Middle East & Africa Hydrogen Projects
Current and future trends, challenges and opportunities

16 November 2022, MEED Webinar
Ed James, Head of Content & Research, Middle East & Africa
Edward.james@meed.com
HYDROGEN ECONOMY
With huge industrial demand and renewable energy storage potential, hydrogen could play a critical role in the world’s transition to a cleaner, more sustainable energy mix.

INDUSTRIAL PRODUCTION
98%
Hydrogen made from compressed natural gas or other carbon-releasing hydrocarbons

~600 billion cmy/y total hydrogen production

2%
Hydrogen is derived from water electrolysis, which can be powered using 100% renewable energy sources

INDUSTRY APPLICATIONS
55% Share of hydrogen used for ammonia synthesis

25% for refinery processes

20% for methanol production and other uses

FUEL CELL TECHNOLOGY

500-600km Operational range of the latest fuel cell electric vehicles (FCEVs) based on the consumption of about 1.4kg of hydrogen over 100-120 kilometres

240kg/d Hydrogen output at the region’s first solar-powered water electrolysis plant* at the MSR Solar Park in Dubai – enough to fill 50 FCEVs

NATURAL GAS REPLACEMENT
Hydrogen is an increasingly viable transitional feedstock for gas turbines

$2.5
Typical cost of a kilogram of liquid hydrogen at today’s commercial rates

$1.0
Cost of production of hydrogen with the most competitive solar projects

30%
Estimated net fall in the cost of producing hydrogen from electrolysis by 2030

20% Hydrogen capacity of gas turbines by 2030

100% Hydrogen capacity by 2030 (new or retrofitted)**

30%
Share of gas for homes and businesses replaceable by hydrogen

0% Changes required to gas infrastructure

18% Potential reduction in carbon emissions

0% On-site release of climate-warming emissions

* A joint initiative between Dubai Electricity & Water Authority, Siemens and Expo 2020 Dubai. ** (E) Turbine group cogeneration. cmy/y = Cubic metres a year; kW = Kilowatt hours; kg = Kilograms a day. Sources: IEA, Hydrogen Europe, IEA, MEED, Superpower University.
Middle East Business Intelligence since 1957

MEED.com

MEED Projects
MEA Hydrogen Projects 2023
Report’s pre-launch $4,000 $3,500

Further $100 discount for attendees with code: WEBINAR100

Visit buy.meed.com or scan the QR code to buy the full report before 25th November 2022

Buy MEA Hydrogen Projects 2023 report to:

• Understand each of 50-plus Middle East and Africa hydrogen projects
• Identify new project opportunities with client and procurement details
• Understand risks, set strategy, and minimise risk
• Recognise challenges in the market
• Ensure you don't miss any opportunity by being prepared for market developments
Applications

Green hydrogen is seen as a partial solution in the journey toward net zero. As it has multiple end uses and transportation methods, it is viewed as a particularly flexible fuel source.

Hydrogen applications and decarbonisation

Enable large-scale renewables integration and power generation

Distribute energy across sector and regions

Act as a buffer to increase system resilience

Serve as feedstock

Decarbonize transportation

Decarbonize industry energy use

Decarbonize building heating and power

Enable the renewable energy system → Decarbonize end uses

Green hydrogen production, conversion and end uses across the energy system

Source: Hydrogen Council

Source: Irena
The Hydrogen Revolution

In the MEA region the hydrogen projects sector (especially green hydrogen) is a relatively new phenomenon, with first mentions of it appearing only in 2020 onward. Following the announcement of the region’s first world-scale green hydrogen project at NEOM, the market really began to accelerate.

Annual number of articles, features or comment containing the word ‘hydrogen’ on MEED.com, 2016-22

- October 14, 2019: First mention of the phrase “green hydrogen”
- 8 July 2020: NEOM’s Helios project announced. Region’s first world-scale green hydrogen project
- 20 December 2020: First mention of the phrase “blue hydrogen”
Hydrogen Projects

The acceleration in the market is reflected by the rapid increase in the number of announced projects. In Q1 2022 for examples, there was the equivalent of one new project announced a week. The total value of all announced hydrogen plants alone in MEA is estimated at more than $70bn and more than $120bn when factoring in associated elements such as ASUs, export facilities and renewable energy complexes.

