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# MIDDLE EAST

## The $H_2$ Handbook

Legal, Regulatory, Policy, and Commercial Issues Impacting the Future of Hydrogen

July 2023

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# CONTENTS

# PART I - MENA AND THE EMERGING HYDROGEN ECONOMY

## I. MENA and the GCC

**The Middle East and North Africa region (MENA) stretches from Morocco in the far northwest of Africa to Iran in the Middle East. The core MENA states are reflected in Figure 1 below, but MENA can also be said to include other countries such as Sudan and Djibouti in Africa, as well as Turkey and Azerbaijan in the Caucasus.**

The major financial powerhouses of MENA are the oil- and gas-rich countries of the Arabian Peninsula: Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates (UAE). In 1981, the leaders of these six nations established the Cooperation Council for the Arab States of the Gulf (GCC). The purpose of the GCC was to establish a cooperative framework, which would allow coordination, cooperation, and integration between the member states in all fields.


Figure 1

## II. The Emerging Hydrogen Economy

### A. An International Trend Toward Clean Energy

In 2015, 196 nations—all of whom are party to the United Nations Framework Convention on Climate Change (UNFCCC)—entered into the Paris Agreement; a milestone marking the development of a cohesive, international approach to address climate change. The Paris Agreement is a legally binding international treaty on climate change, signifying the arrival of a global, government-led approach to mitigate climate change, limit global warming, and to realize net-zero greenhouse gas (GHG) emissions by 2050.

Across governments and industry, there is a developing awareness that the emerging hydrogen economy could be vital to efforts to reduce emissions, decarbonize key industrial sectors, and satisfy the Paris Agreement. Governments and corporations (both public and private) are investing in hydrogen, researching its potential as a clean energy fuel that could be central to a global energy transition, and moving away from hydrocarbons and towards clean, net-zero emission fuels. US President Joe Biden has pledged to set the United States on the path to becoming a clean energy economy with net-zero emissions by the year 2050, which would require a huge shift away from hydrocarbon energy sources.

The World Bank estimates that the MENA region contributes approximately 7% of the world's total carbon dioxide emissions, with the GCC countries among the world's top ten polluters per capita.[1] Furthermore, the economies of MENA countries, specifically those in the GCC, are heavily reliant on the export of oil and gas, meaning they risk exposure to any substantial reduction in the global demand for hydrocarbons.

However, the international shift towards green energy presents an opportunity for countries across MENA, especially given the abundance of solar energy across the region, which can be used to produce green energy fuels such as hydrogen. Governments across MENA are therefore well placed to be at the forefront of the international trend towards decarbonization and to develop the infrastructure to compete in future sustainable energy markets.

Hydrogen is likely to be a critical part of the energy mix as the world strives to decarbonize, meaning there will be a rapid increase in global demand between 2021 and 2050. Key net importers of green hydrogen will be markets in Asia and North America, as well as Europe. While European states push ahead with hydrogen initiatives, it is recognized that domestic European production would not be sufficient to decarbonize hard-to-abate industries in the short term or for European nations to achieve their emission targets under the Paris Agreement. Clean fuels such as hydrogen are expected to displace around 10.4 billion barrels of oil (or its equivalent) by 2050, which represents 37% of global oil production.

## B. What is Green Hydrogen?

As of 2021, approximately 95% of the global hydrogen supply is produced using fossil fuels, mostly natural gas, with hydrogen from renewable energy comprising just 0.04%.[2] Existing dedicated hydrogen production facilities rely on natural gas feedstock or the gasification of coal. This results in either "grey" or "brown" hydrogen, depending on whether natural gas or coal is used as the feedstock, respectively. Given the requirement for hydrocarbon to fuel the production of grey and brown hydrogen, together with the associated release of carbon dioxide into the atmosphere as a byproduct of the process, grey and brown hydrogen are not sources of clean energy, despite the absence of emissions when the hydrogen is combusted. The carbon footprint of the grey and brown hydrogen process can be reduced by the use of carbon capture utilization and storage (CCUS) technologies, producing what is known in the industry as "blue" hydrogen, resulting in a significant reduction in the emissions profile. "Green" hydrogen, however, is a zero-carbon fuel produced through electrolysis. Water is split into its constituent parts of hydrogen and oxygen using renewable energy, e.g., from wind or solar, to power the electrolysis process.

Green hydrogen has tremendous benefits, since the hydrogen molecule stores clean energy from renewable sources. Hydrogen can be converted to ammonia (one nitrogen atom bonded to three hydrogen atoms), which is an easy molecule to transport, as the energy density of ammonia by volume is nearly double that of liquid hydrogen, facilitating shipping and distribution. In the form of ammonia, energy can be transported to energy markets, such as Europe, Asia, and North America, where the ammonia can be converted back to hydrogen for use as a fuel.

Hydrogen can potentially decarbonize sectors that are hard to electrify due to the challenges presented by energy storage and demand (i.e., where batteries would be too big and heavy), including haulage, heavy industry like steel manufacturing, and heating. As a method of storing renewable energy, hydrogen presents a viable alternative to batteries.

Green hydrogen is seen as an integral component of the global effort to decarbonize the world's energy industry in the near future.

## C. The Potential Scale of the Hydrogen Economy

It is estimated that global demand for green hydrogen could reach 530 million tonnes by 2050, with a global export market worth US$300 billion. Analysts at Barclays have estimated that the hydrogen economy could be a US$1 trillion market by 2050, "potentially saving 5 gigatonnes in $CO_2$ emissions a year."[3]

To achieve the Paris Agreement's "two-degree scenario" by 2050 (see **Part I -, II** below), global energy-related carbon dioxide emissions will have to be reduced by 60%. The Hydrogen Council, which is an industry-led effort to develop the hydrogen economy established in 2017, considers hydrogen to be "a central pillar of the energy transformation required to limit global warming."[4]

The natural properties of hydrogen give it enormous potential in the world's energy future, supporting its production from low-carbon technologies. The hydrogen molecule is stable, lightweight, and easy to store. Its energy content is three times greater than typical hydrocarbons such as petrol, and when used as fuel, the only byproduct is water (i.e., steam). It can be readily produced at an industrial scale, and it can be stored for long periods of time with minor losses. It can be used to store renewable energy, which can counteract the intermittency of renewable power generation.

The Hydrogen Council asserts that hydrogen can play seven major roles in the energy transition, and "across all seven roles, hydrogen could account for almost one fifth of total final energy consumed by 2050," and up to 25% of the energy required for road transport. The seven roles identified by the Hydrogen Council are:[5]

- Enabling large-scale renewable energy integration and power generation.
- Distributing energy across sectors and regions.
- Acting as a buffer to increase energy system resilience.
- Decarbonizing transportation.
- Decarbonizing industrial energy use.
- Helping to decarbonize building heating and power.
- Providing clean feedstock for industry.

Hydrogen has quickly become a major energy source of the future. It is one of the few renewable energy sources that is, as of 2023, economically viable and sufficiently advanced technologically to be produced on an industrial scale. Because it can be stored, as hydrogen or ammonia, it can also be used to store energy from fluctuating sources of renewable energy such as solar and wind. Its storability allows for international energy distribution, and it can link renewable-abundant regions, such as MENA, with markets that will be net-importers of clean energy, such as Europe. Furthermore, both hydrogen and ammonia can be stored as strategic power reserves. The stage is therefore set for hydrogen to be a major element of the world's net-zero emissions future.

## D. Utilizing Green Hydrogen

If nations are to make satisfactory contributions to the reduction of GHG emissions, as agreed under the Paris Agreement, the development of green hydrogen technology and infrastructure will be a critical element of the process of decarbonizing the energy industry. However, to transition the energy economy (including transport) from hydrocarbons to hydrogen will require enormous investment in the development of the infrastructure needed to produce, store, transport, and distribute hydrogen.

Barclays has estimated that "over the next 30 years, $500 billion in capex will be needed for hydrogen production equipment—and similar amounts for distribution infrastructure."[6]

By way of context, in 2022, the Global CCS Institute found that 40 blue hydrogen facilities equipped with CCS/CCUS were under development.[7] However, the reality is that there is very little green hydrogen infrastructure in place as of 2023, meaning that governments will need to take proactive steps to facilitate the development of the necessary technology and infrastructure, in conjunction with state power companies and private corporations. This will require government funding, as well as incentives for companies to invest in hydrogen, the implementation of domestic regulations in terms of emission targets, and the utilization of hydrogen as an energy source.

## E. The Potential of Green Hydrogen in MENA

Across MENA, and specifically in the GCC, governments are beginning to explore the potential of hydrogen. In terms of project trends, the value of all announced hydrogen plants in MENA is now estimated to exceed US$70 billion.[8] This is an important step in the strategic long-term vision of transitioning towards a clean energy economy as domestic oil and gas reserves are depleted and as the demand for hydrocarbon products diminishes as the world strives to reduce GHG emissions.

States in MENA, particularly in the Gulf, are increasingly focused on green hydrogen projects specifically as a means to diversify their energy mix, reduce carbon emissions, and strengthen energy security. States have recently assessed their nationally determined contributions (NDCs) and found that many of them are not on track to achieving Paris Agreement pledges. However, each state has a different combination of energy security, affordability, and sustainability pathways.[9] Hydrogen is in a unique position to provide emissions reduction to comply with climate change objectives, yet also provide a reliable and secure global energy supply.

Across MENA there is an abundance of renewable energy, including solar and wind power, which can be used to power green hydrogen production. At the Leaders' Summit on Climate, held between the United States and the UAE in 2021, Sultan Ahmed Al Jaber, the UAE's Industry and Advanced Technology Minister and UAE special envoy for climate change, said:[10]

> Due to early investment and policy choices, the UAE now enjoys the lowest-cost solar power in the world, enabling further competitiveness in our industries and services.

The availability of low-cost renewable energy, coastlines with existing port infrastructure, an abundance of unpopulated low-cost land, and relatively cheap capital means that hydrogen production could be more economical in MENA than in other parts of the world.

The oil and gas producing nations of the Gulf are geographically well positioned, with proximity to North American, Asian, and European markets. They already have extensive energy infrastructure in place, including refineries, storage and bunkering facilities, and pipelines. It is likely that existing infrastructure could be repurposed for hydrogen, meaning that the Gulf states may not have to develop infrastructure from scratch. According to the International Energy Agency (IEA), repurposing natural gas pipelines for the transmission of hydrogen can cut investment costs 50%–80%, relative to the development of new pipelines.[11]

In the GCC states, there are a number of large state-owned energy companies (e.g., Aramco in Saudi Arabia, Abu Dhabi National Oil Company (ADNOC) in the UAE, Qatar Petroleum and Qatargas, and the Kuwait Petroleum Corporation). These companies have significant expertise in energy infrastructure and logistics, and the skills and experience of the GCC's energy industry workforce can be transferred to the emerging hydrogen industry. The state-owned energy companies also benefit from having access to substantial financial resources and already have industrial infrastructure in

place, which could be utilized for hydrogen production, storage, and transport. These state-owned industry leaders have been taking steps towards the use of hydrogen; for example, in 2020, Saudi Arabia's Aramco made its first demonstration shipment of blue ammonia to Japan, and in 2022, it delivered its first commercial shipment of blue ammonia to South Korea.[12] Germany also received its first shipment of blue hydrogen from the UAE's ADNOC in 2022.[13] The introduction of hydrogen technology into the GCC's well-established industrial energy sector will allow the GCC states to reduce their carbon emissions while simultaneously modernizing their industrial base and ensure economic growth in the world's net-zero emissions future. However, government leadership will be necessary if state-owned companies are to emerge as frontrunners in the emerging hydrogen economy. In context of the recent environmental shareholder activism for carbon targets to be identified and achieved, the focus on clean energy will become more pronounced.

International demand for oil and gas is expected to diminish as nations look to reduce their carbon footprints. The nascent hydrogen industry appears poised to fill the energy gap.

Hydrogen production is not without some criticism. One criticism of hydrogen is that its production—whether from natural gas or solar—is an inefficient way to capture energy, and the focus in MENA is likely to be on exports, rather than domestic consumption,[14] as there is not yet extensive demand for hydrogen within MENA itself. That said, MENA governments may still look ahead to establishing future domestic and regional markets for green hydrogen and cultivate emerging local demand.

