MEED
Middle East business intelligence

Middle East & Africa Hydrogen Projects

Current and future trends, challenges and opportunities

16 November 2022, MEED Webinar
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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

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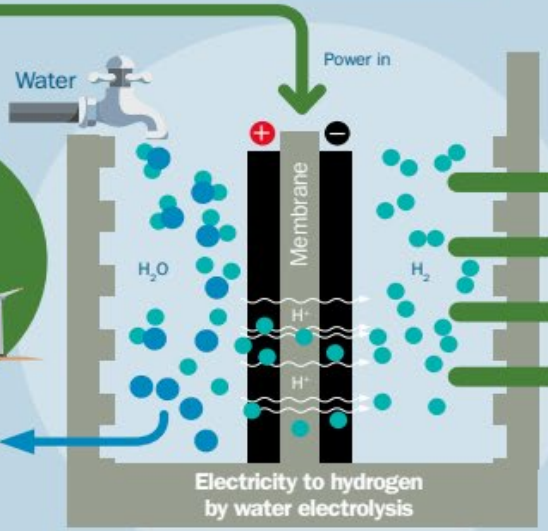
INDUSTRIAL PRODUCTION

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

~600 billion cm/y total hydrogen production

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



Hydrogen

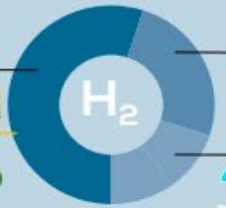
Hydrogen

Hydrogen

Hydrogen

HYDROGEN APPLICATIONS

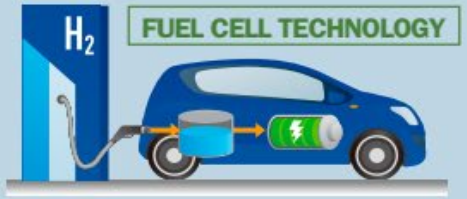
55% Share of hydrogen used for ammonia synthesis



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 1kg of hydrogen over 100-120 kilometres

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

NATURAL GAS REPLACEMENT

Hydrogen is an increasingly viable transitional feedstock for gas turbines

20% Hydrogen capacity of gas turbines by **2020****

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

RENEWABLE OPPORTUNITY

$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

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; **=EUTurbines group targets.
cm/y=Cubic metres a year; kWh=Kilowatt hours; kg/d=Kilograms a day. Sources: EIGA, Hydrogen Europe, IEA, MEED, Swansea University

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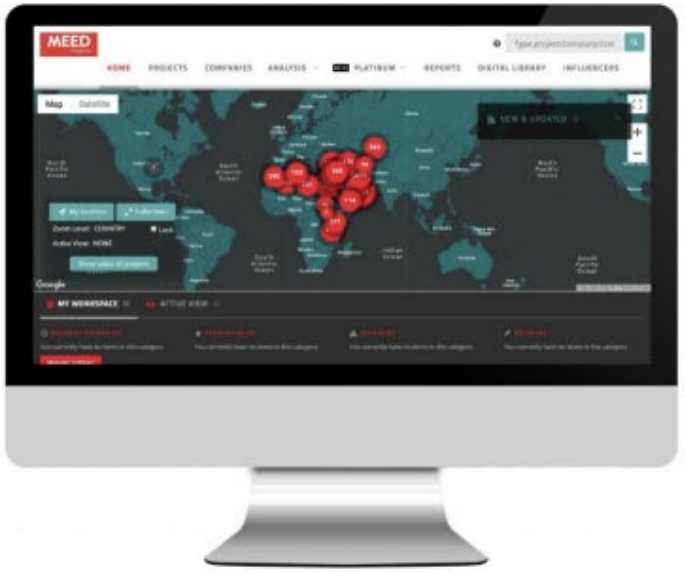

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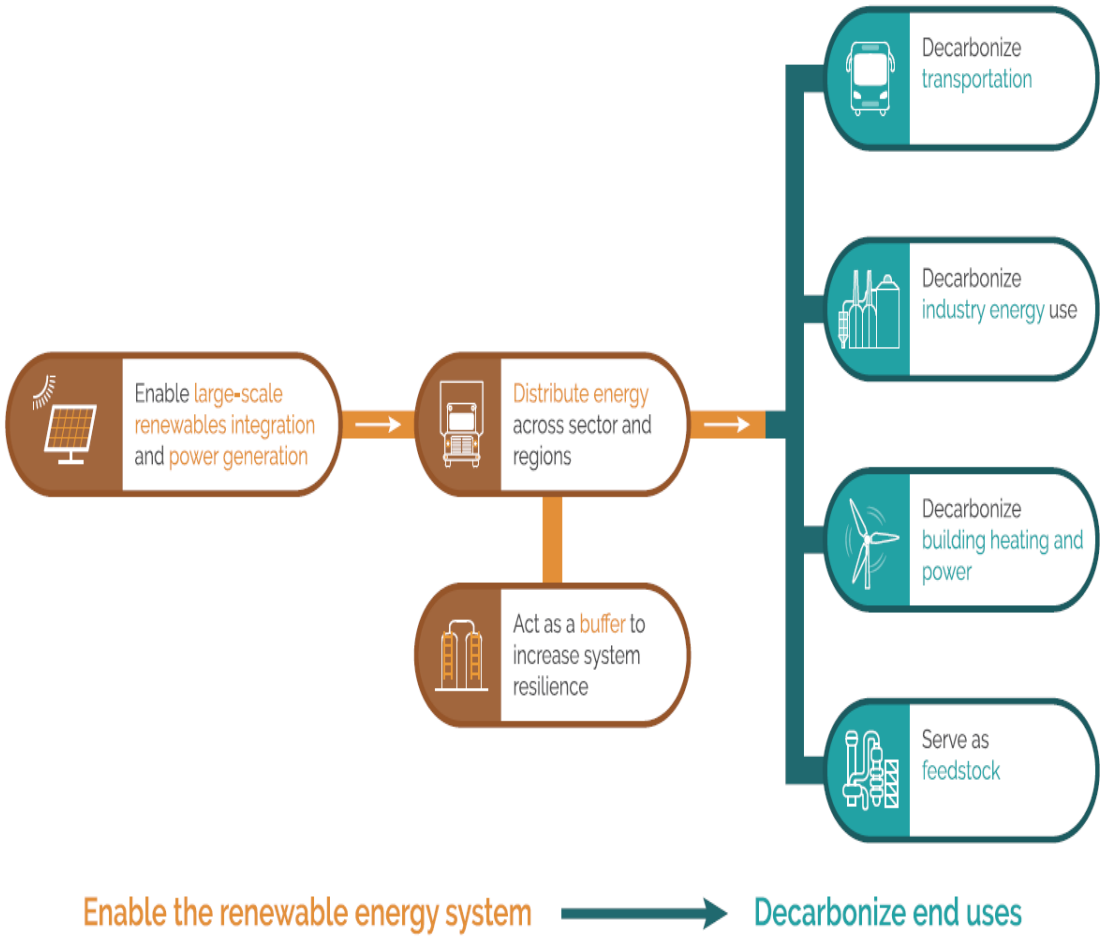
Applications

