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Structuring Green H2 Projects: the Ambitious Plan of the Kingdom of Morocco

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H2

HYDROGEN

Structuring Green H2 Projects: the Ambitious Plan of the Kingdom of Morocco

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Since 2009, Morocco has developed an ambitious renewable energy program aimed at increasing the share of renewable energy in the national energy production and fighting the existential threat of climate change. With solar irradiance and wind levels among the highest of any country in the world and a national political commitment that reflects this potential, Morocco is set to claim its position as a true renewable energy leader both in North Africa and on the African continent as a whole.

Recently, new geopolitical factors, in particular Russia's invasion of Ukraine, have triggered an escalation in oil and gas prices while fossil fuel reserves continue to decrease faster than production in the world. It is becoming clear that if European countries are to retain and, ideally improve energy security in the future, there must be a willingness to diversify renewable resources and develop a Mediterranean energy strategy.

As intermittent energy wind and solar resources are largely influenced by the weather (even with storage technology) and current biofuel technologies are not always environmentally friendly, *"Hydrogen has the potential to become the fuel that powers a clean economy. In the years ahead, it will be possible to produce it at low cost using wind and solar power to store it underground for months, and then to pipe it on-demand to power everything from ships to steel mills"*[1].

In that context, thanks to its privileged geographic location close to Europe, with access to the Mediterranean and a wide coastline on the Atlantic, Morocco is well equipped to fulfil its ambition of becoming a major player in renewable energy and guaranteeing its energy sovereignty and supporting the energy needs of Europe.

1 Kobad Bhavnagri, head of industrial decarbonization from Bloomberg NEF.

What is Green Hydrogen and what is it for?

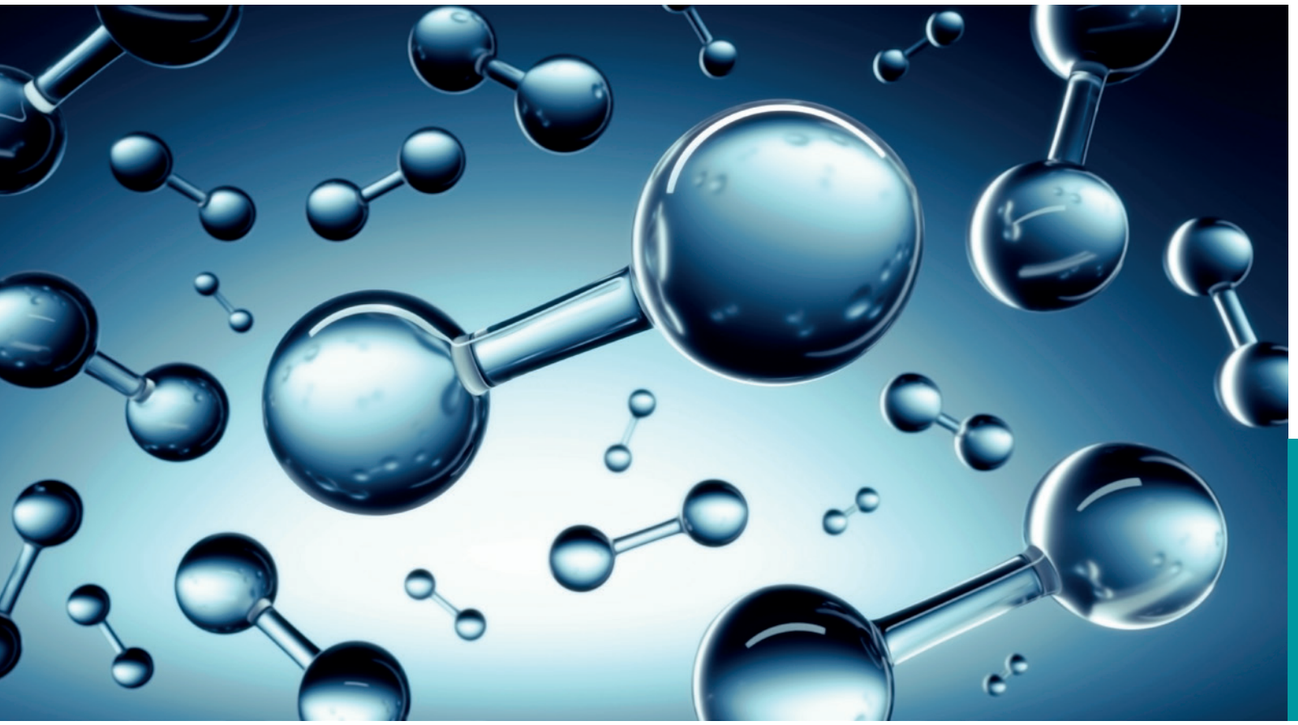
Hydrogen (H2) is assimilated to an invisible and odourless gas. This gas is a very light chemical element that is found in abundance on Earth. It is rarely found in its pure state but is part of the composition of water and hydrocarbons. Hydrogen is a source of energy that can be stored in large quantities and over the long term. Hydrogen also exists in natural form in underground deposits.