Hydrogen provides a solution for sectors such as heavy transportation and some industries that require high temperatures and for which renewable energy cannot be utilized.[15] Furthermore, hydrogen, particularly blue hydrogen, represents a decarbonization alterative for countries that are focused on mitigating post-COVID-19 market volatility issues and that are moving toward energy security and affordability.[16]

Some key issues for the MENA region lie in the need for increased collective action and collaboration on climate change impacts, mitigation, and adaption efforts in order to build green partnerships and impactful cross-border cooperation on climate change issues.[17] According to the Breakthrough Report, issued jointly in 2022 by the IEA, the International Renewable Energy Agency (IRENA), and the United Nations, hydrogen, along with power, road transport, steel, and agriculture, are the five sectors under the Breakthrough Agenda that are essential to achieving international climate goals.[18]

Another issue with producing hydrogen from fresh or desalinated water is the expense, energy consumption, carbon emissions, and relative inefficiency.[19] However, a group of scientists from the Royal Melbourne Institute for Technology, Australia, have recently discovered a way to produce green hydrogen directly from seawater, thereby reducing the pressure on fresh water sources, as well as eliminating the need for desalination plants and the subsequent production saline waste.[20] The lead researcher, Dr. Nassir Mahmood, stated, "… to be truly sustainable, the hydrogen we use must be 100% carbon-free across the entire production life cycle and must not cut into the world's precious freshwater reserves."[21]

In sum, hydrogen—and particularly green hydrogen—is in a unique position to provide a reliable and secure global energy supply, while providing emissions reduction alternatives to comply with climate change objectives. States in MENA, and most notably the GCC, are becoming increasingly aware of their unique potential to deliver affordable and accessible clean energy to the global economy.

## F. The Cost and Utility of Hydrogen Technology

The development of green hydrogen production at scale will need to balance cost and utility, as well as renewable capacity.[22] The technology for the production of green hydrogen exists, but in terms of cost, it is not yet able to compete with fossil fuels. Cost for green hydrogen potential needs to be

assessed in the context of production and technology costs, which will inevitably decrease where there is further innovation, economies of scale, and optimization of the supply chain.[23] The global supply of green hydrogen generation can be fully satisfied with costs below US$2 per kilogram of hydrogen by 2050, according to IRENA's global supply-cost calculations.[24] To bring costs down, the hydrogen industry needs to be scaled up, and there now exists the public and political drive for this to happen.

### Production

The IEA has assessed the current cost of producing green hydrogen (based on 2018 data) as ranging between US$3–7.5 per kg.[25] The Hydrogen Council has set a target price point as US$2 per kg (delivered).[26] According to the Hydrogen Council, only when this target is achieved can green hydrogen be viable for use across heavy industry.[27] There is therefore some way to go before the production of green hydrogen is cost effective. However, the IEA assessment reflects green hydrogen production in small-scale projects, including pilot projects. In regions with access to affordable renewable energy, with existing energy infrastructure in place, it is likely that the scaled-up production of hydrogen would significantly decrease the production price.[28] There is also a potential market for green hydrogen in the Gulf, where it can be used in traditional heavy industrial processes, for example, in the production of ammonia and steel, as well as for oil refining. If these industrial sectors shift to the use of green hydrogen, this further reduces costs, since transportation is regional rather than global.

### Consumption

As of 2021, global annual consumption of hydrogen reached 94 million tonnes.[29] Green hydrogen should eventually replace grey or blue hydrogen in industrial applications, but the global demand for green hydrogen is forecast to rise up to 530 million tonnes per year by 2050, as it becomes more widely used as a fuel. According to IRENA, the portion of hydrogen to total final energy consumption is projected to comprise 14% in 2050, with the renewable share in hydrogen at 94%.[30]

### Transportation

With an abundance of solar energy, MENA countries are well placed to develop green hydrogen facilities as part of the global drive to decarbonize the energy sector. However, while production costs may be lower in MENA than elsewhere in the world, transporting green hydrogen to demand centers, e.g., the European and Asian markets, can be costly, particularly since transport infrastructure has not yet been developed. For states across MENA to actively participate in the emerging hydrogen economy, the supply chain infrastructure must be put in place, which will bring down the cost of getting the product to market.

Potential options for transport include shipping liquefied hydrogen, or converting hydrogen into ammonia for shipping, as per Aramco's first shipment of blue ammonia to Japan in 2020. Moreover, it will be important to begin the transition towards the use of green hydrogen within MENA, creating a regional demand where the green hydrogen is produced. Establishing markets in close proximity to the production facilities would reduce the need for long distance transport.

### Finance

The development of a broad international framework will be necessary to develop the hydrogen industry to an industrial and commercially viable scale. This would need to include involvement from governments, state-owned energy companies, sovereign wealth funds, and the private sector—in terms of capital, expertise, and resources. According to a global study of infrastructure funds by Boston Consulting Group and EDHECinfra, roughly US$6 to US$12 trillion in assets will be needed from the public and private sectors between 2025 and 2050 to both produce and transport low-carbon hydrogen, with investment extending into hydrogen infrastructure and across the hydrogen value

chain.[31] This will enable the realization of both global decarbonization goals and the economy of scale that can bring down costs across the value chain, making the fuel a tenable replacement for hydrocarbons.[32]

### Legislation Moving Forward

The green-hydrogen market will be driven by major net-energy importers, such as Europe and Asia. Government support and innovation will be needed across these markets to develop the necessary infrastructure to transition towards clean fuels. The development of the necessary infrastructure requires an international strategic approach and cooperation, though decisions need to be made about whether hydrogen should be transported by pipeline, liquefied and transported by sea or road, or converted into ammonia for shipment. The EU Important Projects of Common European Interest,[33] the US Inflation Reduction Act,[34] and the German H2Global Initiative[35] are just a few examples of how countries are moving forward with legislation to implement hydrogen as a pillar into their policies and national strategies, with the intent to support commercial scale projects for low-emission hydrogen production and infrastructure.[36] Such decisions are likely to be determined on a case-by-case basis by each country or even by specific market participants.

## G. Corporate Interest in MENA's Hydrogen Future

In MENA, governments will need to take the lead in the transition to the hydrogen economy; national policies need to be developed alongside the necessary legal and regulatory frameworks. Public funding needs to be made available, along with schemes to incentivize companies to transition to clean energy, for example, tax breaks for reducing emissions and penalties for polluters. In the GCC, led by their respective governments, state-owned energy corporations will need to drive the transition from hydrocarbons toward clean energy technology. Simultaneously, governments and state-owned organizations will need to work hand in hand with the private sector, where there is access to capital, knowledge, experience, and existing energy infrastructure. It is expected that industry heavyweights, such as the United States' Cummins, Japan's Mitsubishi Heavy Industries (MHI), Germany's Siemens Energy, and South Korea's Hyundai, among others, will be important players in the emerging hydrogen economy.

Since the signing of the Paris Agreement in 2015, governments across MENA have made it clear that they intend to develop hydrogen production and transportation facilities and be part of the world's emerging hydrogen economy. A number of steps already have been taken by GCC governments to develop the necessary infrastructure, such as the formation of the Abu Dhabi Hydrogen Alliance and the initiation of hydrogen projects in countries such as the UAE, Oman, and Saudi Arabia. In terms of project trends, the value of all announced hydrogen plants in MENA is now estimated to exceed US$70 billion.[37] A few of the key projects are the Neom Green Helios Fuels project in Saudi Arabia and Oman's Legacy Initiatives.[38]

With MENA governments setting out clear ambitions to develop hydrogen infrastructure, corporations operating in the clean energy sector are beginning to show interest in the Middle East. For example:

- Mitsubishi Power, a subsidiary of MHI, has delivered three gas turbine generators for the 2,400 megawatt (MW) Fujairah F3 independent power producer clean energy project; the turbines can operate on a 30:70 hydrogen to natural gas mix, with the capacity to increase the hydrogen utilization up to 100%. The project is a joint venture between the South Korean firm Samsung C&T Corporation, owned and operated by Fujairah Power Company F3 LLC, a special purpose company (SPC) jointly owned by the Abu Dhabi National Energy Company (TAQA) and Mubadala Investment Company, as well as Marubeni Corporation and Hokuriku Electric Power Company,[39] and will be the largest combined cycle power plant facility in the UAE, with the capacity of powering the equivalent of 380,000 households on clean energy.

- Germany's Siemens Energy entered into a public-private partnership (PPP) for a joint venture with Dubai's state utility Dubai Electricity & Water Authority (DEWA) and Expo 2020. The 300KW green hydrogen plant produced hydrogen for use in hydrogen vehicles at Expo 2020, but it also will be able to accommodate future applications and test platforms for the different uses of hydrogen, including transport and industrial applications. Another use is to produce hydrogen, using solar photovoltaic (PV), to store the gas, and then to deploy it for re-electrification or other such purposes.[40] Siemens Energy has earmarked AED25 million (approximately US$6.8 million) for this project.[41]

- Indian firm Acme Group is partnering with Norway's Scatec ASA and Oman's Public Authority for Special Economic Zones and Free Zones (OPAZ) and is investing in a US$3.5 billion green hydrogen and ammonia plant in Oman's Special Economic Zone at Duqm (SEZAD), which could establish Oman as a regional green energy hub, with storage and transportation facilities complementing the development of green hydrogen production plants.[42] The production complex, powered by 3 GWp of solar and 0.5 GWp of wind turbine capacity,[43] to produce 1.2 million tonnes of green ammonia, has received the world's first green hydrogen and green ammonia certificate to a production facility by the German inspection company TUV Rheinland.[44] The term sheet for offtake has been signed for the first phase of green ammonia in July 2022.[45]

- Fusion Fuel, an Irish company listed on Nasdaq, which makes electrolyzers, has agreed to work with the Lebanese engineering and construction firm Consolidated Contractors Company to develop green hydrogen plants across MENA. The parties have agreed to cooperate on projects involving the production of green hydrogen for potential clients in the refining and petrochemical industries in order to reduce their carbon footprint.[46] The companies aim to develop demonstrator plants in several countries in the region, including Oman, Kuwait, and Qatar.[47]

There is also a developing trend towards an international, collaborative approach to bring down the cost of hydrogen production. One such initiative is the United Nations' Green Hydrogen Catapult project. Launched in 2020, seven of the world's largest energy companies, including Saudi Arabia's ACWA Power, announced a global coalition to accelerate the scale and production of green hydrogen in an effort to transition the world's most carbon-intensive industries—including power generation, chemicals, steelmaking, and shipping—towards clean energy. The Green Hydrogen Catapult initiative would like to see green hydrogen industry leaders, including ACWA Power, CWP Renewables, Envision, Iberdrola, Ørsted, Snam, and Yara, drive down the cost of hydrogen to US$2 per kg by 2026, approximately half its current price. The partner companies aim to do this with 25 gigawatts (GW) of green hydrogen production by 2026, equivalent to a 50-fold increase in production.[48]

On 14 November 2022, leading stakeholders from across the shipping value chain signed a joint statement on Green Hydrogen and Green Shipping at CO27.[49] The signatories, including United Nations Climate Change High-Level Champions and nonprofit Rocky Mountain Institute, the Aspen Shipping Decarbonization Initiative, the Getting to Zero Coalition, the Green Hydrogen Catapult, the Green Hydrogen Organization, ACWA Power, A.P. Moller – Maersk, CWP Global, Australia's Fortescue Future Industries (FFI), InterContinental Energy, and MAN Energy Solutions, brought together both suppliers and consumers of green hydrogen to aim to ensure an adequate supply of green fuel and demand for zero-emissions shipping through cross-sector partnerships.[50]

## H. The Status of Hydrogen Projects in the GCC and MENA

One of the stated objectives under Article 4 of the GCC charter is "to stimulate scientific and technological progress in the fields of industry."[51] In regard to the exploration of hydrogen and its potential as a major global fuel and a replacement for oil and gas, there is state-driven research

across GCC states. However, the approach so far is piecemeal, with governments developing their own energy visions and launching localized pilot projects. Hopefully, this will pave the way for regional collaboration, which will allow the GCC states to work together to drive down the costs of hydrogen production, storage, and transportation.

A number of projects now are underway across the GCC and MENA. While the GCC states are the major players in terms of energy production in the Gulf, there are other nations across MENA that are developing renewable and clean energy technologies that can combat climate change, particularly Egypt. The key projects and research and development programs that are underway in MENA are detailed in **Part V** below.

# PART II - INTERNATIONAL AGREEMENTS ON CLIMATE CHANGE

**In order to understand the commitment of the Gulf states to developing clean energy, it is important to understand the background of the international agreements to which they are party.**

## I. The Kyoto Protocol

The Kyoto Protocol was adopted on 11 December 1997, but did not come into force until 16 February 2005. It is an international agreement, signed by 192 countries, to operationalize the UNFCCC by committing signatories to limit or reduce GHG emissions in accordance with agreed individual targets. The convention requires signatories to adopt policies and measures to mitigate their GHG emissions and to report periodically.