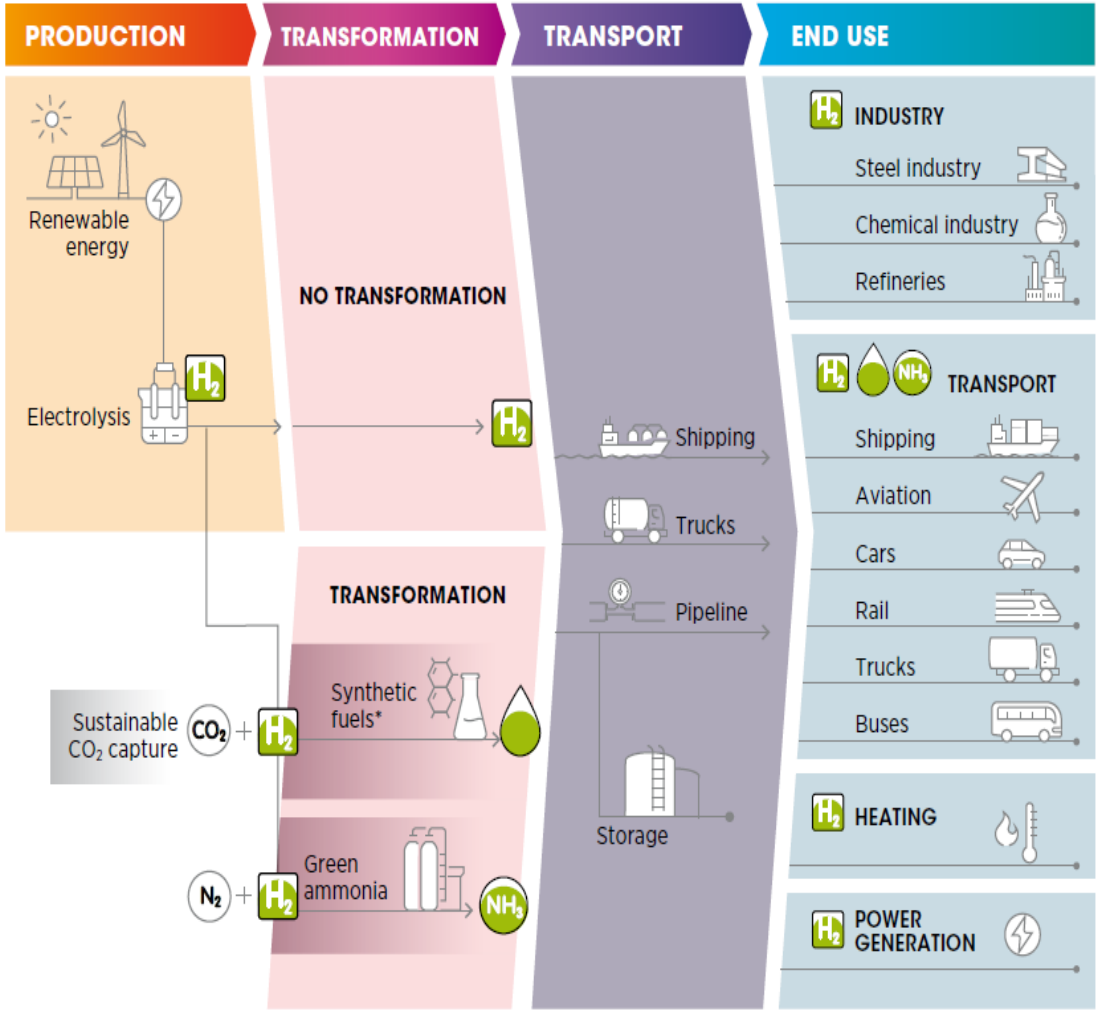
Green hydrogen is seen as a partial solution in the journey toward net zero. As it has multiple end uses and transportation methods, it is viewed as a particularly flexible fuel source.

