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Supporting a sustainable future

EU-BASED HYDROGEN PRODUCTION: THE KEY TO ENERGY SOVEREIGNTY AND INDUSTRIAL COMPETITIVENESS

NUCLEAR

- IS A LOW-CARBON ENERGY SOURCE
- ENSURES SECURITY OF SUPPLY
- IS ENVIRONMENTALLY, ECONOMICALLY AND SOCIALLY SUSTAINABLE

EU NUCLEAR INDUSTRY IN NUMBERS

- ACCOUNTS FOR **25%** OF ELECTRICITY
- ALMOST **50%** OF LOW-CARBON ELECTRICITY
- SUPPORTS AROUND **1Mn** JOBS
- TURNOVER OF **100bn** PER YEAR

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EU-based hydrogen production: the key to energy sovereignty and industrial competitiveness

In today's rapidly evolving global landscape, the European Union (EU) is facing an energy trilemma in terms of energy security, environmental sustainability, and economic competitiveness. As a result, it must find a balance between ensuring a reliable and affordable supply of energy, reducing greenhouse gas emissions, and supporting economic growth. Reimagining how hydrogen, a versatile and clean energy carrier, can play an important leading role in transforming the energy system is key in this respect.

A recent survey[1] shows that intensive gas buyers expect to reduce their gas demand in the future, in large part by fuel switching i.e. adopting hydrogen or synthetic gases produced via hydrogen.

For the time being, the European Commission's focus is primarily on hydrogen produced exclusively from renewables, with a significant share of this hydrogen being imported from third countries, notably from the global south. This will result in an important increase in energy demand due to transportation and losses while potentially exploiting countries where energy poverty is high and affecting Europe's energy sovereignty by creating a dependency on imported renewable hydrogen. In addition, these plans are expected to lead to an increase in the downstream costs relating to compression, storage, and transport (with these potentially accounting for 50-80%[2] of total production costs). Enhanced quality assurance in terms of environmental impact and chemical purity of the imported hydrogen will also increase costs.

The REPowerEU plan foresaw 10 million tonnes (Mt) of domestic hydrogen production complemented with 6 to 10 Mt of imported hydrogen by 2030[3]. Following the communication on the 2040 climate targets[4], this ambitious plan has been downsized to 3 Mt, perhaps to align it with the realistic forecasts of domestic production via renewables. This is where other low-carbon energy sources, such as nuclear, could fill the gap and help meet the original ambitions, as the main target remains unchanged: Net Zero by 2050.

These unprecedented volumes of hydrogen production will serve to satisfy demand from a whole host of sectors including industrial heat, ammonia, refining and petrochemicals, ground transportation and the steel industry. For example, demand from the ammonia production sector alone could quadruple between 2030 and 2050.

In their recent energy plans, countries such as France[5] and Belgium have included the goal of becoming a leader in green hydrogen production and building a national hydrogen industry to reduce greenhouse gas emissions from energy intensive sectors such as industry and transport. This upcoming "hydrogen era" will lead to a significant increase in electricity consumption, which currently accounts for about 22% of total energy consumption in the EU[6], as most of the hydrogen will be produced via electrolysis. European electricity demand is thereby expected to increase by 500 TWh per year, starting from just below 4000 TWh per year.

Recent crises (COVID, Ukraine) have highlighted the need for a reindustrialisation strategy and greater energy sovereignty in the EU. Since 1991, industry's share of GDP in the EU has fallen by 5 points to about 15% in 2008[7], value around which it stabilised. According to a Deloitte study for UNIDEN[8], this deindustrialisation has led to the loss of 13,000 jobs in the main manufacturing industries, as well as 3 billion euros of lost income over a 20 year period. A secure supply of affordable energy is key to the development of industry.

[1] How gas buyers' needs will shape the market | McKinsey
[2] Hydrogen for Net-Zero, Hydrogen council
[3] Implementing the repower EU action plan: investment needs, hydrogen accelerator and achieving the bio-methane targets, SWD (2022) 230 final, 18.5.2022
[4] 2040 climate target
[5] French national strategy for low carbon hydrogen 2020
[6] https://www.iea.org/regions/europe
[7] https://data.worldbank.org/indicator/NV.IND.MANF.ZS?locations=EU
[8] « Le redéploiement industriel un enjeu social, économique et un instrument de maîtrise de notre empreinte carbone », Janvier 2021, Deloitte

If instead existing and dispatchable low-carbon energy sources, such as nuclear or other net-zero technologies as defined in the Net-Zero Industry Act[9] such as gas with Carbon Capture & Storage (CCS)are used to produce hydrogen, they could create a domestic backbone for hydrogen production.

The main advantage of hydrogen production via nuclear is that the load factor of the installed electrolysers will be maximized with baseload production (possibility to reach 8000h/year with nuclear and improve the lifetime and payback of the installation). One existing nuclear power plant with a capacity of 1000MW, and a capacity factor of over 90%, coupled with 1000MW of electrolysers could produce about 0.16Mt of low-carbon hydrogen per year, providing an uninterrupted supply to end-users. This output could increase further by up to 20% if coupled with High Temperature Electrolysers capable of using nuclear steam.

In terms of cost competitiveness, the reference is still the "grey hydrogen", produced directly from natural gas (without CCS) via Steam Methane Reforming in a ballpark of 1.5-2.5 EUR/kg, while emitting about 11 kg_{CO2}/kg_{H2}[10]. Renewable fields promise competitive electricity prices by the end of the decade, estimated by the Hydrogen Council[11] at 2.3 – 3.7 EUR/kg for hydrogen production upstream cost[12], but are affected by uncertain downstream costs[13] of 0.6 – 4.3 EUR/kg[14]. On the opposite, domestic production, even via nuclear technologies that may increase the upstream cost to a range between 4.3 – 6.0 EUR/kg[15] (or around 15% less if nuclear heat is used), would allow limiting the downstream cost to around 1 EUR/kg or less as they can be more conveniently deployed close to end-users. Without perspectives of long-term gas price increase, only a carbon tax of at least 150 EUR/t_{CO2} will make low-carbon options as competitive as grey hydrogen.

