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GREEN HYDROGEN – THE MISSING PIECE IN THE EUROPEAN ENERGY MIX

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Abstract

The potential of Green (clean) hydrogen is huge. In Europe, total hydrogen demand is expected to grow to more than 45 million tons by 2050. Many sectors – from transportation to heating to heavy industry – are likely to turn to it as they seek to de-carbonize over the next few decades, with investments in the technology already soaring.

Clean hydrogen will become a cornerstone of the energy transition and de-carbonization efforts in Europe and around the globe. Green hydrogen (H2) can be used as a renewable fuel or feedstock in all major CO2-emitting sectors, including those where direct electrification is not possible.

The paper looks at the potential of green hydrogen becoming the solution, being the missing piece to the Green Deal ambitions of Europe. Europe possesses the technology and certainly can afford to create the right infrastructure to become a leader in applying, producing and the distribution of green hydrogen.

Keywords: transport, renewable energy resources, green hydrogen, de-carbonization, intelligent pipelines

JEL: O13, Q01

Introduction

The paper aims to provide economically viable conclusions that green hydrogen could be an effective solution for Europe's energy mix and could also support the transition towards green energy in a cost effective and socially just manner. The paper also looks at the potential of green hydrogen to be employed in the transportation sector.

The research also looks at the longer-term prospects for the storage and transportation of green hydrogen supplies and the costs involved to secure them as well as the decision-making process required to take place to realize them.

The methodology employed in the current analysis is based on putting together and analyzing the available and most recent developments in Europe concerning:

- Methods for producing green "clean" hydrogen
- The current so called back stoppers of the process

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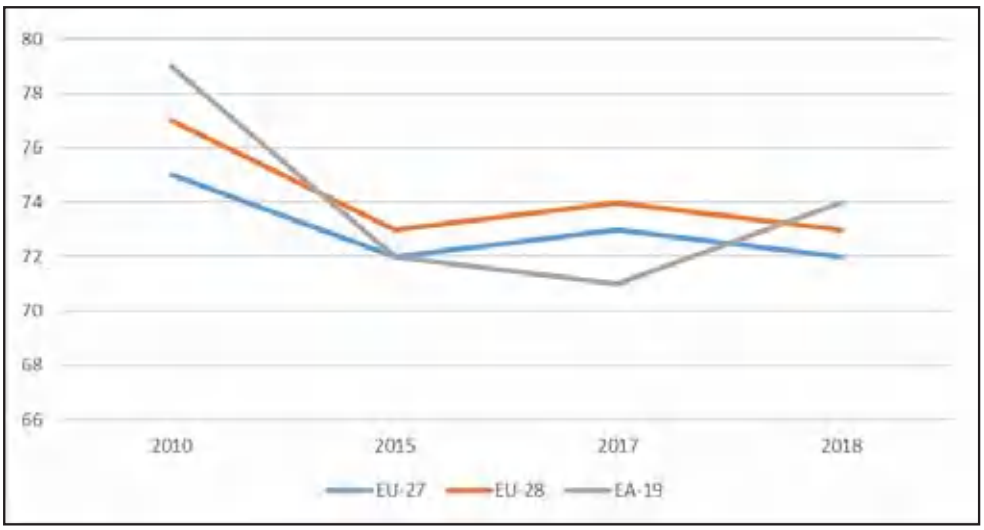
- Efficient ways of transporting green hydrogen
- Employing green hydrogen in the transportation sector



Source: The author (Eurostat, 2021).

Figure 2: Electrolysers capacity target (in tens of GW) by 2024 in some leading EU countries

Resources are (funds and R&D efforts) pouring into green (clean) hydrogen as policymakers and private investors realize that this fuel will soon become a cornerstone of the energy transition and de-carbonization efforts.

