant H2 projects in Croatia.

Energy companies in Croatia also see hydrogen as a business opportunity. INA, national oil company owned by the Croatian state and Hungarian oil company MOL, produces hydrogen for its own consumption in its refinery in the coast city of Rijeka. For H2 production, INA uses natural gas and is considering producing hydrogen using water electrolysis. However, in order to expand its production of hydrogen INA needs to secure more users. To achieve this, INA is currently negotiating with the City of Zagreb on including 20% of Zagreb's buses to be run on hydrogen fuel. In order to procure 20 to 80 buses and to build a hydrogen refueling station, Zagreb needs to secure 30 million euros, which could take 2-3 years. INA's plan is to have 3 hydrogen refueling stations built in Croatia in three major cities – Zagreb, Split and Rijeka. According to EU directive 2019/1161, the share of clean buses in Croatia by year 2025 should be 27%, and by 2030 38%.

The national energy company dealing with distribution of electricity, HEP Group (Hrvatska Elektroprivreda), is considering producing hydrogen from electric energy surpluses on wind farms.

Currently, Croatia has developed two flagship projects in the hydrogen sector. The first is the Croatian hydrogen refueling station developed by the Faculty of Mechanical Engineering and Naval Architecture of the University of Zagreb. The hydrogen refueling station is based on the ecological solution of using solar energy to produce hydrogen for cleaner transport. The aim of the project is to open the first solar hydrogen refueling station – coupling a hydrogen refueling station with a solar power plant - in order to ensure the autonomy of the first Croatian hydrogen powered bicycle and to introduce hydrogen vehicles on the streets and motorways of Croatia.

A hydrogen fuel cells powered bicycle is the second flagship project in Croatia. A hydrogen powered bicycle is an electric bicycle whose electric motor obtains electric energy from a fuel cell stack with total power of 300 W. The fuel cell is a device which uses hydrogen and oxygen to produce electricity as the main product.

PROSPECTS FOR HYDROGEN TECHNOLOGIES IN SLOVAKIA

VERONIKA ORAVCOVÁ RESEARCH FELLOW, SLOVAK FOREIGN POLICY ASSOCIATION

Since the approval of the strategic document 'Energy policy of the Slovak Republic in 2014', which contains general statements such as "the importance of alternative fuels such as LPG, CNG and electric vehicles, as well as hydrogen-based drive systems, is expected to increase in transport"[1], very little has changed from the point of view of hydrogen development in the country. The future role of hydrogen is seen by the Slovak government to particularly apply to the transport sector, and there are two crucial areas where the support for hydrogen-based technologies has been emerging: legislative support and research and development.

By the end of 2019, there were no hydrogen-powered vehicles registered in the country. The crucial factor that inhibits the development is the lack of infrastructure, as there are no hydrogen filling stations accessible to the public. The first step for legislative support for development of hydrogen infrastructure - hydrogen filling stations – was only introduced by the end of 2019. In November, the government approved crucial documentation that revised and updated the National Policy Framework for the Development of the Alternative Fuels Market. The document sets national targets for hydrogen development and predicts the registration of 3,600 hydrogen vehicles by 2030. The document also supports development of hydrogen filling stations and sets specific targets to build a core network of 6 public hydrogen fillers by 2025 and 18 by 2030[2].

Moreover, the subsidy scheme supporting hydrogen infrastructure (and vehicles) has also entered into legislation with the amendment of the Act no. 71/2013 Coll. on the Provision of subsidies provided by the Ministry of the Economy. Subsidy mechanism was introduced to support the construction of hydrogen filling stations, where the eligible applicant may be the municipality or self-governing region, natural person - entrepreneur or legal entity. The beneficiary is obliged to operate a publicly accessible hydrogen filling station in the selected region for at least five years[3]. However, no subsidy programme has been launched yet.

