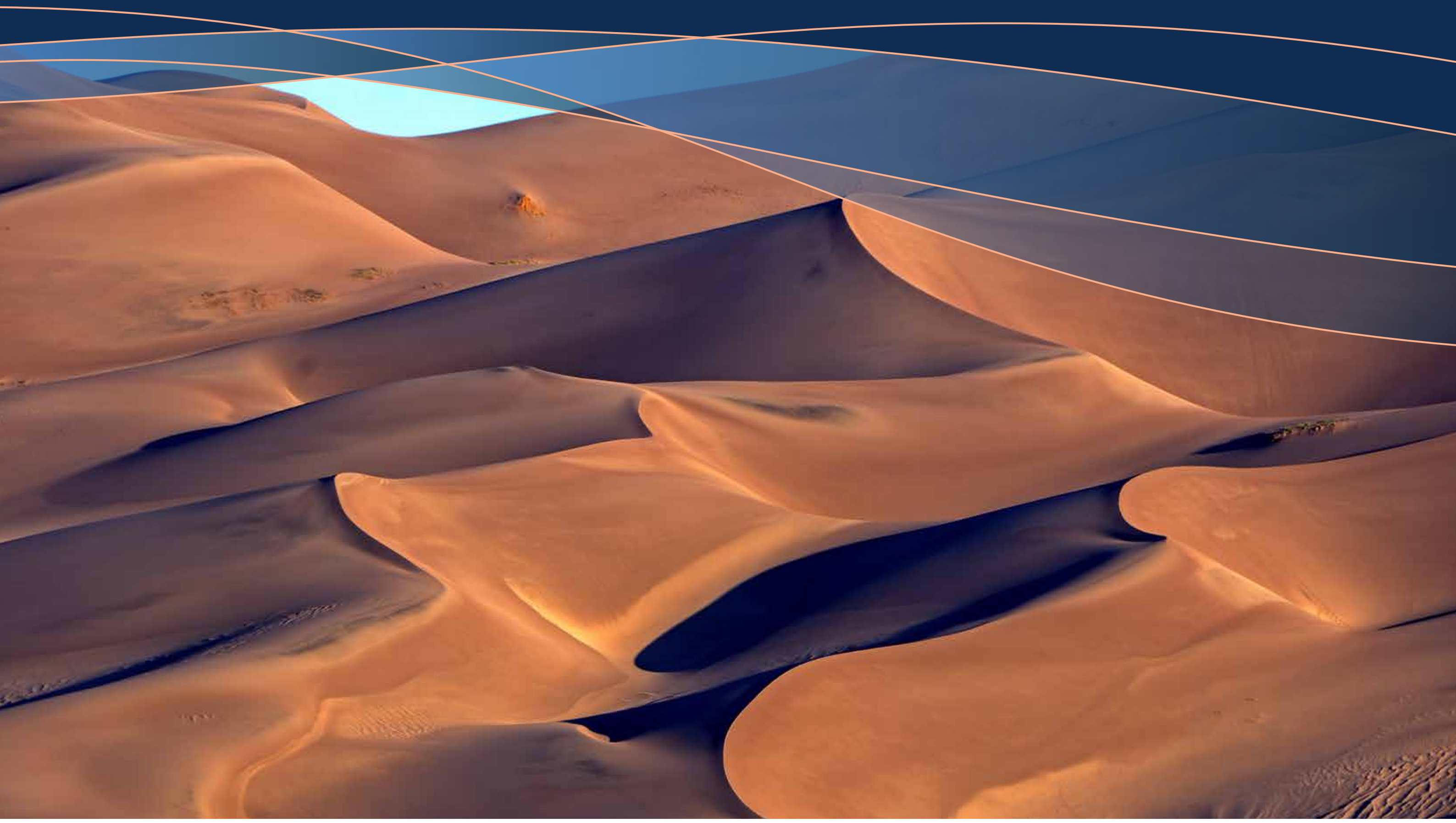
Gaffney Cline

North Africa's Hydrogen Opportunity



Introduction

North Africa, endowed with abundant renewable energy resources (high solar irradiation and wind speed) and substantial natural gas reserves, holds immense potential for both blue and green hydrogen.

