Fresh water for electrolysers and green hydrogen in arid locations

Ensuring that high-intensity solar regions can support the hydrogen economy

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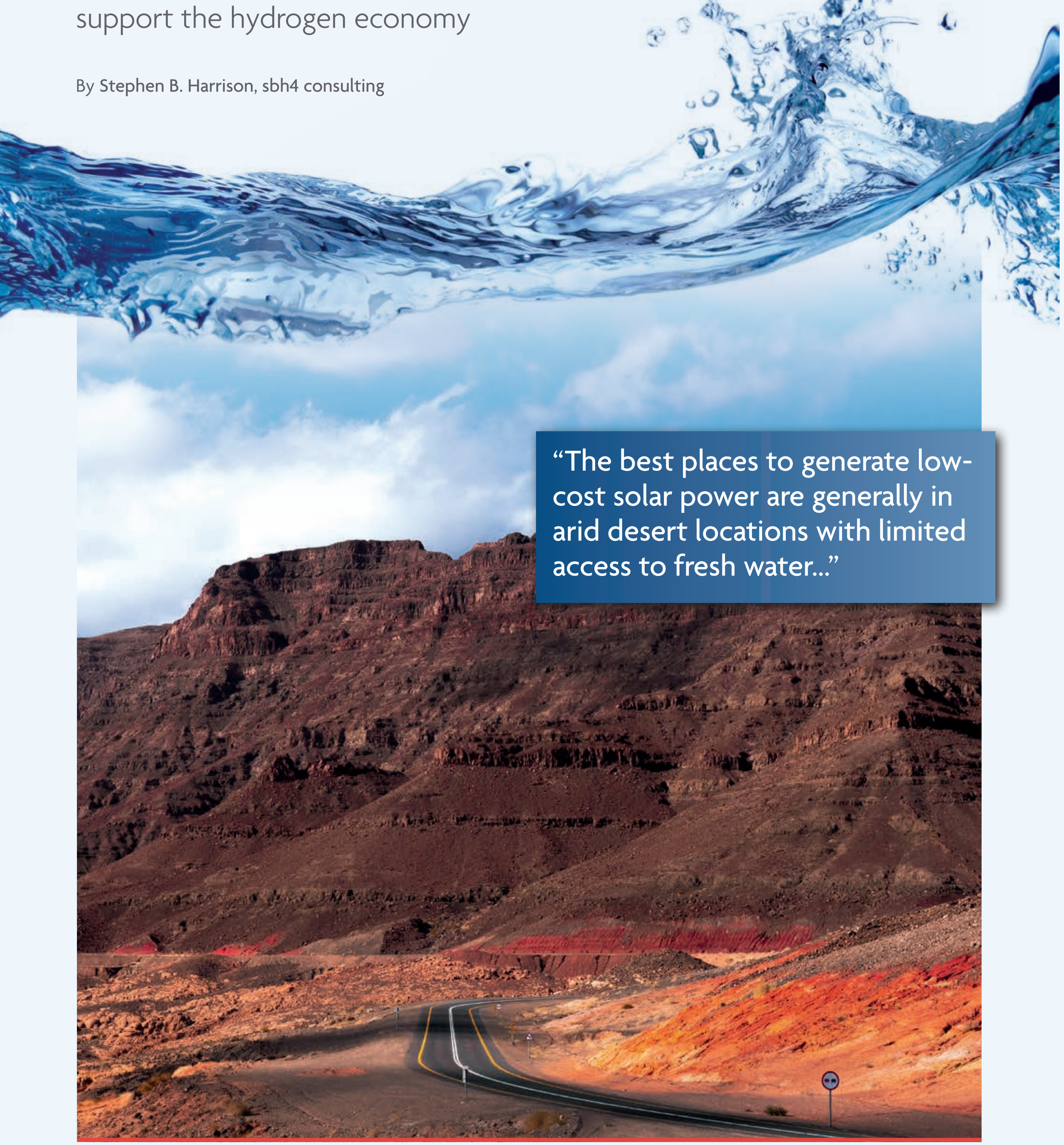


"The best places to generate low-cost solar power are generally in arid desert locations with limited access to fresh water..."