The National Energy and Climate Plan delivered to the European Commission by the end of 2019, which updates the 2014 Energy policy strategy, lists the support of renewable energy sources (RES) for electricity, heat production and hydrogen within the energy policy priorities. According to the plan, natural gas should remain an important part of decarbonisation efforts in the immediate future, however, in the long-term perspective these should be decarbonised gases and hydrogen[4]. It is expected that hydrogen will play its role in the transport sector (with the projection to consume 2 ktoe of hydrogen produced from RES by 2030)[5]. The new programming period for 2021 - 2027 will focus especially on the use of RES: the government supports transport infrastructure aimed at electric and hydrogen vehicles. However, it is important to note that government plans to support the production of hydrogen from RES or low-carbon hydrogen, its carbon footprint should be 60% lower (e.g. with CCS or CCUS) compared to hydrogen production in the natural gas reform process) to be used in transport, industry or high-efficiency cogeneration.

In Slovakia, there are several organisations and research institutions that are focusing on hydrogen development. To support hydrogen technologies in the transition to a low-carbon economy and to shape public policy in this area, the National Hydrogen Association was established in 2015[6], and is a member of the European association Hydrogen Europe. The Association is also developing cooperation with the EU's technology initiative, the Fuel Cells and Hydrogen Joint Undertaking. In December 2018, Hydrogen Fuel Cells Slovakia was established, focusing on development of hydrogen technologies in the country. The organisation cooperates with the Slovak University of Technology in Bratislava[7]. In May 2019 Slovak R&D and battery production company InoBat, together with the Hungarian MOL Group, signed a Memorandum of Understanding for developing hydrogen technology projects in the Central and Eastern European region. This focused on sourcing and hydrogen supply and the development and testing of hydrogen-rich liquid fuel, its distribution and even recycling facilities[8]. ▶

1. Ministry of Economy (2014). Energy Policy of the Slovak Republic.https://www.mhsr.sk/uploads/files/47NgRIPQ.pdf. Accessed 30 June 2020.
2. Ministry of Economy (2019). RevíziaaaktualizáciaNárodnéhopolitickéhorámca pre rozvojtrhu s alternatívnymipalivami. https://www.economy.gov.sk/uploads/files/8Hvhoqz5.pdf. Accessed 30 June 2020.
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4. Ministry of Economy (2019). National Energy and Climate Plan, page 10. https://www.mhsr.sk/uploads/files/IjkPMQAc.pdf. Accessed 1 July 2020.
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6. Slovak National Hydrogen Association (n.d.) Národnávodíkováasociácia (NVAS). https://nvas.sk/sk/o-nas/. Accessed 1 July 2020.
7. FuelCell (n.d.) Hydrogen Fuel Cells Slovakia. https://fuelcell.sk/vodik/. Accessed 1 July 2020.
8. FuelCellsWorks (2019, May 17). InoBat and MOL Group to Develop Hydrogen Technology Projects in Central and Eastern Europe. https://fuelcellsworks.com/news/inobat-and-mol-group-to-develop-hydrogen-technology-projects-in-central-and-eastern-europe/. Accessed 1 July 2020.

It can be expected that the research of hydrogen technologies will gain also political support. The new Minister of Economy (appointed after the 2020 February parliamentary elections) Richard Sulík, admitted in June 2020 that he does not necessarily see the future of car transport in Slovakia in electromobility, but for him, it is more promising to use hydrogen in passenger transport. He also plans to set up a Centre for Hydrogen Research in cooperation with the Technical University of Košice[9]. The University, together with other institutions (P. J. Šafárik University, Slovak Academy of Science, Promatech Centre and Slovak National Hydrogen Association), also recently developed a 'Hydrogen Strategy for Košice Self-Governing Region', aiming to detect areas with high deployment of hy- drogen technologies across industrial sectors within the region[10], a unique local initiative to support hydrogen technologies.

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10. Slovak National Hydrogen Association (2020). HYDROGEN+ STRATEGY KOŠICE REGION. https://nvas.sk/Hydrogen_Study_Kosice_Region_2020.pdf. Accessed 1 July 2020.

POLAND IS JOINING THE EUROPEAN HYDROGEN ECONOMY

MAREK FOLTYNOWICZ

CLUSTER OF HYDROGEN TECHNOLOGIES, POMERANIAN CHAMBER OF COMMERCE

Climate change, along with decarbonisation of energy, is one of the key challenges for the future. This is why, on 12 December 2019, the European Council endorsed the objective of achieving a climate-neutral EU by 2050. As part of the European Green Deal, hydrogen is to be the mainstay of energy supply decarbonisation. On 22 June this year, Hydrogen Europe published its recommendations on the hydrogen strategy for Europe. As Europe is clearly banking on "green" hydrogen, what is Poland doing in this regard?

