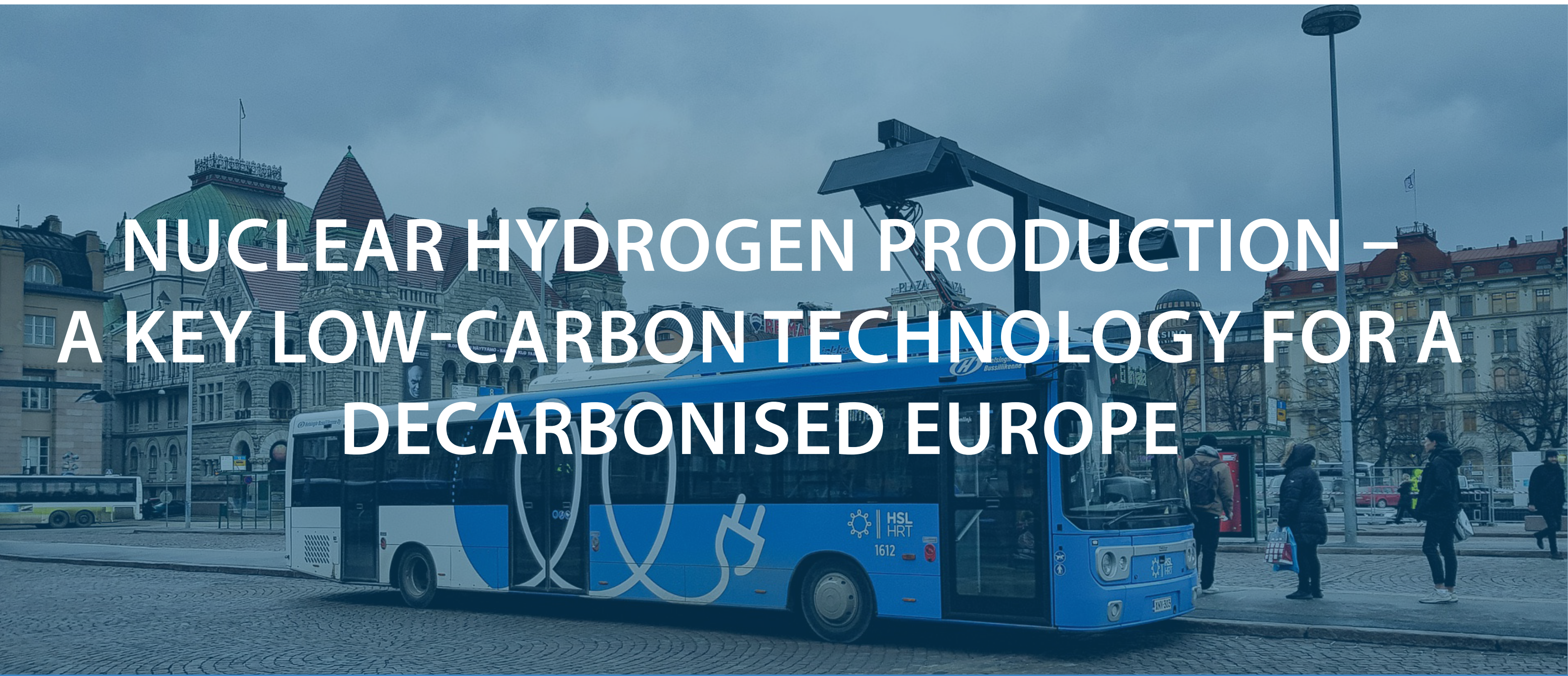
FORATOM
THE VOICE OF THE EUROPEAN NUCLEAR INDUSTRY