The dominant path to green hydrogen is splitting water molecules using renewable electrical power on an electrolyser. The main source of renewable power generation globally at present is hydro power. Where electrolysers are used in proximity to a hydro dam, there will always be access to fresh water to create hydrogen.

However, the main ramp up in renewable power generation is from wind and solar power. The optimum location for wind power generation is often offshore, in salt water. The best places to generate low-cost solar power are generally in arid desert locations with limited access to fresh water. Hence the conundrum: how will fresh water be made available to the giga-scale green hydrogen projects of the future?

Variable renewable power generation for green hydrogen

Electrolysers are an expensive capital asset and represent a high portion of the capital investment for green hydrogen projects. It is therefore essential that electrolysers have a high utilisation rate, meaning they operate for many months each year and many hours each day.

Hydro power generation is seasonal, according to the rainy and dry periods. Some large dam schemes can oscillate between 5GW of power generation during the wet season and only a few hundred MW at the end of the dry season. Considering that the power they produce will be required for a range of applications in addition to hydrogen generation on electrolysers, the utilisation of hydro power for electrolysis may be as little as four months per year, or 33%.

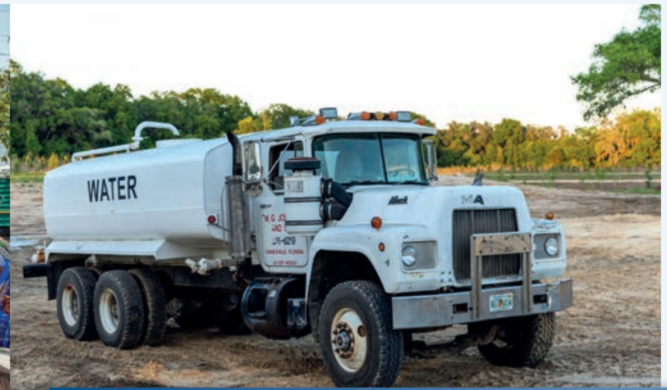
Solar power is also variable, on a much shorter timescale. At best, the sun will be above the horizon for an average of 12 hours per day through the course of a year, and the sun will only be high enough to generate significant solar power for perhaps 10 hours per day. This caps the utilisation of a solar-only electrolysis scheme at about 42%.

Wind power has a seasonal, weekly, and daily bias. In Europe the autumn and winter seasons are especially windy. But periods of high and low pressure come and go on a weekly basis driving weather patterns and wind speeds. Also, a daily cycle of onshore sea breezes during sunny afternoons and offshore land breezes during cooler periods also influence the overall profile. It is only on very few locations, such as Patagonia, where the wind blows steadily throughout the day and year that can deliver optimal electrolyser utilisation through wind-only schemes.

Green hydrogen superpowers of the future

High utilisation is key to the international competitiveness of GW-scale green hydrogen projects that are being developed to produce clean energy vectors for international trade. The market is global, and the customers are free to choose the lowest cost supplier. Shipping costs are small in comparison to renewable power generation and >>

Solar power generation in Quinghai, China



> "Water tankers deliver fresh water to many villages in South Asia where families eagerly fill their portable water containers from hose pipes"

>> electrolysis costs, so optimal electrolyser utilisation and low-cost renewable power are essential to ensure international competitiveness.

Some of the variable renewable power modes are intermittent, meaning that power generation falls to zero. Alkaline electrolysers are the cheapest technology to purchase, but they do not cope well with unplanned shutdowns. They prefer a protective current to always flow. It avoids corrosion of the electrodes and degradation of electrolysis efficiency.

Batteries can be built into the system to ensure a trickle of power flows during periods of no wind or sunlight. Alternatively, power can be drawn from the grid to compliment the renewable power generation. However, using grid power may undermine the 'green' credentials of the hydrogen and reduce its potential market.

The best solution is integrated wind and solar power generation so that they can complement each other during the day and night. Green hydrogen superpowers of the future will be nations or regions that have ideal conditions for integrated wind and solar. The perfect combination for electrolysis is where the wind picks up during the later afternoon hours and blows steadily through the night until the sun rises again at dawn.