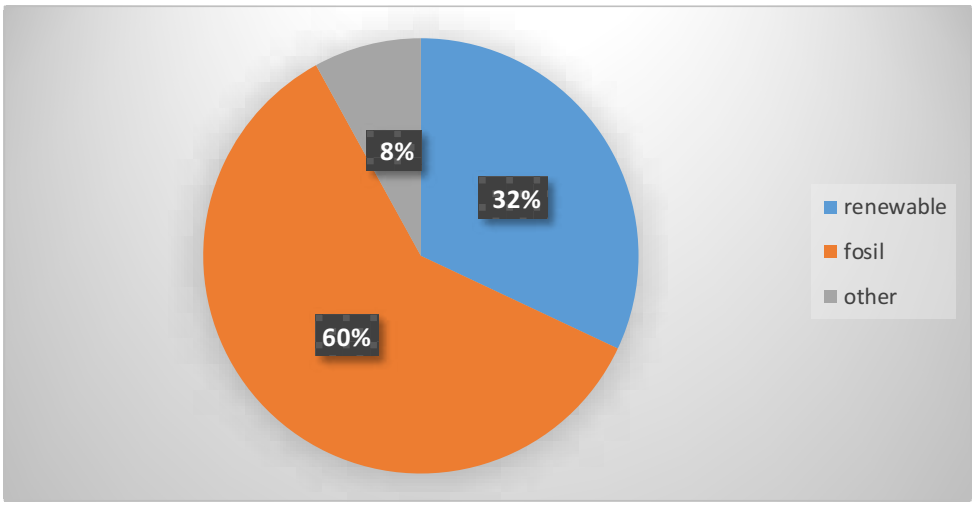
Having said that, a key component of the clean hydrogen economy has been overlooked – this is large-scale transportation to move clean hydrogen from production sites to points of use. The connectivity between production sites and demand sites is a serious pending problem. In most cases the favorable production locations are in remote, renewable-rich areas, whereas the heavily industrialized areas are usually in densely populated areas.

Clean hydrogen offers a path to de-carbonization provided it can be transported. There are three main hydrogen carrier technologies: "liquefied hydrogen, ammonia and liquid organic hydrogen carriers (LOHC). There's no single solution in terms of the balance between use and price, usually juggling between the tree is necessary (Berger, 2020).

Green hydrogen transportation

Green energy is an important part of the electricity mix, its share in the overall electricity flow continues to be meager. Renewable energy sources contribute only 38% to the European electricity mix in 2020, substantially overtaken by fossil fuels.

But the share of electricity in global final energy consumption was only 19% in 2018, and stagnating. Sectors such as heavy industry, with huge energy needs to process heat from burning fossil fuels, for example, making them difficult to electrify, and a lack of grid infrastructure to transport green power from areas of production to areas of demand, are largely to blame.



Source: The author (Eurostat, 2021), shows figuratively the disproportion in usage of fossil to renewables for electrify generation.

Figure 3: Total electricity generation for 2018 in EU-28

The wide expansion of renewable energy sites and therefore the optimization of electrolysis methods have made hydrogen (or hydrogen-gas mixtures) a very attractive solution for the transport and storage of energy with zero pollution and CO2 emissions.

Getting hydrogen from global production sites to end users at the lowest possible cost will be key to the success of the green economy. The potential for onsite green hydrogen production in European demand centers is limited.

Distributing renewable energy. Energy supply and demand don't seem to be compatible. For centuries, industry and governments have developed energy

transport and transit systems that carry fossil-fuel based energy (predominantly oil, gas and coal) from resource rich to resource poor regions.

Globally, we need to transition from distributing unsustainable fossil-fuel based energy to sustainable, renewable energy. Some countries are not well positioned to generate renewable energy, whereas others have excess capacity and potential. Hydrogen and its compounds have a high energy density and can be easily stored and transported, (re)distributing renewable energy efficiently and flexibly.

Developing pipelines for transporting hydrogen and hydrogen gas mixtures from renewable energy sources seems to be a perspective to consider. There's an urgent need for viable, large-scale clean hydrogen transportation solutions. Four hydrogen transportation technologies have the best potential: Pipelines that transport gaseous hydrogen; hydrogen transported as ammonia; liquefied hydrogen (LH2); and hydrogen stored in liquid organic hydrogen carriers (LOHC). The three non-pipeline technologies are referred to as hydrogen carriers.

PIPELINES (GASEOUS H2) – Gaseous hydrogen may be transported in pipelines, like fossil fuel. Before injection, the hydrogen is mechanically compressed to the operating pressure of the pipeline. Considering the pipeline's characteristics and native conditions, the hydrogen must be recompressed at certain distances along the pipeline before it reaches its destination.

Instead of building new pipelines, existing fossil fuel pipelines are often repurposed to move hydrogen. Bulgaria Gas Interconnector line pipe may be a recent example for a pipeline suited to carry hydrogen.

The selection of suitable materials for the construction of a hydrogen transport pipeline, as well as the certification of a product that will guarantee its long-term safe use in full operating conditions is a research priority for European industry and academia. A wide range of research collaborations is also being developed with gas distribution companies, international forums, such as European Pipelines Research Group (EPRG), and international research centers related to the subject.

Speaking of transportation, the transport sector itself is one of the main emitters of CO2. The De-carbonizing transport sector is a challenge on its own. In 2019, transport accounted for nearly 30% of the global final energy use and 23% of the total energy sector direct CO2 emissions. Reducing oil use and CO2 emissions in long-distance transport modes – heavy-duty trucking, maritime shipping and aviation – are particularly difficult because of their energy and power density requirements (Freymüller, 2021).