In Morocco, the Moroccan National Office of Hydrocarbons and Mines (ONHYM) is the authority in charge of the exploitation of the national potential of this type of deposit.

Green hydrogen is produced via electrolysis to divide water into hydrogen and oxygen gas. Electrolysis is a clean, renewable technique in which electric current is used to split water into hydrogen and oxygen gases. The hydrogen gas is then captured and compressed. If the electrolysis is powered with renewable energy, green hydrogen is produced with zero carbon emissions. However, it is the most difficult and expensive to produce.

Once produced, the hydrogen can be used for a variety of industrial, agricultural and transportation applications.

For hydrogen to make a significant contribution to clean energy transitions, it could be used in sectors where it is almost absent such as an exportable renewable fuel (either in liquid form or by converting hydrogen to ammonia (which can then be exported globally)), in the transport sector, to power hydrogen fuel-cell vehicles, as an energy source provided it is injected as gas into gas networks and in industry, including for fertilizer production and petroleum refining.



Moroccan Hydrogen Plan – Recent Developments

Moroccan Hydrogen Strategy

As part of a far-sighted Royal vision, a three-level strategy is being implemented by Morocco to promote the implementation of hydrogen and its derivatives.

2020 – 2030: In the short term, two pillars will be considered for the development of the green hydrogen industry in Morocco. The first involves using Hydrogen as a raw material in industry, in particular for the production of green ammonia in the fertilizer industry. The second relates to the export of products derived from green hydrogen to countries aiming to decarbonize their economy.

2030 – 2040: In the medium term, the reduction in the cost of green hydrogen products and the implementation of environmental regulations, will make it possible to develop the first projects, especially for ammonia and hydrogen, at both a national and international level.

2040 – 2050: For this period and beyond, business cases for ammonia, hydrogen and green synthetic fuels for export are expected to improve, and the technology used for the development of green hydrogen would accelerate worldwide, particularly in Morocco. This expansion will evolve further through the local use of green hydrogen in industry, for heat production and in urban mobility and other types of public transport. Some demand could appear in the transport sector, probably associated with green hydrogen used for freight, mining and public transport within the framework of the pilot projects.

National players

In 2020, the Ministry of Energy Transition and Sustainable Development has set up a “GreenH2” cluster with the aim of implementing a competitive and innovative green hydrogen production ecosystem and green hydrogen regulatory framework.

The Institute for Research in Solar Energy and New Energies (IRESEN) and the Polytechnic University Mohammed VI (UM6P) are also key players in the green hydrogen sector as they carry out significant research work on green hydrogen. In partnership with the OCP Group, IRESEN and UM6P have signed in 2021 a cooperation framework agreement aiming to set up the technological platform GREEN H2A dedicated to the R&D and to the Innovation in the field of Green Hydrogen and its applications. The platform’s intention is to raise awareness of the use of green raw materials in the industrial sector and the production of fertilizers.

The various projects in Morocco

Only a few Green Hydrogen projects are currently being developed in Morocco.

The HEVO Ammonia Morocco[2] project is a project developed by the Portuguese technology companies Fusion Fuel Green, Consolidated Contractors (CCC) and Vitol. The project aims to produce green ammonia and hydrogen[3].

The French company Total Eren is investing 100 billion dirhams (about 10.1 billion dollars) with the ambition to develop a mega-project for the production of hydrogen and green ammonia in the Guelmim-Oued Noun region of Morocco. This project should generate more than 10 GW by combining solar and wind energy.

2 The estimated total investment is 865 million dollars with the objective of achieving a production of 31,850 tons per year of green hydrogen, 151,800 T/year of nitrogen and 183,650 T/year of green ammonia.