NUCLEAR HYDROGEN PRODUCTION – A KEY LOW-CARBON TECHNOLOGY FOR A DECARBONISED EUROPE



NUCLEAR

Is a low-carbon energy source

Ensures security of supply

Is environmentally, economically and socially sustainable

EU NUCLEAR INDUSTRY IN NUMBERS

Accounts for **26%** of electricity

Almost **50%** of low-carbon electricity

Supports around **1Mn** jobs

Turnover of **100bn** per year

May 2021

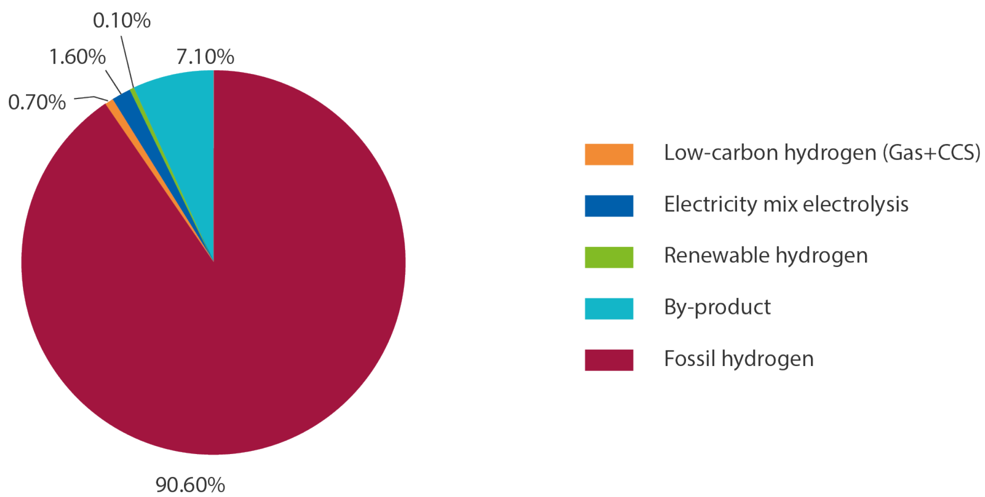
The EU has set itself the very ambitious target of decarbonising its economy by 2050. Achieving this will require a massive transformation of the energy, industry, transport and building sectors. And it will come at a cost. Whilst solutions already exist to decarbonise the power sector by 2050, hard-to-decarbonise sectors such as transport and industry remain a challenge. Whilst a limited number of sectors do already use hydrogen, this hydrogen cannot currently be considered as decarbonised as it is produced from unabated coal and gas. Therefore, the challenge is two-fold: producing hydrogen which really is low-carbon and expanding its use to a broader range of energy intensive sectors.

This position paper focuses on hydrogen produced from nuclear power or heat and the role which it can play. It aims to provide some clarity on the solutions currently under development and relevant costs, as well as a series of policy recommendations which can help unleash the hydrogen economy and thus contribute towards achieving the ambitious decarbonisation targets.

Political environment

In 2020, and as part of the European Green Deal, the European Commission issued its hydrogen strategy. According to this proposal, large scale hydrogen plants are due to be deployed across the EU in order to provide a clean source of energy for a variety of sectors . In order to do this, it is planning to provide significant support to projects, with a primary focus on renewable based option. The strategy includes a low-carbon hydrogen category, under which nuclear will definitely play an important role, even if it is not mentioned.

Hydrogen is one way of making use of excess renewable energy production, when for example there is a lot of wind and sun available. However, if sectors such as industry and transport are able to make the switch, this will require a very significant – and constant – volume of hydrogen. Given the variable nature of RES and the volume of installed capacity needed to provide a continuous supply of electricity to produce this hydrogen, will there be enough renewable electricity available to meet demand - and is this the most cost-effective approach?



Current EU hydrogen production[1]