MEA Hydrogen Project launches by year and quarter 2020-2022

---

Source: MEED Projects

* Covers only hydrogen plant element
Why Now?

A major factor behind the acceleration in hydrogen project activity is the rapid reduction in renewable energy costs. Solar PV costs are now as low as $0.045 a kilowatt hour, and on an IPP basis developers in the region have been offering a LCOE to offtakers as little as 0.0135 cents a kilowatt hour (3 times cheaper than the global average).

**Global renewable energy costs ($/kWh)**

**GCC solar photovoltaic IPP tariffs, Low bid – LCOE ($cents/kWh)**

Source: IEA

Source: MEED
Why Now?

Thanks to a combination of factors such as net zero targets, diversity and security of supply, and increasing gas prices, growth for hydrogen is expected to increase dramatically. As more production comes onstream and technology improves, the average cost of green hydrogen is forecast to decrease to about $2 a kilo in 2030 from $5 today.

Forecast global hydrogen demand (million metric tonnes a year)

Source: IEA
There are multiple reasons for the sudden growth in hydrogen projects. Perhaps the biggest is the region’s understanding that in the long-run, it needs to replace hydrocarbons exports with a cleaner fuel as the world undergoes energy transition. Thanks to high irradiation levels, space and location, the region is acting fast to take first mover advantage and secure offtake agreements globally, and as a consequence retain some of its position as the world’s prime energy exporter.
Hydrogen Market
Technology and Output

Although most currently planned hydrogen capacity is destined for export, MEA has great potential for the development of domestic demand using existing gas pipeline networks. Almost all announced projects to date will produce either hydrogen or green ammonia. There is a paucity of data, but it is likely that most MEA schemes will utilise either PEM or Alkaline electrolysis technologies.

Number of planned or operational hydrogen projects by electrolysis technology

- Proton exchange membrane, 291, 20%
- Biomass, 25, 2%
- Gas with carbon capture, 101, 7%
- Alkaline, 195, 13%
- Solid oxide, 38, 2%
- Other, 33, 2%
- Unknown or undisclosed, 791, 54%

Global and MEA Number of planned or operational hydrogen projects by output

- Other, 6, 9%
- Ammonia, 33, 48%
- Hydrogen, 1150, 78%
- Methane, 65, 4%
- Methanol, 37, 3%
- Synfuels, 16, 1%
- Other or undisclosed, 128, 9%
Geographic Distribution

The hydrogen market in the region is dominated by a handful of countries – Egypt, UAE, Oman, Morocco, South Africa, Saudi Arabia and Namibia. All to MEA represents approximately 8% of all known projects globally, but a far higher proportion in terms of total output given the higher average capacities.

### Distribution of hydrogen projects by country

- **Egypt**, 29
- **United Arab Emirates**, 18
- **Oman**, 14
- **Morocco**, 8
- **South Africa**, 8
- **Saudi Arabia**, 7
- **Namibia**, 5
- **Qatar**, 3
- **Kenya**, 2
- **Mauritania**, 2
- **Others**, 15

### Number of hydrogen projects by region

- **Europe**, 656 (49%)
- **Africa**, 65 (5%)
- **South America**, 66 (5%)
- **North America**, 148 (11%)
- **Asia**, 152 (11%)
- **Oceania**, 158 (12%)
- **Former Soviet Union**, 56 (4%)
- **Middle East**, 48 (3%)

Source: MEED, GlobalData
Type and Source

Green hydrogen is the dominant type of future production, with so far only a few blue hydrogen projects definitively announced. In terms of electricity sources, solar or a combination of solar and wind power are by far the most common technologies to be employed.
MEA Hydrogen Projects 2023
Report’s pre-launch $4,000 $3,500

Further $100 discount for attendees with code: WEBINAR100

Visit buy.meed.com or scan the QR code to buy the full report before 25th November 2022

Buy MEA Hydrogen Projects 2023 report to:

- Understand each of 50-plus Middle East and Africa hydrogen projects
- Identify new project opportunities with client and procurement details
- Understand risks, set strategy, and minimise risk
- Recognise challenges in the market
- Ensure you don't miss any opportunity by being prepared for market developments

Further $100 discount for attendees with code: WEBINAR100

Visit buy.meed.com or scan the QR code to buy the full report before 25th November 2022

Buy MEA Hydrogen Projects 2023 report to:

- Understand each of 50-plus Middle East and Africa hydrogen projects
- Identify new project opportunities with client and procurement details
- Understand risks, set strategy, and minimise risk
- Recognise challenges in the market
- Ensure you don't miss any opportunity by being prepared for market developments
Hydrogen Projects
Hydrogen is fast emerging as MENA states seek to take advantage of cheap solar energy and enhance their position as global energy exporters. More than $120bn of planned hydrogen projects but only 2 so far under construction (Ain Sokhna pilot and NEOM).