Despite reservation from the Polish government over the reach 2050 goals, Poland and Polish companies are actively involved in the implementation of the hydrogen economy. The Polish Hydrogen Strategy, currently under preparation by the Ministry of Climate, is not only to define development lines, but will also provide grounds for obtaining EU structural funds as part of the new financial framework (e.g. the Just Transition Fund).

Poland was one of the signatories of the Tokyo statement pertaining to hydrogen technologies on 23 October 2018. Poland actively promotes an economy based on hydrogen, which is used in today's transport and energy sectors.

Polish company Solaris is a renowned European manufacturer of battery (BEV) and fuel cell (FCEV) electric buses. Solaris Urbino 12 Hydrogen, the latest generation hydrogen bus, has been operating in several European cities for years. As part of its steel treatment process, Stalprodukt S.A. has launched the production of hydrogen at a quality grade of 5.0, which is required to power fuel cells. Unfortunately, there is still no hydrogen refuelling point in Poland and only one hydrogen vehicle has been registered to date (Toyota Mirai). After all, road transport in Poland produces more than 15% of CO2 emissions and therefore, widespread introduction of electric vehicles, including those with fuel cells, will significantly contribute to environmental improvement. The announced initiatives of Polish energy companies are encouraging. The aforementioned Polish Hydrogen Strategy will encompass cooperation with the largest Polish companies that run hydrogen projects.

Cluster of Hydrogen and Clean Coal Technologies has been operational in Gdańsk since 2017. Its mission is to initiate work to increase the importance of hydrogen technologies and promote hydrogen. This year, the 3rd international edition of PTCHET 2020 (Polish Conference on Hydrogen Energy and Technology) will be held, this time on-line. During last year's edition, a declaration on the creation of the Pomeranian Hydrogen Valley was signed.

A few hydrogen projects are already underway in Poland, of which the most advanced is being carried out by TAURON - Wytwarzanie S.A., the leader of the CO2-SNG consortium, grouping both Polish and French institutions. Since 2018, the consortium has been responsible for a project involving the development of a technology for the conversion of carbon dioxide obtained by combustion of fuels in industrial installations into synthetic natural gas, which is almost pure methane. Hydrogen is obtained in the process of electrolysis which is fed by the surplus of cheap electricity from renewable sources (RES) during off-peak loads. The project assumes that this may be a way to store surplus electricity from renewable sources and, at the same time, a possible solution to the problem of CO2 management.

A project called "Integrated hydrogen and biomethane in-situ generation system" (BioHyMet), undertaken by a consortium led by PGE Energia Odnawialna, is functionally similar, although still in the R&D phase. Based on its own electrolyser structure with a pump-free electrolyte refilling system and an original methanisation system, the project will use energy from a wind farm.

The oil company PKN ORLEN S.A. has experience of selling hydrogen at filling stations in Germany. It has just presented broad plans for hydrogen activity. A hydrogen hub is to be built in Włocławek with the use of hydrogen as a chlorine production by-product. Once the refuelling infrastructure is deployed, the purified hydrogen will be used by city buses. A similar hydrogen purification plant with the necessary infrastructure will be built in Płock and in Silesia region.

LOTOS SA Group has implemented the HESTOR research project consisting of storing hydrogen obtained from RES in salt caverns. Another project of this kind is also being pursued by the state-owned company PGNiG S.A. In 2018, the "PURE H2" project developed by LOTOS S.A. received financial support from the Connecting Europe Facility. A hydrogen purification plant and a distribution station will be built in Gdańsk. Warsaw and Gdańsk will both have their first hydrogen filling stations and the tender procedure for the selection of the contractor is currently ongoing.

This hydrogen is to power the city buses of Gdańsk, Gdynia, Tczew and Wejherowo. These 4 cities and towns have just received support from the FCH-REGIONS.EU to implement hydrogen buses.

