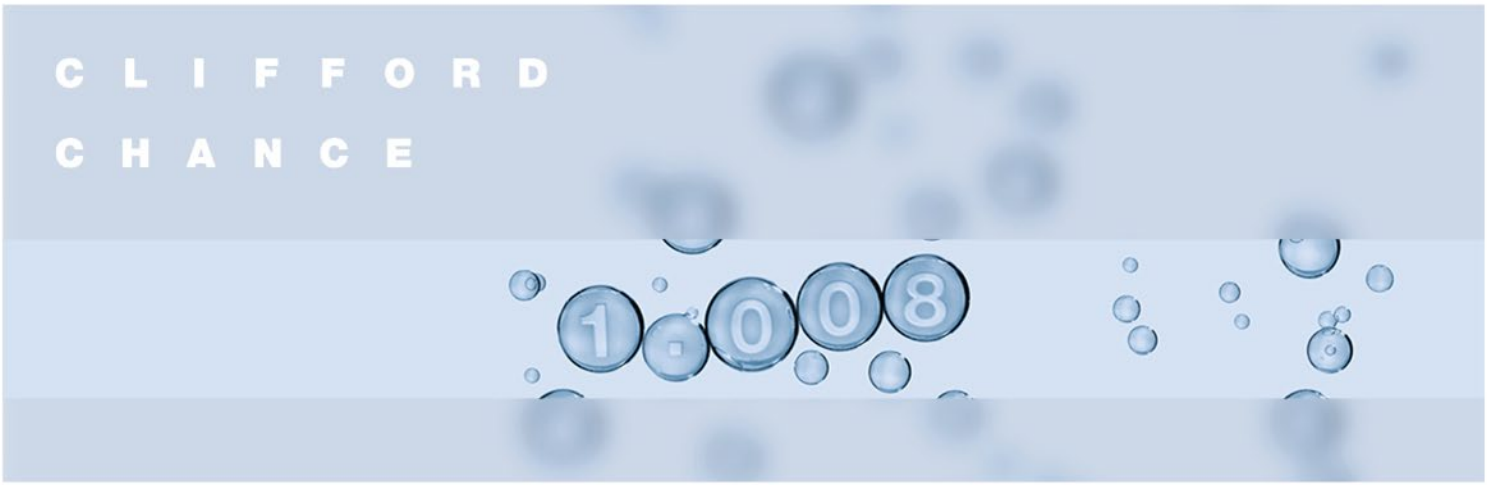

FOCUS ON HYDROGEN: ROLE OF HYDROGEN IN TURKEY'S ENERGY TRANSITION

Turkey is one of the most dynamic regions in the world for renewables. In just over a decade, Turkey has tripled its installed renewable generation capacity to around 45 gigawatts and invested nearly USD 40 billion in renewable energy projects. Building on this momentum, will Turkey be ready to stay ahead of the pack in renewable energy leadership – this time with hydrogen?

Key points

- Turkey's hydrogen road map to be published in 2021
- Hydrogen expected to be a significant part of Turkey's energy strategy
- Efforts already being made to blend hydrogen in the natural gas network and introduce into transport and electricity sectors
- Huge potential for boron to launch Turkey's hydrogen market

HYDROGEN OVERVIEW

A remarkable surplus of hydrogen exists in the universe. With its energy-carrying properties, hydrogen has many potential applications, including in electricity generation, transport and heating. As hydrogen does not release harmful emissions at the point of use, it has long been seen as having the potential to play a key role in meeting climate change goals.

Turkey has an impressive energy strategy to meet the continual rise in the country's demand for energy, including a commitment to produce at least 50% of its power from renewables by 2023, marking the centennial anniversary of the Turkish Republic. Although the impact of Covid-19 may have caused some delay in the plans, government officials have continued to emphasise the intention to promote the use of hydrogen to meet the country's ambitious sustainable energy targets.

Production of hydrogen

Hydrogen can be extracted using different methods which are typically categorised as follows:

- **'grey' hydrogen** – hydrogen extracted from fossil fuels such as natural gas
- **'blue' (low-carbon) hydrogen** – produced from fossil fuels but combined with carbon capture and storage (CCS) or other low-emission technologies
- **'green' (renewable or clean) hydrogen** – produced via electrolysis powered by renewable electricity, biogas processing or biochemical conversion of biomass.

There is also hydrogen produced from nuclear energy (some call it "pink hydrogen"), which is another production route to consider, especially for Turkey given that introducing nuclear energy into the country's energy mix has been amongst the top priority targets of policy makers and the first phase of

the Akkuyu Nuclear Power Plant, Turkey's first nuclear power plant, is expected to become operational in 2023.

Applications of hydrogen

Hydrogen is already regarded as a critical resource in some industrial supply chains, and it has the potential to reshape various sectors including renewable energy storage and transportation.

For Turkey, hydrogen's main potential applications are in the following areas:

- **transportation** – fuelling electric vehicles or in the maritime and aviation industries
- **heating** – replacing or supplementing gas heating
- **electricity** – renewable generation is used to produce hydrogen which can be stored and transformed into electricity for future use
- **industrial processes** – as an energy source in various processes, including hydrocarbon refining, fertiliser production and the steel industry.