Currently, all six of the GCC states and Egypt are party to the Kyoto Protocol.[52] However, the Kyoto Protocol differentiated between "developed" and "developing" states, and it only set binding targets for 37 developed nations,[53] which did not include any MENA states. Belarus was subsequently added to the list of countries with binding targets, bringing the number of states with established emission targets up to 38. The Doha Amendment was circulated in 2012, whereby a number of the signatories extended their target periods up to 2020. As of 15 June 2022, the threshold for entry into force for the Doha Amendment was achieved, with 148 parties having deposited their instrument of acceptance.[54]

Despite the fact that there were no concrete steps established under the protocol for the Gulf countries, the fact that all GCC states and Egypt signed the Kyoto Protocol confirms that they are mindful of the need to combat climate change by reducing emissions.

## II. The Paris Agreement

The Paris Agreement is a legally binding international treaty on climate change. It was adopted by 196 parties at the 21st Conference of Paris, on 12 December 2015, and entered into force on 4 November 2016.[55]

The overarching aim of the Paris Agreement is to enhance the global response to climate change and limit global warming. Some of the key aspects of the Paris Agreement include:

- Long-term temperature goal: Limiting the global temperature increase to well below 2°C compared to preindustrial levels (the "two degree scenario"), while pursuing efforts to limit the increase to 1.5°C.

- Global peaking and "climate neutrality": In order to achieve the temperature goal, signatories should aim to reach the global peaking of GHG emissions as soon as possible and undertake rapid reductions thereafter.

- Mitigation: The Paris Agreement requires all signatories to contribute to the overarching temperature goal by establishing NDCs. All signatories are responsible for implementing and reporting on their NDCs, pursuing domestic measures to achieve their targets.

While the Paris Agreement does not establish specific emission targets or targets dates for signatories, it is a milestone in the process of multinational cooperation towards tackling climate

change; whereby parties have entered into a binding agreement, unifying them in their ambition to undertake multilateral steps to combat climate change and adapt to its effects.

All of the GCC countries are signatories to the Paris Agreement. However, as of April 2023, Iran has not yet committed to the Paris Agreement, along with Libya and Yemen.[56] Turkey and Iraq signed in October and November of 2021, with Eritrea signing in February of 2023. While the MENA and GCC states are not bound to any specific emissions targets, the Paris Agreement is a guiding principle whereby governments have committed to reduce national carbon footprints.

## III. The Net-Zero Producers Forum

Qatar, Saudi Arabia, Canada, Norway, and the United States collectively represent 40% of global oil and gas production. In April 2021, these five countries released a joint statement regarding the establishment of a "Net-Zero Producers Forum," agreeing to:[57]

> …come together to form a cooperative forum that will develop pragmatic net-zero emission strategies, including methane abatement, advancing the circular carbon economy approach, development and deployment of clean-energy and carbon capture and storage technologies, diversification from reliance on hydrocarbon revenues, and other measures in line with each country's national circumstances.

The primary aim of the Net-Zero Producers Forum is to tackle climate change and is dedicated to developing long-term strategies to reach global net-zero emissions.

When Qatar announced it would participate in the Net-Zero Producers Forum, Qatar's Minister of State for Energy Affairs, and Vice Chairman, President, and CEO of QatarEnergy, His Excellency Mr. Saad bin Sherida al-Kaabi stated:

> We believe that our engagement in this forum is an important mission consistent with, and supported by, our ambition to create a better and more sustainable future for humanity.

A source from Saudi Arabia's energy ministry was quoted in the Saudi Press Agency (Saudi Arabia's national news agency), stating:

> Saudi Arabia is a strong advocate of the key role that technology and innovation can play in the campaign to reduce and remove GHG emissions and help the world reach its net zero targets.

In May, 2022, the UAE joined as the sixth member of the Net-Zero Producers Forum, bringing the total global oil production of the forum to 45% and 40% of natural gas production.[58]

The fact that Qatar, UAE, and Saudi Arabia—key energy producers in the Gulf—have announced their intentions to be a part of this initiative is indicative of their commitment to the reduction of emissions on a global scale and supports the implementation of the Paris Agreement on climate change.

# PART III - A VISION FOR SUSTAINABILITY ACROSS MENA

**If the international community is to achieve the goals set out in the Paris Agreement detailed above, there will need to be a transition away from hydrocarbon energy production, which according to IRENA, "accounts for two-thirds of global emissions in the energy industry."**[59]

Hydrocarbons will need to be replaced with low-carbon or carbon-free energy sources, such as blue or green hydrogen. CCUS may be implemented in the hydrocarbon sector as an interim measure to reduce carbon emissions as the hydrogen market develops. But the transition to renewable and low-carbon energy sources will be fundamental in national strategies to achieve relevant targets. However, IRENA has observed that:[60]

> At present, the level of detail contained in NDCs differs from country to country, with little in-depth analysis and limited quantitative information about the role of renewable energy in meeting GHG emission reduction targets.

While the Paris Agreement is the principle international treaty guiding the development of national targets and strategy, the NDCs of many states are not specific enough to be used to set practical emission targets. Similarly, many states have not yet established the legal and regulatory framework that will be necessary to encourage and regulate the emerging hydrogen economy.

Presently, the international approach to developing the hydrogen value chain remains piecemeal, with a lack of international or regional strategy. However, certain of the key energy players across MENA are developing their own national energy strategies and visions, as detailed below.

## I. The United Arab Emirates

In 2015, the UAE submitted its first NDC to the UNFCCC, setting out its commitment to reduce carbon emissions and to increase the share of clean power of the total energy mix. Confirming this commitment, the United Arab Emirates submitted its second NDC in December 2020. The UAE's second NDC, reflecting the UAE's "enhanced ambition with the inclusion of an economy-wide emissions reduction target," establishes a 23.5% reduction in the UAE's GHG emissions by 2030.[61] The second NDC identifies technological innovation and sustainable finance as key enablers of the UAE's green transition, with a focus on the following key sectors: energy, industry processes and product use, waste, agriculture, and land use change and forestry.

In 2016, the UAE established the Council for Climate Change and Environment, an inter-ministerial, inter-Emirate governance body to reinforce policies and strategies on climate change, environmental and sustainable development, and to "create partnerships with the private sector and conduct studies and lead scientific research."[62]

In 2017, the UAE launched "Energy Strategy 2050," which is the first unified energy strategy in the UAE that is based on supply and demand.[63] The strategy aims to increase the contribution of clean energy in the total energy mix from 25% to 50% by 2050, while reducing the carbon footprint of power generation by 70%, potentially saving AED700 billion by 2050. The Energy Strategy 2050 also seeks to increase consumption efficiency of individuals and corporations by 40%. In 2021, Minister of Energy and Infrastructure Suhail Al Mazrouei explained that the Energy Strategy 2050 is intended to "diversify the future energy mix, and raise the contribution of clean energy to the total energy mix produced in the country to 50%." As part of the Energy Strategy 2050, in order to meet the growing

energy demand and ensure a sustainable growth for the country's economy, the UAE government aims to invest AED600 billion by 2050.

One of the main branches of the Energy Strategy 2050 is research, development, and innovation to ensure the sustainability of energy. This has seen the UAE invest in research and development into green hydrogen energy solutions and work hand in hand with the private sector in order to launch joint initiatives.

On the launch of Energy Strategy 2050 in January 2017, Sheikh Mohammed bin Rashid said:[64]

> The Gulf countries are similar in their economic structure, and we hope that we will one day have a unified GCC energy strategy in order to ensure sustainable growth for our people and global influence for our economies.

While, as of 2021, there is not yet a unified energy strategy across the Gulf, it is clear that the leaders of the regional governments are beginning to recognize the need to collaborate to develop the clean energy industry.

Similarly, the UAE has recognized the need to draw in expertise from abroad. It is actively pursuing agreements with foreign governments (such as Japan and Korea) and private companies (such as Siemens Energy) in order to develop hydrogen technology and look for ways to develop a supply chain with all of the necessary logistical components. For example, in 2021 the UAE entered into an agreement to research opportunities for hydrogen development with the Japanese government, indicative of the intention to develop a clean energy supply chain from the Middle East, where green and blue hydrogen can be produced, to markets such as Asia, where there is an appetite for clean energy fuels.

In March 2021, in support of the Energy Strategy 2050, the UAE's Ministry of Energy and Infrastructure, in partnership with Khalifa University and IRENA, launched the National Energy Integrated Model (the Model). The purpose of the Model is to support the UAE's ambition to increase the proportion of clean energy in the UAE's total energy mix to 50% by 2050. By providing a common framework that brings together stakeholders across the energy sector, the Model is intended to support the formulation of a strategic future for sustainable energy in the UAE, relying on the experience of IRENA and the research capabilities of Khalifa University and drawing on that experience to develop a road map for the development of sustainable energy over the next 50 years.

At the 2021 launch of the Model, Under-Secretary of the Ministry of Energy and Infrastructure for Energy and Petroleum Affairs Sharif Al Olama said:[65]

> The National Integrated Energy Model is a major supporter of the national energy strategy that was launched in 2017; work is currently under process on developing a national energy strategy to harmonize developments in the energy sector at local and global levels, and it takes into account the UAE's orientation towards diversifying energy sources and developing the sector, finding various solutions in addition to traditional energy, in a way that supports sustainable development, national economies, and the country's passage to the next 50 years of achievements, up to the UAE Centennial 2071.

In January 2021, the Abu Dhabi sovereign wealth fund Mubadala Investment Company signed a memorandum of understanding (MOU) with ADNOC and Abu Dhabi Developmental Holding Company (ADQ) by which the parties agreed to form the Abu Dhabi Hydrogen Alliance. The UAE Ministry of Energy and Infrastructure joined the Hydrogen Alliance later in 2021. Through the Hydrogen Alliance, the group is aiming to establish Abu Dhabi and the UAE as a leader in the

emerging international markets of green and blue hydrogen, while bolstering the development of a green hydrogen economy in the UAE.[66]

Practical steps also have been taken in terms of implementing pilot projects and preparing the supporting regulatory framework, as follows:

- Dubai's first green hydrogen plant was commissioned in May 2021. DEWA, in collaboration with Expo 2020 Dubai and Siemens Energy, is implementing the green hydrogen project at DEWA's R&D Centre at the Mohammed bin Rashid Al Maktoum Solar Park. It is intended that the plant will produce green hydrogen that will be used to supply vehicles powered by hydrogen fuel cells for use during Expo 2020.

- Complementing this pilot green hydrogen vehicle project is the development of the first set of domestic regulations regarding hydrogen vehicles. The Emirates Authority for Standardization and Metrology (ESMA) has established the first set of regulations regarding vehicles that use hydrogen fuel cells.

In May 2021, the inaugural Middle East Energy virtual event was held, bringing together MENA stakeholders to discuss the regional opportunities for clean energy. At the virtual summit, Minister of Energy and Infrastructure Suhail Al Mazrouei reiterated the UAE's commitment to reduce carbon dioxide emissions and increase clean energy use by 2050. Assistant Under-Secretary of the UAE Ministry of Energy and Infrastructure Yousif Al Ali explained the UAE's commitment to taking a global lead in terms of hydrogen production:[67]

> The UAE is well-positioned to be one of the top producers of hydrogen in the world. The UAE is committed and working with confidence to reduce the nationwide carbon footprint, by working on the demand side, supply-side and working on our different energies and future technologies to reduce our carbon footprint.

The UAE government's ambition, as set out in its Energy Strategy 2050 and seen through the projects underway in the UAE, is for the country to take a leading role in the world's emerging hydrogen economy, including an ambition to become one of the top global hydrogen producers.

In September 2022, the UAE Ministry of Energy and Infrastructure partnered with the German firm Fraunhofer-Gesellschaft and GHD to create its National Hydrogen Strategy. The key elements are proper infrastructure, technological readiness, and market access.[68] The new strategy will be launched later this year, likely ahead of COP28.[69]

In February 2023, the UAE Ministry of Energy and Infrastructure launched two initiatives to increase its domestic clean energy capacity and uptake, in line with its Energy Strategy 2050: (1) the UAE Geospatial Platform for Future Energy, a means to track and assess the progress of implementing the national strategy through continuous updating and analysis of the data on clean energy initiatives across the UAE;[70] and (2) the Potential for Renewable Energy Storage Uptake Report, which will assess the technical and economic capacity of storage technologies in the UAE power grid.

