中德能源与能效合作
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FACTSHEET

THE PRICE OF GREEN HYDROGEN AND DERIVATIVES

The green transformation of economies requires green hydrogen and derivatives. However, without well-designed subsidies and sufficient carbon pricing, green hydrogen and its derivatives are not yet cost-competitive compared to its fossil counterparts.

Western Europe in general, and Germany specificially, have substantially different preconditions for the production of green hydrogen and its derivatives. Yet for both cases, a closer look on best practice examples in terms of policy design provides measures for reaching cost-competitiveness of green hydrogen and derivatives.

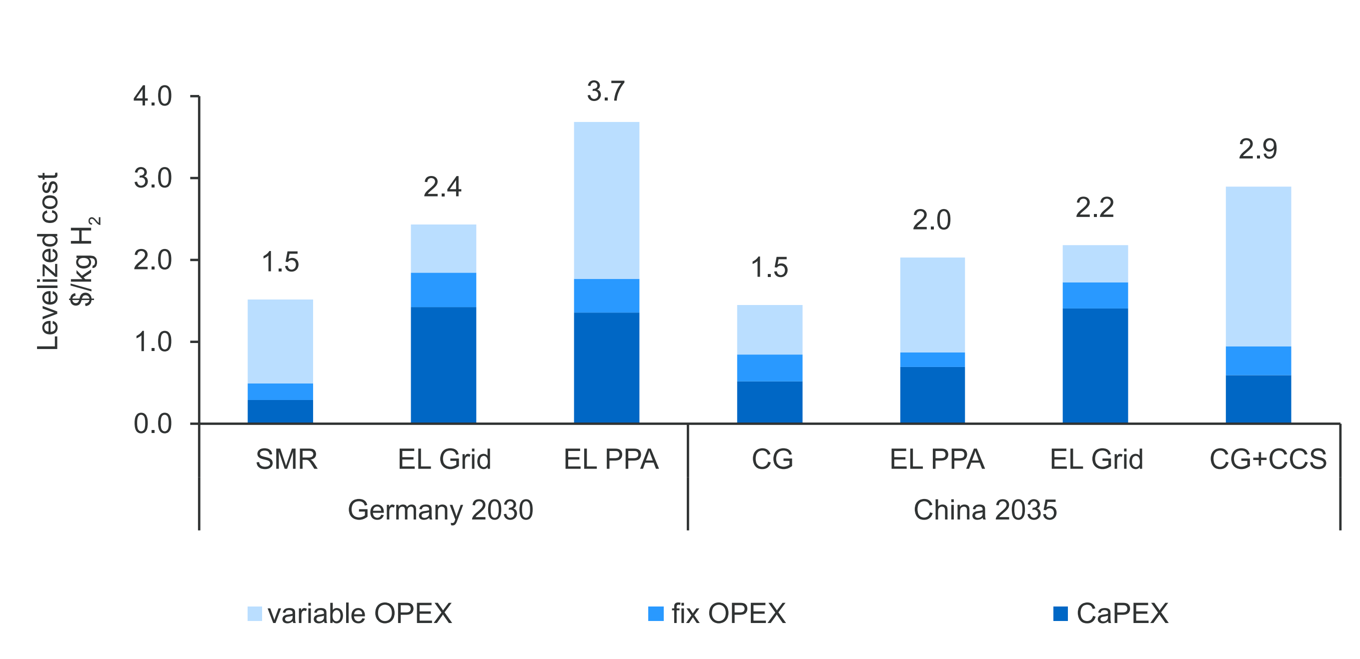
Cost of hydrogen and derivatives production in China and Germany/Western Europe

According to IEA data from 2023, the price of hydrogen production via electrolysis in Western Europe and China is as follows: produced with grid electricity prices, Western Europe has a price range of 7.1–12.4 USD/kg H_2, while in China, it ranges from 4.2–4.6 USD/kg H_2. If the electricity stems from variable renewable energy sources in 2021, Western Europe would produce hydrogen in the price range of 4.9–7.8 USD/kg H_2, while China would produce in the price range of 3.7–5.2 USD/kg H_2. According to the announced pledges scenario, the price range of variable renewable energy sources for electrolysis in 2030 is projected to decrease to 1.1–3.5 USD/kg H_2 in Western Europe and to 1.3–2.6 USD/kg H_2 in China.