▶

PGNiG S.A., has signed a contract for the construction of an electrolysis installation and a hydrogen filling station in Warsaw (the so-called Hydratank project). Similarly, ZE PAK S.A. has signed a contract for the construction of an electrolysis installation and a refuelling infrastructure in Konin. In this case, the electrolysis process will use energy generated by biomass boilers. Extremely ambitious plans have been put forward by Jastrzębska Spółka Węglowa, which intends to launch the production of hydrogen from coke-oven gas.

Finally, the HGaaS project, an innovative service solution, investigates the possibility of integrating pioneering devices into a self-regulating network of hydrogen generators. In addition, they will be interfaced with vehicles via the Internet to allow an appropriate amount of hydrogen to be reserved for refuelling at the nearest station.

All these initiatives and projects show how Poland is getting ready for a hydrogen future. After their successful completion, we will no longer be a "blank spot" on the hydrogen map of Europe.

SECTOR COUPLING: OPPORTUNITIES AND CHALLENGES FOR POLAND

KRYSTIAN KRUPA LEADER OF THE ENERGY, INFRASTRUCTURE AND ENVIRONMENT AREA, JAGIELLONIAN INSTITUTE

Sector coupling can provide Poland with an opportunity for sustainable growth based on **new technologies, whilst respecting the natural environment. The electrification of heating, industry, and transport**, underlying the concept of sector coupling, combined with an effort to reduce emissions of greenhouse gases and other pollutants into the atmosphere, will be the cornerstone of transformation.

The growing use of electricity in the Polish heating, industry and transport sectors, as a result of sector coupling, will reduce the dependence of the national economy on fossil fuels, while stimulating the **development of an innovative-based model for the electric power industry**, i.e. resting upon low and zero-emission (mostly dispersed) generation units, energy storage, smart grids and digital technologies.

DEVELOPMENT MODELS OF THE ELECTRIC POWER INDUSTRY IN POLAND

CONTINUITY MODEL

- **Based on centralised low-emission and large-scale electric power industry**, e.g. Gen III nuclear power plants or big gas-fired power plants, extension of transmission grids
- **Photovoltaics and wind power will only supplement** the mix.
- Country-scale **collective and district heating systems** based on demand-driven **gas and biomass generation units**
- **Risk of failure to meet emission reduction targets** and inherent in the financing of investment
- **Inconsistent with the objectives of EU's energy and climate policies**

INNOVATIVE MODEL

- **Based on geographically dispersed RES** (photovoltaics, wind power)
- **Low or zero emission peak-load fuel-based generation units** (natural gas, biogas and eventually green hydrogen) to **supplement the mix** in order to balance the system
- **Strengthening the role of distribution grids**
- Extensive **electrification of the collective and district heating and transport sectors**
- **Collective and district heating based on gas and biomass generation units** only in metropolitan areas
- **Green hydrogen distribution** based on existing gas networks
- **Consistent with the objectives of EU's energy and climate policies**