These initiatives, combined with public policy and regulatory frameworks, are strategically positioned to showcase UAE's progress towards Paris Agreement goals ahead of the UNFCCC COP28 November meeting and global stocktake later this year in Dubai's Expo City.[71] The goal of COP28 is to provide the stimulus to mobilize US$100 billion a year for climate action, with the latest figure at approximately US$83.3 billion in 2020.[72]

The UAE hopes to set itself apart as a leader for climate action, not only in the GCC, but also in the broader MENA region through strong economic and political agendas focused on energy transition objectives.[73]

### Abu Dhabi

Abu Dhabi has recently unveiled its hydrogen policy and regulatory framework in an attempt to become a major player in the global low carbon and clean hydrogen economy.[74] The Abu Dhabi Department of Energy (DoE) is working with key government and private stakeholders, such as ADNOC, Mubadala Investment Company, Masdar (renewable energy company), ADQ, TAQA, Emirates Water and Electricity Company, Abu Dhabi Ports, Ministry of Infrastructure and Energy, Department of Economic Development, Department of Municipalities and Transport, the Department of Finance, and Environment Agency – Abu Dhabi (EAD).[75] The Undersecretary of the DoE, His Excellency Engineer Ahmed Mohammed Belajer Al Rumaithi, stated:

> …Locally produced hydrogen will act as a driver of innovation and economic diversification, allowing for the decarbonisation of the economy in line with UAE National Energy Strategy 2050, Net Zero commitment and improved energy security and to support the economic, environmental, and social sustainability requirements of the emirate.[76]

Abu Dhabi issued the Draft Public Policy on Low-Carbon Hydrogen in August 2022, which was approved by the Abu Dhabi Executive Council and circulated for public consultation in October 2022.[77] The final public policy is due to be released in April 2023,[78] and the statement issued by the DoE requires that "all relevant entities will be responsible for developing the necessary legislations, strategies, regulatory and non-regulatory policies, and regulations to support the implementation of this Policy."[79]

Abu Dhabi aims to become one of the world's largest producers of blue hydrogen, announcing plans to increase carbon capture capacity from 800,000 tonnes to five million tonnes by 2030, to shift its grey hydrogen production, which relies on natural gas, to blue.[80]

Abu Dhabi is also looking to take competitive advantage of its abundance of land, water, and solar electricity to become a global supplier of green hydrogen on a large scale, in line with the high-level Hydrogen Roadmap announced at COP26 in Glasgow in 2021.[81]

## II. Saudi Arabia

In November 2016, Saudi Arabia ratified the Paris Agreement and its Intended Nationally Determined Contribution (INDC) became its NDC. Saudi Arabia's ambition under its first NDC was to "seek to achieve mitigation co-benefits ambitions of up to 130 million tonnes of CO2eq avoided by 2030 annually through contributions to economic diversification and adaptation."[82] Saudi Arabia has therefore committed to reduce its carbon dioxide (or equivalent) emissions by up to 130 million tonnes annually by 2030, with the reduced emissions coming "through contributions that have co-benefits in diversifying the economy and mitigate GHG emissions."[83]

In its first NDC, Saudi Arabia set out its intention to diversify its economy, including the development of "renewable energy and energy efficiency technologies to enhance economic growth." Saudi Arabia recognized the need for economic diversification, investment, and renewable energy programs. Given its hydrocarbon industrial base, in an effort to reduce industrial emissions, Saudi Arabia "plans to build the world's largest carbon capture and use plant. This initiative aims to capture and purify about 1,500 tonnes of $CO_2$ a day for use in other petrochemical plants."[84]

In a world that is moving towards clean energy and away from hydrocarbons, Saudi Arabia is beginning to recognize the importance of developing a clean energy industry. In an effort to reduce its

reliance on oil and gas, Saudi Arabia has launched a number of environmental initiatives and now plans to generate 50% of its domestic energy requirement from clean energy sources by 2030.

According to Saudi Arabia's Vision 2030, "we will transform Aramco from an oil producing company into a global industrial conglomerate."[85] Under Vision 2030, Saudi Arabia has increased its renewable energy targets, aiming for 27.3 GW within five years and 58.7 GW by 2030.[86] However, Saudi Arabia remains pragmatic in its approach, and while committed to reducing emissions, the country will continue to develop its conventional hydrocarbon energy sector, with plans to "double our gas production, and construct a national gas distribution network."[87]

Saudi Arabia already stands out as a MENA leader in terms of hydrogen projects since it is already building a 5 GW green hydrogen plant, which will provide power for the Neom giga-project. Furthermore, Saudi Arabia's state-owned Aramco made the world's first shipment of a cargo of blue ammonia to Japan in September 2020.

Of the GCC state-owned energy companies, Aramco appears to be leading efforts to incorporate renewable, clean energy into its operations. As the global demand for low carbon fuel rises, Aramco is developing zero-carbon technologies, such as green hydrogen and CCUS, with plans to develop and implement infrastructure for hydrogen fuel by 2030.

In February 2021, Aramco Chief Technology Officer Ahmed al-Khowaiter said, "we don't see much growth in [the hydrogen] market until 2030, when the infrastructure and policies will be in place."[88] He added that Aramco is targeting Japan and Korea as potential hydrogen markets toward the end of this decade.

Saudi Arabia's National Vision 2030 includes a National Industrial Development and Logistics Programme, comprised of four sectors: energy, mining, industry, and logistics, resting on two pillars of local content and the fourth industrial revolution (4IR).[89] the Saudi Arabia's efforts to grow and diversify the economy also include, among other things, designing new policies, addition of five new shipping lines to their ports, and the launch of multiple utility-scale renewable energy projects.[90]

Saudi Arabia's National Renewable Energy Programme (NREP) is a strategic initiative to diversify the nation's energy resources to achieve longer-term sustainability, reduce their dependence on fossil fuels through a mix of renewable energy sources, and reduce carbon dioxide emissions.[91] Saudi Arabia plans to increase renewable energy sources and natural gas to 50% by 2030, by developing new industry for renewable energy technology, funded through PPP.[92] Since Saudi Arabia is considering nuclear power, it has created a new Nuclear and Radiological Regulatory Commission, to help ensure that stringent standards are rigorously applied.[93]

The NREP and the Public Investment Fund's (PIF) 2.06 GW Shuaibah 2 solar PV project was awarded during the third round of contracts in 2022, toward Saudi Arabia's overall goal of 27.3 GW of renewable energy capacity by 2024 and 58.7 GW by 2030.[94]

## III. Oman

Oman's 2015 INDC projected that "Oman will control its expected GHG emissions growth by 2% to be 88714 Gg during the period from 2020-2030."[95] While this target is modest compared to other countries, Oman has identified the need to increase its use of renewable energy and to "develop new legislation on climate change which will support the adoption of low carbon and energy efficient technology."

Oman's Vision 2040 rests on three pillars: people and society, governance, and economy and development. This last pillar includes Oman's ambition to preserve environmental sustainability.[96] One of the identified priorities is "environment and natural resources," whereby:[97]

> The future strategy in natural resource management will focus on developing nontraditional sources of natural resources, such as the use of renewable energy to reduce production cost and subsequently enhance the competitiveness of economic sectors. New infrastructure projects will be geared towards green economy, green strategies and renewable energy production.

The government of Oman has therefore identified the need to explore renewable energy and diversify energy sources, and it is now a national objective to develop "a green and circular economy that addresses national needs and moves consistently with the global trends."[98] Whereas in 2015, none of Oman's energy demand was satisfied by renewable sources, it now targets 20% renewable energy consumption by 2030 and 35–39% by 2040.

Oman is in the process of developing a renewable energy strategy and encouraging investment in renewable and alternative energy resources. As part of this strategic development, an international consortium was formed in May 2021, comprising Hong Kong-based InterContinental Energy, Oman's energy holding company Oman Oil and Orpic Group (OQ), and EnerTech, a subsidiary of the sovereign wealth fund Kuwait Investment Authority. The consortium aims to develop Oman's green fuel infrastructure, with the ambition of developing a plant that will produce green hydrogen by 2028. The planned plant will be opened in phases, with hopes for the plant to reach capacity by 2038.

The project is intended to be performed in stages, meaning the capital investment will be distributed over a period of about 14 years, commencing in around 2024 when the consortium partners envisage signing the first offtake agreements.

However, the total investment required is estimated to be in the region of US$28 billion, which equates to about 40% of Oman's current gross domestic product, so funding for the project remains an issue.

Proposed projects such as this indicate that Oman is taking steps to transition towards clean energy and intends to establish industrial production of green hydrogen and green ammonia in support Oman's economic diversification strategy, but it remains to be seen whether the government will facilitate the access to capital that such projects will require.

Geographically, Oman is well placed to have access to hydrogen markets in Europe and Asia. In the Al Wusta region, there is abundant solar and wind power, with a long coastline giving access to water. In line with Vision 2040, Oman is developing the SEZ at Duqm, Al Wusta Governorate, since it provides a strategic and competitive location to develop largescale green hydrogen production. Duqm is considered to be very well located for green energy production, given the site's abundant wind and solar resources, its proximity to a thriving industrial zone, the existing port facilities, and easy access to global energy markets, in particular, Europe, Japan, and South Korea, where the greatest demand for green hydrogen and its derivatives exist.[99]

The Omani Ministry of Energy and Minerals announced that Hydrogen Oman, a subsidiary of Energy Development Oman, and Chairman His Excellency Engineer Salim Al Aufi signed multiple term sheets with a number of developers in green hydrogen projects in Oman, known as the Legacy Initiatives, worth US$51 billion (RO20 billion), over seven years.[100] The projects will be located in the Al-Wusta and Dhofar governorates, close to the ports in Duqm and Salalah.[101]

A clear regulatory framework by the Omani Ministry of Energy and Minerals is due to follow shortly, in compliance with the royal decree issued on 16 February 2023, "Oman Sultani Decree No. 10/2023 On the Allocation of Some Land for the Purposes of Renewable Energy and Clean Hydrogen Projects," clarifying the method of land allocation and the structuring of the clean hydrogen projects, as well as commitments to investors.[102] The usufruct rights over this land have been granted to Oman Hydrogen Company. They can parcel up usufruct rights on this land and can contract with third parties to use the parceled land for renewable energy and clean hydrogen projects.[103] The key developers come from Belgium, Japan, the United Kingdom, the Netherlands, India, the UAE, Kuwait, Singapore, Germany, and Oman.[104] The agreements will be for a contracting period of 47 years: seven to develop the projects, and 40 years for operation.[105]

The six projects will have a total combined capacity of 15 GW of electricity, built on an area of approximately 1,500 square kilometers.[106]

1. BP Alternative Energy Investments Limited (Duqm)

   BP Alternative Energy Investment is planning a green hydrogen project in Duqm, with 1,600 MW renewable energy capacity and projected 70,000 t/y green hydrogen capacity. The project will be set up on an area of 320 square kilometers.[107]

2. BP Alternative Energy Investments Limited (Dhofar)

   BP Alternative Energy Investment is planning a green hydrogen project in Dhofar, with 1,700 MW renewable energy capacity and projected 80,000 t/y green hydrogen capacity. The project will be set up on an area of 427 square kilometers.[108]

   In total, the two projects in Duqm and Dhofar, will provide 3.3 GW of electricity.

3. Green Energy Oman (GEO)

   Green Energy Oman's project is in joint partnership with InterContinental Energy, OQ, Shell, and EnerTech Holding Company, projected to have a renewable energy capacity of 14,000 MW. The project will be set up on an area of 337 square kilometers.[109]

4. Green Hydrogen and Chemicals SPC

   The Green Hydrogen and Chemicals SPC project is being developed by Acme Group (India), and plans on a renewable capacity of 1,000 MW, with a green hydrogen capacity of 38,000 t/y. The project will be built on 80 square kilometers of land and provide production capacity of 1 GW of electricity.[110]

5. Hyport Duqm Consortium

   Hyport Duqm is comprised of OQ (Oman's energy holding company), Uniper, and DEME, aiming to provide a renewable capacity of 2,000 MW and 1,000-electrolyzer capacity. DEME is a prime investor in Hyport Duqm and seeks to jointly develop the green hydrogen and green ammonia plant with 500 MW of electrolysis capacity in Oman with OQ.[111] The energy for the plant will be provided by 1.3 GW of wind and solar power.[112]

6. SalalaH2 Consortium

   SalalaH2 is comprised of OQ, Linde, Marubeni, and Dutco, and it plans on a renewable capacity of 400 MW electrolyzer capacity.[113]

One project not included in the term-sheet agreement signing was the US$8.5 billion green hydrogen project in Dhofar, led by Saudi utility and hydrogen developer and investor Acwa Power.[114] The

auctions planned for the development and sub-usufruct agreements intend for them to be awarded to schemes that will deliver integrated projects, covering the full green hydrogen value chain, partnering with a government-owned entity after the bids, with the aim of supporting Oman's goal to produce 1 million tonnes a year of green hydrogen by 2030.[115]

## IV. Qatar

The Qatar National Vision 2030 identifies four central pillars to the government's development strategy, the fourth pillar being "Environmental Development." The Qatar National Vision states:[116]

> The environmental pillar will be increasingly important as Qatar is forced to deal with local environmental issues, such as the impact of diminishing water and hydrocarbon resources, and the effects of pollution and environmental degradation, as well as international environmental issues such as the potential impact of global warming.