### Selected active MEA renewable energy projects

<table>
<thead>
<tr>
<th>Project</th>
<th>Country</th>
<th>Budget ($m)</th>
<th>Status</th>
<th>Electrolyser capacity (MW)</th>
<th>Renewable energy capacity (MW)</th>
<th>Green hydrogen (t/y)</th>
<th>Ammonia (t/d)</th>
<th>Stakeholders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green Energy Oman (GEO)</td>
<td>Oman</td>
<td>28,000</td>
<td>Feasibility</td>
<td>13,000</td>
<td>25,000</td>
<td>15,000</td>
<td>27,400</td>
<td>OQ, InterContinental Energy, EnerTech</td>
</tr>
<tr>
<td>Amun</td>
<td>Morocco</td>
<td>16,000</td>
<td>Concept</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>CWP Global</td>
</tr>
<tr>
<td>Acme Group green hydrogen hub</td>
<td>Egypt</td>
<td>13,000</td>
<td>Concept</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Acme Group</td>
</tr>
<tr>
<td>SCZone hydrogen plant 4</td>
<td>Egypt</td>
<td>11,000</td>
<td>Concept</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Globeleq Company</td>
</tr>
<tr>
<td>Masdar - Hassan Allam SC Zone green hydrogen project</td>
<td>Egypt</td>
<td>10,000</td>
<td>Feasibility</td>
<td></td>
<td></td>
<td></td>
<td>100,000</td>
<td>Masdar, Hassan Allam</td>
</tr>
<tr>
<td>RenewPower SCZone green hydrogen project</td>
<td>Egypt</td>
<td>8,000</td>
<td>Concept</td>
<td></td>
<td></td>
<td></td>
<td>220,000</td>
<td>Renew Power, NREA, EETC, TSE</td>
</tr>
<tr>
<td>Neom Helios Green Fuels</td>
<td>KSA</td>
<td>6,500</td>
<td>Execution</td>
<td>2,000</td>
<td>4,000</td>
<td></td>
<td>650,000</td>
<td>Acwa Power, Air Products, Neom, Baker Hughes, Thyssenkrupp</td>
</tr>
<tr>
<td>Posco green ammonia plant</td>
<td>Oman</td>
<td>5,000</td>
<td>Concept</td>
<td></td>
<td></td>
<td></td>
<td>2,740</td>
<td>Acwa Power, OQ, Air Products</td>
</tr>
<tr>
<td>H2 Oman</td>
<td>Oman</td>
<td>5,000</td>
<td>Concept</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Engie, Masdar</td>
</tr>
<tr>
<td>Engie-Masdar hydrogen hub</td>
<td>UAE</td>
<td>4200</td>
<td>Concept</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sohar Port, Port of Rotterdam, PIF, Posco, Samsung C&amp;T</td>
</tr>
<tr>
<td>Sohar Port/ Port of Rotterdam project</td>
<td>Oman</td>
<td>4,000</td>
<td>Concept</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sohar Port, Port of Rotterdam, PIF, Posco, Samsung C&amp;T</td>
</tr>
<tr>
<td>Green hydrogen export plant</td>
<td>KSA</td>
<td>4,000</td>
<td>Concept</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Phelan Energy Group</td>
</tr>
<tr>
<td>Phelan green ammonia project</td>
<td>Egypt</td>
<td>3,500</td>
<td>Concept</td>
<td></td>
<td></td>
<td></td>
<td>6,849</td>
<td>Alfanar</td>
</tr>
<tr>
<td>SCZone hydrogen plant 1</td>
<td>Egypt</td>
<td>3,500</td>
<td>Concept</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SCZone, H2Industries</td>
</tr>
<tr>
<td>1GW waste-to-hydrogen project</td>
<td>Egypt</td>
<td>3,000</td>
<td>Concept</td>
<td></td>
<td></td>
<td></td>
<td>300,000</td>
<td>Sasol, Itochu</td>
</tr>
<tr>
<td>Sasol Boegoebai Green Hydrogen Project</td>
<td>KSA</td>
<td>3,000</td>
<td>Concept</td>
<td>2,800</td>
<td></td>
<td>400,000</td>
<td>2,200</td>
<td>Acme Group, Tatweer, Satec</td>
</tr>
<tr>
<td>ACME green hydrogen &amp; ammonia facility</td>
<td>Oman</td>
<td>2,500</td>
<td>Feasibility</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Enertrag, Nicholas Holdings</td>
</tr>
<tr>
<td>Hyphen Green Hydrogen Complex</td>
<td>Namibia</td>
<td>2,000</td>
<td>Concept</td>
<td></td>
<td></td>
<td></td>
<td>125,000</td>
<td>Taqa, Abu Dhabi Ports, Thyssenkrupp</td>
</tr>
<tr>
<td>Taqa – AD Ports green ammonia plant</td>
<td>UAE</td>
<td>2,000</td>
<td>Concept</td>
<td>577</td>
<td></td>
<td>100,000</td>
<td></td>
<td>Taqa, Emirates Steel</td>
</tr>
<tr>
<td>Taqa-Emirates Steel</td>
<td>UAE</td>
<td>2,000</td>
<td>Concept</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sonagol</td>
</tr>
<tr>
<td>Sonangol Angola Hydrogen Project</td>
<td>Angola</td>
<td>2,000</td>
<td>Concept</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Hydrogene de France</td>
</tr>
<tr>
<td>HDF Energy Swakopmund Hydrogen Project</td>
<td>Namibia</td>
<td>2,000</td>
<td>Concept</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: MEED
The Green Hydrogen Project by Hyphen Hydrogen Energy is Namibia’s first green hydrogen production project. The project is situated at the Tsau/Khaeb National Park, near the coastal town of Luderitz. The project is part of the larger Southern Corridor Development Initiative (SCDI) of the Namibian government, aimed at large-scale hydrogen production and export.