Source: Own study

INSTYTUT JAGIELLOŃSKI

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PROJEKT: PIOTR PERZYNA

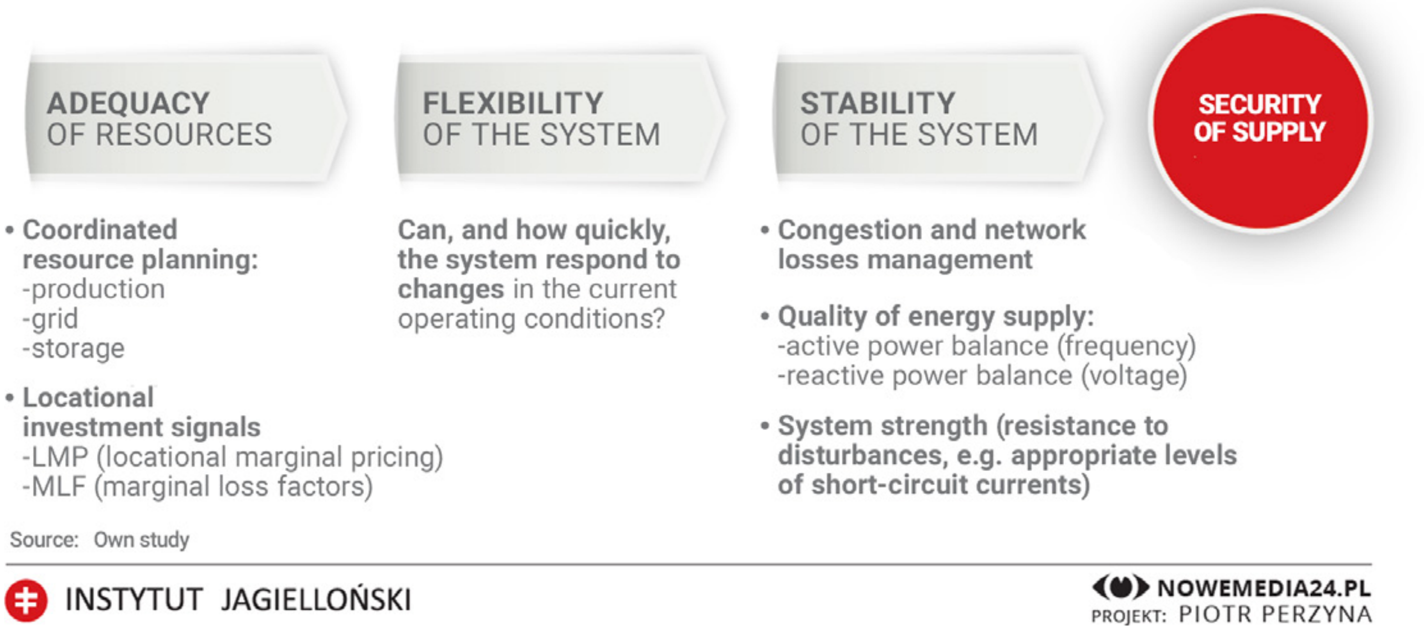
The development of low and zero-emission electricity generation technologies in Poland, in line with the spirit of sector coupling, will create the potential to reduce air pollution (carbon monoxide, nitrogen, sulphur and dust), while providing an opportunity to build energy independence upon national renewable energy resources. Import of energy carriers (e.g. nuclear or gaseous fuel) could be limited to the level necessary to supplement the energy mix.

In a broader sense, the expansion and transformation of the Polish energy mix is likely to not only propel the heating, industry and transport sectors, but also encourage:

- the growth of the national R&D sector (including closer cooperation between universities and business),
- the development of new industries related, for example, to energy-storage technologies, use of digital technologies for demand management or dispersed generation units,
- the construction of a part of or the entire national supply chain for new generation units (e.g. nuclear, photovoltaic, gas or wind) and energy storage (e.g. battery storage or green hydrogen).

In the context of sector coupling and the European Green Deal requirements, the primary objective of the development of the Polish power industry will be to meet the expected increase in demand for electricity from the heating, industry and transport sectors, while maintaining the operational safety of the electric power system (frequency, voltage) based largely on weather-dependent RES, as well as achieving the lowest possible emission levels. The above postulates should be fulfilled at the lowest possible system cost, including the total costs of electricity generation (variable and fixed), investments in the co-ordinated construction of new infrastructure (generation units, energy storage as well as expansion and digitization of the grid) and the costs of system services provision.

FIGURE 2: KEY CHALLENGES IN TERMS OF ENSURING SECURITY OF ELECTRICITY SUPPLY



Elaborating a concept and then a plan for the development of the Polish power industry, as well as ensuring financial and material resources for its implementation seem to be the key challenges on the way to achieving the above-mentioned objective. Apart from the strategic challenge, meeting the energy transition targets will be a challenge in terms of **organisation and coordination of specific areas and activities.**

It is worth noting that the development plan for the Polish power industry does not have to be fixed once and for all. On the contrary, it should be flexibly adaptable to the course of development within an innovative scheme. For this reason, **the development of the Polish electric power industry should be founded on:**

- **public discussion based on analysis and understanding of the current state and the ongoing changes,**
- **integrated planning** (simultaneous development of production, storage and grid) with a view to minimizing the total system cost.