The same data set for ammonia from electrolysis shows the following values: with grid electricity, Western Europe can produce ammonia at a price range of 1.510–2.568 USD/tonne, and China at 883-971 USD/tonne. In the case of variable renewable energy being the source of electricity in the base year 2021, production prices for ammonia range between 1.275–1.911 USD/tonne in Western Europe and 891–1.169 USD/tonne in China. For the announced pledge scenario for renewables in 2030, China could produce ammonia at a price of 484–709 USD/tonne, while Western Europe has a price range of 802–1.004 USD/tonne.

The study "The cost competitiveness of renewable hydrogen in China and Germany" compared the levelized costs for hydrogen from various sources for the target year 2030 in Germany and 2035 in China. In Germany, hydrogen produced via steam methane reforming of natural gas (SMR) will remain the cheapest option to produce hydrogen at 1.5 USD/kg H_2. This price corresponds to the predominant grey hydrogen production method in China, the coal gasification (CG). If CG would be used with carbon capture and storage (CCS), the price rises to 2.9 USD/kg H_2, which is the most cost intensive production method listed for China in 2035. Hydrogen produced with grid electricity would cost 2.2 USD/kg H_2 in China in 2035, while it would cost 2.4 USD/kg H_2 in Germany in 2030.

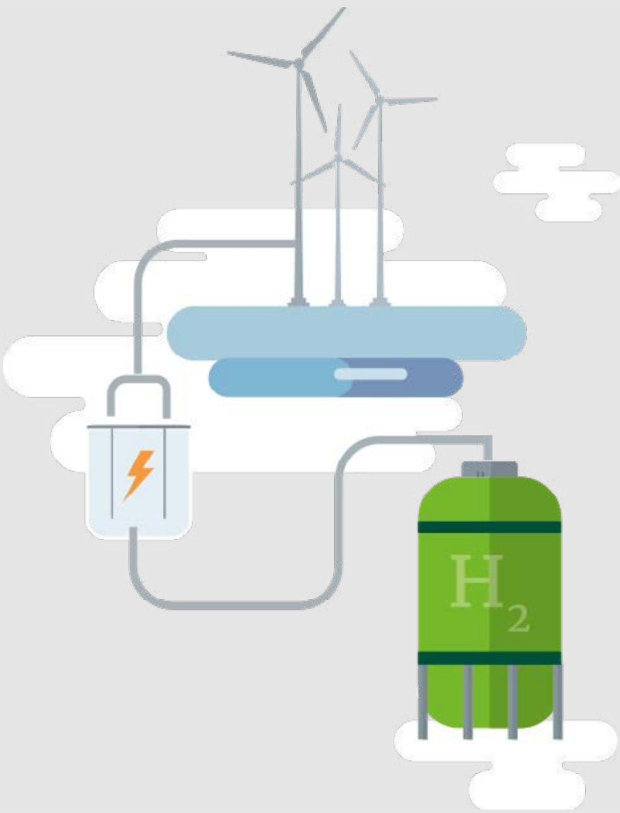
Regarding electrolysis with designated renewables purchased via PPAs, green hydrogen prices in Germany in 2030 would be 3.7 USD/kg, while being 2.0 USD/kg in China in 2035. The price difference mainly stems from higher capacity factors in China.



© Cam, E.; Moritz, M.; Schönfisch, M.; Wild, P. (2022): The cost competitiveness of renewable hydrogen in China and Germany. An analysis of the chemical, steel and aviation sector

How could green hydrogen and its derivatives become cost-competitive?