Hydrogen applications and decarbonisation



Source: Hydrogen Council

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

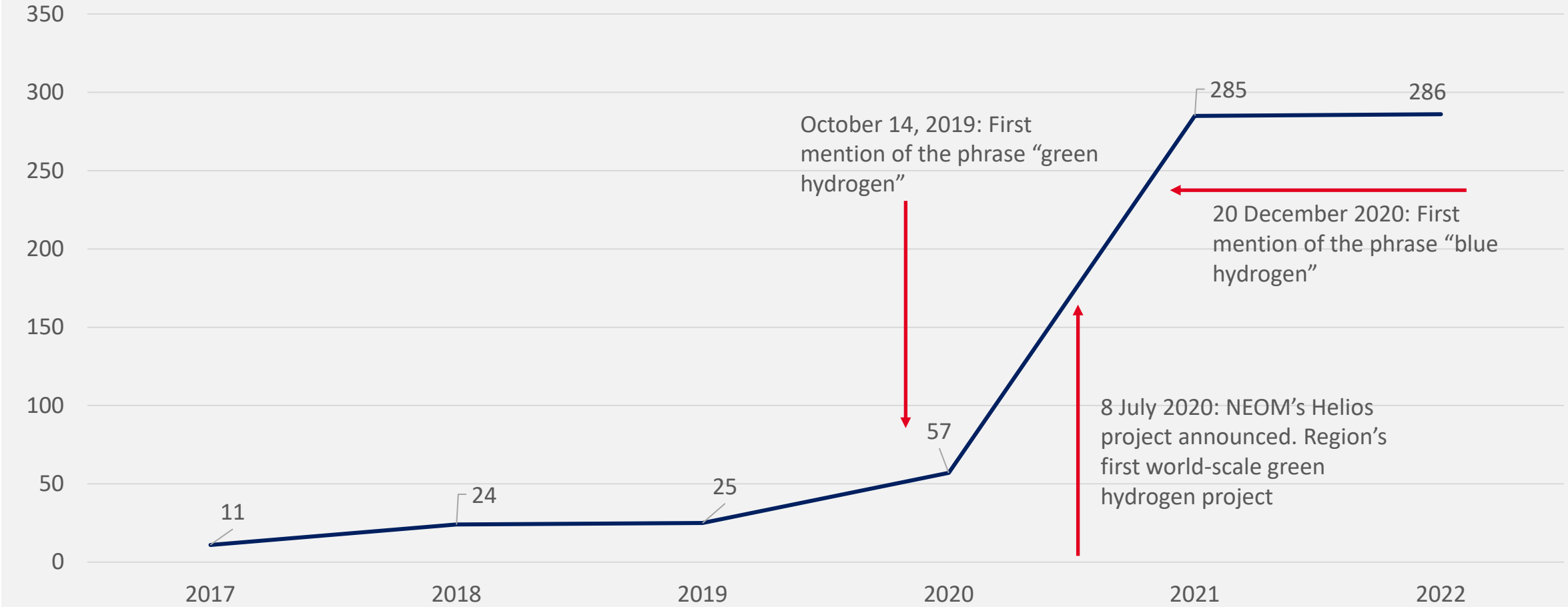


Source: Irena

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

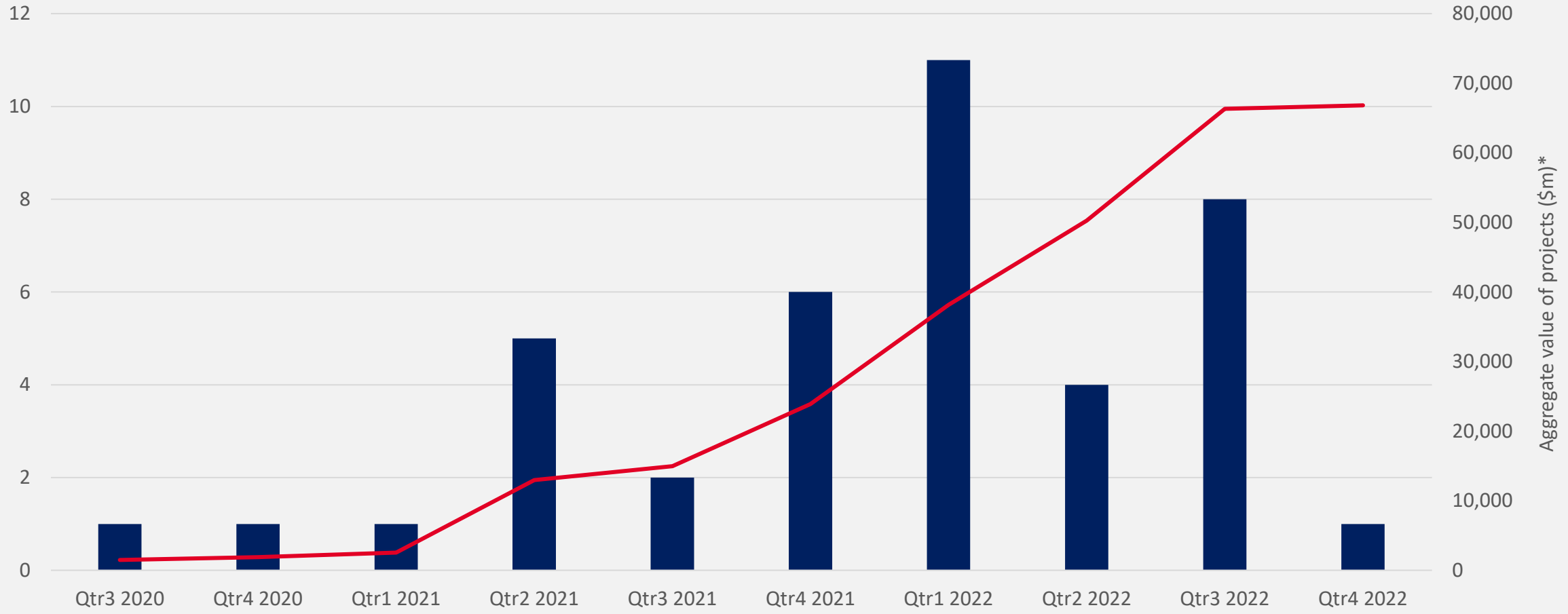


Source: MEED

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



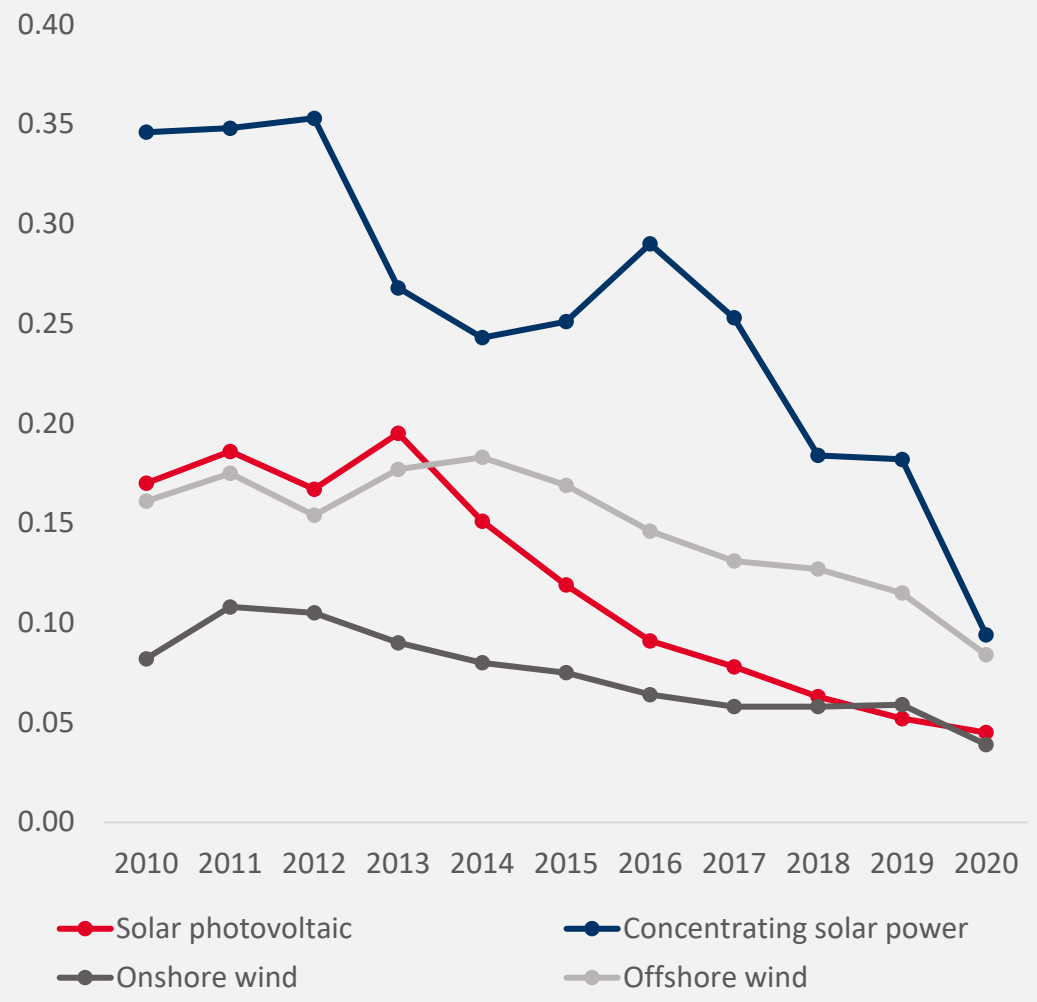
Source: MEED Projects

* Covers only hydrogen plant element

Why Now?

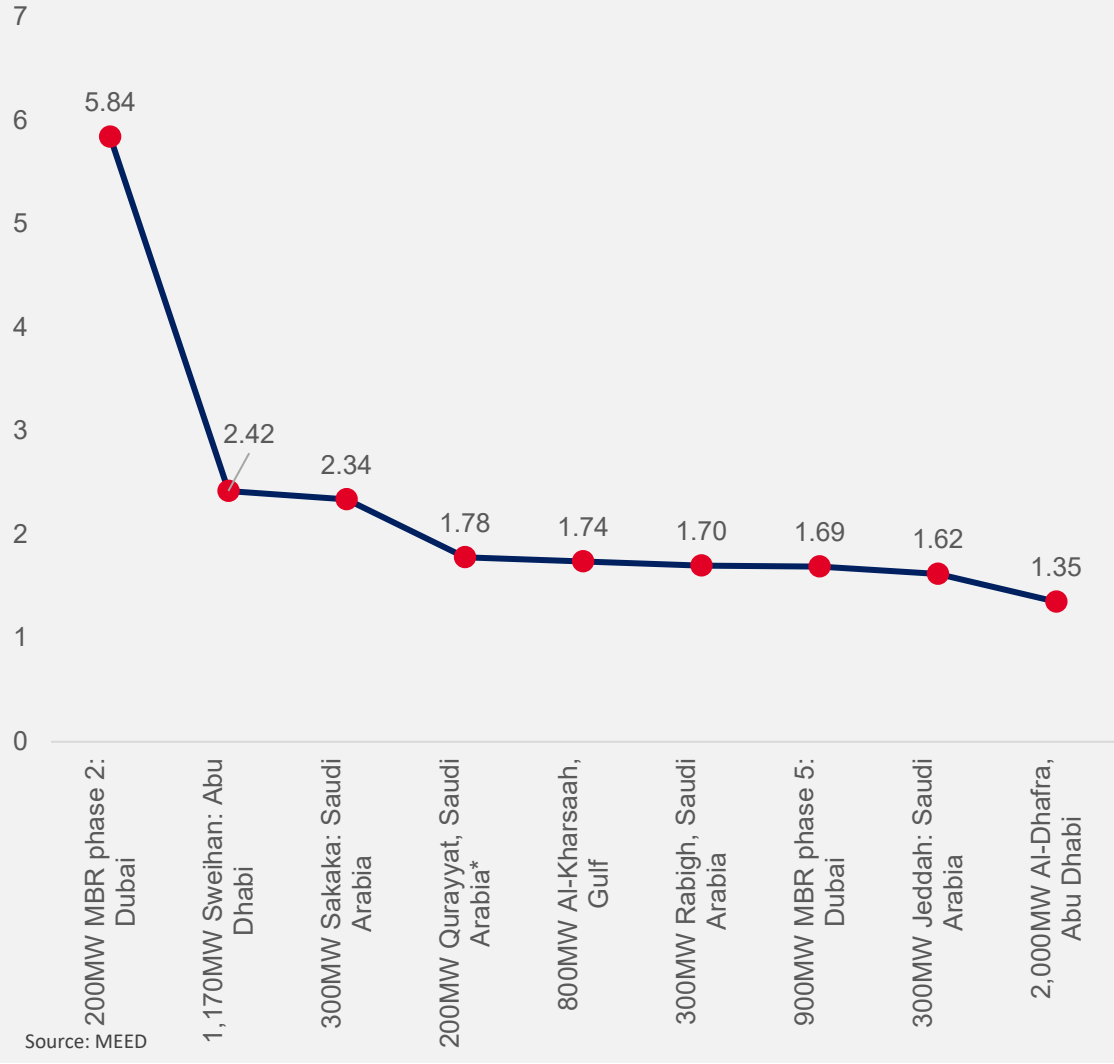
A major factor behind the acceleration in hydrogen project activity is the rapid reduction in renewable energy costs. Solar PV costs are now as low as $0.045 a kilowatt hour, and on an IPP basis developers in the region have been offering a LCOE to offtakers as little as 0.0135 cents a kilowatt hour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

Global renewable energy costs ($/kWh)