Hyphen Hydrogen Energy is a joint venture of the two companies, Nicholas Holdings Limited, an investment and project development company focused on African infrastructure projects, and Enertrag, a German renewable energy company. Hyphen was appointed as the preferred bidder of the project in November 2021.

The project will be built at an estimated cost of $10bn. – roughly the equivalent of Namibia’s annual GDP. The Namibian government has plans to take up to 24 per cent stake in this, raising $500m from its own funds, according to James Mnyupe, the Namibian government’s green hydrogen commissioner.

Hyphen’s project is proposed to be set up on 4,000 km2 of land owned by the government. Hyphen is working with the Namibian government, as of November 2022, in drawing up an implementation agreement that will trigger the start of a feasibility study for the project by the end of 2022. Boston Consulting Group and Lazard have been appointed as strategic and financial advisors respectively. Slaughter and May, and ENS Africa are the legal advisors.

Construction on the project is expected to start in 2025. The entire project will be completed in two phases with the first phase to be commissioned in 2026. Total production from the entire project, expected to be commissioned by the end of 2030, will be 350,000 tons per year of Hydrogen and 1.7 million tons of Ammonia per year.

The project will use solar and wind energy, both of which are plentiful in Namibia. Around 5–6GW of renewable energy will be required for the project to power 3GW of electrolyser capacity. Surplus electricity generated at the project could be exported by Namibia to the South African Power Pool (SAPP).

Apart from this, the project will also result in the creation of 15,000 jobs for a period of 4–5 years and around 3,000 permanent jobs, of which 90 per cent are expected to be staffed by local Namibians. Hyphen has also indicated its interest in developing common user infrastructure to facilitate the scale-up of future hydrogen projects in the SCDI area that could result in a 10 per cent increase in project realisations.

Hydrogen produced at Hyphen’s plant will be aimed at German consumers and the EU in general.