3 3,650 tons of green ammonia in 2022, 20,000 tons in 2023, 40,000 tons in 2024 and 60,000 tons in 2025 and 2026. As for the production of hydrogen, 616 tons will be produced in 2022, 3,472 in 2023, 6,940 in 2024, 10,411 in 2025 and 2026.

Key Challenges

The enthusiasm around green hydrogen should undoubtedly be welcomed and encouraged, but while the sector remains at a nascent stage, there needs to be some pragmatism as to what green hydrogen can achieve and at what cost.

Regulation

As of today, Morocco lacks a comprehensive regulatory regime or specific regulations that address and accommodate hydrogen issues. This is common for most jurisdictions in the region.

Permitting and Licensing

Since hydrogen production facilities store, handle and process large quantities of hazardous materials and are subject to stringent safety, reporting and licensing requirements, one of the key questions is whether a hydrogen production facility will be classified as a "major hazard facility".

As indicated below, to the extend qualified as such by applicable law, the construction of green hydrogen facilities will require specific authorisations from various competent authorities.

In addition, hydrogen production facilities will be subject to various environmental regulations.

Production of electricity

As green hydrogen is not subject to a specific sectorial regulation, it seems possible for the energy production component of a hydrogen project to be developed under the regime of Law 13-09 on renewable energy as amended and supplemented, which sets out the framework, distribution and marketing terms and conditions of renewable energy.

We note that Law 13-09 provides for two regimes for the development of renewable energy production facilities, namely (i) a declaration regime for projects of less than 2 megawatts and more than 20 kilowatts and (ii) an authorisation regime for projects with an installed capacity of more than 2 megawatts.

In some jurisdiction lacking an appropriate legal framework, hydrogen production projects are structured under the energy self-consumption scheme, if the same developer is both the producer of energy and the producer of H2. This is because the energy is produced exclusively for industrial purposes i.e. the production of H2. Morocco has recently adopted a new law applicable to self-consumption projects, but its application has not yet been tested for this type of integrated project.

Transportation of the electricity from the power plant to the H2 plant

The current regulatory framework does not envisage off-grid IPPs.

If the renewable energy facility is not located in the same place as the green hydrogen production facility, the facility will need to be connected to the national grid which will transport the electricity to the green hydrogen production site.

The operator of a renewable energy facility must have the right of access to the national low-voltage, medium-voltage, high-voltage and/or extra-high-voltage electricity grid, within the limits of the available technical capacity of the grid, for the purpose of transporting electricity to the Green Hydrogen production site.

The terms and conditions related to the national low-voltage, medium-voltage, high-voltage and extra-high-voltage electricity network's access will need to be laid down in an agreement between the operator and the national transmission system operator or, where applicable, the relevant low-voltage and medium-voltage electricity network operator(s).

The recent law applicable to self-consumption projects intends to facilitate the interconnexion between the production sites and the consumption site, but remains to be seen how it will be applied in practice.

Water supply and desalination plants

Sourcing and securing a sufficient volume of suitable quality water for use in the electrolysis process is a key challenge[4]. The use of the water, depending on its source, will require an authorisation or concession and , the construction of a desalination plant may be necessary, in particular if water is sourced from the sea.

The construction of a desalination plant also requires several authorisations and permits, including (i) a building permit in accordance with the provisions of the law on urban planning and construction, (ii) a prior authorisation or declaration, as the case may be, in accordance with the regulations on unhealthy, inconvenient or dangerous establishments, (iii) an environmental acceptability decision issued after examination of an environmental impact assessment and (iv) an authorisation or concession, as the case may be, necessary to extract and use sea water.

H2 storage and transportation

Transport and storage of Hydrogen is a key issue. A number of laws and regulations may apply to the on-site storage of hydrogen and subsequent transport off-site. It is worth noting that a number of substances other than hydrogen may also be present on site during the production process, such as potassium hydroxide, which may also be subject to legal requirements.

Morocco does not have a hydrogen pipeline network and the natural gas pipeline network is relatively limited. In addition, the injection of hydrogen into a natural gas pipeline raises issues as hydrogen tends to embrittle the metal of the pipe and the welds.

In addition, there are no regulations to the construction of pipelines for the transport of hydrogen. The only existing regulation relates to gas pipelines for the transport of liquid petroleum products, liquefied petroleum gas or natural gas fuel (*Dahir 1-72-255*).

Use of pipelines for export

It is important to understand the current regulatory framework that applies to the export of hydrogen and its related substances both in Morocco and in the country of export, and if hydrogen is considered for the gas network supply, how it could participate in the domestic market.