Source: IEA

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

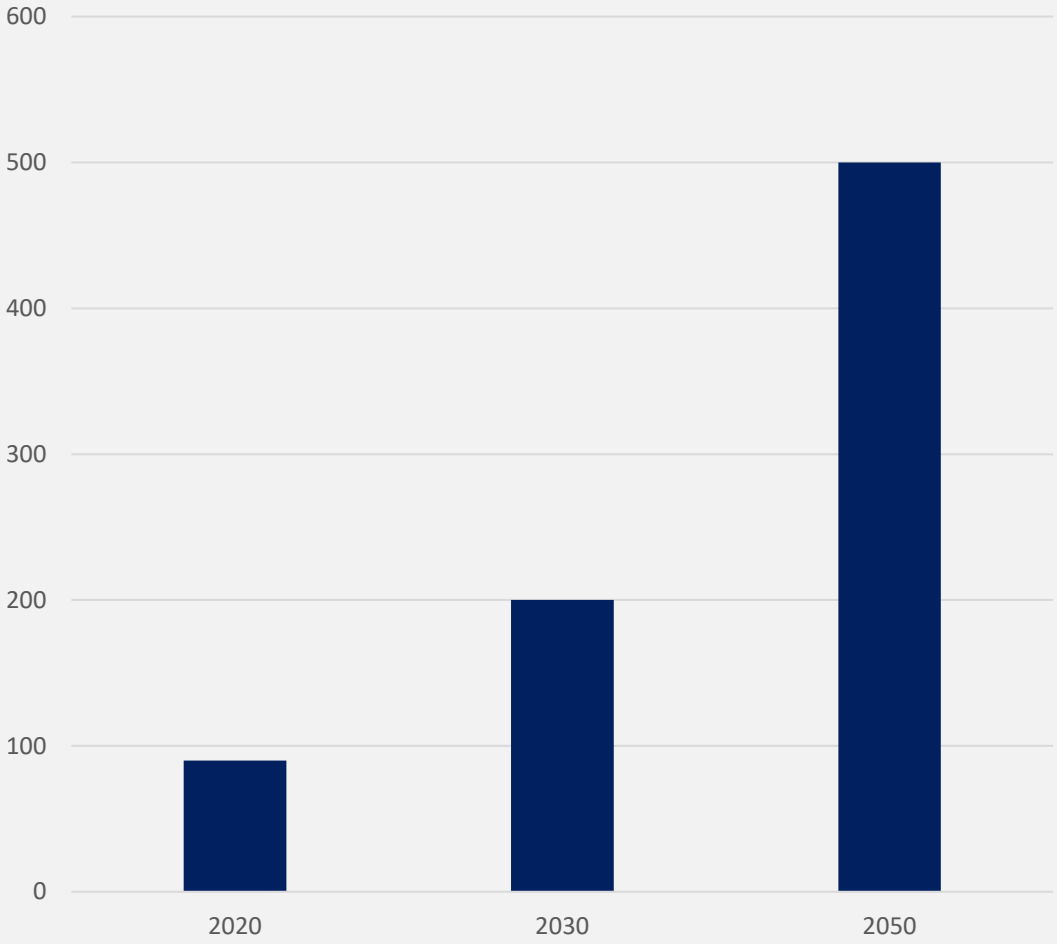


Source: MEED

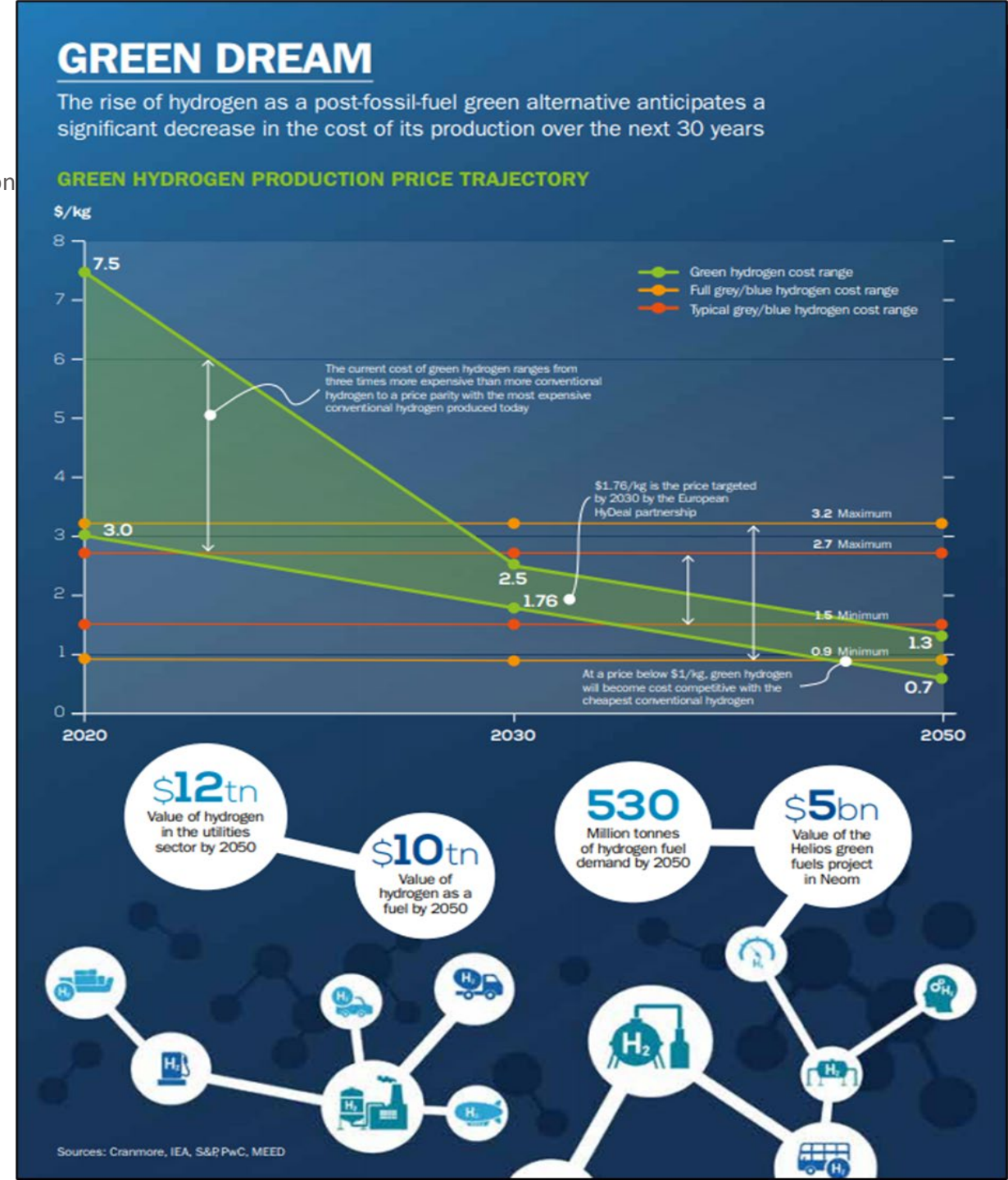
Why Now?

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)