Source: MEED Projects, Hyphen Hydrogen Energy, and other secondary sources
Hyphen - Green Hydrogen Project - >$9bn

Overview

5–6GW solar and wind energy capacity
Estimated to be $10bn – equivalent to Namibia’s annual GDP
Electrolyser 3GW
Transforming this renewable energy through electrolysis to produce >350,000 tons of green hydrogen per annum
Production, storage and export of ammonia of up to 1.7m tons annually

Resource:
10m/s wind speed
2,000–2,800 full load hours per year

Stakeholders

Nicholas Holdings – > 30 years of experience in infrastructure investment in sub-Saharan Africa
ENERTRAG – One of the largest renewable energy companies in Germany with involvement with green hydrogen since 2011

Status

Project is expected to go into feasibility study phase by the end of 2022 as soon as implementation agreement is signed between Hyphen and the Namibian government.
Project sponsors are in talks reportedly with financial institutions who have evinced interest in the project.
The Namibian government has plants to take up a 24 per cent stake in the project raising at least $500m from its own pocket.
The Boston Consulting Group and Lazard have been appointed as strategic and financial advisors respectively.
Slaughter and May and ENS Africa are on board for legal advisory services.

<table>
<thead>
<tr>
<th>Year</th>
<th>Announcement date</th>
<th>Phase I construction expected to be taken up in January</th>
<th>First production from the planned facility in December</th>
<th>Full capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2021</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2025</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2026</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2030</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: MEED, OQ, InterContinental Energy, EnerTech and other secondary sources
Namibia has excellent solar and wind resources, so much, that German federal research minister, Anja Karliczek said in August 2021 that Namibian green hydrogen could be the cheapest in the world, with costs falling to around €1.50–2.00/kg.

Namibia has excellent co-located wind and solar resources, large swathes of uninhabited, government-owned land – and the industry has strong support from the government.

Hyphen’s project is one of 10 projects that has been taken up on the 26,000km² of land the government has earmarked for Hydrogen projects in the Tsau/Khaeb National Park, now known as the SCDI. The SCDI is just one of several regions that the government says is ideal for Hydrogen production projects.

Hyphen says that its project could increase electricity generation capacity in Namibia by 5GW. It is expected that the project will generate around 1.5–2 Terawatt Hours (TWh) of electricity a year which will be surplus to the project’s requirements. More such projects could effectively lead to the country transforming into a net electricity exporter.

Hyphen’s project will be able to generate 1kg of Hydrogen from 9kg of water.

Hyphen’s sister company, Hyphen Technical, together with partners TransNamib, CMB.TECH, and the University of Namibia was appointed in August 2022 to develop two hydrogen powered locomotive prototypes with two hydrogen-diesel dual fuel engines.

The electrolysis unit and renewable energy complex will be located in the 4,000 km² concession area which will be fed by desalinated seawater piped from the desalination plant at Luderitz port. Any excess electricity will be exported by NamPower on a 66kV overhead transmission line.

Hydrogen from the electrolysis process will be piped to the port where it will be combined with nitrogen from the co-located air separation unit to create ammonia. A multi-buoy terminal will be built to export the ammonia by ship.

Likely EPC contracts will cover the port, ammonia, electrolysis and associated infrastructure separately. It is likely that the renewable energy element will be procured on a long-term PPP basis with a developer.
Green Energy Oman – >$28bn

Overview

25GW solar and wind energy capacity
14GW electrolyser capacity

Transforming this renewable energy through electrolysis to produce >1.8m tons of green hydrogen per annum

Production, storage and export of ammonia of up to 10m tons annually

Resource:
- 9m/s wind speed
- 2,000 kWh/m² solar irradiation

Stakeholders

OQ – Oman’s integrated energy company
ICE - Hong Kong based green fuels developer
Enertech – Kuwait government-backed clean energy investor and developer

Status

Energy Yield Assessment by DNV across Al Wusta. The study spans 2 years of data monitoring.