Countries like Chile, Namibia and Oman stand out as excellent green hydrogen production locations. Western Australia and southwestern China are also blessed with ideal conditions for integrated wind and solar power generation. These locations have the potential to be the green hydrogen superpowers of the future. But looking at this list leaves us asking the question: how can we get abundant fresh water to these arid locations to feed the electrolysers?

Drilling, driving and desalination

The technologies that will bring fresh water to electrolysis schemes are exactly those that are relied on today to make potable water available in arid locations. Desalination is used extensively in the Middle East to make water available for the emerging vertical farming sector and coastal cities. Water tankers deliver fresh water to many villages in South Asia where families eagerly fill their portable water containers from hose pipes. Drilling for groundwater is common on every continent, except for the frozen Antarctic.

Whilst the technologies are known, the challenge related to making fresh water available for green hydrogen projects may be several multiples greater than has been faced up to now. Taking Inner Mongolia in China as an example, rapid electrolyser capacity expansion around major projects that are often backed by state owned enterprises will leverage the province's renewable power resources.

Inner Mongolia in China has vast solar and wind resources, making it an ideal place for green hydrogen production. The province's green hydrogen production target for 2025 is 500,000 tonnes. However, in this land-locked location, sea water desalination is not feasible. The most cost-effective option is drilling deep for ground water.

Green hydrogen project development in the MENA region

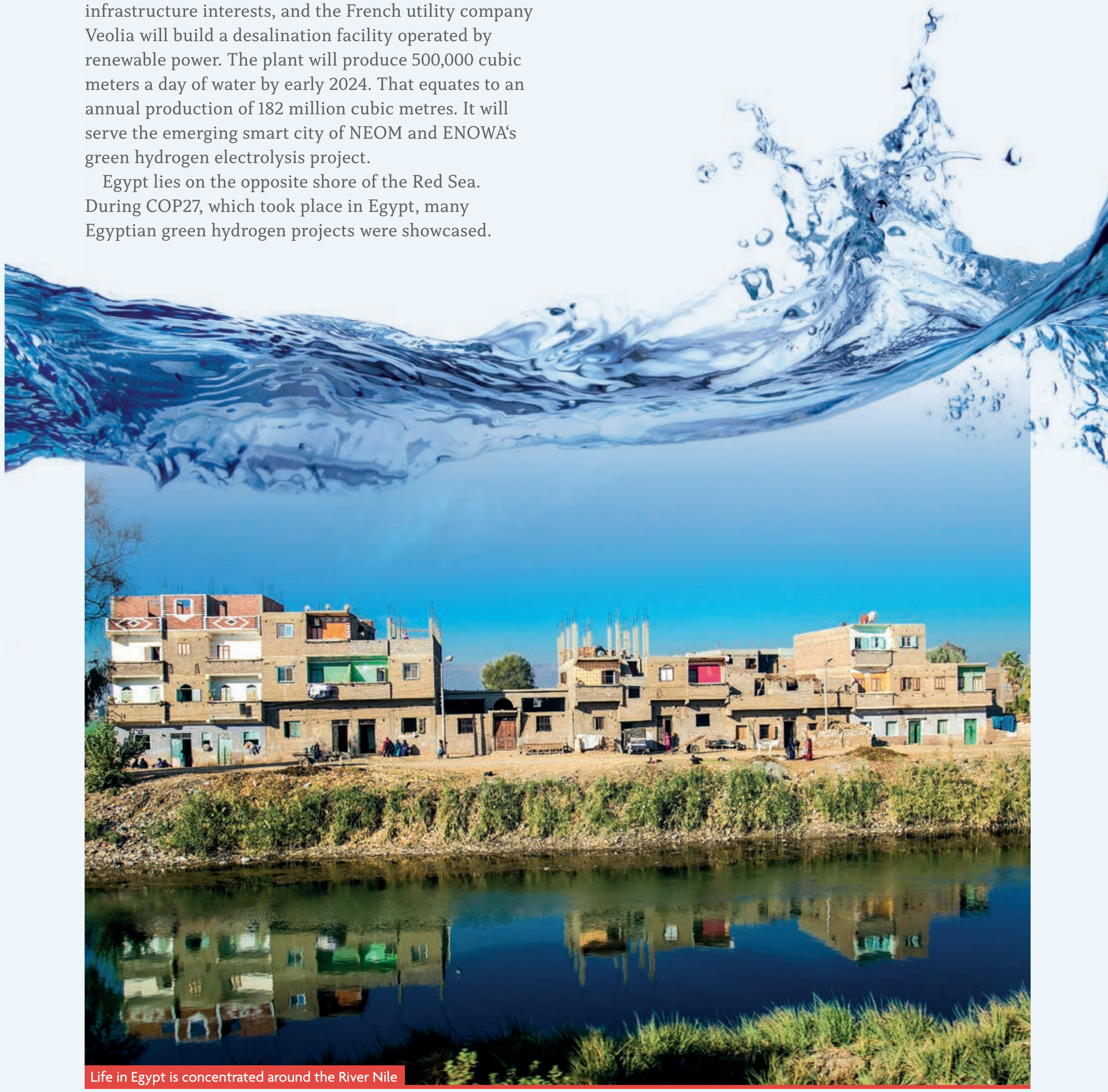
The world's first GW-scale green hydrogen project to be announced and taken through FID is sponsored by Air Products, ACWA Power and ENOWA, a subsidiary of NEOM. The scheme will use atmospheric pressure alkaline electrolysers from Nucera to generate green hydrogen from integrated wind and solar power generation. Air separation, implemented by Air Products will produce nitrogen to react with the hydrogen to make green ammonia for export.