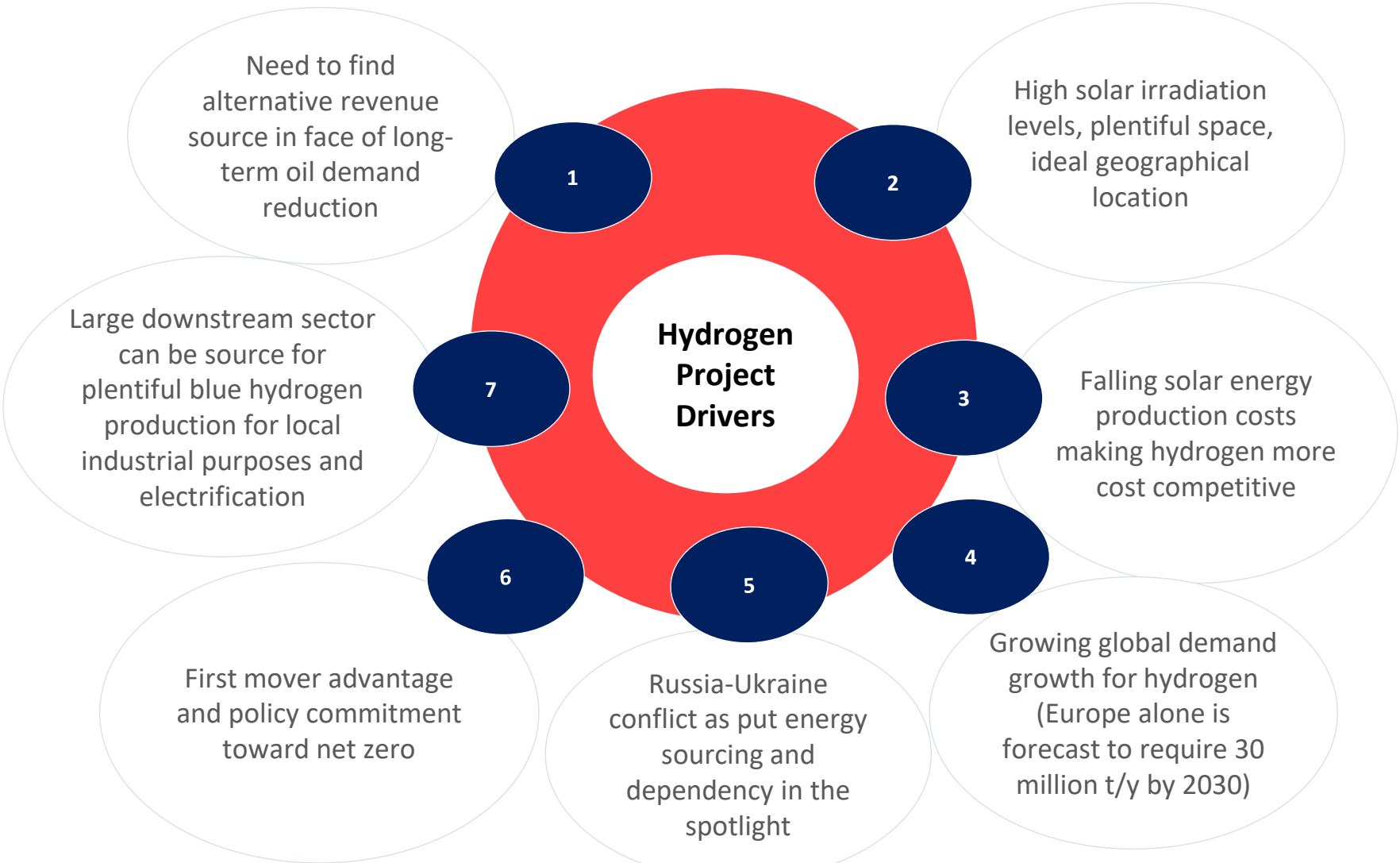


Source: IEA



Market Drivers

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.



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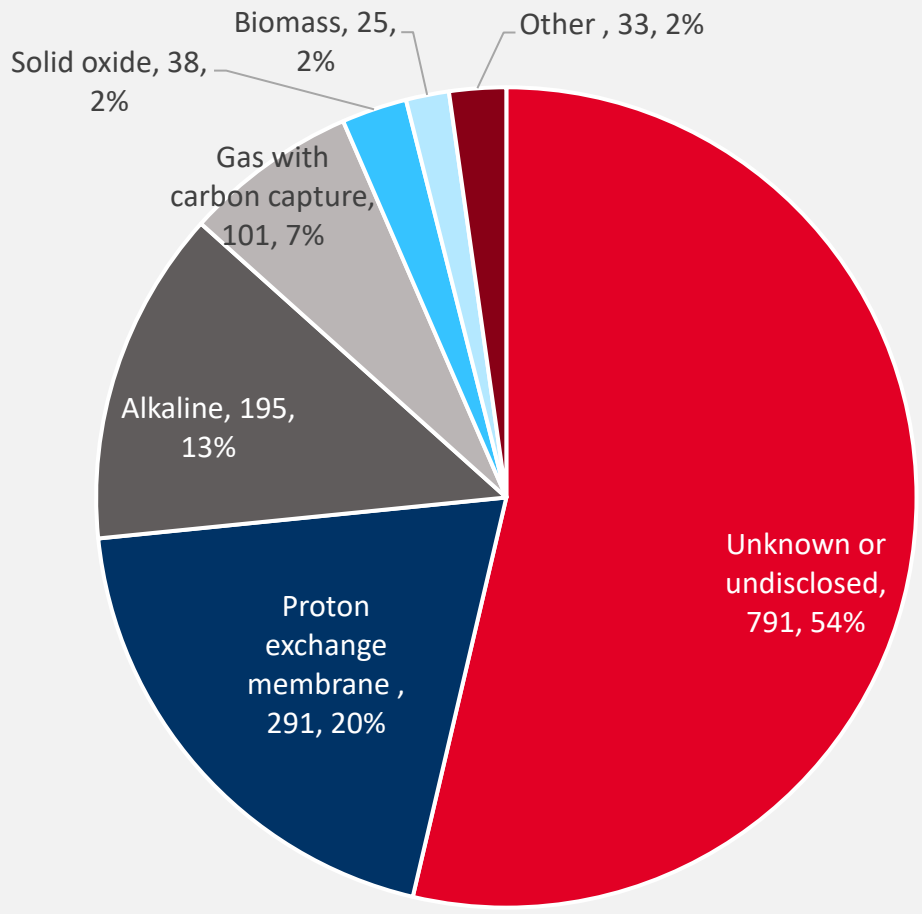
Hydrogen Market

Technology and Output

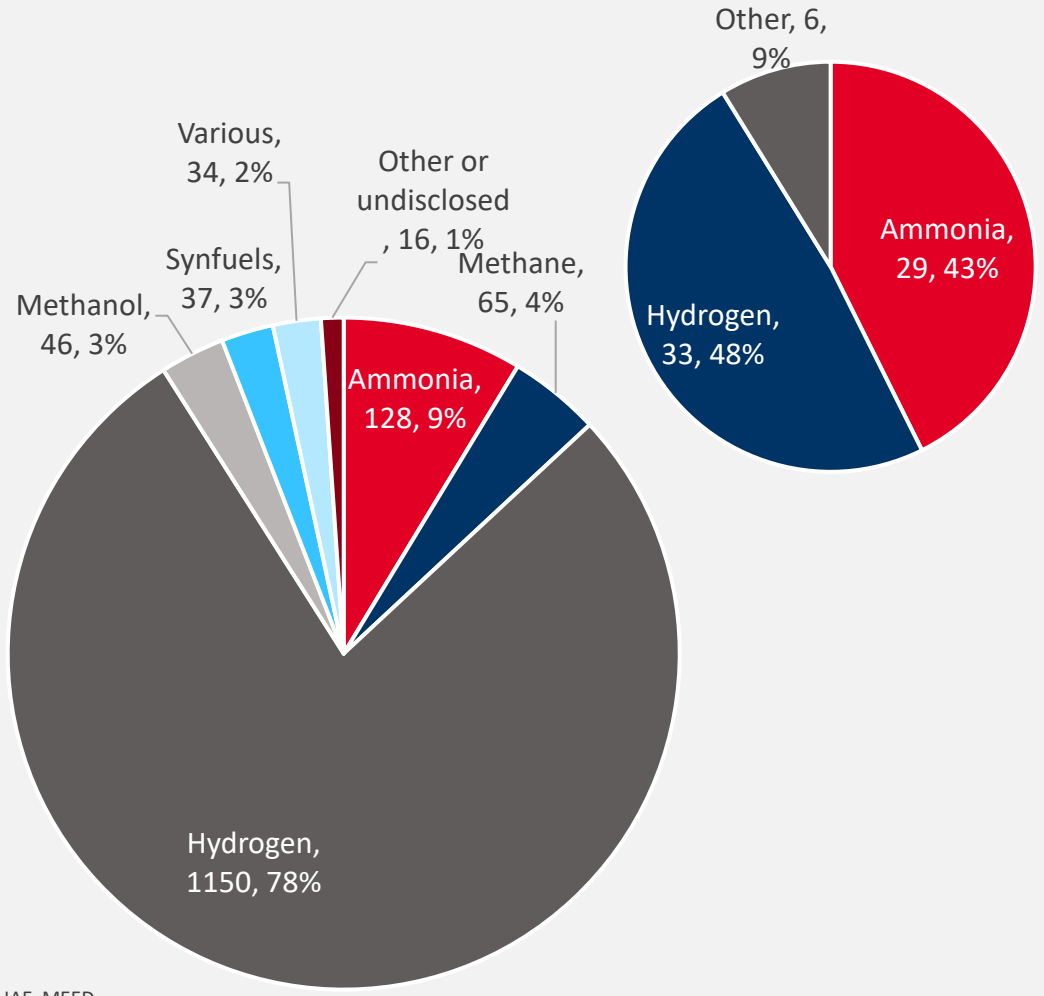
Although most currently planned hydrogen capacity is destined for export, MEA has great potential for the development of domestic demand using existing gas pipeline networks. Almost all announced projects to date will produce either hydrogen or green ammonia. There is a paucity of data, but it is likely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