Turkey's hydrogen efforts so far have mainly focused on transportation and heating.

Turkey completed its first hydrogen bus project in 2012 in cooperation with the International Centre for Hydrogen Energy Technology (ICHET). The same year, Turkey launched a hydrogen production and fuelling facility in Istanbul, this time in cooperation with both ICHET and the United Nations Industrial Development Organisation (UNIDO), to fuel hydrogen-powered vehicles and ships. Turkey's National Energy Efficiency Action Plan 2017-2023 promoted the use of hydrogen-powered vehicles in the transportation sector with a view to reduce carbon emissions, which has led to Turkish research institutions developing a number of successful prototypes for fuelling vehicles with hydrogen.

On the heating side, successful tests for blending hydrogen in the natural gas network are being conducted at pilot sites, and framework legislation that allows blending hydrogen into the country's wider distribution and transmission grids is expected to be introduced in 2021.

Green hydrogen

If carbon emissions can be eliminated from the hydrogen extraction process, then, seeing that the element does not emit carbon at the point of its use, green hydrogen has the potential to become a vital technology in approaching climate and environmental challenges whilst providing an accelerated transition to renewable energy.

However, it is generally recognised that to satisfy demand for hydrogen during a transition phase in which large-scale production of renewable hydrogen is gradually being achieved, renewable hydrogen is likely to be complemented by the production of low-carbon hydrogen. Accordingly, it is likely that both green and blue hydrogen will play a role in Turkey's energy transition.

SNAPSHOT OF HYDROGEN IN TURKEY

Turkey's Hydrogen Strategy

In January 2020, Turkey's Ministry of Energy and Natural Resources (**MENR**) published a "white paper" in an effort to start formal discussions for determining Turkey's hydrogen road map. The white paper sets out that, following a consultation phase, MENR will publish in early 2021 a "red paper" containing its views and recommendations for promoting the market, which is expected to be followed by a "green paper" setting out the implementation guidelines for Turkey's national hydrogen strategy.

In a workshop on the use of hydrogen in the energy sector organised by the MENR in January 2020, the Minister of Energy and Natural Resources described hydrogen as "the energy carrier of the future", which was expected to mirror Turkey's efforts to lower the consumption of oil, natural gas and other fossil fuels.

In a subsequent press release, the Minister announced the country's short-term targets for hydrogen as:

- increasing the overall generation of renewable energy;
- decarbonising the heating sector;
- generating hydrogen from local coal; and
- incentivising the use of boron for the storage and conservation of hydrogen.

2020 also saw a lot of activity around laboratory testing, supported by the government, to explore ways of blending hydrogen in Turkey's natural gas network at different grades (5%, 10% and 15%). Officials most recently announced that they would further attempt a 20% laboratory test blend and, if successful, the blending tests – currently carried out at a site near Konya, Turkey – would start to be carried out in the actual distribution and transmission system in 2021. In parallel, new legislation that would allow 1-2% blending is expected to be introduced in 2021.

Current regulatory framework

A legislative framework for regulating the licensing, production, transmission and distribution of hydrogen is yet to be established in Turkey. Legislation that could apply to hydrogen includes the Natural Gas Market Law (Law No. 4646), the LPG Market Law (Law No. 5307) or the Law on Use of Renewable Energy Resources for the purpose of Generating Electricity Energy (Law No. 5346). However, none of these instruments specifically refer to hydrogen or provide a clear categorisation that would clearly cover hydrogen.

It may be worth noting that the Energy Market Regulatory Authority of Turkey (**EMRA**) has included a vague category called "solar/hydrogen" in certain resolutions relating to construction periods for renewable energy facilities, however these resolutions lack substance to regulate hydrogen in a meaningful way.

Nevertheless, Turkish authorities, in cooperation with international bodies, universities, research institutions and private companies, have been taking promising steps on promoting hydrogen, while also introducing some 'piecemeal' legislation that could pave the way for more widespread hydrogen use in the future.

In order to set the groundwork for promoting the use of hydrogen in transportation, the Ministry of Industry and Technology of Turkey has introduced mirroring regulations adopted from the EU with respect to the technical quality standards applicable to hydrogen-powered vehicles and the use of mixed fuels, in an effort to allow the anticipated trade and traffic of hydrogen-powered vehicles to be virtually similar in both jurisdictions.

Further, the Regulation on Increasing Efficiency and Use of Energy Resources published by MENR on 27 October 2011 sets out that state institutions carrying out or supporting research and development projects connected with the use of hydrogen must prioritise economically viable projects concerning hydrogen production technologies based on renewable energy sources (such as hydro, wind, solar and geothermal energy).

More recently, on 2 May 2019, the Ministry of Transport published the Regulation on Rules and Procedures Regarding Increasing Energy Efficiency in Transportation, which lists hydrogen amongst the clean energy resources to be promoted by the Ministry of Transport in its projects as an alternative to fossil fuel.