The previous section indicates that, based on the 2030 scenarios from the IEA and projected prices, green hydrogen from electrolysis is likely to become cost-competitive in China between 2030 and 2035. This is especially true with the assumption that fossil hydrogen and derivatives will need to deploy Carbon Capture and Storage (CCS). In Germany, there remains a risk that without policy measures, the cost-competitiveness will not develop. However, in both cases, policy measures can pave the way for green hydrogen sooner and avoid lock-in effects.



Generally speaking, these measures can either support cost-competitiveness by making fossil production more expensive or by subsidizing the production and/or offtake of green alternatives.

One especially effective policy measure is carbon pricing, either via taxes or tradable certificates. The advantage here is that the cheapest options for decarbonisation will be prioritised first, thereby promoting all forms of RE-based production methods. At the same time this approach increases the cost intensity of fossil production methods in comparison.

Another market-based mechanism is the construct of Carbon Contracts for Difference (CCfDs). The idea is to provide companies with a flexible subsidy to bridge the gap between conventional and green production. CCfDs are allocated by auctions to first transform the cheapest options. Once green production becomes cheaper than conventional production, the CCfD acts as a repayment mechanism. When the green products achieves price competitiveness, the CCfD can be resolved.

Hydrogen supply contracts are a further option. Here, the state acts as an intermediary to guarantee offtake for the producers and supply for the consumers while bridging the price gap.

A targeted measure to increase cost-competitiveness in predefined industries are sector-specific subsidies. Here, either the producer or the consumer receives subsidies to incentivize green production methods.

These measures can be combined and adjusted for each country and each sector. Potential secondary effects on the market must thoroughly be taken into account.

EU and US approach to the hydrogen market ramp-up

In the following, the approaches of the EU and the US to the green hydrogen market ramp-up are portrayed as examples for fundamentally different strategies.

The EU is developing a comprehensive set of directives, regulations, and funding schemes to promote the development and deployment of green hydrogen. One central element is the recently reformed EU Emission Trading Scheme (ETS) that now includes free allocation of emission certificates for green hydrogen producers until 2026 to create a level playing field with grey hydrogen producers, who already receive free allowances. This allows the green hydrogen producers to subsidize their production costs by selling the emission certificates.

Further core elements of the EU hydrogen regulatory framework are sub-quotas for 'renewable fuels of non-biological origin' (RFNBOs) – i.e. green hydrogen and derivatives – for the transport and industry sector lined out in the (provisional) Renewable Energy Directive (RED), the RefuelEU Aviation and FuelEU Maritime regulations.

Besides this regulation-focused approach, the EU has created a complex landscape of funding programs for hydrogen.

The most relevant and hydrogen-specific funding program is the European Hydrogen Bank (EHB). The proposed funding mechanism is redirecting surplus from the EU ETS channelled through the EU Innovation Fund towards the EHB. The first tranche is expected to be 800 million euros. This first funding is supposed to support green hydrogen projects with a fixed premium, which is determined via a first round of auctions in autumn.

While the EU's approach mostly incentivizes market participants to take the pending final investment decisions via regulatory frameworks and funding schemes, the US' main instrument for addressing the challenge of bringing the price for green hydrogen down is the Inflation Reduction Act (IRA).

The IRA is an investment package aiming at mitigating the potential economic impacts from transitioning towards a low-carbon economy. Within the IRA, the most important provisions for supporting clean hydrogen projects are the Clean Hydrogen Tax Credits with a planned volume of $5 billion, which are part of the energy and climate fund comprising $369 billion. Depending on the CO_2e footprint attached to 1kg of produced hydrogen accompanied by a mandatory set of employment and apprenticeship standards, projects can obtain up to $3/kg H_2 of tax credits. Some studies conclude that, if green hydrogen is eligible for full tax credits – which still has to be determined with the GHG reduction calculation methodology currently being prepared in the US – green hydrogen production in the US could even become cost-negative by 2032.

Concisely, while both the EU and the US share the goal of driving down costs for green hydrogen, their strategies differ in emphasis and complexity. While the EU focuses on regulatory frameworks with a strong incentive for renewable hydrogen, the US chose an incentive structure built on tax credits.

Legal information

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