In 2022, the EU launched REPowerEU, with the aim of diversifying away from Russian energy imports. This document included an upgraded hydrogen target of 20 Mtpa by 2030, which is to be met solely using renewable hydrogen. Additionally, REPowerEU determines that half of the upgraded target should be met by renewable hydrogen imports, with North Africa being touted as one of the potential sources of hydrogen for importation into the EU. With regards to financing such a target, the EU plans to support and finance future hydrogen projects through EU-wide schemes such as Carbon Contracts for Difference (CCfD), which could be financed by revenues from the EU Emissions Trading System (ETS).

In response, African countries are organising resources to invest in the requisite technologies. The African Green Hydrogen Alliance—comprising of Morocco, Mauritania, Namibia, Egypt, South Africa and Kenya—was launched in May 2022 and aims to expand its membership on the continent.
In October 2022, Morocco hosted the Executive Vice President of the European Commission for the European Green Deal to sign a Memorandum of Understanding (MoU) on the establishment of a Green Partnership. This was followed by an agreement signed in November between the EU and Egypt creating the EU-Egypt Renewable Hydrogen partnership. Morocco is also being touted as the main North African country for green hydrogen exports to Europe[1,2].

1 https://mepc.org/journal/hydrogen-fueling-eu-morocco-energy-cooperation
2 https://www.freiheit.org/spain-italy-portugal-and-mediterranean-dialogue/tunisia-and-morocco-set-path-europes-green-hydrogen

However, realisation of this hydrogen trade potential comes with its own set of challenges, which are detailed below and include EU bureaucracy, costs and financing, water scarcity and domestic availability of renewable energy. In addition, competition from other future hydrogen exporting regions, such as the Gulf countries, will also present a challenge.

Challenges

EU Bureaucracy

As highlighted above, part of the EU's strategy is to import green hydrogen, potentially from North Africa. However, to do this, the EU is also planning to implement certification processes with future exporting countries to ensure that future hydrogen imports are produced to the same standards as the renewable hydrogen produced in the EU. While the mechanism for this is not clear, the EU Delegated Acts for Renewable Fuels of Non-Biological Origin (RFNBO) provides a possible example of the principles behind these certifications and commensurate increased administration requirements and bureaucracy.

The Delegated Acts for RFNBO outlines the conditions for renewable hydrogen (green hydrogen) and renewable hydrogen-based fuels and establishes the principle of "additionality". This principle stipulates that renewable energy must be specifically constructed for electrolyser operation up to 36 months before production. Additionally, the Acts offer a methodology for calculating life-cycle greenhouse gas emissions for RFNBOs, which consider emissions across the entire lifecycle, including upstream, processing and transport.

The EU considers three ways for renewable electricity to be used to produce renewable hydrogen:

1. The first method involves a direct connection to an incremental renewable energy plant that must be constructed solely for electrolyser operation to avoid using existing renewable energy capacity for hydrogen production.
2. The second method involves purchasing grid electricity produced with a renewable energy component of over 90 per cent,
3. The third method involves a Power Purchase Agreement (PPA) between the renewable energy operator and the hydrogen producer, which must meet the principles of temporal and geographical correlation to be considered renewable.

The principle of additionality is also required unless the grid emission intensity is lower than 64.8 gCO_2/kWh. The rules will be gradually phased in, and both domestic and non-EU producers will need to comply with the EU framework's requirements for producing renewable hydrogen.

An example of the EU bureaucracy at play is Germany's flagship import programme, H2Global. This initiative ran its first tender in September 2023 to purchase volumes of green ammonia, methanol and synthetic aviation fuels from outside the EU. However, recent reports in the media from lawyers working with companies bidding for H2Global, highlighted the onerous and document-heavy required process being utilised, which runs the risk of excluding companies with limited German-language operations or access to qualified juridical translators. In addition, the report highlighted that the programme was conducted under the EU's public procurement laws, as well as state aid regulations due to the involvement of government subsidy, which means that companies that do not understand and have experience in such activities, are at a major disadvantage. Furthermore, there are requirements for a company to prove their experience in similar sectors (i.e. production of fossil-based hydrogen at large-scale, production of green energy, transport of comparable hazardous goods) which forces smaller and/or embryonic companies to partner up, to form consortia, or hire subcontractors to fulfil these experience-based obligations.

Cost and Financing

Another challenge associated with green hydrogen exports are production costs and project financing options.