The project will be implemented in Tabuk in north-western Saudi Arabia. This is an arid region with less than 2mm of rainfall per month in winter and no precipitation in summer. Tabuk lies on the eastern coast of the Red Sea, so the most viable option to obtain fresh water for the electrolysers will be desalination.

To support the green hydrogen project, the Japanese conglomerate Itochu which has energy and infrastructure interests, and the French utility company Veolia will build a desalination facility operated by renewable power. The plant will produce 500,000 cubic meters a day of water by early 2024. That equates to an annual production of 182 million cubic metres. It will serve the emerging smart city of NEOM and ENOWA's green hydrogen electrolysis project.

Egypt lies on the opposite shore of the Red Sea. During COP27, which took place in Egypt, many Egyptian green hydrogen projects were showcased.

The Suez Canal Economic Zone stretches from Port Said at the northern end of the Suez Canal to Al Sokhna at the Canal's southern tip. The zone has become a hub for green hydrogen projects with announcements from companies such as France's EDF Renewables (through the Green Fuel Alliance), Norway's Scatec, Australia's Fortesque Future Industries and UAE-based AMEA Power. >>

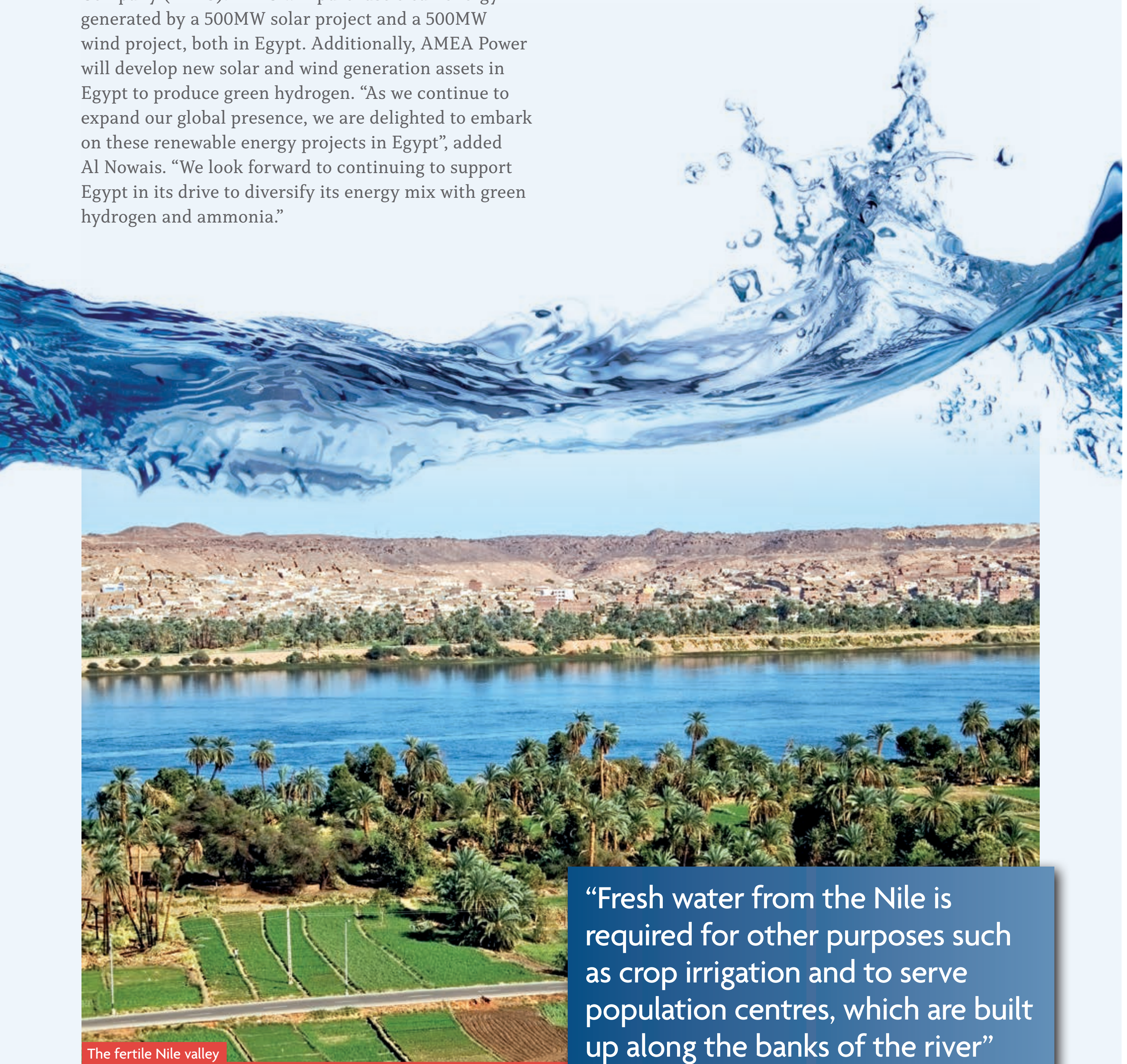


Life in Egypt is concentrated around the River Nile