In 2015, Qatar made a report to the UNFCCC on its INDCs. Referring to the four pillars of the Qatar National Vision 2030, the report asserted that the forth pillar "is of high importance as it seeks to strike a balance between development needs and environmental protection, and supports international efforts to mitigate the effects of climate change."[117] While Qatar's INDCs do not include emission targets, Qatar's report does cover the government's investment in research and development into clean energy and its ambitions for "utilizing clean energy and renewables, reducing emissions to the atmosphere and developing technologies that convert emissions into useful products."

The Qatar government also has raised the necessity for the countries of the Gulf to cooperate to protect and conserve the environment, and it has stated its objective to encourage "regional cooperation to put in place preventive measures to mitigate the negative environmental effects of pollution arising from development activities."[118]

In line with the government's approach to protecting the environment, state-owned QatarEnergy (formerly Qatar Petroleum)[119] has developed its own "Environmental Sustainability Plan." In 2021, QatarEnergy launched a sustainability strategy, setting targets to reduce carbon emissions from its upstream and liquefied natural gas (LNG) facilities by 2030. QatarEnergy aims to reduce carbon emissions at its LNG facilities by 25%, reduce emissions from its upstream facilities by at least 15%, and cut flaring intensity by 75%. QatarEnergy also aims to end outline flaring by 2030 and limit methane emissions, setting a methane intensity target of 0.2% across all QatarEnergy facilities by 2025.

Between 2012 and 2018, the company spent US$900 million on reduced flaring, and it has earmarked a further US$170 million for investment up to the end of 2021. QatarEnergy also has committed to employing CCUS facilities to capture more than 7 million tonnes of $CO_2$ annually by 2027. QatarEnergy also is aiming to add more than 4 GW of renewable energy, reducing Qatar's annual emissions by up to 5 million tonnes per year.

Qatar's Minister of State for Energy Affairs, and Vice Chairman, President, and CEO of QatarEnergy, His Excellency Mr. Saad bin Sherida al-Kaabi, said the sustainability strategy will "play a decisive role in helping reduce the impact of climate change by implementing measures to curb emissions, produce LNG using the latest proven carbon reduction technologies, and compensating for residual emissions where necessary."

Additionally, Qatar's successful bid for the 2022 FIFA World Cup produced a fully carbon-neutral event, and associated infrastructure, so the government is clearly alert to the challenges of reducing the country's carbon footprint.[120]

Qatar is one of the world's largest producers of natural gas, and it is now also exploring the potential of green hydrogen. At the Arab League's 16th meeting of the expert committee on renewable energy and energy efficiency in Cairo, on 15 March 2023, green hydrogen was at the top of the agenda, given pressing global concerns over the energy crisis as well as the urgent need to form a pan-Arab strategy for green hydrogen moving forward.[121] Qatar was represented by the Qatar General Electricity & Water Corporation (Kahramaa), and His Excellency Assistant Secretary-General and Head of Economic Affairs sector in the Arab League, Ambassador Dr. Ali bin Ibrahim al-Malki, discussed the energy transition in the Arab region, in particular, electric cars, water desalination, and renewable energy.[122]

QatarEnergy has partnered with the German firm Siemens to build a pilot plant for green hydrogen production in the Ras Laffan Industrial City. The plant will have a capacity of 1.2 MW and use renewable energy to produce hydrogen via electrolysis. The project is expected to be completed in 2025. Ras Laffan will also be the home of a US$6 billion petrochemicals plant.[123]

QatarEnergy established the affiliate QatarEnergy Renewable Solutions, which centers on renewable energy and sustainability.[124] A local research and policy group, H2 Sustainability Energy Solutions, a joint venture between the Colleges of Engineering and Business and Economics at Qatar University, provides multi-sector $H_2$ supply chain mapping portfolios to decarbonize and enhance Qatar's energy mix, while providing a portfolio of $H_2$ production, transportation, and storage challenges.[125]

Qatar is already investing in blue ammonia and hydrogen, with a US$1 billion plant, called "Ammonia-7." Qatar sees blue hydrogen as a key player in the future of energy transition, particularly since new technologies and processes enable cleaner production methods, which, in turn, lead to advantages and competitiveness in global markets.[126] Furthermore, blue hydrogen may be necessary to supplement green hydrogen going forward to 2050, as green hydrogen requires an extensive amount of renewable power demand, in some cases projected to be 46,000 TWh annually from solar and wind in Accelerated Energy Decarbonisation Scenarios.[127] As the quantity of renewable energy is predicted to be so immense, Qatar would be prudent to consider producing hydrogen from other sources, such as blue hydrogen.[128] QatarEnergy has signed agreements with Industries Qatar QSC and Qatar Fertiliser Co. to produce 1.2 million tonnes per year of blue ammonia.[129] Ammonia can be shipped to countries who will then convert it to hydrogen for clean fuel, utilize the ammonia as a fertilizer, or to produce electricity.[130] ThyssenKrupp AG (Germany) and Consolidated Contractors (Greece) will build the plant.[131] For the hydrogen to be considered "blue," the carbon dioxide that is produced will have to be CCUS.[132] At present, plans include that approximately 1.5 million tonnes of $CO_2$ will be CCUS, with further plans to capture 11 million tonnes by 2030.[133] In addition to the new facility at Ras Laffan, which is the largest $CO_2$ recovery and sequestration facility in the MENA region, currently capturing 2.2 MTCO2e/year since 2020, the North Field East aims to diversify its deployment of carbon capture and sequestration through recovery of jetty boil-off gas, reduction of NOx emissions through Dry Low NOx technology, and recovery of water consumption and treatment, targeting 75% recovery.[134]

Additional measures include Qatar's signing of an agreement with Royal Dutch Shell to participate in joint investments in blue and green hydrogen projects in the United Kingdom, centering on industrial and transport sectors, particularly in the London metropolitan area.[135] The Qatar Minister of State for Energy Affairs, and Vice Chairman, President and CEO of QatarEnergy, His Excellency Mr. Saad bin Sherida al-Kaabi, stated the partnership with Shell, "creates a viable path for innovation and investments in low carbon fuels and technologies across the UK's energy sector, a key area of investment for QatarEnergy."[136] Qatar has also recently signed an agreement with the Hydrogen Convergence Alliance of Korea for cooperation in the hydrogen sector, particularly in the areas of supporting the growth of the hydrogen industry, technology development, and the supply of hydrogen energy.[137]

Investment coming into Qatar for hydrogen projects is derived from Nikkiso Clean Energy & Industrial Gases Group, part of Nikkiso Co., Ltd, Japan, who is expanding into the Middle East, particularly into Qatar, in the Ras Bufontas Business Innovation Park.[138]

## V. Egypt

Egypt contributes around only 0.6% of global GHG emissions.

Although a low contributor to global emissions, the low-lying Nile Delta is one of the most vulnerable areas in the world in terms of rising sea levels. In response to rising global temperatures, Egypt signed the UNFCCC in 1992, and it signed the Kyoto Protocol in 1999. Sensitive to the fact that the country is vulnerable to rising global temperatures, in 2010, Egypt initiated the National Strategy for Adaptation to Climate Change and Disaster Risk Reduction,[139] indicating that climate change is high on the agenda of the government.

In November 2015, Egypt submitted a climate action plan to the UNFCCC, identifying its INDC, which became the country's first NDC in 2017. This recognized that "the key for Egypt to mitigate GHGs emissions is to provide appropriate foundations for the development of low carbon energy systems" and one of the pathways for achieving a reduction in carbon dioxide emissions was the "widespread diffusion of locally-appropriate low-carbon energy production technologies."[140] However, Egypt's NDC does not provide quantifiable targets for reduced emissions. Furthermore, its NDC is conditional on the receipt of international funding, to the tune of US$73 billion.[141]

Launched in 2016, and updated in 2018, Egypt's Sustainable Development Strategy, Egypt Vision 2030, is the national agenda regarding Egypt's long-term strategic plan towards sustainable development. Egypt Vision 2030 focuses on three dimensions of sustainable development: economic, social, and environmental. One of the objectives is an "integrated and sustainable ecosystem" whereby "Egypt seeks to preserve both development and the environment through the rational use of resources to preserve the rights of future generations to a safer and more efficient future."[142] Egypt Vision 2030 illustrates the government's determination to diversify the energy mix and to improve the efficiency of electricity consumption.

One example of Egypt's diversification is its wind project at Ras Ghareb. Egypt has an onshore wind energy potential of approximately 20,000 MW, which is focused in the Gulf of Suez. With the aim of exploiting this renewable energy source, Egypt's first 250 MW wind-based independent power project is currently under construction in Ras Ghareb, with numerous other utility-scale solar PV independent power projects also under way in the country.

Egypt is a major gas exporter, with large natural gas reserves. With 2,450 kilometers of coastline and 1,530 kilometers of riverbank along the Nile, Egypt's geography is suitable for the large-scale, low cost production of hydrogen using electrolysis, as well as the production of blue hydrogen, using CCUS technology. Given the abundance of both natural gas and renewable energy sources (notably solar and wind) and its proximity to global energy marketplaces, such as the European Union, Egypt is potentially well placed to establish itself as a hydrogen producer and supplier, and the government is developing its strategic approach to the emerging hydrogen economy.

As part of Egypt's 2035 Integrated Sustainable Energy Strategy to provide the continuous security and stability of its energy supply, Egypt is ramping up the development of its renewable energy sector.[143] Part of its new energy strategy, announced at COP27 in November 2022, is to bring forward its goals of sourcing 42% of energy from renewable sources from 2035 to 2030, through the implementation of four key pillars: energy subsidy reform, energy efficiency, renewable energy, and hydrogen.[144] At present, approximately 20% of Egypt's energy needs are met by renewables.[145] Egypt

also recently signed eight framework agreements to develop green hydrogen and ammonia projects, hoping to corner 5% of the global market by 2040.[146]

Furthermore, the European Bank for Reconstruction and Development (EBRD) is supporting the Egyptian government in the drafting of its Hydrogen National Strategy's approach and long-term aims.[147] Lastly, EBRD is helping to prepare a low-carbon pathway road map, modelled on the Global Ammonia Technology Roadmap from COP26 and the IEA Ammonia Technology Roadmap, for Egypt's nitrogen-based fertilizer sector, which will be the first country-level application of the global road map, providing a blueprint for other countries.[148]

## VI. Kuwait

Kuwait is taking steps to establish a national hydrogen strategy as it continues to assess the role hydrogen may play in its energy transformation. In context of the transition to cleaner fuels and low-carbon energy sources, hydrogen is seen by Kuwait as a fuel of the future and the potential means by which to secure a position in the clean energy market, while reducing the state's dependence on oil revenues (which is a key aim of Kuwait's Vision 2035). The production of blue hydrogen for export is often seen as the natural starting point for an oil exporter such as Kuwait. However, given the abundance of solar energy and existing infrastructure, any future hydrogen policy will likely focus on the potential production and export of green hydrogen.

While Kuwait is yet to announce plans for any hydrogen specific projects aimed at export, a hydrogen production facility was previously constructed as part of the Shuaiba refinery which allowed high sulphur heavy crude to be processed. The Shuaiba refinery, which closed in April 2017, was Kuwait National Petroleum Company's (KNPC) first refinery. The tanks and export facilities of the Shuaiba refinery have since been assimilated into KNPC's Clean Fuels Project which itself incorporates Hydrogen Membrane Units to recover and recycle purified hydrogen for use in the Atmospheric Residue Desulphurization process.

# PART IV - THE NEED FOR A LEGAL AND REGULATORY FRAMEWORK ACROSS MENA

**As of 2023, there is no overarching strategy for the development of hydrogen across the GCC or the Middle East. Similarly, there is a lack of hydrogen-related legislation in the GCC states, the three exceptions being the UAE National Hydrogen Strategy being developed; the Abu Dhabi Draft Hydrogen Public Policy on low-carbon hydrogen due April 2023, which will spur the drafting of new legislation and regulatory policies; and the Egyptian National Hydrogen Strategy intended to formulate the state's long-term goals for hydrogen legislation and policy going forward. Other than these, as of 2023, there are no specific regulations regarding the development, implementation, or licensing of hydrogen facilities. The limited regulation of hydrogen in countries such as the UAE, Saudi Arabia, or Egypt is indicative of the fact that the development of hydrogen projects remains at an early stage.**

While the Gulf states now are investing in clean energy, most of these projects are at the research or pilot stage. So far, only Saudi Arabia and the UAE have taken the next step. In 2020, Saudi Arabia's Aramco made its first demonstration shipment of blue ammonia to Japan, and in 2022, it delivered its first commercial shipment of blue ammonia to South Korea.[149] Germany also received its first shipment of blue hydrogen from the UAE's ADNOC in 2022.[150]

In the words of UAE Undersecretary of the Ministry of Energy and Petroleum Affairs at the Ministry of Energy and Infrastructure, His Excellency Mr. Sharif Salim Al Olama, speaking at the Siemens Energy week virtual conference in 2020:[151]

> Hydrogen is very high on our agenda, right now we are really at initiation phase…We are in the process of setting the roadmap of where we are going with hydrogen.