Battery electric vehicles (BEVs), Hybrid electric vehicles (HEVs) and plug-in hybrid electric vehicles (PHEVs) are already reducing vehicle emissions, particularly in passenger vehicles.

However, fully decarbonizing transport would require deployment of green hydrogen-powered electric cell electric vehicles (FCEVs) and battery electric vehicles (BEVs). Green Hydrogen is the leading technology to decarbonize the transport sector, including trucking and shipping. Additionally, to lowering CO2 emissions, this can support local air quality improvements and noise reductions (Lust, 2021).

Conclusion

Europe has the opportunity to be the leader-continent (the think-tank) in generating and applying new green technologies to cut back emissions and improve people's quality of life. The problems that the Green Deal is facing are often invisible to us but real figures and statistics show something different. In 2019, pollution was liable for 6.67 million deaths worldwide, including the premature death of 500,000 babies, with the worst health outcomes occurring within the developing world.

Renewable energy comes from sources or processes that are constantly disposable, but unreliable enough. These sources of energy include solar power, wind energy, geothermal energy, and hydroelectric power.

The investments to empower the renewable resources are quite high indeed but the return is fairly long-term to justify it. Europe is one of the richest continents, which makes it even more achievable to invest in the switch from fossil fuels to clean energy for the sake of the quality of the people's life.

Green hydrogen is perhaps a bigger part of the solution due to its efficiency and the existing options for storage, unlike other renewable sources. As concerns about climate change drive the energy transition, green hydrogen will likely be the solution of choice across a number of high-emission sectors (Forrest, 2021).

Hydrogen plays a key role within the energy mix towards energy transition, but only if this is based on renewable hydrogen produced by clean fuel. Not all hydrogen is the same. The molecule is the same irrespective of how hydrogen is produced, but if hydrogen is produced from gas or coal, or with electricity generated by burning gas or coal, then there is nothing clean or green about it. In fact, the CO2 emissions from fuel hydrogen production are so high that they render the entire emissions footprint of a hydrogen electric cell beyond a standard combustion engine.

While the majority of emissions can be reduced using electrification generated by renewable power, other emissions are hard to electrify, due either to greater technical challenges or the nature of the production process.

Two areas that are hard to electrify are heavy industry and heavy-duty transportation. Both have high energy demands, and in many cases, high heat

requirements or particular feedstock with strong emission profiles like: the steel production process, petrochemicals, and manufacturing aluminum etc.

Nowadays we are experiencing faster energy transition and it is required even more and more. We are experiencing historical transitions between major energy sources. Most of these shifts lasted over a century or longer and were stimulated by resource scarcity and technological innovations. As the energy mix is constantly being enriched by classical and new energy sources, the production of energy evolved significantly (Zinoviev, Nikolov, 2021).

Hydrogen policy, markets, industry and related infrastructure should be designed to support green hydrogen primarily. Green hydrogen must be prioritized and differentiated from all forms of fossil fuel and fossil fuel-derived hydrogen, including blue hydrogen. The world economies are still pouring direct and indirect subsidies for fossil fuels. These certainly have regressive social outcomes and devastating environmental impacts. Energy sector policies that promote non-green hydrogen are reinforcing these distortions.

European governments should work towards eliminating unnecessary regulatory barriers and harmonize standards across sectors. Public support for research and development is essential to lower costs and increase efficiency, including for electrolysers, fuel cells and hydrogen-based fuels.

Green (clean) hydrogen can soon become the key part of the energy transition and de-carbonization efforts. More importantly it can serve for socially just transition of the EU economies and can mitigate the risks of social exclusion.

Green hydrogen (H2) can be used as a renewable fuel or feedstock in all major CO2-emitting sectors, including those where direct electrification is not possible. By producing the gas using electrolysis powered by renewable sources, green power becomes easier to store and transport as an energy carrier, enabling sector coupling. (RNG works,2021).

Clean hydrogen can then be used as a combustion fuel in industrial or mobility applications, or be reconverted to electricity in a fuel cell.

Green Hydrogen enables reliable renewable energy:

- ✓ Electricity from renewables is variable, and residential and industrial demand is often not well matched with supply. Electrolysis can convert excess electricity into hydrogen during times of oversupply and release it when demand peaks.
- ✓ Hydrogen can also be used for long-term, carbon-free energy storage as an energy buffer and strategic reserve.
- ✓ Underground storage of hydrogen is a well-established industry practice. Hydrogen can be stored over long periods of time and scales compatible with seasonal energy storage, making it a leading candidate to enable the seasonal balancing of renewable power sources.

Government support should be redirected toward more efficient, equitable and sustainable options such as the green hydrogen. This will stimulate investment and job creation.

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