In addition to the abovementioned strategic challenges, it is also important to mention the existence of a number of **specific challenges and highlight their multi-faceted nature** (a combination of technical, economic and legislative challenges), such as:

- development of electricity markets, enabling appropriate pricing of electricity and system services (system flexibility) and identifying possible locations for investments in new capacities
- development of solutions to manage demand, dispersed generation units, storage facilities and the power grid
- development of big data and cyber security solutions
- monitoring EU legislation and making appropriate changes to the national legal order.

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1. http://jagiellonski.pl/news/722/laczenie_sektorow_zielonej_energii_co_to_oznacza_dla_polski_raport

SYNCHRONISATION AND RENEWABLES - ARE THE ANY SYNERGIES?

LIUTAURAS VARANAVIČIUS HEAD OF STRATEGY DEPARTMENT, LITGRID

The connection between Lithuania and Poland will allow the countries to install additional 1.7 GW offshore wind farms.

The synchronization of Lithuania and its neighbors with the European electricity system will not only allow the Baltic States to break free from the Moscow-controlled energy ring, but will also provide a boost to the development of renewable energy as the energy system looks to meet the 2050 objectives.

Last month, Lithuania, Latvia, Estonia and Poland applied for EU funding from the Connecting Europe Facility (CEF) for the second largest phase of the synchronization project. The cost of the agreed projects amounts to almost EUR 1.22 billion and the largest project of this stage is the Lithuanian-Polish undersea electricity cable Harmony Link.

The implemented projects will not only prepare the Baltic electricity transmission system for connection to the continental European networks, they will also help to connect and manage renewable energy resources in electricity transmission systems, as well as protect the country's green energy targets from unfair competition from third countries.

The infrastructure for synchronization with the networks of continental Europe in the Baltic States and Poland will enable the implementation of the European Union's "Green Deal" and open other opportunities to exploit the potential of the country's renewable production sources by creating advanced services for consumers.

"HARMONY LINK" AND WIND FARMS

In the second stage, investments in Poland should reach a maximum of EUR 535.76 million. However, the country will reap an estimated EUR 350 million in benefits from offshore wind power alone from Harmony Link and the four internal lines in Poland. According to the cost-benefit analysis done by PSE, LITGRID, AST and Elering, two new and two reconstructed internal lines in Poland will allow the connecting of an additional 1,000 MW of offshore wind to the country's electricity system. It should be noted that the country will still have to build these power plants - they are not included in the synchronization project.

The electricity transmission network in the North-West of Lithuania - from Bitėnai to Jurbarkas, strengthened in parallel with the construction of Harmony Link (both needed for the synchronization project), will allow the integration of the first 700 MW of offshore wind power plants into the Lithuanian energy system. These capacities are planned approximately 30 km offshore, near Palanga. However, it should be noted that there will be no physical connection of wind farms to Harmony Link - the cable will run from Klaipeda to Poland without any stops or branches.

Finally, Harmony Link will allow more efficient electricity exchange between Lithuania and the continental EU countries, balance the electricity transmission system, and increase competition in the region. Electricity generated by wind farms requires a well-developed interconnector line infrastructure. The development of Harmony Link and internal networks in Lithuania and Poland will allow the export of surplus electricity when the wind blows.

SYNCHRONOUS CONDENSERS

In preparation for connection to the continental European networks, nine synchronous compensators in total, or three per each Baltic country, will be constructed in the electricity transmission systems of Lithuania, Latvia and Estonia. These are previously unused in Baltic energy systems and are technology devices that will ensure system reliability and power quality; they will allow smooth integration of wind farms and ensure stable voltage and frequency parameters.

As the high-voltage grid digitizes, we face new challenges in ensuring electricity parameters and balancing intermittent electricity generation. Synchronous condensers will compensate for the shortcomings of new wind technologies and ensure consumers not only a reliable electricity supply, but also high quality of electricity.