[1] Hydrogen Europe (2020), *Hydrogen Europe 2020 monitor*

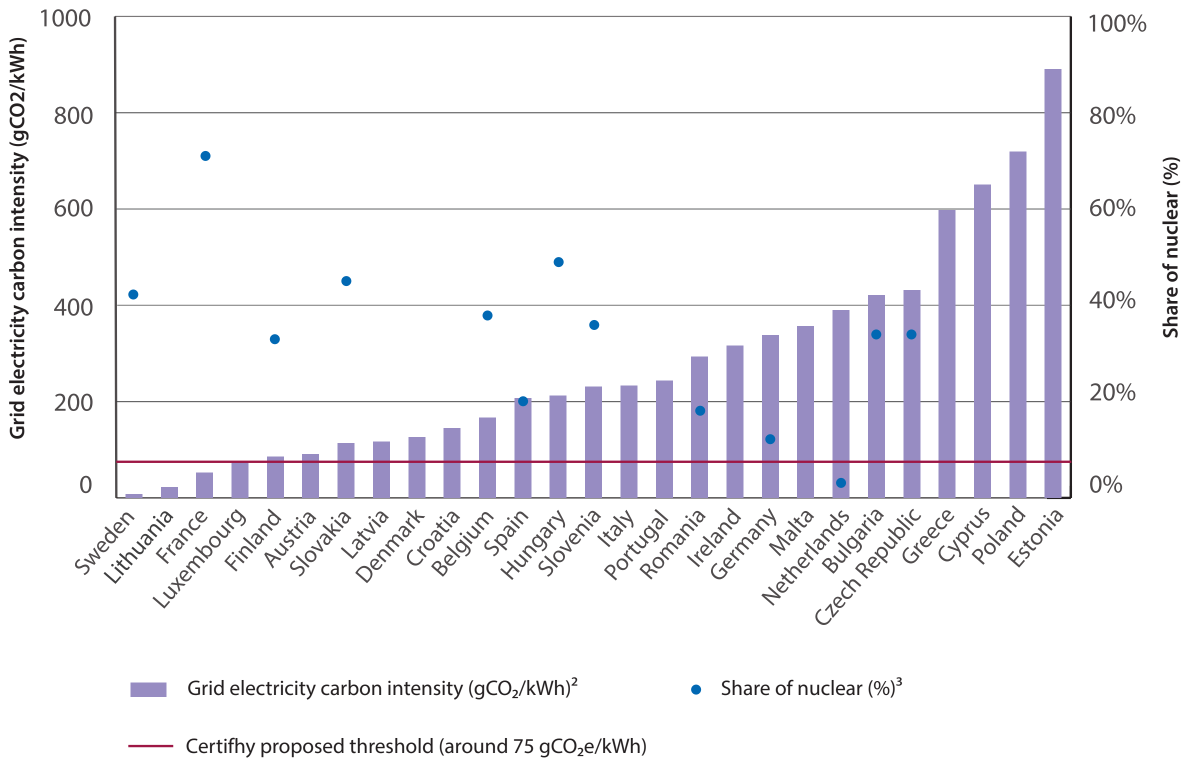
In FORATOM's opinion, it is essential that the EU apply a technology neutral approach when it comes to hydrogen projects. Given that the ultimate goal is to help sectors to decarbonise, the hydrogen strategy must support all low-carbon projects, regardless of the source of energy used to produce the hydrogen. This is why we favour a categorisation which is CO2 emission-based.

Producing low-carbon hydrogen with nuclear

Several hydrogen projects already exist, but the majority are based on unabated natural gas and even coal, which means that the hydrogen cannot be considered as low-carbon. At the same time, electrolysers capable of producing hydrogen from low-carbon electricity and water also exist. Whilst these electrolysers are considered to be a mature technology capable of providing an alternative to fossil-based hydrogen, the challenge is moving towards the large-scale use of this technology as today global electrolyser capacity only stands at around 25MW.

From an economic perspective, Electrolysers work best in a continuous, rather than stop/start, mode, which is why a steady supply of low-carbon electricity is needed. So, whilst it is possible to use renewable sources when they are available, nuclear can provide the constant supply of energy needed to keep the electrolyser running 24/7. There are two ways of doing this:

- First of all, by connecting the electrolyser directly to the grid if there is an abundant supply of low-carbon electricity available. In the case of countries such as France, Sweden and Finland, this form of hydrogen can be considered as low-carbon because their electricity grid is decarbonised thanks to a high share of nuclear production.



Grid electricity carbon intensity in the EU-27 Member States[4]

[2] European Environment Agency (2020), Greenhouse gas emission intensity of electricity generation [Data visualisation]

[3] European Commission. Directorate General for Energy. (2020). EU energy in figures : Statistical pocketbook 2020. Publications Office.