Domestic production of hydrogen can help solve the challenges listed above. Reindustrialization will be enabled thanks to the domestic production of hydrogen. This will in turn lead to job creation and economic growth, as well as the preservation of energy sovereignty. Furthermore, producing hydrogen domestically will support greater penetration of renewables. For example, a nuclear plant dedicated to hydrogen production would complement renewables making available additional capacity in the event there is not enough electricity being produced to meet demands from the grid.

[9] Net Zero Industry Act – final compromise text
[10] "Hydrogen production technologies and costs", Hydrogen Europe, Group of Experts on Gas 23-24 March 2021,
[11] "Hydrogen Insights 2023: The state of the global hydrogen economy, with a deep dive into renewable hydrogen cost evolution" Hydrogen Council, McKinsey & Co, December 2023

[12] production via electrolysis, including electricity cost.
[13] packing, transport, storage, and unpacking
[14] "Assessment of Hydrogen Delivery Options", European Union, 2021 – JRC124206
[15] With best-in-class electrolysers and current cost of nuclear electricity 70 -100 EUR/MWh

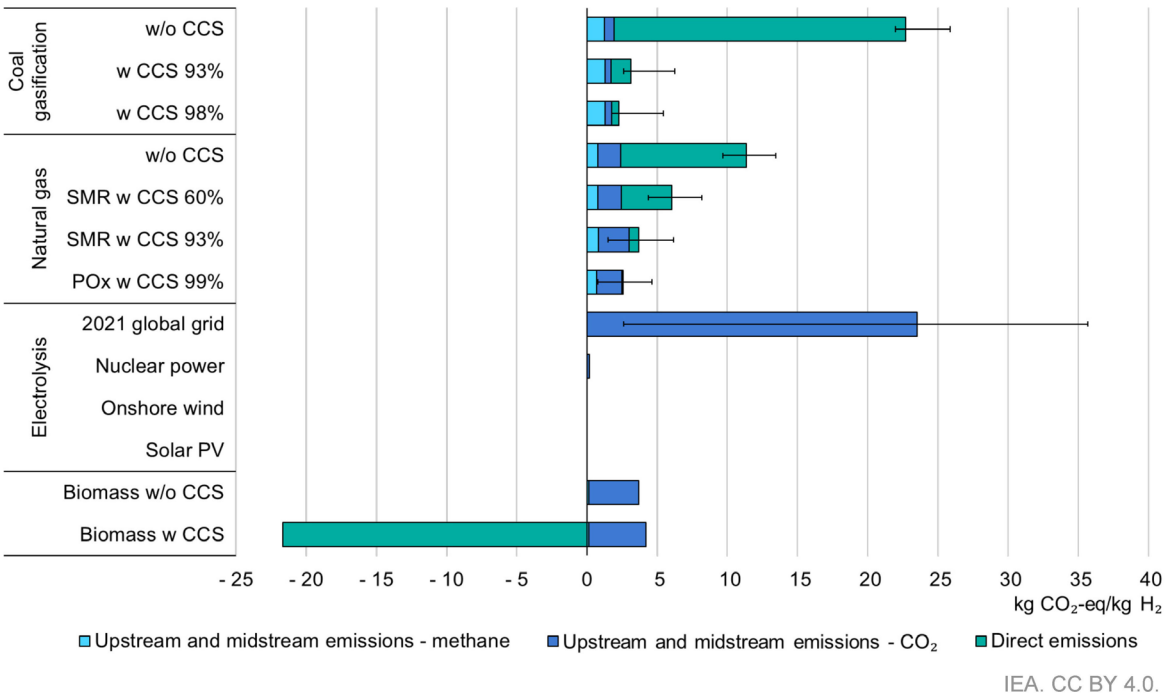
Policy recommendations:

To support the deployment of domestic hydrogen production nucleareurope recommends that the EU focus on

- Encouraging a diversified approach to hydrogen production that recognizes the potential of all net-zero technologies, including nuclear energy, to enhance energy security.
- Emphasising the importance of energy sovereignty in the context of hydrogen production. EU policies should aim to reduce dependence on imported hydrogen from third countries, thereby ensuring that European Member States maintain control over their energy future.
- Developing policies to support the growth of domestic hydrogen industries, recognising their role in reindustrialisation and job creation. Such policies should consider financial incentives, regulatory frameworks, and collaborative initiatives to ensure the competitiveness and sustainability of domestic hydrogen production facilities.
- Advocating for strategic investments in infrastructure that support domestic hydrogen production, storage, and distribution. The EU should consider developing a comprehensive hydrogen infrastructure plan that prioritises proximity to end-users, cost-effectiveness, and environmental sustainability.
- Allocating resources for research and development initiatives focused on improving the efficiency and cost-effectiveness of hydrogen production technologies, including nuclear-based methods. The EU should foster collaboration between industry, research institutions and governments to accelerate innovation in the hydrogen sector.

Appendix:

Figure 3.15 Comparison of the emissions intensity of different hydrogen production routes, 2021



About us

nucleareurope is the Brussels-based trade association for the nuclear energy industry in Europe. The membership of nucleareurope is made up of 15 national nuclear associations and through these associations, nucleareurope represents nearly 3,000 European companies working in the industry and supporting around 1.1 million jobs.

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