In a modern network with decreasing baseload generation, green, asynchronous energy producers should contribute to voltage management. In the past, this was usually done through cross border connections or with the help of traditional generators in the system. But we are aiming in 2050 for 100% green energy targets and this is more difficult to do with the old methods and infrastructure. ▶

Therefore, by investing in synchronous condensers we also ensure the correct network parameters for synchronous connection to the networks of continental Europe and create better conditions for the electricity transmission system of the future. By the way, we are not the only ones using synchronous condensers for an increase of electricity transmission quality, in Denmark, where the green generation is abundant, these devices are also used to solve the challenges of the network related to voltage stability.

NEW CAPACITY MECHANISM AND LOCAL GENERATION

Synchronization not only gives us opportunities, but also creates responsibilities. One of them is that we must be able to manage the emergency disconnection from Poland and ensure stable operation in 'island mode'. This may be due to natural, technical, or other conditions and is likely to occur infrequently, but is still a possibility.

The system needs to be prepared to control the frequency independently from Poland. Therefore, the Nordic assistance through the NordBalt and Estlink connections, as well as the future connection with Poland, will be very important. However, the local generation will play a key role.

We will still have to build the national electricity generation facilities that will ensure it. The market-wide capacity mechanism adopted by law in the Lithuanian Parliament on the 5th of June, will allow this to be done. In this way, we will ensure sufficient reserve power from the moment of disconnection from the Russian electricity system, in 2025. However, this will not only address the issue of independence, working in an island regime, it will also supplement the network with electricity generation equipment, which will also be used for balancing green energy in the electricity system.

THE NEW NUCLEAR POWER PLANT IN BELARUS

We must not forget the context in which we are preparing to break away from the Russian energy ring. For some time now, we have also been striving to level the playing field for electricity producers in our market and have also decided not to allow electricity to be imported from the Belarusian nuclear power plant Ostrovec, to Lithuania.

Unfair competition of production facilities include both power plants in Kaliningrad which buy natural gas at a much lower price than the European price and do not pay pollution taxes (and possibly a Belarusian nuclear power plant that does not implement all safety measures to gain market share). Market access for these producers distorts competition and creates obstacles to the transparent development of renewable energy in the Baltic region.

By disconnecting the electricity transmission lines with Belarus and Kaliningrad in 2025, and with Russia in Latvia and Estonia, we will physically eliminate these third-country electricity producers from the European market. I think this is how synchronization creates the kind of justice we have been striving for, for decades.

It is true that the President of the European Commission, Ursula von der Leyen, has promised to ensure the taxation of imported polluting electricity to achieve a "Green Deal". This would at least level the playing field for EU peripheral electricity producers. However, we in Baltic states will probably be happy with the European tax decision for several years, i.e. until 2025. Synchronization with continental Europe will then solve the problem of unfair competition and unsafe power plants when we will physically disconnect from third countries.

CEEP FEEDBACK ON SMART SECTOR INTEGRATION STRATEGY

Smart Sector Integration represents an important part of the process of transformation of European economy towards climate neutrality and as such can contribute to the European Green Deal, if properly planned and executed. Similarly to many other strategies the integration of the energy sector with industry and consumer's needs, should take into account the characteristics and restrains of sectors, businesses and technology. Therefore, there is a need to develop a comprehensive set of measures and incentives to create proper investment signals but also to encourage the right consumer behaviour.

For the sake of this paper we understand the smart sector integration as an interlinkage between energy, transport, building, industry sectors and final consumers. These links and relations which are currently rigid and often one directional, will evolved in the multidimensional areas and will impact the conduct of market participants.

In order to achieve a well-integrated clean energy system with better links between the different sectors, it is necessary to ensure that all sectors fully contribute to decarbonisation. To design this process in a cost-efficient way, the energy sector needs a cross-sectoral (electricity and gas) and holistic approach, keeping in mind all aspects: wholesale, networks, retail and potential impacts on infrastructure development.

First of all, different starting points in the energy transition journey should be taken into account. EU member states differ significantly in terms of their energy mixes, level of RES deployment and structure of heavy industry and transport sector. The strategy should be adapted to the local circumstances and offer various pathways of achieving it. There is no one-size-fits-all approach to sector integration and different starting points for Member States shall be respected.

Smart sector integration should address various policy objectives, this is to say: decarbonisation, energy security, sustainability, environmental priorities, social welfare and inclusion. Therefore, the strategy should take a holistic approach and not concentrate too much on the one aspect.