The countries of MENA and the GCC already have begun the process of diversifying into clean methods of energy generation. However, in order to maintain and develop economic growth, the regional governments need to establish a strategic policy road map, coupled with an appropriate legal and regulatory framework, to facilitate the emergence of the MENA and GCC states as leaders in the emerging hydrogen economy. Developing a legal and regulatory framework will be a crucial step if the GCC is to attract the fiscal and technological investment that will be essential components to the development of the hydrogen industry in the Middle East.

# PART V - HYDROGEN PROJECTS IN KEY MENA STATES

**A range of factors can affect a country's potential for hydrogen production, including government policy, geolocation, availability of solar power, availability of natural resources (i.e., oil and natural gas), existing industrial infrastructure, and the affordability of finance. Across the GCC and Egypt, there is an uptick in renewable energy projects; in terms of hydrogen projects, most remain at the research and development stage, albeit some projects are underway. Below we consider some of the key hydrogen projects across MENA.**

## I. The United Arab Emirates

### A. DEWA's Pilot Green Hydrogen Project for Expo 2020

State-owned DEWA is developing a pilot green hydrogen mobility project for Expo 2020 (to be held from 2021–2022).[152]

The pilot plant will produce hydrogen using renewable solar energy, store it, and use it for re-electrification, transportation, and other industrial uses. At Expo 2020, green hydrogen produced at Dubai's Mohammed bin Rashid Al Maktoum Solar Park will power a fleet of fuel-cell vehicles. By 2030, the solar park should have capacity to generate 5 GW.

The project is part of DEWA's strategic approach to develop hydrogen technologies in line with Dubai's ambitious clean energy targets, i.e., for 75% of its energy to consumption to be satisfied by renewable sources by 2050.

The US$14 million project is a PPP project between DEWA, Expo 2020 Dubai, and Germany's Siemens. The project was tendered in 2018, broke ground in February 2019, and is on track to be commissioned ahead of Expo 2020.

The pilot project should pave the way for large-scale hydrogen projects and allow DEWA and Siemens to refine the production of hydrogen so that the cost of the process can be reduced. In relation to this pilot project, UAE Undersecretary of the Ministry of Energy Sharif Salim Al Olama stated that the competitive prices for solar power in the region will enable Dubai "in the near future to produce a very competitive price for green hydrogen."

### B. ESMA Draft Technical

Regulations for hydrogen-powered vehicles complementing DEWA's pilot green hydrogen mobility project for Expo 2020, ESMA announced that it has completed drafting the technical regulations for hydrogen fuel cell vehicles.

Hydrogen-powered vehicles, which are environmentally friendly and emit only water vapor, also will be used for Expo 2020, fueled by locally produced green hydrogen. The UAE is the first country in MENA that has developed regulations for hydrogen-powered vehicles, demonstrating that the UAE intends to be a regional leader in terms of establishing a legal and regulatory framework for low-carbon fuels.

The UAE has implemented a three-tiered approach to developing legislation for more environmentally friendly vehicles. The first step was related to hybrid semi-environmentally friendly cars, the second step related to electric vehicles that are more environmentally friendly vehicles, and the third step was

hydrogen vehicles, which produce zero-emissions. ESMA Director-General Abdullah Al Maeeni stated that the third step had to consider hydrogen technology:[153]

> The project covers the general safety requirements that must be met in hydrogen vehicles, in terms of setting requirements for storage tanks used, types and metal manufactured, and tests to be performed on cylinders in particular, as well as the need for safety valves to prevent high pressure inside the cylinder and keep them from different influences.

In March 2021, UAE Vice President and Prime Minister and Ruler of Dubai Sheikh Mohammed bin Rashid al-Maktoum announced the approval of a national system for hydrogen fuel-powered vehicles. Also announced was the approval of a national water and energy demand management program, aiming to increase energy efficiency by 40% across the three most energy-consuming sectors: industry, construction, and transport. A shift toward hydrogen-powered vehicles could substantially cut emissions produced by regional transport, such as haulage and, potentially, shipping.[154]

## C. Masdar Green Hydrogen Pilot Project

In January 2021 the Abu Dhabi Hydrogen Alliance was formed between Abu Dhabi's ADNOC, holding firm ADQ, and Mubadala Investment Company, which owns Masdar. The first project to emerge from the Hydrogen Alliance is the Masdar green hydrogen pilot project, which is supported by Germany's Siemens Energy, Japan's Marubeni, Etihad Airways, the Lufthansa Group, the Khalifa University, and the DoE. The idea behind the project is to commission a green hydrogen plant that will produce hydrogen fuel for use in local vehicles, such as buses, in Masdar City and to develop aviation fuel for use by Etihad and Lufthansa. There also will be research into the use of fuel in the maritime and shipping industry. The plant design is expected to be ready by the end of 2021, with construction taking an additional two years.[155]

## D. ADNOC Research Carbon Dioxide Capture Technology

The UAE is looking at blue and grey hydrogen, capitalizing on its experience in CCUS. The UAE intends to study the technology of CCUS with hydrogen production from fossil fuels.

Currently, state-owned ADNOC, the UAE's biggest energy producer, has the ability to capture 800,000 million tonnes per year of carbon dioxide from Emirates Steel and inject it into its oil reservoirs for enhanced oil recovery.

ADNOC is on track to expand its CCUS capacity at least five-fold to 5 million tonnes of carbon dioxide annually by 2030, capturing the carbon dioxide at its own natural gas plants. ADNOC's Shah gas plant has the potential to enable the capture of 2.4 million tonnes of carbon dioxide, while the Habshan and Bab plants could enable the capture of almost 2 million tonnes.

## E. ADNOC Blue Ammonia Facility in Ruwais, United Arab Emirates

ADNOC, in partnership with state holding company ADQ, is planning to develop a 1,000 kiloton blue ammonia project at a downstream facility in the Ta'ziz industrial zone in Ar-Ruwais, Abu Dhabi. The plant will take blue hydrogen, derived from natural gas feedstock as carbon dioxide is captured and stored, and convert it into blue ammonia, which is easier to store and transport as a fuel source.

ADNOC and ADQ are both members of the Abu Dhabi Hydrogen Alliance, which aims to develop hydrogen infrastructure in the UAE and this project is part of the strategy to meet the demand for low-carbon fuels and to establish the UAE as a key hydrogen exporter in the emerging hydrogen economy. ADNOC and ADQ have further plans to develop projects worth US$5 billion at the Ruwais Derivatives Park.

Dr. Sultan Al Jaber, Minister of Industry and Advanced Technology and managing director and group chief executive of ADNOC, stated that this facility "is a significant milestone in the development of our blue hydrogen and ammonia business, building on the UAE's strong position as a producer of competitive, low-carbon natural gas and our leadership role in CC and underground storage."[156]

The project is currently in the design stages, with UK contractor Wood undertaking front-end engineering and design work. Final investment decisions are expected in 2022, and the project should commence in 2025.

## F. Mubadala Investment Company and Snam to Explore Green Hydrogen Potential

Abu Dhabi's sovereign wealth fund Mubadala Investment Company and Italy-headquartered Snam have agreed to a joint exploration of hydrogen development and investment opportunities across the UAE, as well as globally.

Snam (a gas transmission system operator) is part of the Hydeal consortium, an initiative with ambitions to deliver 100% green hydrogen to European markets at €1.5 (US$1.8) per kilogram, including transport and storage overheads, by 2030.

A memorandum of understanding was signed by the companies in early 2021, and the companies released a statement stating their intention to "carry out a number of assessment activities, including technical and economic feasibility studies, to explore potential projects and solutions [that will] foster and promote hydrogen development in the UAE, and elsewhere globally."

Mubadala Investment Company's chief executive officer of UAE investments, Musabbeh al-Kaabi, described the collaboration as "an extension of our joint efforts to develop a hydrogen economy for the UAE ... and [in] advancing the role hydrogen will play to meet future energy demand globally."[157]

Snam has a business unit dedicated to the development of new hydrogen technologies and projects, and it was a pioneer in the blending of hydrogen into existing natural gas pipeline networks. The relationship with Mubadala Investment Company allows Snam to enhance its presence in the GCC, giving it access to the strategic MENA markets for potential hydrogen production.

## G. Mubadala Investment Company and Siemens to Explore Green Hydrogen Potential

Mubadala Investment Company and Siemens Energy of Germany have agreed to establish a partnership to push for investment and development into green hydrogen production. Under the partnership, the partners hope to establish an Abu Dhabi-based leader in the synthetic fuels sector. They intend to investigate green hydrogen technology and use technological advancement to drive down the costs of green hydrogen and synthetic fuels production. They intend to utilize renewable energy to produce green hydrogen and synthetic fuels, providing clean and transportable energy to fuel new hydrogen-based economies, supplied from the UAE. In this way, Mubadala Investment Company and Siemens Energy will have access to internationally emerging hydrogen markets.[158]

## H. ADNOC and GS Energy to Explore Hydrogen Potential

In a virtual summit between ADNOC and South Korea's GS Energy in March 2021, the two companies agreed to explore Abu Dhabi's opportunities in the hydrogen economy. GS Energy has a long-standing strategic relationship with ADNOC, with approximately 10% of South Korea's imported oil coming from the UAE. UAE Minister of Industry and ADNOC Group chief executive officer Sultan Ahmed Al Jaber said that ADNOC and GE Energy were "identifying possible areas of investment in Abu Dhabi's emerging blue hydrogen ecosystem." While ADNOC is beginning to explore opportunities, this remains at the preliminary stages, with no targets or projected outcomes.

### I. Cooperation Agreement Between the UAE and Japan to Explore Hydrogen Opportunities

In April 2021, the UAE's Ministry of Energy and Infrastructure and the Japanese Ministry of Economy, Trade, and Industry (METI) signed a virtual cooperation agreement to explore hydrogen development opportunities. The aim of the agreement is to expand the joint areas of collaboration and enhance investment in the hydrogen sector, supporting the ambition to accelerate the energy transition towards a low-carbon future.

The agreement was signed by Suhail Al Mazrouei, Minister of Energy and Infrastructure, and METI State Minister Ejima Kiyoshi.

At the virtual conference, Suhail Al Mazrouei explained that cooperation with Japan was an important step towards developing hydrogen production, building the supply chain and transport links between the two countries, and developing the necessary regulations and policies. He stated that the agreement:[159]

> Also aims to open broad prospects for growth and development as part of the two countries' efforts to diversify the energy mix, relying on clean energy, building more partnerships, and strengthening cooperation to take advantage of the opportunities associated with the global leadership of the UAE and Japan in the fields of innovation, technology, and sustainability.

### J. UAE, Egypt, and Germany Cooperate to Develop Major Green Hydrogen Plant in Mauritania

One example is the development of a major green hydrogen project in Mauritania, which the UAE is developing jointly with Egypt and the German investment company Conjuncta, with an estimated capacity of 10 GW and production of 8 million tonnes of green hydrogen for export per year.[160] The UAE has made no secret of its intention to capitalize upon Africa's potential for the generation of green hydrogen,[161] which has caught the interest of Masdar and the Egyptian renewable energy provider Infinity.[162] In the MENA region as a whole, there is currently 3.3 GW of wind that is operational and a further 4.3 GW in development.[163] In terms of Solar PV, in the MENA region, there is 7.5 GW operational and 10.9 GW in development.[164]

## II. Saudi Arabia

### A. The Neom Green Helios Fuels Project

In July 2020, Saudi Arabia's utility developer ACWA Power and Neom signed an agreement with US-based Air Products for a US$5 billion hydrogen-based ammonia production facility powered by renewable energy. The project, jointly owned by all three partners, will be based in Neom and will be part of Saudi Arabia's US$500 billion giga-project in Neom.

The planned facility will include a 20 MW electrolysis plant that will produce hydrogen from solar and wind power, supplied by the technology division of Germany's ThyssenKrupp unit Uhde Chlorine Engineers. The Saudi and German governments have been collaborating on clean hydrogen developments in Saudi Arabia, and in December 2020, the German government confirmed it would contribute around the equivalent of US$1.83 million to the planned hydrogen electrolysis plant.

