Hydrogen production costs: is a tipping point near?

Wood Mackenzie
POWER & RENEWABLES

Report brochure

1. Key Takeaways

Executive summary

2020 may be an inflection point for the emerging low-carbon hydrogen market. When we initially assessed the cost landscape for the market, the project pipeline was sitting at 3.2GW of electrolyzer capacity. Since then, it has quadrupled.

What else has happened? The European Commission and Germany, Netherlands, Norway, Portugal, Spain released detailed hydrogen strategies looking to scale the hydrogen market dramatically this decade. Elsewhere, the largest announced green hydrogen project of 1.3GWs was launched and BP, Shell, and Repsol made commitments to deploying low carbon hydrogen projects in order to meet their net zero emissions goals.

However, the high costs to produce low carbon hydrogen are the most significant barrier to its mass adoption for use across the global energy market. How quickly will costs fall? And what will drive those cost reductions? Hydrogen production costs: is a tipping point on the horizon examines the production costs of green, blue, grey and brown hydrogen from 2020 to 2040. We use dynamic pricing to assess the competitiveness of green with fossil generation. We also expanded to include both PEM and Alkaline electrolyzers, different deployment sizes, different capex assumptions, plus added Saudi Arabia to our analysis given the activity in solar and grey hydrogen markets there.

2020 will be seen as an inflection point in the trajectory of low-carbon hydrogen

The market has been red hot even with the economic challenges created by COVID-19

In October 2019, Wood Mackenzie published its first analysis on the green hydrogen market. A wave of change has happened in the hydrogen market since then:

- The green hydrogen project pipeline consisted of 3.2GWs of electrolyzer deployments in October 2019. Today that pipeline has ballooned to 15GWs and counting.
- 22 100MW+ green hydrogen projects have been announced which in total include targets for 48GW of electrolyzer deployments by 2030
- One gigawatt scale manufacturing facility has been announced, adding to the two 1GW manufacturing facilities already under construction
- The European Commission and five countries (Germany, Netherlands, Norway, Portugal, Spain) have released detailed hydrogen strategies
- The largest ever project of 20MW is expected to be completed by year-end. And at the same time, the largest announced project of 1.3GWs was announced
- Three new blue hydrogen projects have been announced
- BP, Shell, and Repsol made commitments to deploying low carbon hydrogen projects in order to meet their net zero emissions goals
- Hundreds of new hydrogen refueling stations and fuel-cell buses deployments have been announced

Even with a multitude of challenges that await the nascent market, Wood Mackenzie more firmly believes that there will be some form of low-carbon "hydrogen economy" in the near future. We believe that given the degree of explicit policy, corporate and social support that has blossomed in 2020, green hydrogen will be able to successfully scale and realize production cost declines of up to 64% by 2040. Moreover, if additional explicit policy support comes to fruition in the coming months, perhaps costs will fall even faster, and more universally, than outlined in this analysis. The energy transition is dynamic and if 2020 is any indication, so too will be the low-carbon hydrogen landscape.

On average, green H2 production costs will equal fossil fuel based H2 by 2040

In some cases and regions that arrives by 2030. Rising fossil fuel prices will boost green competitiveness

Green costs will fall by up to 64% by 2040

With the announced project pipeline for green hydrogen projects growing from 3.5GWs to just over 15 GWs in nine months of 2020, we expect there will be large and stable enough volumes for this nascent market to scale. Sub $30/Mwh renewable electricity prices and high utilization rates will still be required for competitiveness.

Grey costs will rise by 82% by 2040

While in 2020 grey is the lowest cost hydrogen colour (ex: China), due to the forecasted increase in natural gas prices costs of grey hydrogen will rise by 82% by 2040. However in Saudi Arabia and the United States grey hydrogen will continue to be the lowest cost colour until 2040.