Hydrogen Production Costs

In terms of blue hydrogen production, the cost of natural gas has been relatively unstable and poses a challenge to costs, since events in Ukraine. In addition, the capital costs required to establish CO_2 capture, transportation and storage infrastructure are also high and need to be factored into project development.

As an example, the levelised cost of grey (unabated) hydrogen production from natural gas ranges between $0.5/kg to $2/kg, while the levelised cost for blue hydrogen (with CCS) ranges between circa $1.8/kg to $4.7/kg.

Green hydrogen production ranges between $3/kg - $12/kg. The relatively high price of green hydrogen is due to the high cost of renewables and high cost of electrolysers. Electrolysers are expensive, although there are companies vying to improve the costs of green hydrogen production, such as Norwegian electrolyser-maker Nel ASA, who announced a goal of producing green hydrogen at $1.50 per kilogram by 2025. In addition, as with examples of solar PV and other renewables, costs will reduce as the technology matures.

Financing

The other hurdle that North African countries may experience in developing their hydrogen export-focused projects, is to secure financing. The levelised cost of hydrogen is sensitive to the cost of financing and therefore one of the viable options is to utilise development bank financing, which is generally backed by governments and provides preferential interest rates. This potentially enables the North African countries to secure capital that supports minimization of the price of their hydrogen. However, the issue that crops up with accessing development bank financing is, once again, the EU's Delegated Acts' rules around additionality. The Acts prohibit electrolysers from drawing on renewables projects previously built with state aid "in the form of operating aid or investment aid", even if they otherwise meet the Delegated Acts' criteria of coming on-line within three years of the electrolysers.

The EU's policy regarding future import supplies of hydrogen suggests that it will either come through hydrogen pipelines or through shipping.

For North Africa, the relative proximity indicates that pipelines may be the preferred option. The specific timeframe for pipeline design concept to operation varies, contingent on factors such as pipeline length and complexity, environmental and social impact evaluations, land acquisition, permitting processes and technical hurdles. Examples are found when considering natural gas pipelines, such as the Trans-Adriatic pipeline, unveiled in 2003, commencing construction in 2016, and realizing initial gas deliveries in 2020. Another instance is the Nord Stream 2 pipeline linking Russia and Germany, announced in 2011 and completed in 2021, but obviously not delivering gas at present.

While the typical construction period of major infrastructure pipelines can typically span two to five years, this period, though relatively short, is eclipsed by many technical, commercial and contractual prerequisites preceding construction initiation. Additionally, establishing transnational hydrogen pipelines might demand more time and effort, than pipelines constructed for existing sectors, due to the absence of existing expertise and potential presence of a myriad of regulatory, environmental and technical intricacies.

Given the extensive lead times and diverse considerations antecedent to transnational pipeline construction, the significant utilization of hydrogen pipelines within the EU is projected to commence no earlier than 2030. Consequently, shipping ammonia by vessel is anticipated to be the preferred method for hydrogen-derivative deliveries until dedicated pipelines attain greater prominence.

Water Scarcity

The production of green hydrogen requires abundant resources of fresh water (distilled water). For example, to produce 1 kg of hydrogen, approximately 9 litres of water are needed. Consequently, hydrogen production for European imports equivalent to a nominal 30 GW installed capacity would require approximately 27 million tonnes of water per year.