Once commissioned, the facility intends to integrate 4 GW of renewable solar and wind power, use electrolysis to produce up to 650 tonnes of green hydrogen per day, produce nitrogen by air separation, and produce 1.2 million tonnes of green ammonia per year, which can then be transported around the world to be used to produce green hydrogen for the transport market.

While the project is still in the design phase, there are plans for it to be delivered as early as 2025, which would make it one of the world's first green hydrogen and green ammonia export projects.

Saudi Arabia considers hydrogen a fundamental future energy source, which has a particularly wide array of potential applications, from industry to fuel, to electricity, to the transportation of power. Hence, Saudi Arabia has invested US$500 billion into the Neom giga-project in the northwest of the country, which is the world's largest utility-scale, commercially based hydrogen facility powered entirely by renewable energy.[165] The giga-project is envisioned to be powered entirely by renewable energy and to host industrial facilities, including an approximately US$8.5 billion green hydrogen project, which would convert green hydrogen into ammonia.[166] The renewable energy plants will also supply power to other giga-projects on the Red Sea and Qiddiya.[167]

The Neom green hydrogen project is expected to have full financial closure soon, having risen from the original US$5 billion to US$8.7 billion, impacted by the Russia-Ukraine war and rising global inflation.[168] The total financing consists of US$5.852 billion senior debt and US$475 million of mezzanine debt facilities.[169] The financing scheme is comprised of a consortium of 21 financial institutions and two government funds,[170] secured in the form of US$1.5 billion from the Saudi National Development Fund and US$1.2 billion from the Saudi Industrial Development Fund.[171]

The overall aim of the Neom project is to have 4 GW of renewable capacity, scaling up to scenarios of 40 GW.[172] Neom will produce green hydrogen, which will be exported as green ammonia.[173] The export potential for the venture runs from Japan to Korea, Florida, California, and parts of Europe.[174] ThyssenKrupp Nucera will provide the electrolysis technology and ThyssenKrupp AG electrolyzers[175] to produce the green hydrogen, Haldor Topsoe will provide the technology to produce the green ammonia, Baker Hughes will be the technology partner for the hydrogen compression, and Air Products will install its air separation technology for the plant.[176] The intended production capacity of green ammonia is expected to be up to 1.2 million tonnes annually, or 600 tonnes of green hydrogen per day, with the direct impact of the Neom green hydrogen plant saving up to 5 million tonnes of $CO_2$ per year.[177] The infrastructure for the green hydrogen project has been awarded to Larsen & Toubro (L&T), who were selected in December 2022 for the estimated US$4 billion engineering, procurement, and construction contract to build the wind, solar, and battery energy storage infrastructure for the project.[178] Additionally, according to the limited notice to proceed agreement, L&T will be in charge of the execution of the power grid and power generation work.[179]

Additionally, in order to combat climate change and reduce $CO_2$ emissions through green hydrogen, Neom's energy, water, and hydrogen subsidiary Enowa has signed an agreement for critical infrastructure with Air Products Qudra to build, own, and operate the first hydrogen fueling station in Neom, helping to decarbonize heavy transportation, such as buses and heavy-duty trucks.[180]

## B. Aramco and Hyundai Oilbank Plan Blue Hydrogen Project

In March 2021, Saudi Arabia's state-owned energy company Aramco announced an agreement with South Korean industrial giant Hyundai to cooperate on a blue hydrogen project. The Hyundai Oilbank Company,[181] which refines hydrocarbons, will import Aramco's liquefied petroleum gas (LPG) into South Korea, where it will be used to produce blue hydrogen. During the production process, Hyundai will capture and store carbon dioxide, which will then be shipped to Saudi Arabia and provided to Aramco for use in carbon-based enhanced oil recovery. Furthermore, Hyundai Oilbank plans to build a LNG boiler by 2024, which will use blue ammonia (produced by Aramco) as feedstock.

Hyundai Oilbank intends to sell blue hydrogen as fuel for vehicles, part of a wider plan to establish 300 hydrogen charging stations across South Korea by 2040. Hyundai Oilbank also intends to use the blue hydrogen as fuel for thermal power plants and utilize it to power desulphurization processes.

In order to develop the international infrastructure, Korea Shipbuilding & Offshore Engineering Company, a subsidiary of Hyundai Oilbank, is building ships capable of transporting LPG and carbon simultaneously, and it is also planning ammonia carriers as well as ammonia-fueled ships.[182]

### C. Aramco Ships Blue Ammonia to Japan

In September 2020, Aramco shipped a cargo of blue ammonia to Japan for use in zero-carbon power generation, supplementing coal and natural gas. This was the outcome of a pilot study into zero-carbon power generations undertaken by Saudi's Aramco and Japan's Institute of Energy Economics, in partnership with Aramco subsidiary Saudi Basic Industries Corporation.[183]

### D. Marubeni Corporation and Saudi Arabia PIF

A Memorandum of Understanding was signed on 1 March 2023 between the Marubeni Corporation and PIF to conduct a feasibility study for the development of another clean hydrogen project in Saudi Arabia, with the intent to supply clean hydrogen to both domestic and international markets.[184] Marubeni, a developer and operator of international independent power production and infrastructure works programs, has ownership interests in four projects in Saudi Arabia.[185]

## III. Oman

### A. Sumitomo and Ara Petroleum Hybrid Hydrogen Project

In March 2020, Japan's Sumitomo and Oman's Ara Petroleum signed a MOU in relation to a hybrid hydrogen project in Oman. They are currently conducting a feasibility study for a project that would involve the production of hydrogen from gases generated as a byproduct of oil and gas production at an Ara Petroleum refinery.

If the project goes ahead, it is expected to produce an estimated 300–400 tonnes of hydrogen annually from flare gas generated at the site. A 20 MW solar plant will be installed at the site to power the hydrogen production facility, and it is intended that the hydrogen produced will be used as fuel for fuel cell vehicles that Ara Petroleum will introduce at the site.[186]

### B. PDO Block 6 Green Hydrogen Project

Petroleum Development Oman (PDO) has engaged Hinicio, a Brussels-based consultancy firm, to undertake a feasibility study for the development of a green hydrogen pilot project within PDO's Block 6 cluster. The feasibility study should take about seven months to complete, and it will allow PDO to evaluate the viability of green hydrogen technologies before any commercial rollout.

According to a local media report citing PDO Corporate Research and Development Adviser Zakiya al-Azri:[187]

> PDO's pursuit of green hydrogen is driven by a desire to reduce its dependence on natural gas for its energy requirements while, at the same time, exploring low or zero carbon fuel alternatives as part of a commitment to reduce greenhouse gases responsible for global warming.

It is likely that the proposed green hydrogen pilot project will be supported by PDO's solar-paneled car park at Mina al-Fahal, Muscat, and the 100 MW Amin solar project.

## C. Sohar Port Green Hydrogen Hub

In Oman, there are plans for Sohar Port and Freezone to become the country's first green hydrogen hub by using low-cost solar power to produce carbon-free green hydrogen, which will be used to help fuel clean vehicles and reduce onsite emissions.

The Sohar Port and Freezone is managed by Sohar Industrial Port Company, a 50:50 joint venture between the Port of Rotterdam and the Sultanate of Oman. Sohar is working in collaboration with the Port of Rotterdam, as well as Hydrogen Rise and other international research institutions, to identify cost-effective solutions for the utilization of hydrogen as an alternative to natural gas.

With excellent renewable resource conditions, coupled with the declining costs for solar PV power generation, Sohar intends to build electrolyzers at the port in order to produce a low-cost supply of green hydrogen, which can be stored for use on demand. Sohar will also be exploring the potential to use green hydrogen to power seagoing vessels.

Mark Geilenkirchen, chief executive officer of Sohar Port and Freezone, explained that "the hydrogen stored for later delivery (via pipelines and trailers) will be used by the port's industries and tenants for clean transport and industrial purposes." Geilenkirchen also stressed the need to scale up the hydrogen industry in order to bring production costs down and make hydrogen an economically viable alternative fuel, explaining that an industrial "scale-up will be critical to bring down the costs of technologies for producing and using clean hydrogen, such as electrolyzers, fuel cells and hydrogen production with CCUS."[188]

## D. Acme SEZAD Green Ammonia Plant

Indian ACME Group has announced a collaboration with Norway's Scatec ASA and OPAZ and is investing in a US$3.5 billion green hydrogen and ammonia plant in SEZAD, which could establish Oman as a regional green energy hub, with storage and transportation facilities complementing the development of green hydrogen production plants.[189] The two parties signed a memorandum of understanding (MOU), which sets out their ambition to produce green hydrogen and green ammonia from renewable energy, to support the energy transition, and to enable the integration of a higher proportion of renewable energy in both the transportation and manufacturing sectors. The planned facility will produce hydrogen through water electrolysis using renewable energy, which will then be processed into ammonia.

The production complex, powered by 3GWp of solar and 0.5 GWp of wind turbine capacity,[190] will produce 1.2 million tonnes of green ammonia and is the world's first production facility to receive a green hydrogen and green ammonia certificate from TUV Rheinland, a German inspection company.[191] The term sheet for offtake has been signed for the first phase of green ammonia in July 2022.[192]

Speaking at a press conference in March 2021, founder and chairman of ACME Group, Manoj Kumar Upadhyay, said, "this is an exciting beginning of global alliances for producing green hydrogen and ammonia—the most important future source of energy that will help decarbonize the world."[193]

Upadhyay also said that the large-scale plant is "strategically planned to cater to international markets for supply of green ammonia across Europe, America and Asia region."[194]

## E. DEME and OQ Green Hydrogen Plant in Duqm

In 2020, DEME and OQ, Oman's energy holding company, announced a joint project to develop a green hydrogen plant in the SEZAD, along with OPAZ. Duqm has the geographic advantage of

abundantly available renewable energy (solar and wind); large, accessible sites; and access to Oman's port infrastructure.

Having jointly conducted a prefeasibility study for the project, which demonstrated the potential for such a project, OQ and DEME have moved to the engineering and design phase of the project. The electrolyzer capacity for the first phase of the hydrogen plant is expected to be between 250 and 500 MW. Following this first phase, the project can be scaled up, with a final capacity of 1 GW.

There are corresponding plans to develop a clean hydrogen facility at Oman's Sohar Port. An OPAZ site on Oman's windy coast has been reserved for the installation of a solar and wind park.

Dr. Ali bin Masoud Al Sunaidi, Chairman of the Board of Directors of OPAZ, said of the project:[195]

> The start of this cooperation between DEME and OQ is very important, not only for the project, but towards the biggest cause of placing Duqm as hub in the Hydrogen Value chain. The step is also complementing the recently announced decision of the Public Authority of Special Economic Zones and Free Zones of dedicating 150 square km of land for green energy projects in the Special Economic Zone at Duqm, in line with the Oman Vision 2040.

The facility is intended to contribute to the decarbonization of the regional industry in Oman, producing green hydrogen and its derivatives (such as green ammonia) for export to the international market, especially in Europe.

### F. Oman, Hong Kong, and Kuwait Consortium Plan Green Hydrogen Project

In May 2021, an international consortium was formed, comprising Hong Kong-based InterContinental Energy, OQ, and EnerTech, a subsidiary of the sovereign wealth fund Kuwait Investment Authority. The consortium aims to establish a green hydrogen plant, and it is planning the development of a 25 GW solar and wind farm project in Oman's Al-Wusta Governorate, powering the electrolysis of water sourced from the Arabian Sea, to produce green hydrogen and its derivatives, such as green ammonia, for domestic, regional, and international markets.

The first production from the planned facility is expected from 2028, with the first phase of the project—comprising about one-third of the final capacity—expected to be completed in 2032, with the project expected to reach full capacity in 2038.[196]

## IV. Egypt

### A. Egypt and Siemens Plan Green Hydrogen Pilot

In January 2021, Egyptian Minister of Electricity and Renewable Energy Mohamed Shaker and Joe Kaiser, chief executive officer of Germany's Siemens, signed an agreement to explore a potential pilot project for the production of green hydrogen in Egypt. Although details of the location, capacity, and technology of the pilot project remain under discussion, the pilot project will be in line with Egypt's clean energy strategy to increase renewable energy sources.[197]

### B. DEME Explores Green Hydrogen Production in Egypt

In or around March 2021, DEME signed an agreement with the Egyptian Ministry of Electricity and Renewable Energy, the Ministry of Oil and Mineral Resources, and the Egyptian Navy to conduct studies on the production of the low-carbon fuel in Egypt. This exploratory agreement falls squarely within Egypt's strategy to expand clean and green energy production, as well as increase the share of renewable energy in the electric energy mix.