Feasibility study by Worley Group to optimize generation, transfer and transformation through electrolysis into hydrogen and production, storage and export of ammonia

Environmental & Social Impact Assessment by HMR

Korean Gas Technology Corporation (Kogas-Tech) has signed an MoU to collectively explore opportunities

Prequalification of EPC contractors expected to start in 2025

Key facts

Project
- Green Energy Oman

Country
- Oman

Location
- Duqm

Client/Project Company
- Green Energy Oman

Estimated cost
- >$28bn

Hydrogen capacity
- 1.8 million t/y (all phases)

Ammonia capacity
- 9.9 million t/y (all phases)

Electrolyser capacity
- 14GW

Renewable energy capacity
- 14GW wind, 10GW solar

Project sponsors
- OQ, Intercontinental Energy, Enertech

Start date
- 2026

Full completion
- 2038

Resource:
- 9m/s wind speed
- 2,000 kWh/m² solar irradiation

Announcement date
- 2021

Financial closure for Phase 1 (8,000MW)
- 2025

First production from the planned facility
- 2028

Final phase/Full capacity
- 2038
Overview

Development of a Green Hydrogen and Green Ammonia Plant at Kizad with ammonia capacity of 200,000 tonnes utilizing 800MW solar PV electricity
Estimated project cost is more than $1bn
Electrolyser – Multi-megawatt
Usage of 800MW Solar plant capacity
Production, storage and export of hydrogen ammonia regional and international markets

Stakeholders

Helios Industry – Project client
Deloitte – Financial services client
Thyssenkrupp – Technical study
Developers – Kepco, Samsung C&T, Chemie-Tech, Petrolyn LLC, KOWEPO

In June 2022, technical studies were completed by Thyssenkrupp
In June 2022, Kepco, Samsung C&T, and KOWEPO, along with UAE firm Petrolyn Chemie (JV of petrolyn and ChemieTech), have signed a JDA to develop the first phase

Status

In June 2022, technical studies were completed by Thyssenkrupp

Project
Kizad Green Ammonia
Country
UAE
Location
Kizad, Abu Dhabi
Client/Project Company
Helios Industry
Estimated cost (Budget)
>$1bn
Hydrogen capacity
TBC
Ammonia capacity
40,000 t/y first phase 200,000 t/y total
Electrolyser capacity
Multi-megawatt
Renewable energy capacity
300MW first phase, 800MW total
Project sponsors
Kepco, Samsung C&T, Chemie-Tech, Petrolyn LLC, KOWEPO
Start date
2023
Full completion
2026

Picture Courtesy = Kizad Area in Abu Dhabi and Abu Dhabi Ports, Source: MEED, Helios Industry, Offshore Energy Biz, and other secondary sources
H2 Waste to Hydrogen Plant– $3bn

Overview

Development of a 1GW liquid organic hydrogen carrier hub at the northern entrance of the Suez Canal.
Production of 300,000 tonnes of green hydrogen per annum with electricity generated from 4 million t/y of organic waste and non-recyclable plastic.
Client says LCOE will be half the cost of current green hydrogen production.
Output will be sold locally by truck.
Estimated to cost $3bn.
The project is expected to be implemented in three phases with the first phase due for completion by the end of 2026.

H2 Industries will be developer and the EPC contractors.
The General Authority for the Suez Economic Zone (SCZone) is the master developer.

Stakeholders

- H2 Industries Inc

Status

The project is still in the initial stage of development – the study phase.
Main contract tender issue and commercial bid submission expected during 2024.
The project will be developed as an onshore Engineering Procurement Construction (EPC) contract.

<table>
<thead>
<tr>
<th>Project</th>
<th>H2 Waste to Hydrogen Plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country</td>
<td>Egypt</td>
</tr>
<tr>
<td>Location</td>
<td>East Port Said Industrial Zone</td>
</tr>
<tr>
<td>Client/Project Company</td>
<td>H2 Industries</td>
</tr>
<tr>
<td>Estimated cost (Budget)</td>
<td>$3bn</td>
</tr>
<tr>
<td>Hydrogen capacity</td>
<td>300,000 t/y</td>
</tr>
<tr>
<td>Ammonia capacity</td>
<td>-</td>
</tr>
<tr>
<td>Electrolyser capacity</td>
<td>TBC</td>
</tr>
<tr>
<td>Renewable energy capacity</td>
<td>-</td>
</tr>
<tr>
<td>Project sponsors</td>
<td>H2 Industries Inc</td>
</tr>
<tr>
<td>Start date</td>
<td>2024</td>
</tr>
<tr>
<td>Full completion</td>
<td>2026</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Approval granted for the project</th>
<th>Main contract award and commencement of construction</th>
<th>Project completion and commissioning</th>
</tr>
</thead>
<tbody>
<tr>
<td>2022</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2024</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2026</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: MEED
Kizad Brooge Hydrogen - $1.5bn