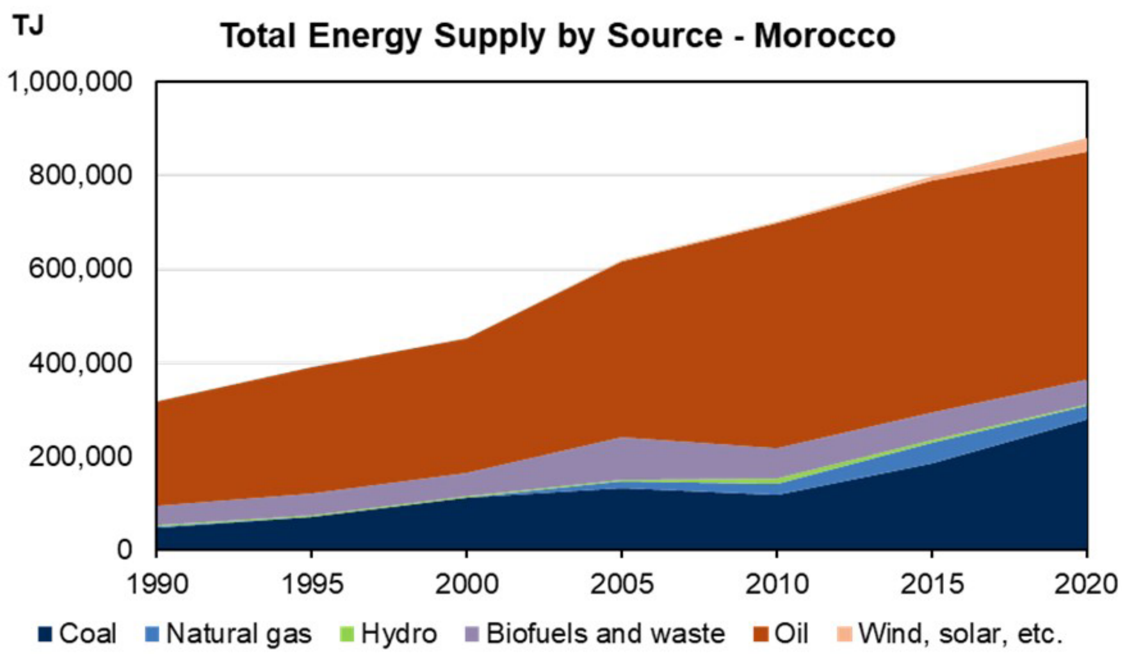
Water resources in North African countries are generally scarce. Morocco, as example, which is being touted as the likely candidate for green hydrogen exports to the EU, suffers from limited water resources. The World Bank describes Morocco as one of the world's most water-stressed countries and that water scarcity imposes significant economic constraints, which are expected to worsen due to climate change[1]. According to UNICEF, Egypt is also "facing an annual water deficit of around seven billion cubic metres and the country could run out of water by 2025, when it is estimated that 1.8 billion people worldwide will live in absolute water scarcity"[2].

Therefore, a major challenge would be the availability of water for renewable hydrogen production.

Domestic Availability of Renewable Energy

Another challenge is the provision of sufficient renewable power to produce green hydrogen. In the case of Morocco, the majority of energy consumed in the country is from imported fossil fuels and the share from domestic renewable energy production is mostly biofuels with limited other renewable energy sources (Figure 1). In 2020 for example, the total energy supply constituted 58% oil & gas, 32% coal and circa 10% from the combination of renewable energy (mostly bioenergy and waste, then wind, solar energy and hydro).