AMEA Power's chairman, Hussain Al Nowais, said that "in April 2022, we signed an MoU to produce 390,000 tonnes of green ammonia per annum to predominantly serve export markets, as well as a portion to the local markets. The facility will be located close to the port of Ain Sokhna in in Egypt." The project involves $2bn of investment and is one of several green hydrogen and ammonia projects that the company is currently discussing across the Middle East and Africa.

AMEA Power has already signed power purchase agreements with the Egyptian Electricity Transmission Company (EETC). EETC will purchase clean energy generated by a 500MW solar project and a 500MW wind project, both in Egypt. Additionally, AMEA Power will develop new solar and wind generation assets in Egypt to produce green hydrogen. "As we continue to expand our global presence, we are delighted to embark on these renewable energy projects in Egypt", added Al Nowais. "We look forward to continuing to support Egypt in its drive to diversify its energy mix with green hydrogen and ammonia."

The amount of hydrogen generation by the AMEA Power hydrogen electrolysis scheme will require more than a million cubic metres of water per year, which is expected to come from desalinated water from the Red Sea. Fresh water from the Nile is required for other purposes such as crop irrigation and to serve population centres, which are built up along the banks of the river. Therefore, major desalination facilities will be required to support this and other green hydrogen projects in the Suez Canal Economic Zone. H2V



The fertile Nile valley

"Fresh water from the Nile is required for other purposes such as crop irrigation and to serve population centres, which are built up along the banks of the river"