300,000 metric tonnes of green ammonia capacity in first phase
Estimated to cost $1.5bn
A further capacity expansion up to 600,000 metric tonnes of green ammonia per annum planned under the second phase of the project

Brooge Energy – Project client
Ernst & Young – Project consultancy services
Thyssenkrupp Uhde – Technical study for the project

In July 2022, the client has signed the preliminary land lease agreement for the development of the project
Main contract tender issue as well as commercial bid submission expected during Q3 2023
The project will be developed as an Engineering Procurement Construction (EPC) contract

Brooge Energy – Project client
Ernst & Young – Project consultancy services
Thyssenkrupp Uhde – Technical study for the project

In July 2022, the client has signed the preliminary land lease agreement for the development of the project
Main contract tender issue as well as commercial bid submission expected during Q3 2023
The project will be developed as an Engineering Procurement Construction (EPC) contract

Project name: Kizad Brooge Hydrogen
Country: Abu Dhabi, UAE
Location: Khalifa Industrial Zone (Kizad)
Client/Project Company: Brooge Energy
Estimated cost (Budget): $1.5bn
Hydrogen capacity: -
Ammonia capacity: 822 tonnes per day
Electrolyser capacity: -
Renewable energy capacity: -
Project sponsors: Brooge Energy
Start date: 2024
Full completion: 2026

<table>
<thead>
<tr>
<th>Year</th>
<th>Project event</th>
</tr>
</thead>
<tbody>
<tr>
<td>2022</td>
<td>Project announcement</td>
</tr>
<tr>
<td>2023</td>
<td>Main contract award and commencement of construction</td>
</tr>
<tr>
<td>2026</td>
<td>Project completion and commissioning</td>
</tr>
</tbody>
</table>

Source: MEED, Brooge Energy, Oil & Gas Middle East, and other secondary sources
Challenges

• While there is undoubtedly huge potential for hydrogen in the region, only two projects have reached the construction stage. Most others are still going through the feasibility stage and it will be some time before they come to market.

• The lack of offtake agreements is a major impediment as no project can be financed without them. A key stumbling block is price as hydrogen is still ultimately more expensive than other fuels especially when given the lack of infrastructure and the cost of transportation.

• Likewise, to date almost all announced green hydrogen projects appear to be export orientated. There has been little impetus to date to utilize any future output locally. Ultimately, many projects are likely to only succeed when or if there is some local offtake agreement, but this will require domestic political input given the oil-dominated economies of the region.

• Another potential issue is the shortage of global electrolyser manufacturing capacity. Current world production capacity is about 8GW a year, mainly from China and Europe, but the Middle East and Africa alone are going to require at least 75GW of electrolysers as a minimum in order to develop their projects. Although manufacturing capacity is growing fast, much more capacity will have to come onstream if all projects are to go ahead.

• It is also not certain that countries are fully onboard with hydrogen as the fuel source. In the UK there is a policy discussion ongoing that other technologies can be applied more cheaply and efficiently. For instance, green hydrogen is projected to not reach the emissions performance of a home boiler using air source heat pump technology until 2040, while the latter can reduce emissions of 75% compared with existing gas boilers immediately.

• Nonetheless, it is clear that hydrogen is going to represent a project opportunity and companies are advised to prepare for a rush of new projects over the next 3-5 years.
Buy MEA Hydrogen Projects 2023 report to:

- Understand each of 50-plus Middle East and Africa hydrogen projects
- Identify new project opportunities with client and procurement details
- Understand risks, set strategy, and minimise risk
- Recognise challenges in the market
- Ensure you don’t miss any opportunity by being prepared for market developments

Further $100 discount for attendees with code: WEBINAR100

Visit buy.meed.com or scan the QR code to buy the full report before 25th November 2022

Report’s pre-launch $4,000 $3,500
Q&A
Do you have any questions?

Ed James
Head of Content
MEED
edward.james@meed.com
Tel: +971 50 661 4048

Further $100 discount for attendees with code: WEBINAR100

Visit buy.meed.com or scan the QR code to buy the full report before 25th November 2022