# Making the business case for clean hydrogen

**Europe can lead the world on emission-free hydrogen, but it needs to solve the dilemma that industry offers the greatest potential demand, while the profit margins are in transport. Bart Biebuyck from the European Fuel Cell and Hydrogen Joint Undertaking argues the value of emission-free hydrogen must be judged by more than its price tag versus fossil fuels**

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The European Commission's landmark Green Deal that will set the EU on track to climate neutrality by mid-century is great news for hydrogen. The EU cannot become climate neutral by 2050 or deliver a 50-55% greenhouse gas emission reduction in 2030 without emission-free hydrogen. In most decarbonisation scenarios, hydrogen and its derivative fuels make up between 10% and 23% of final EU energy consumption in 2050.

The problem is that virtually all hydrogen in use today is so-called "grey" hydrogen. This is hydrogen produced from natural gas via a process which emits CO2. Capturing and storing that CO2 to create "blue" or "decarbonised" hydrogen and the ultimate goal, producing "green" or "renewable" hydrogen from water via renewable-powered electrolysis, are more expensive options that have yet to be launched at industrial scale.

Today, grey hydrogen costs around €1.50 a kilo, blue hydrogen €2-€3 a kilo and green hydrogen €3.50-€6 a kilo. Europe's flagship "hydrogen valley" project in the Northern Netherlands aims to bring the cost of renewable hydrogen down to €1 a kilo by 2030. Key to making this happen is large quantities of cheap renewable power and cheaper electrolysers. We are currently at a power price of about €50 a megawatt hour (MWh) with 10 megawatt (MW) electrolysers. We need to at least halve the power price and double the electrolyser size to have a chance of getting to €1.50 a kilo.

## PATENT LEADER

Energy-intensive industries are the biggest hydrogen consumers with annual demand of around seven million tonnes a year in Europe. With the goal of climate neutrality by 2050, there is growing interest in renewable hydrogen as one of the only options to decarbonise high-temperature processes and feedstocks.

The European Fuel Cell and Hydrogen Joint Undertaking (FCH JU), an EU public-private partnership, is helping fund a 6 MW electrolyser at a steel plant owned by Voestalpine in Linz, Austria fuelled by hydropower and a 10 MW electrolyser at a Shell refinery in Koeln, Germany. The electrolyser at the Shell plant is fuelled by wind power that would otherwise be curtailed. Overall, the FCH JU has spent €100 million on over 30 electrolysis projects.

Industry interest in electrolysers has increased as prices have dropped. The two main technologies, alkaline and polymer electrolyte membrane (PEM) electrolysers, cost around €400 and €600 a kilowatt (kW) respectively today. We expect these prices to halve to €200-300/kW within the next five years. Our next goal is to see a 20 MW electrolyser built in Europe.

To that end, the FCH JU announced on January 22, 2020 that it will provide €11 million to support a first-of-its-kind 20 MW electrolyser to be built by Nouryon and Gasunie at the Djewels project in Delfzijl, the Netherlands. The companies plan to take a final investment decision this year. In parallel, they are exploring the possibility of boosting the installation from 20 MW to 60 MW. Energy companies such as Engie and RWE already have plans for 100 MW electrolysers and the goal for 2030 is to have the first 1 GW device.

Europe is the global leader in electrolysis technology. It has filed about twice as many patents and publications as its nearest competitors — the US, China and Japan — over the last ten to 15 years. Germany, France, Italy, the UK and Denmark have led the charge. They have given us a three-year lead in electrolysis that we can — and must — maintain through continued innovation. Part of Europe's unique expertise is creating and installing electrolysers adapted to industrial complexes.

## MISMATCH

Yet final investment decisions for the first big electrolysers are pending, with the business case still insufficiently clear. Energy-intensive industries can provide the volumes to reap economies of scale in emission-free hydrogen production. But they are also the most price-sensitive of all economic sectors.

Every cent matters. Some companies are prepared to pay a premium for emission-free hydrogen, but not three to four times the "grey" price.

The potential margins are in transport. Renewable hydrogen produced at €1.50 could be sold for €6 at the pump. Transport is also where most of the policy incentives are to date, notably the EU's new renewable energy directive, which incentivises the use of green hydrogen in vehicles.

The EU's alternative fuel infrastructure directive — due to be updated in 2021 — foresees nearly 1000 hydrogen refuelling stations for an estimated one million fuel cell vehicles in Europe by 2025. The first European hybrid fuel cell bus developed by Van Hool, a Belgian company, won the best bus in the world award in 2019. Investments are starting in trucks, rail — 42% of Europe's railways are not yet electrified — shipping and even aviation. The first four-seater hydrogen-fuelled plane took off in Germany in 2016.

## COMPETITIVE HYDROGEN

"We need electrification," says Professor Katsuhiko Hirose, one of the world's authorities on hydrogen. "But we also need storage. I describe it as the milk to cheese conversion." The physicist spent nearly 40 years at car company Toyota, leading work on the hybrid Prius model before moving onto fuel cells and the Toyota Mirai, a mid-size hydrogen fuel cell car.

Hirose's argument is simple: the affordability of hydrogen depends on how you value decarbonisation. By converting milk to cheese, you can keep it for longer, it becomes a more valuable product and it can serve as a substitute for other products. Similarly, hydrogen can store power for later use, raise its value by taking that power into other sectors (such as transport or industry; sector coupling) and serve as a drop-in replacement for high value fossil fuels such diesel and jet fuel.

"If you compare hydrogen with natural gas or coal, it is expensive," Hirose told a Wind Meets Gas conference in Groningen, the Netherlands, in October 2019. "But you need to compare it with other low-carbon alternatives, such as an all-electric society. Then it starts to look more attractive." Hydrogen can make use of existing natural gas infrastructure while offering a way to decarbonise the most challenging parts of the economy. "Our goal is not a hydrogen economy," said Hirose. "It is a sustainable society."

Clean Hydrogen Europe, which is what the FCH JU will be called in future, has requested a doubling of its budget from January 2021 to extend its support beyond traditional sectors and regions: we want to start funding projects in

heavy and long-distance transport, energy-intensive industries and Central and Eastern Europe. We are in the starting blocks but must not miss the start. Climate neutrality by 2050 requires EU policies to stimulate clean hydrogen production and use across the European economy.

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