Number of planned or operational hydrogen projects by electrolysis technology



Source: MEED, GlobalData, IEA

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

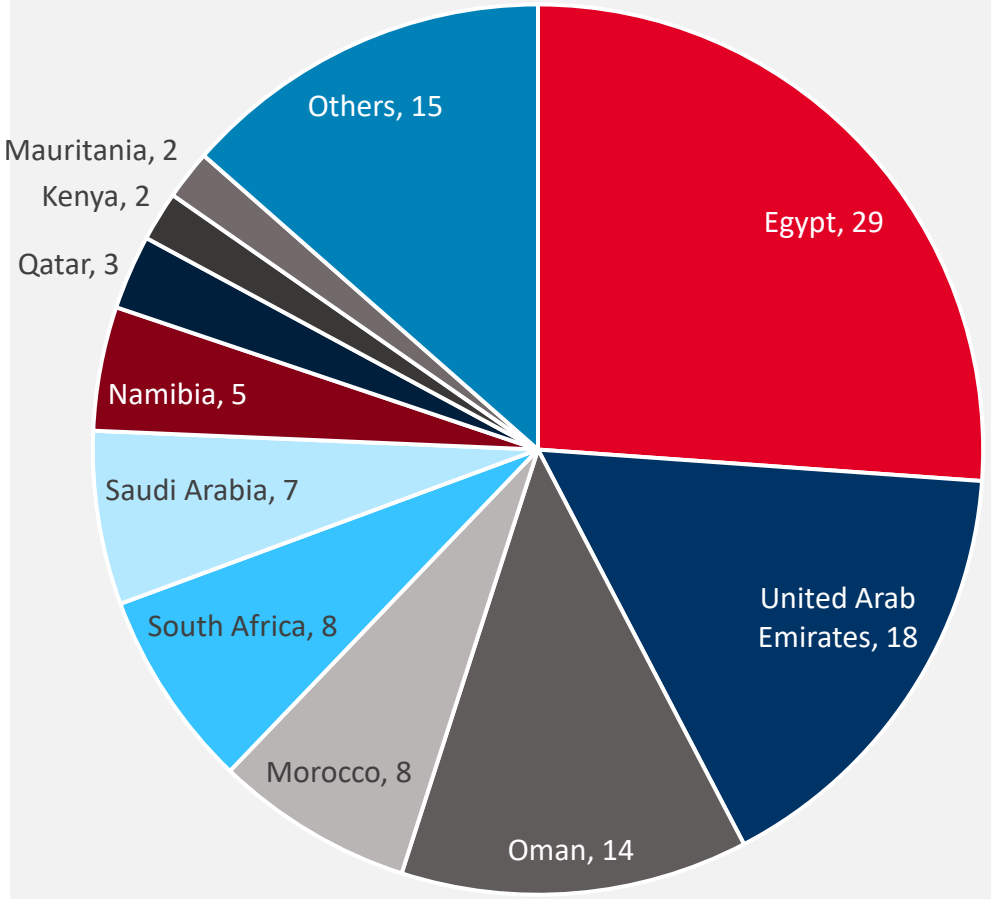


Source: IAE, MEED

Geographic Distribution

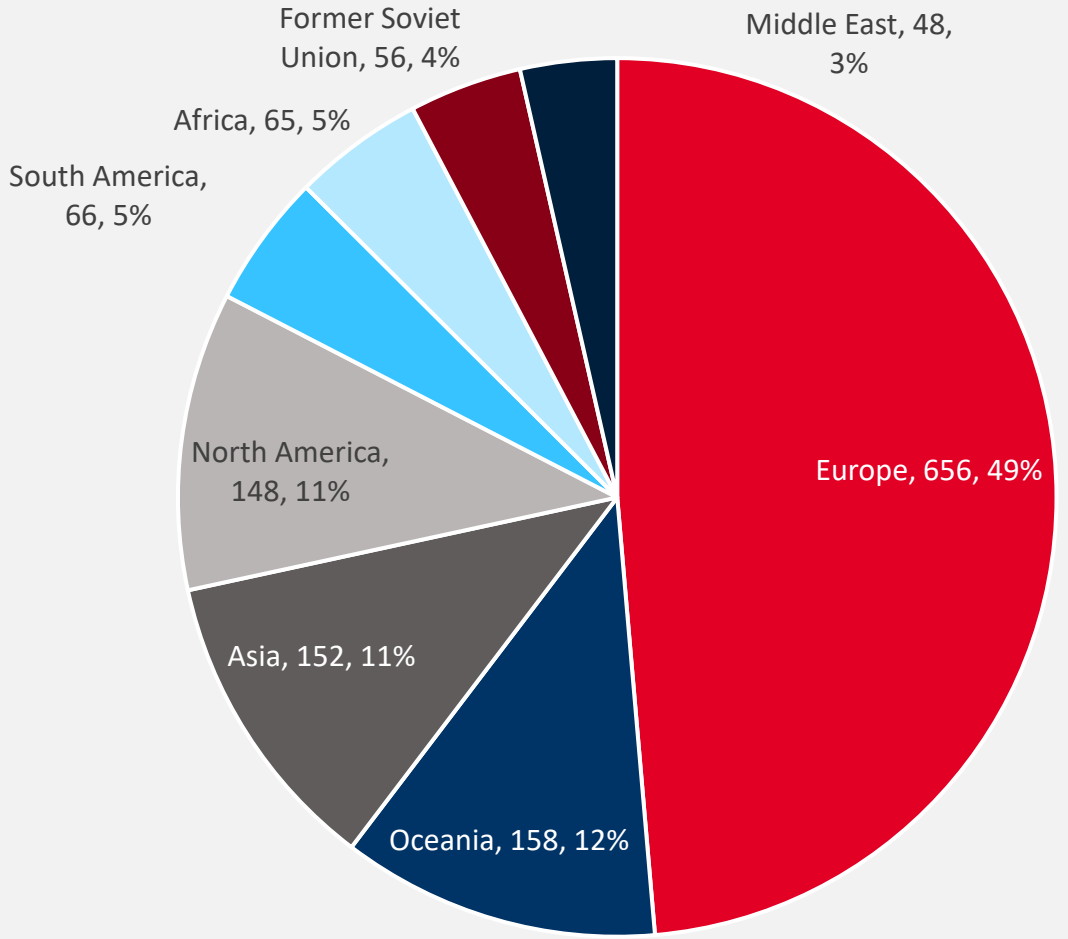
The hydrogen market in the region is dominated by a handful of countries – Egypt, UAE, Oman, Morocco, South Africa, Saudi Arabia and Namibia. All to MEA represents approximately 8% of all known projects globally, but a far higher proportion in terms of total output given the higher average capacities