The largest natural gas pipeline in Morocco is the Maghreb Europe Pipeline (GME) which connects directly to Europe. It is currently managed and operated by the Office National des Hydrocarbures et des Mines.

This pipeline is, to date, only used for the transport of natural gas. In the future, this pipeline could offer a critical export route for H2. If it is envisaged to use the GME for the transport of green hydrogen, it will be necessary to determine the conditions under which H2 could possibly be injected into the GME and the maximum quantity of green hydrogen to be injected while guaranteeing the proper functioning and safety of the pipeline. In the short term, it may be possible for H2 to be blended with natural gas until such time as the pipeline transitions to being solely for the transportation of H2.

4 A 100 MW capacity electrolyser consumes approximately 500 tons of water per day.

Getting the full benefit of green energy

Another challenge that H2 producers should have in mind, in particular if the green H2 is exported to the European Market are the European rules related to the guarantees of origins. In order to benefit from the advantages of the 'green energy' producers need to prove that the energy that was used to produce the H2 is green. These may be challenging if the energy is transported via the public grid between the production site(s) and the H2 plant(s) and the green H2 is then transported through the pipeline, which both transport green and non-green energy/gas.

Significant Costs requiring State Investment

Currently, green hydrogen production is roughly 10 times as expensive as natural gas production. There are few electrolysers in existence, and the renewable energy required to make the production process carbon free is limited.

For hydrogen to see widespread adoption, the production cost needs to be significantly reduced. For that, nationwide support from government, the private sector as well as research institutes will be needed to articulate the key benefits that the Green Hydrogen industry might bring to Morocco.

Project structures and risks

Hydrogen's success will ultimately depend on lenders and sponsors' financing and government policy that will drive the development of the sector, at least in the early stages. In the short term, projects will likely be limited to small-scale research & development and projects with industrial processes which target specific end-users.

Early large-scale projects will likely be financed through multi-source structures which are heavily dependent on grant funding and concessional debt, and limited to projects that have robust long-term offtake arrangement and/or strong sponsors.

Hypothetical H2 Project

A hypothetical hydrogen project is likely to involve:

- a special purpose company (H2Co) established for the purpose of developing and operating the project, whose activities will likely be funded through a mix of equity investment and project finance;
- the production of green hydrogen at a hydrogen production facility owned by H2Co, using an electrolyser to be built as part of the facility;
- the supply of renewable electricity to H2Co from an adjacent wind or solar facility owned by the H2 producer through the self consumption regime or by a renewablesCo via a corporate power purchase agreement (PPA);
- facilities, adjacent to the hydrogen production plants, ideally also owned by H2Co, for conversion of the hydrogen to a more efficiently transportable form such as liquefied hydrogen, ammonia or methylcyclohexane;
- an offtake agreement to be entered into between H2Co and an offtaker (which may be one or several of the sponsors), whereby the offtaker agrees to purchase the green hydrogen product from H2Co; and
- potentially transportation arrangements with a transportCo in order to transport the hydrogen product from its production point to the offtaker's preferred destination.

Developing and implementing renewable hydrogen projects involves various risks along the project's entire value chain. As an emerging technology, a key consideration will be the degradation and durability of electrolysis cells and their components.

To address technology risk, financiers will likely take a conservative view of financing arrangements and employ measures to strengthen their financing package. Similar to what is often seen in natural resources projects, financiers may also seek a completion guarantee, at least for the first few large-scale projects that come to market.

Given the lack of a merchant market for hydrogen, financiers will focus on projects with long-term offtake arrangements with credible counterparties similar to what is done in the LNG space. They will likely require offtake arrangements in the form of 'take and pay' contracts, where the offtaker would be liable to take and pay for the delivery of the hydrogen products. As it is a nascent market, financiers may also require various forms of State support and guarantees.

In addition project developers and financiers will focus on ensuring that appropriate supply arrangements for water and electricity are in place. The destination and or medium of transportation is also crucial. Projects are expected to be developed on a 'point-to-point' basis, with specific end-users. Some hydrogen producers will likely be located near the end-user and use existing infrastructure (e.g. large steel, mining, and refining). Project sponsors will need to demonstrate that a project has reliable transportation arrangements in place.

Green hydrogen continues to be seen as the 'magic wand' to achieving a net-zero future. In practice, the road ahead is likely to be long and winding.

Key contacts

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