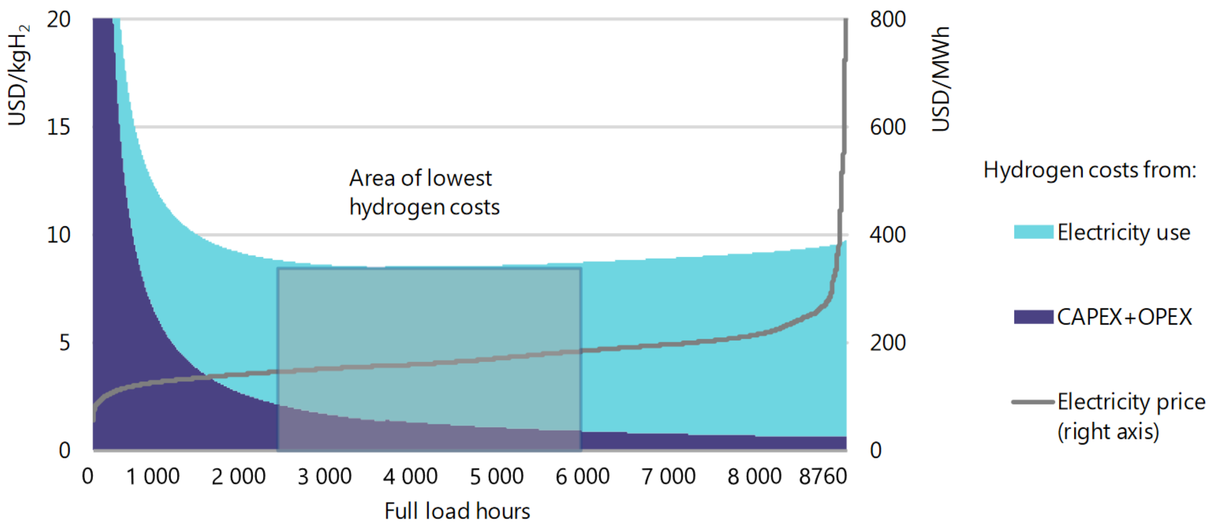
[4] European Environment Agency, *op. cit.*

- Secondly, by connecting the electrolysers directly to the nuclear power plant. This solution is both technically and economically feasible, and comes with the added benefit that the plant could provide both electricity and steam to feed the electrolysers.

Several nuclear to hydrogen projects are currently under development in Europe. For example, in the UK, the Hydrogen2Heysham project is looking into conventional low temperature electrolysis which uses cheap off-peak electricity. In addition, the Fuel Cells and Hydrogen Joint Undertaking Strategic Research Agenda also recognises that the high temperatures produced from Generation IV nuclear reactors could be potentially used in the production of Hydrogen.

Economic considerations

Today, one kg of hydrogen produced using gas equipped with carbon capture technologies costs between €1.3 - €2 (the challenge here being the large-scale deployment of CCS which still needs to be demonstrated combined with the need to store the captured CO2). This compares to between €2.6 - €9.5 per kg of hydrogen produced through electrolysis (depending on the technology). This means that in order to render hydrogen produced from low-carbon electricity economically viable, the cost of these technologies will need to fall by more than 50%. An electrolyser's CAPEX is expected to be paid off more rapidly if it somewhere between 3000 to 6000 hours per year (equivalent to 125 – 250 days/year). Indeed, this fits in with the notion mentioned above that electrolysers work best if they are run in a more continuous mode.



Notes: CAPEX = USD 800/kW$_e$; efficiency (LHV) = 64%; discount rate = 8%.
Source: IEA analysis based on Japanese electricity spot prices in 2018, JEPX (2019), *Intraday Market Trading Results 2018*.

Hydrogen costs from electrolysis using grid electricity[5]

In order to provide an affordable and sufficient supply of low-carbon hydrogen to, for example, industry, electrolysers will therefore need to run constantly on low-carbon electricity - and this is unfortunately not something which variable renewables can guarantee. **However, nuclear is both low-carbon and dispatchable, which is why it offers the perfect solution.** In addition, by connecting an electrolyser directly to a nuclear power plant this will reduce costs related to, for example, the network and taxes.

[5] International Energy Agency (2020), Hydrogen, Paris: IEA

Key policy recommendations

- Acknowledge the positive role which low-carbon nuclear energy can play in the EU's Hydrogen Strategy
- The classification of hydrogen and guarantees of origin should be based on a detailed life-cycle assessment of the carbon intensity of the source used to produce the hydrogen.
- In order to ensure rapid development of clean hydrogen projects at a more competitive cost , much more attention should be given to economic aspects and supply reliability as both are key issue for industry.
- Prioritise the assessment of **full smart system costs including LCOE and LCOH (Hydrogen), including nuclear technologies**.
- Support Innovation, Research and Development into all low-carbon hydrogen projects.
- Recognise previous research into nuclear-produced hydrogen in Europe and at international level and provide details on how this can be reflected in the EU hydrogen strategy.
- Increase synergies between the SET Plan actions, Horizon Europe and Euratom R&D programmes in relation to low-carbon hydrogen production.

About us

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

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Avenue des Arts 56
1000 Brussels
tel +32 2 502 45 95
foratom@foratom.org
www.foratom.org