Distribution of hydrogen projects by country



Source: MEED, GlobalData

Number of hydrogen projects by region

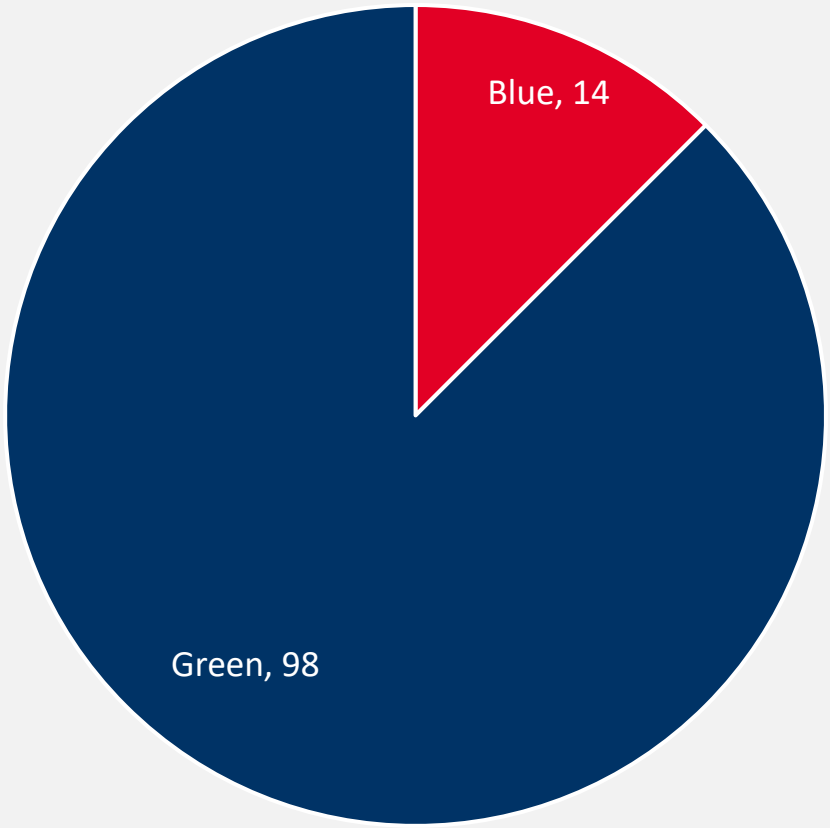


Source: MEED, Globaldata

Type and Source

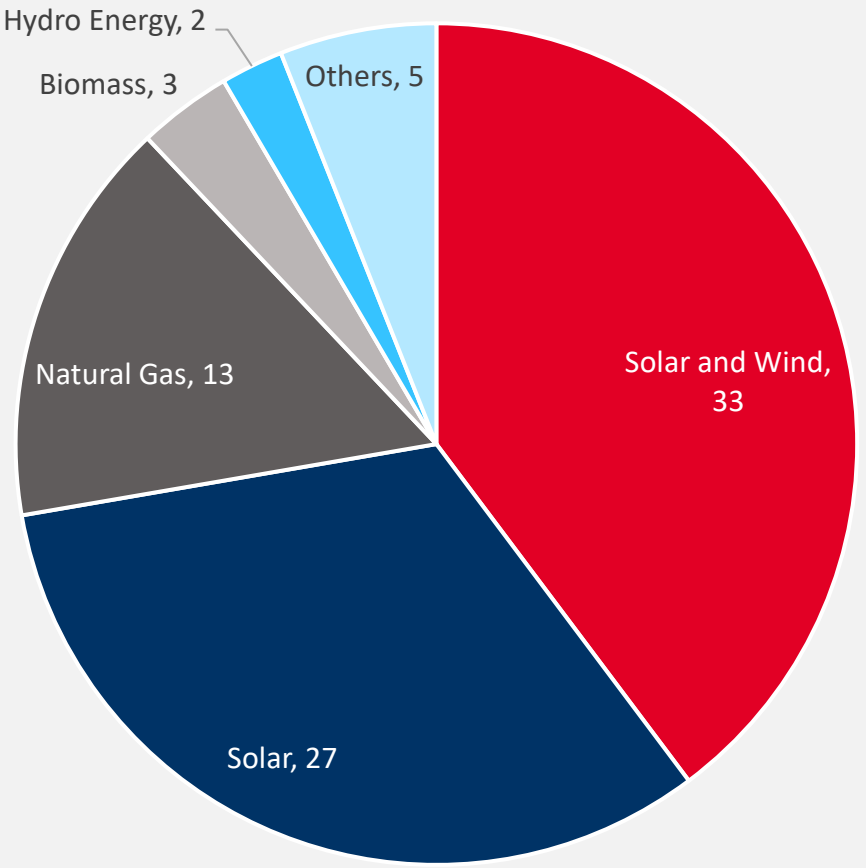
Green hydrogen is the dominant type of future production, with so far only a few blue hydrogen projects definitively announced. In terms of electricity sources, solar or a combination of solar and wind power are by far the most common technologies to be employed

Breakdown of MEA hydrogen projects by type



Source: MEED, GlobalData

Breakdown of MEA hydrogen projects by known electricity source



Source: MEED, Globaldata

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Hydrogen Projects

Active 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

Project	Country	Budget ($m)	Status	Electrolyser capacity (MW)	Renewable energy capacity (MW)	Green hydrogen (t/y)	Ammonia (t/d)	Stakeholders
Green Energy Oman (GEO)	Oman	28,000	Feasibility	13,000	25,000		27,400	OQ, InterContinental Energy, EnerTech
Amun	Morocco	16,000	Concept		15,000			CWP Global
Acme Group green hydrogen hub	Egypt	13,000	Concept					Acme Group
SCZone hydrogen plant 4	Egypt	11,000	Concept					Globeleq Company
Masdar - Hassan Allam SC Zone green hydrogen project	Egypt	10,000	Feasibility			100,000		Masdar, Hassan Allam
RenewPower SCZone green hydrogen project	Egypt	8,000	Concept			220,000		Renew Power, NREA, EETC, TSE
Neom Helios Green Fuels	KSA	6,500	Execution	2,000	4,000	650,000	3,290	Acwa Power, Air Products, Neom, Baker Hughes, Thyssenkrupp
Posco green ammonia plant	Oman	5,000	Concept		4,000			Posco
H2 Oman	Oman	5,000	Concept	2,200	3,500	1,000,000	2,740	Acwa Power, OQ, Air Products
Engie-Masdar hydrogen hub	UAE	4200	Concept		200	34,700		Engie, Masdar
Sohar Port/ Port of Rotterdam project	Oman	4,000	Concept		3,500			Sohar Port, Port of Rotterdam
Green hydrogen export plant	KSA	4,000	Concept					PIF, Posco, Samsung C&T
Phelan green ammonia project	Egypt	3,500	Concept				6,849	Phelan Energy Group
SCZone hydrogen plant 1	Egypt	3,500	Concept					Alfanar
1GW waste-to-hydrogen project	Egypt	3,000	Concept			300,000		SCZOne, H2Industries
Sasol Boegoebaai Green Hydrogen Project	KSA	3,000	Concept	2,800		400,000		Sasol, Itochu
ACME green hydrogen & ammonia facility	Oman	2,500	Feasibility				2,200	Acme Group, Tatweer, Scatec
Hyphen Green Hydrogen Complex	Namibia	2,000	Concept			125,000		Enertrag, Nicholas Holdings
Taqa – AD Ports green ammonia plant	UAE	2,000	Concept		577	100,000		Taqa, Abu Dhabi Ports, Thyssenkrupp
Taqa-Emirates Steel	UAE	2,000	Concept					Taqa, Emirates Steel
Sonangol Angola Hydrogen Project	Angola	2,000	Concept					Sonagol
HDF Energy Swakopmund Hydrogen Project	Namibia	2,000	Concept					Hydrogene de France

Source: MEED

Hyphen Green Hydrogen Project - >$9bn

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.

Key project facts

Project name	Namibian Green Hydrogen Project
Country	Namibia
Location	Tsau/Khaeb National Park
Client/Project Company	Hyphen Hydrogen Energy
Estimated cost (Budget)	$9.4bn
Hydrogen capacity	350,000 t/y (all phases)
Ammonia capacity	1.7 million t/y (all phases)
Electrolyser capacity	3GW
Renewable energy capacity	5–6GW
Project sponsors	Nicholas Holdings Limited, ENERTRAG
Construction start date	2025
Full completion	2026 (first phase), 2030 (expected full commissioning)

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
2,600–2,800 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.