Exploring new ways to make use of boron

Turkey's energy strategy aims in general to lessen the country's dependence on external resources, and one of the highlighted objectives is to explore new ways of making use of boron.

Turkey has approximately 72.8% of the world's known reserves of boron, which belongs to a class of elements that can effectively store significant amounts of hydrogen. Boron, with its non-flammable and non-explosive features, is listed among the major raw materials to be used in the development of sodium borohydride fuel cells (a fuel cell that converts hydrogen into electric energy), and could have a very important place in Turkey's overall hydrogen road map.

Turkey's National Boron Research Institute (**BOREN**) is keeping a very close eye on the developments around hydrogen. BOREN established its Hydrogen Technologies Laboratory in 2018, in a bid to explore innovative technologies for integrating hydrogen into a variety of strategically important industries for Turkey. In this respect, a significant dynamism has been achieved, especially in transportation, where Turkey's commercial maritime, heavy ground shipping, air travel, and public transit sectors could all be adapted to this new green energy source. As a recent showcase of boron's potential, in 2020, BOREN developed and premiered a new domestically produced zero-emission automobile prototype that runs on hydrogen and uses boron to store its fuel.

What sets Turkey apart: strong track record in renewable energy

Located at the crossroads of Asia in the East and Europe in the West and surrounded by sea on three sides, Turkey has an extensive shoreline, a vast landscape and mountain range, a rich renewable energy potential, and strong enthusiasm towards a clean energy reform – all of these factors should help Turkey to position itself as a regional hydrogen storage hub and a pioneer in the emerging hydrogen industry. With its commitment to an energy strategy to lessen the country's dependence on external resources, Turkey has an impressive track record of realising large-scale energy projects in all

renewable energy resources, including wind, solar, hydro and geothermal power.

A critical gap in global carbon emission reduction efforts may very well be filled by green hydrogen, especially in Turkey where significant progress has already been made in the renewable energy sector. Green hydrogen responds to a variety of overlooked opportunities in the existing renewable energy market, having the potential to meet the demands of heavy industry, the transportation sector, and electricity generation operations.

Turkey has clear potential to procure the necessary renewable energy input from newly constructed or contemplated onshore and offshore wind projects or large-scale solar plants or other renewable resources. To what extent such sources can be complemented by 'blue' hydrogen produced from natural gas with carbon capture is an ongoing debate. Turkey has so far proven to be enthusiastic about implementing innovative application methods in favour of this plan, initially in the heating sector, by generating hydrogen from local coal and exploring new ways to decarbonise the heating sector through blending hydrogen with methane on the gas distribution system.

BANKABILITY

The most common forms of green finance in Turkey have been green credit lines and loans made available by IFIs. Two major players are the European Bank for Reconstruction and Development (EBRD) and the World Bank. The French Development Agency (AFD), the German Development Bank (KfW) and the European Investment Bank (EIB) are also active in the Turkish green energy market, while some projects are financed or co-financed by the Asian Development Bank (ADB), the Islamic Development Bank (IsDB) and the Japan Bank for International Cooperation (JBIC) together with other multinational and local partners. The Turkish energy market anticipates a similar liquidity sources when hydrogen is introduced into Turkey's highly dynamic green finance road map, also considering the EU's strategic priority of promoting hydrogen in the coming years.

The expansion of the green hydrogen industry and the associated risks will require committed parties and a favourable environment. PPP schemes, and, at least initially, stable, long-term offtake agreements between green hydrogen producers and distributors or end-users, as well as other usage, storage, conversion, or transportation arrangements, will all be critical to the feasibility and bankability of any project. Financing options may also be limited by the creditworthiness of the parties involved and the stability of the energy market. Depending upon the electrolysis technique used, technology risk would be an important factor to assess, and, at least initially, we expect completion guarantees or fully wrapped EPCs. Ultimately, the bankability of hydrogen will become more clear once Turkey formally establishes a national hydrogen strategy and introduces forward looking legislation along with financial support schemes in line with its previous energy transition endeavours.

CONCLUSION

Renewable and low-carbon hydrogen is a source of hope for both meeting carbon emission reduction targets and fostering industrial recovery after the Covid-19 pandemic crisis. However, as was the case at the outset of wind and solar power generation, the clean hydrogen industry needs support and time to become cost-effective and competitive compared with fossil-based hydrogen and other energy sources.

Financial support schemes (including in the form of carbon pricing) and progressive legislation are examples of the support needed from governments and public authorities in order to convert hope into reality.

The EU is currently at the forefront of the global carbon zero transition agenda – the European Commission's strategic long-term vision estimates that the share of hydrogen in Europe's energy mix will grow to 13-14% by 2050.

Turkey, as the EU's sixth largest trading partner and a notable player in the global renewable arena, is also expected to build on this dynamism and roll out a clear national strategy for the use of hydrogen during the course of 2021. By joining this global trend, Turkey is not only expected to address local energy market needs but also build international market opportunities for investors.

ABOUT

Focus on Hydrogen is a Clifford Chance briefing series covering hydrogen-related developments globally. 1.008 is the standard atomic weight of hydrogen.

For other hydrogen publications, please see our thought leadership page here.

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