Figure 1: Morocco - Total Energy Supply by Source

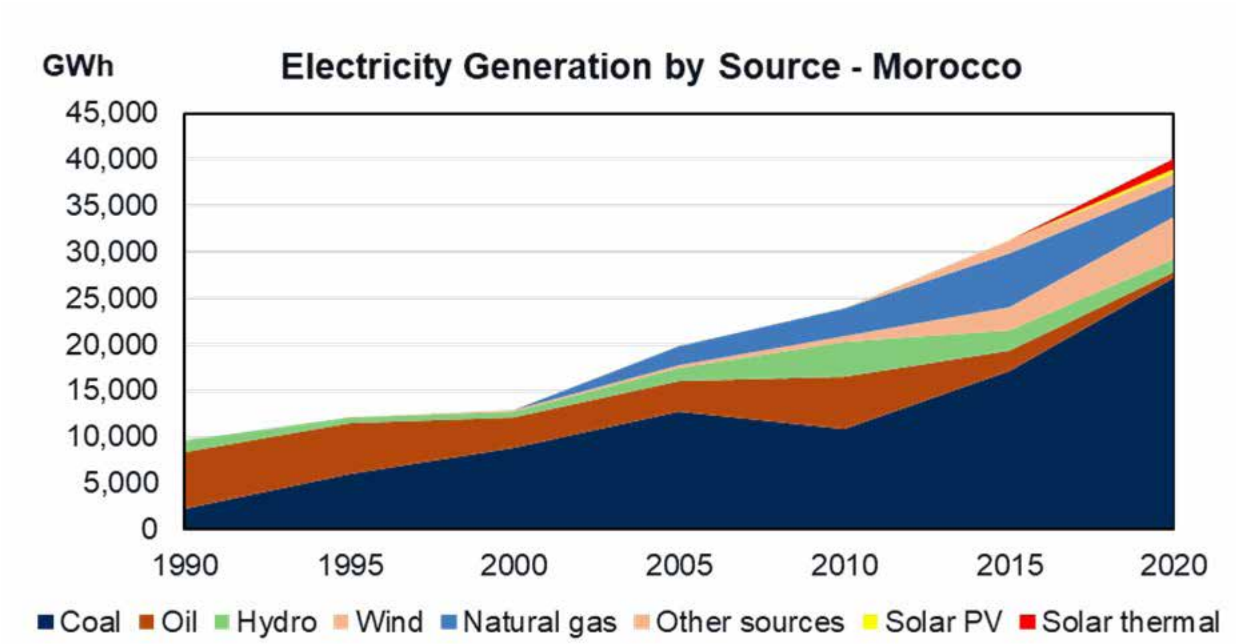


Source: IEA, GaffneyCline Analysis

1 https://www.worldbank.org/en/news/press-release/2023/07/24/new-world-bank-program-in-morocco-supports-efforts-to-boost-water-security-and-resilience-for-all
2 https://www.unicef.org/egypt/documents/water-scarcity-egypt

With regards to electricity generation, only 21% of power generation is from renewables, whilst most of the electricity is generated from coal (Figure 2). An ever-increasing consumption of coal inhibits a reduction in CO_2 emissions, as burning coal is one of the heaviest GHG contributors (for 1 kWh from coal, 0.4 kg CO_2 is produced; 1 kWh from natural gas, 0.2 kg of CO_2 is produced).

Figure 2: Morocco - Electricity Generation by Source



Source: IEA, GaffneyCline Analysis

Nevertheless, Morocco's commendable strides in overhauling its energy subsidy system and ramping up renewable energy output play a pivotal role in realizing the objectives outlined in the country's National Energy Strategy 2009-2030 and its National Determined Contribution (NDC). As per the Strategy, Morocco aims to achieve a renewable installed power capacity of 52%, distributed as 20% wind, 20% solar, and 12% hydro, by 2030. Despite the current modest contribution of renewable energy generation, the expansion of wind and solar installed capacities over the past few years underscores a noteworthy trajectory of growth.

Competition from the Gulf

The Gulf countries, and in particular Saudi Arabia, Qatar, the UAE and Oman, have the potential to become major players in blue and green hydrogen production and export. Their advantage lies in abundance. Saudi Arabia, Qatar and the UAE boast some of the world's largest natural gas reserves, providing a readily available feedstock for blue hydrogen production. QatarEnergy, for instance, is building the world's largest blue ammonia plant, set to produce 1.1 Mtpa by 2026. The UAE is aiming to produce 15 Mtpa of blue hydrogen by 2050, while Oman plans to export 1 Mtpa by the same date. Saudi Arabia also sees huge economic potential in blue hydrogen, allocating the eastern Jafurah gas field, the largest shale gas field in the country, for the purpose of producing blue hydrogen.

Cost competitiveness is another key factor. The Gulf states enjoy low natural gas prices and a significant existing energy infrastructure, allowing them to offer blue hydrogen at attractive rates. The Gulf's established maritime port infrastructure also gives them a significant advantage when it comes to export. In addition, and this is another major factor, the Gulf countries have the financial means to drive the investments required in both blue and green hydrogen production.

Summary and Conclusion

The Interest in blue and green hydrogen is rising dramatically in the EU and globally. As of Q2 2023, over fifty countries have published, or in the process of publishing, a low carbon hydrogen strategy (green and/or blue). The EU's intent is to produce 10 Mtpa and import another 10 Mtpa of green hydrogen by 2030, the largest hydrogen import target announced to date. The EU has identified potential green hydrogen suppliers within the EU neighbourhood, and by 2030, the EU aims to establish at least three major hydrogen corridors from North Africa, the North Sea and Ukraine.

North Africa possesses favourable conditions for blue and green hydrogen development, however there are several challenges that stand in the way of realizing its full potential including EU bureaucracy, costs and financing of hydrogen projects, transportation of hydrogen, water scarcity and availability of renewable energy in the source country.

Tackling the challenges highlighted above and overcoming economic barriers through strategic investments are essential steps to unlock North Africa's hydrogen capabilities. The EU also needs to reduce the regulatory burden for increased ease of import of hydrogen.

By addressing these challenges collectively and strategically, North Africa can emerge as a pioneer in the global hydrogen market, contributing significantly to a sustainable energy future.

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