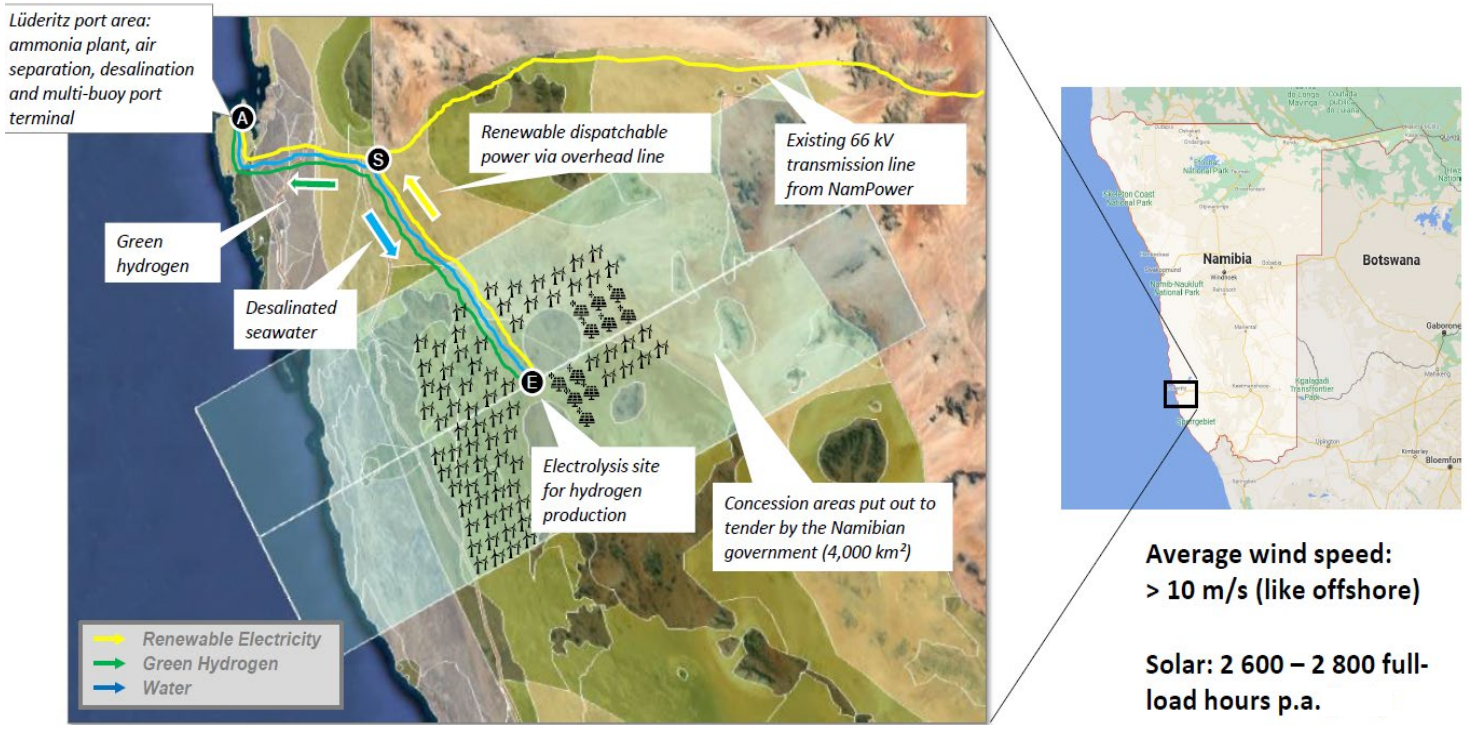
The Boston Consulting Group and Lazard have been appointed as strategic and financial advisors respectively.

Slaughter and May and ENS Africa are on board for legal advisory services.

2021	2025	2026	2030
Announcement date	Phase I construction expected to be taken up in January	First production from the planned facility in December	Full capacity

Source: MEED, OQ, InterContinental Energy, EnerTech and other secondary sources

Hyphen - Green Hydrogen Project - >$9bn



Average wind speed: > 10 m/s (like offshore)

Solar: 2 600 – 2 800 full-load hours p.a.

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

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 26,000km^2 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.

Source: Hyphen Hydrogen Energy, ENERGYMONITOR

Green Energy Oman– >$28bn

Overview

25GW solar and wind energy capacity

Estimated to be $28bn

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

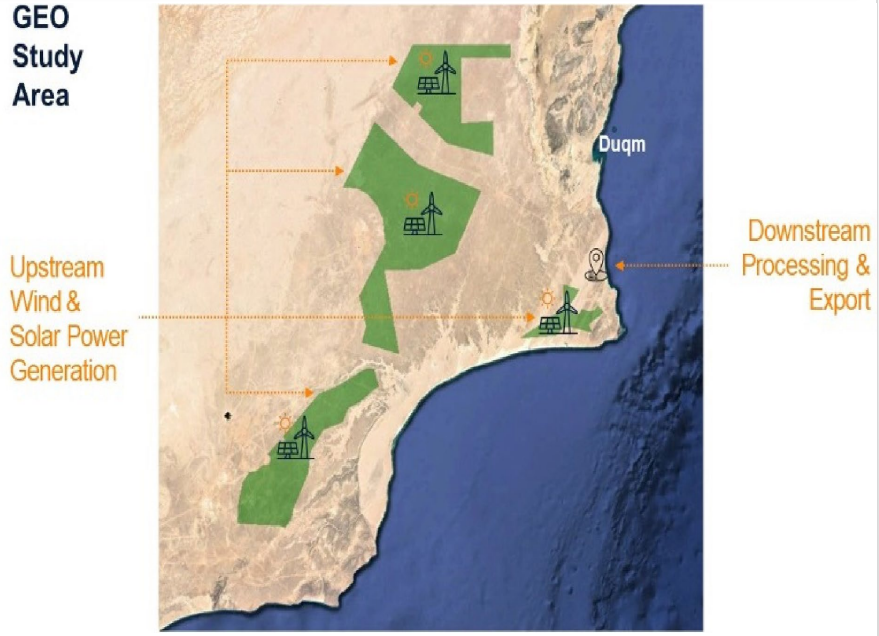
Korean Gas Technology Corporation (Kogas-Tech) has signed an MoU to collectively explore opportunities

Prequalification of EPC contractors expected to start in 2025

2021	2025	2028	2032	2038
Announcement date	Financial closure for Phase 1 (8,000MW)	First production from the planned facility	Final phase	Full capacity

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



Meed | OQ

Helios Industry – KIZAD Green Ammonia - >$1bn

Overview

Development of a Green Hydrogen and Green Ammonia Plant at Kizad with ammonia capacity of 200,000 tonnes utilizing 800MW solar PV electriicty

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

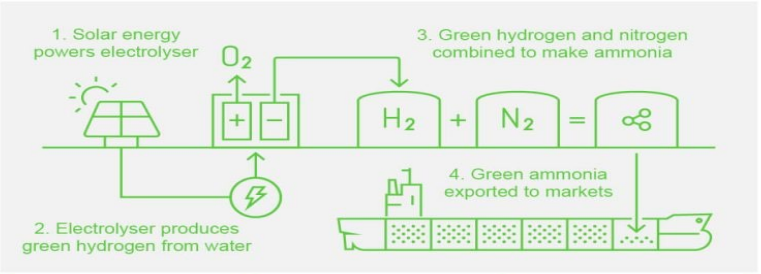
Status

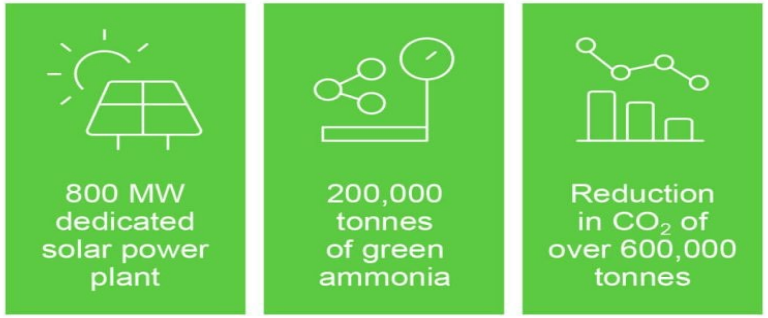
In June 2022, technical studies were completed by Thyssenkrupp

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

2021	2022	2024	2026
Project announcement	Technical studies completed in June	Main contract award and commencement of construction	Project completion and commissioning

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

Stakeholders

H2 Industries will be developer and the EPC contractors.

The General Authority for the Suez Economic Zone (SCZone) is the master developler

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

2022	2024	2026
Approval granted for the project	Main contract award and commencement of construction	Project completion and commissioning

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

Source: MEED

Kizad Brooge Hydrogen - $1.5bn

Overview

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

Stakeholders

Brooge Energy – Project client

Ernst & Young – Project consultancy services

Thyssenkrupp Uhde – Technical study for the project

Status

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

2022	2023	2026
Project announcement	Main contract award and commencement of construction	Project completion and commissioning

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

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

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Q&A

Do you have any questions?

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