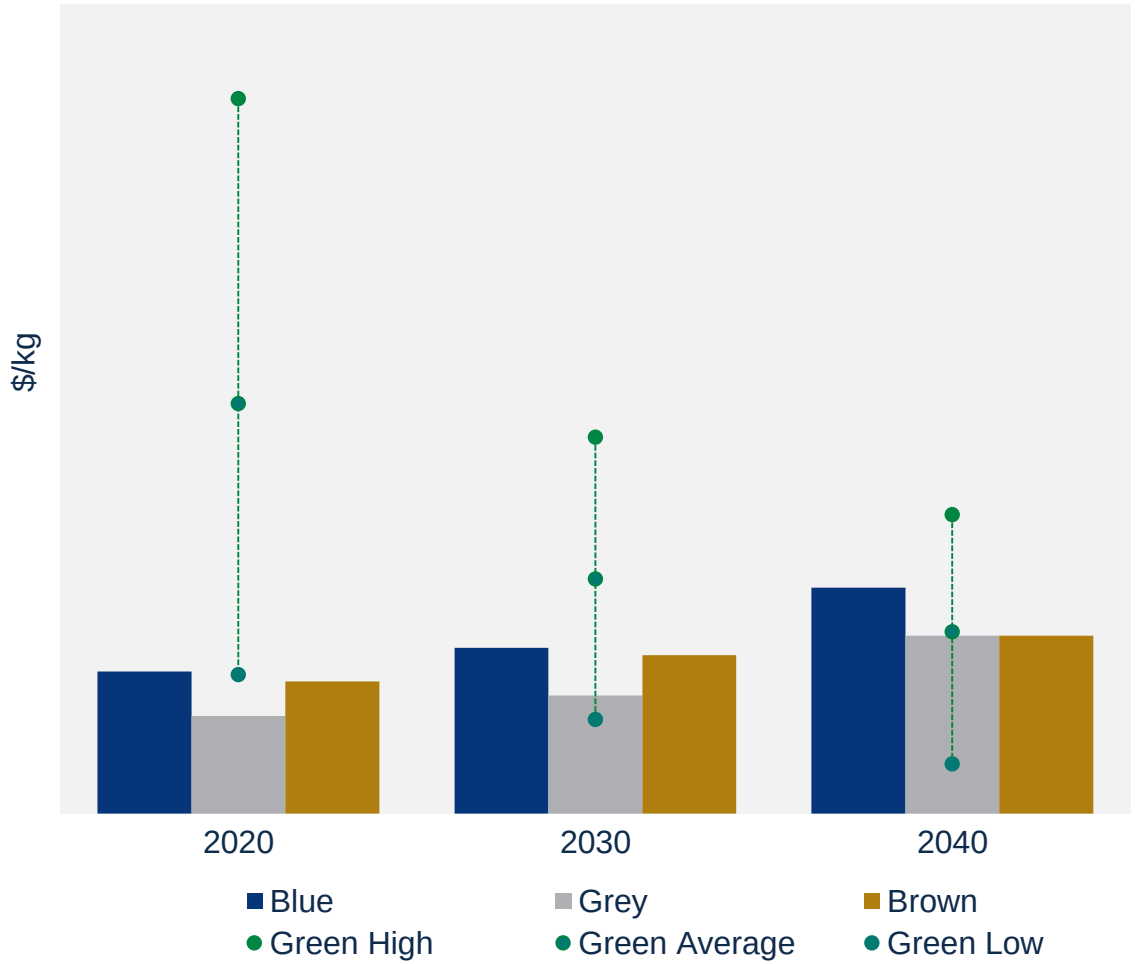
Blue costs will rise by 59% by 2040

More projects need to be deployed to accurately determine the cost trajectory of this colour. The success of blue H2 will be linked to the success of the CCS technology; which has be plagued by high costs and project cancellations. Similar to grey, the forecasted cost profile is largely determined by natural gas prices.

Brown costs will rise by 35% by 2040

Outside of China, brown is higher cost fossil fuel alternative to grey. High costs and major negative environmental externalities make this colour an unlikely option in most markets going forward.

Global average H2 production costs by type 2020 & 2040 ($/kg)



Source: Wood Mackenzie Energy Transition Service (Data available in full report)

Source: Wood Mackenzie

Wood Mackenzie uses a levelized cost of hydrogen model to examine the competitiveness of on-site green hydrogen production

Proprietary hydrogen production cost model is supported by a bottom-up electrolyzer capex model. Output provides over 50,000 data points.

Country Coverage

Factor sensitivity and variables

Green hydrogen:

- Electricity prices: grid electricity to surplus renewables
- Electrolyzer type: Alkaline or PEM
- Electrolyzer size: 2 MW, 20 MW, 200 MW
- Electrolyzer load hours: 10% to 100%
- Annual cost outlook to 2040

Blue, Grey or Brown hydrogen:

- Gas and coal prices
- Cost outlook to 2040

Source: Wood Mackenzie

Hydrogen research at Wood Mackenzie

We will be publishing at least one more report and dataset on hydrogen in 2020

Lay foundation for hydrogen research	Buildout additional datasets and coverage	Expand across all colours and long-term drivers	Forthcoming hydrogen reports
• *Green hydrogen production: landscape, production and costs* **October 2019**	• *Hydrogen mobility market* **February 2020** • *Green hydrogen project pipeline doubles in five months* **March 2020** • *Green Steel: is hydrogen met coal's kryptonite?* **April 2020**	• *2020 Hydrogen Landscape: what the last decade tells us about the future* **May 2020** • *Hydrogen production costs: is a tipping point near* **Aug 2020**	• *2040 Hydrogen Outlook* **Q4 2020**

We aim to provide the most complete proprietary datasets, analyses and insights on the hydrogen market as our work on the hydrogen economy accelerates.

Source: Wood Mackenzie

2. About the full report

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About the Analyst

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Ben is a subject-matter expert in carbon and emerging technology for Wood Mackenzie's Energy Transition Practice. His focus includes the hydrogen economy, carbon capture and storage and direct air capture, among other technologies. Prior to this role, Ben was a senior solar analyst with Wood Mackenzie specializing in PV systems and balance-of-system components. Before joining Wood Mackenzie, Ben worked in China and the U.S. in cleantech manufacturing and for the National Renewable Energy Laboratory. Ben holds a bachelor’s degree in East Asian studies from Skidmore College and a master’s degree in international environmental policy from the Middlebury Institute of International Studies.

Report access information

The report ‘Hydrogen production costs’ is only available with a subscription to Wood Mackenzie’s Energy Transition Service. The Energy Transition Service and Tool leverage our entire commodity analysis platform to deliver integrated energy market research underpinned by extensive expertise, proprietary models and robust market knowledge. It will help you gain insight into how the fuel mix will evolve and affect oil, gas, coal, nuclear and renewables.

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