The overarching goal of the strategy should be to contribute to the future proofed EU energy system which is ready to deliver 2050 net zero emissions goal and provide EU citizens with competitive energy prices, secure energy supply and cost-effective decarbonisation.

Within the decarbonisation process, the smart sector integration should encompass the new forms of low carbon energy, their interlinks with the current system and the potential impact on the transformation and the way how they can contribute to the better integration of the internal energy market and how they can compete on the market in the future.

CEEP would like to underline the need of inclusion of the energy efficiency first principle in the strategy. It is the cheapest, most sustainable form of energy. Sector integration can bring much more into this area – both on the supply and demand side.

The key for smart sector integration seems to be electrification, since there are already many ways to decarbonise energy production. Many other sectors also witness the development of new low-emission technologies, i.e. the industrial production. However, it is crucial not to forget that in some cases it will be hard to make further progress i.e. in fertiliser production. Here, we would like to point out the need of inclusion of CCS/CCUS in the strategy.

The strategy should also look at the options how the changes to the energy systems caused by high RES penetration and the possible excess of production can be efficiently curtailed or stored. Today, EU countries spent a lot of resources for the curtailment which should be avoided in the long run. A closer look at the energy storage option, including batteries, vehicle to grid, home batteries and heat pumps, hydrogen, DSR as well as other forms of storage including PHS should be study in detail.

High penetration of intermittent renewables will require new solutions for safe operation of the power system. Changes in the behaviour of energy consumers will bring additional challenges. Thus, the digitalisation of electricity networks will be an essential factor for energy system integration bringing the flexibility solutions.

The more, investments into grid and networks of electricity and low carbon gases will be needed to make it reality. We cannot forget that high electrification of the European industry can potentially bring more bottlenecks as infrastructure limitations exist and networks are not enhanced in time, or the adaptation of energy users facilities might not be sufficient. ▸

In general, sector integration assumes significant increase in electricity production. Consequently, the energy network needs to be adapted to the changing patterns of production and consumption. This will require massive investments not only in the infrastructure itself but also in R&D.

Electricity from renewable sources will be the basis of the EU's future energy system. However, it will not be able to meet all the EU's zero-carbon energy needs. CEEP believes that gaseous energy carriers should be treated as a part of the solution for the future climate neutral economy and not only as a transition technology.

Renewable gases and hydrogen should be developed on the market basis and operate on an equal level-playing field. CEEP believes that all forms of hydrogen production should be acceptable if they contribute to reaching the targets.

Until 2030 it would be unlikely for green hydrogen to be introduced to the market without subsidies. Also, in some regions access to water required for electrolysis could pose a challenge. At the moment, it is not possible to estimate future relative costs of different form of hydrogen technologies with certainty. Thus, there is a need to invest a lot in research and development and demonstration projects in the coming years in order to have some of the pilot industrial projects by the end of the decade.

Therefore, the support schemes should be used with cautions as in this wide variety of technologies it is not yet clear which ones will provide the best economic output and in which regions they will be suitable to be deployed. The strategy should rather concentrate to create a framework which will facilitate entering the market and scaling up of hydrogen and low carbon gases production and use.

The smart sector integration includes a variety of technologies and services and many of them are at an early stage of development and deployment (i.e. power-to-X). Its production capacity and technology readiness remain at a very low level and at the same time the costs are relatively high. There are also some concerns over the life-cycle energy losses and the form of the market for these products.

Part of the issues related to the smart sector integration should be addressed at the EU level such as the coordination of network expansions (electricity, gas, hydrogen), the development of definitions for renewable and decarbonized gases and a framework for their cross-border trading.

CEEP
Central Europe Energy Partners

Central Europe Energy Partners (CEEP) represents the energy and energy-intensive companies and institutions from Central Europe.

CEEP is the first major body to represent the energy sector companies from the region at the EU level, in order to promote balanced energy transition in accordance with technological neutrality principle, enhance regional cooperation and strengthen the region's energy security within the framework of EU energy and climate policy.

CEEP is an international non-profit association with its headquarters in Brussels (Belgium).

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