## C. Egypt in Cooperation With China Energy Engineering Corporation (CEED)

Alongside CEED,[198] Egypt is currently planning to commence the development of a US$5–US$8 billion green hydrogen plant in May 2024.[199] One of the key developments that led to the agreement is the evolution and expansion of Egypt's critical infrastructure, as well as Egypt's renewable energy sources and facilities.[200] Egypt, in fact, has issued a package of incentives for business enterprises willing to invest in green hydrogen production projects in the country, announced by the cabinet.[201]

## D. Egypt Collaboration With FFI and Norwegian-Based Scatec

Some green energy projects will be implemented jointly with FFI and the Egyptian government, which aims to yield 9.2 GW of electricity from renewables.[202] Egypt also has plans to work closely with the Norwegian-based renewable energy company Scatec to build its first green hydrogen plant in Ain Sokhna, with 100 MW capacity in the Suez Canal Economic Zone, at a cost of US$5 billion.[203] The environmental and social due diligence found that the project passed several levels of social and biodiversity sensitivity issues, stakeholder approvals, and environmental impact assessments.[204]

The financing for these projects has been secured in part through a US$80 million bridge loan signed on 15 March 2023 between the EBRD and Egypt Green Hydrogen SAE, with the aim of developing and operating the first green hydrogen production facility in Egypt.[205] In particular, the loan will support funding the procurement and construction of a 100 MW electrolyzer facility, which will substitute some of the grey hydrogen consumed by the Egyptian Fertilizer Company and create green ammonia to be exported to international markets.[206] Egypt Green Hydrogen SAE is owned jointly by (1) Scatec ASA, Norway; (2) Fertiglobe PLC, Abu Dhabi; (iii) Orascom Construction, PLC, Dubai and Egypt; and (iv) the Sovereign Fund of Egypt.[207]

# PART VI - NEXT STEPS TO ENSURE MENA'S HYDROGEN FUTURE

**It is clear that the Middle East and the wider MENA region have huge potential in the green energy sector, including hydrogen, and it will require a strategic, multilateral approach to develop the region's hydrogen potential. Below, we consider the key steps that need to be taken to ensure the countries of MENA can take the lead in the emerging hydrogen economy.**

## I. Legislation and Regulation

- Specific hydrogen-focused legislation and regulatory frameworks need to be developed and implemented. This includes downstream regulations, for example, regarding the manufacture of fuel cell cars, trucks, and buses.

- A supportive regulatory environment must be established, including a regulatory regime that incentivizes green hydrogen projects, for example, by introducing emissions schemes and providing financial support mechanisms.

## II. Investment

- Governments need to allocate sums and create financing opportunities for investment in hydrogen projects and infrastructure, as well as create conditions to attract foreign investment.

- Because the hydrogen market is nascent, financiers tend to apply more onerous lending principles for hydrogen projects. The limited offtake opportunities for green hydrogen can cause concern for traditional debt financiers. Governments should seek to encourage private equity investors and pension funds to fill the liquidity shortfall.

- Sovereign wealth funds of the GCC should be advised to invest in the emerging hydrogen economy.

- Long-term investments must be made in cross-border transport infrastructure.

## III. Infrastructure

- MENA countries need to exploit their advantage in terms of abundant solar energy and invest in industrial-scale solar plants alongside the development of technology for scaled-up hydrogen production.

- The MENA region is well placed to provide clean energy; so governments and industry should look for ways in which the clean energy can be utilized locally, developing a regional demand for clean energy that is regionally produced.

- The infrastructure for storing and transporting green hydrogen is not yet in place; exploiting existing ports and industrial infrastructure, MENA countries should focus on the development of integrated hubs that combine green hydrogen and ammonia infrastructure. The development of a reliable, cheap storage solution for renewables could be exported globally.

## IV. Public-Private Partnerships

- Further alignment between governments and private sector companies with the requisite knowledge, experience, and capabilities should continue to advance.
- PPPs need to be promoted to foster production and export infrastructure.
- Both the public and private sectors need to take a sensible approach to ensuring appropriate financing, construction, and operational structures can be formulated so as to make the hydrogen market appealing for investment, viable, and competitive. Existing relationships and structures that exist in the MENA PPP sector, for example, can be utilized in the development of green hydrogen plants.

## V. Regional Cooperation

- There needs to be support for the utilization of green hydrogen and its fuel derivatives across major industries within the MENA region. This will provide a market for locally produced hydrogen and provide a launch pad for international expansion. For example:
    - Blending hydrogen into existing domestic and regional gas networks to boost local demand.
    - Local government deployment of hydrogen-powered public transport vehicles.
    - Using hydrogen to power state infrastructure, such as airports.
- Regional and domestic carbon-pricing regimes should be developed in order to facilitate regional utilization of green hydrogen and to realize its potential to decarbonize polluting industries.
- As of yet, there is no regional strategy for the development of hydrogen infrastructure. Governments across MENA should work together to develop a regional program for infrastructure and logistical development.

## VI. International Cooperation

- Attention needs to be given to identifying and developing relationships with potential markets and off-takers in key demand centers such as Europe, North America, and Asia (notably Japan and South Korea).

## VII. Government Targets

- Governments, government bodies, and the public sector must ensure that a supportive environment exists from which to build a competitive hydrogen sector and export offering. Governments should consider encouraging investment in clean energy opportunities by reducing or alleviating taxes for green hydrogen projects and potentially consider the introduction of penalties or a higher tax burden for carbon-heavy energy projects.
- National plans and visions should continue to be developed. It may even be necessary to strictly require and enforce decarbonization limits in certain sectors. Hydrocarbons will remain prevalent in the MENA energy portfolio. However, the carbon footprint of the MENA hydrocarbon industrial base can be offset in the short term with the employment of green technologies, such as CCUS.

- Hydrogen production may be prioritized in the region's state-owned oil and gas companies, such as ADNOC, QP, and Aramco. These energy giants will undoubtedly be able to utilize and adapt their traditional hydrocarbon industrial models to green hydrogen, as they already have the infrastructure, expertise, and capital necessary to develop clean energy and hydrogen technology and infrastructure.

# ENDNOTES

[1] https://www.worldbank.org/en/home.

[2] https://www.gecf.org/_resources/files/pages/gecf-global-gas-outlook-2050/gecf-gas-outlook-2022.pdf.

[3] https://www.investmentbank.barclays.com/our-insights/the-hydrogen-economy-fuelling-the-fight-against-climatechange.html.

[4] https://hydrogencouncil.com/wp-content/uploads/2017/11/Hydrogen-scaling-up-Hydrogen-Council.pdf.

[5] https://hydrogencouncil.com/wp-content/uploads/2017/11/Hydrogen-scaling-up-Hydrogen-Council.pdf.

[6] https://www.investmentbank.barclays.com/our-insights/the-hydrogen-economy-fuelling-the-fight-against-climatechange.html.

[7] https://www.globalccsinstitute.com/resources/global-status-of-ccs-2022/.

[8] https://image.digitalinsightresearch.in/Uploads/ImageLibrary/Active/MEED/2023/March/PDFs/MBR_2303_Digital.pdf.

[9] https://www.gecf.org/_resources/files/pages/gecf-global-gas-outlook-2050/gecf-gas-outlook-2022.pdf.

[10] https://middleeast-business.com/united-arab-emirates-participation-in-biden-leaders-summit-on-climate/.

[11] https://www.iea.org/reports/global-hydrogen-review-2022.

[12] https://maritime-executive.com/article/world-s-first-commercial-shipment-of-blue-hydrogen-delivered-to-korea.

[13] https://www.dw.com/en/germany-receives-first-hydrogen-shipment-from-uae/a-63524001.

[14] https://www.lexology.com/library/detail.aspx?g=831343a3-107d-4607-a72c-cfa79c4ee1b0.

[15] Gas Exporting Countries Forum (GECF), '2022 GECF Global Gas Outlook 2050' 133 https://www.gecf.org/_resources/files/pages/gecf-global-gas-outlook-2050/gecf-gas-outlook-2022.pdf.

[16] Gas Exporting Countries Forum (GECF), '2022 GECF Global Gas Outlook 2050' 133-134 https://www.gecf.org/_resources/files/pages/gecf-global-gas-outlook-2050/gecf-gas-outlook-2022.pdf.

[17] Al-Monitor, 'UAE, Egypt to develop major green hydrogen project in Mauritania' (8 March 2023) https://www.al-monitor.com/originals/2023/03/uae-egypt-develop-major-green-hydrogen-project-mauritania.

[18] https://www.iea.org/reports/breakthrough-agenda-report-2022; https://www.iea.org/reports/breakthrough-agenda-report-2022/executive-summary.

[19] https://www.rmit.edu.au/news/all-news/2023/feb/hydrogen-seawater.

[20] https://doi.org/10.1002/smll.202207310; see also https://www.rmit.edu.au/news/all-news/2023/feb/hydrogen-seawater.

[21] https://www.rmit.edu.au/news/all-news/2023/feb/hydrogen-seawater.

[22] https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2022/May/IRENA_Global_Hydrogen_Trade_Costs_2022.pdf?rev=00ea390b555046118cfe4c448b2a29dc.

[23] https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2022/May/IRENA_Global_Hydrogen_Trade_Costs_2022.pdf?rev=00ea390b555046118cfe4c448b2a29dc.

[24] https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2022/May/IRENA_Global_Hydrogen_Trade_Costs_2022.pdf?rev=00ea390b555046118cfe4c448b2a29dc.

[25] https://www.iea.org/.

[26] We note the very recent announcement of US Secretary of Energy Jennifer Granholm launching an "Energy Earthshot Initiative" focused on the development of hydrogen at a scale sufficient to bring the price down to US$1 per kilogram by the year 2030: https://www.energy.gov/articles/secretary-granholm-launches-energy-earthshots-initiative-accelerate-breakthroughs-toward.

[27] https://hydrogencouncil.com/en/.

[28] https://www.meed.com/winning-the-green-hydrogen-rush.

[29] IEA, 'Global Hydrogen Review 2022' (2022) https://www.iea.org/reports/global-hydrogen-review-2022.

[30] https://www.irena.org/publications/2022/Mar/World-Energy-Transitions-Outlook-2022.

[31] https://www.bcg.com/press/21march2023-low-carbon-hydrogen-alternative-investment-infrastructure-investors.

[32] MEED: Firm says piping hydrogen to Europe is feasible, 16 March 2021.

[33] Hydrogen Europe, 'Launch of IPCEI on Hydrogen' (2023) https://hydrogeneurope.eu/.

[34] US Congress, H.R.5376 - 117th Congress (2021-2022): Inflation Reduction Act of 2022, H.R.5376, 117th Cong. (2022), https://www.congress.gov/bill/117th-congress/house-bill/5376.

[35] H2Global Stiftung, 'H2Global Foundation' https://www.h2-global.de/.

[36] IEA, 'Global Hydrogen Review 2022' (2022) https://www.iea.org/reports/global-hydrogen-review-2022.

[37] Middle East Business Intelligence (MEED), 'MEED Business Review' Vol 08 No 3 (March 2023) 9 https://image.digitalinsightresearch.in/Uploads/ImageLibrary/Active/MEED/2023/March/PDFs/MBR_2303_Digital.pdf.

[38] State of Oman, Ministry of Energy and Minerals, 'Signing Ceremony of Oman's Green Hydrogen Projects' (15 March 2023) https://mem.gov.om/en-us/Media-Center/News/ArtMID/608/ArticleID/1323/Signing-Ceremony-of-Oman%e2%80%99s-Green-Hydrogen-Projects; see also Middle East Business Intelligence (MEED), 'Oman legacy hydrogen projects are worth $20bn' (17 March 2023) https://www.meed.com/oman-legacy-hydrogen-projects-are-worth-20bn.

[39] https://www.adportsgroup.com/en/news-and-media/2023/02/23/fujairah-terminals-handles-three-gas-turbines-for-fujairah-f3-power-plant-project.

[40] https://www.siemens-energy.com/mea/en/company/megaprojects/dewa-green-hydrogen-project.html.

[41] MEED: Dubai inaugurates green hydrogen plant, 19 May 2021.

[42] MEED: Middle East forges hydrogen path, 28 March 2021.

[43] https://renewablesnow.com/news/indias-acme-to-invest-usd-35bn-in-green-hydrogen-ammonia-production-in-oman-751711/.

[44] https://www.omanobserver.om/article/1118055/business/energy/scatec-acmes-oman-project-gets-worlds-first-green-hydrogen-certificate.

[45] https://www.renewableenergymagazine.com/hydrogen/yara-acme-and-scatec-sign-term-sheet-20220715.

[46] MEED: CCC partners with Irish firm for hydrogen schemes, 9 May 2021.

[47] https://www.oilandgasmiddleeast.com/lists/top-25-epc-contractors-2022.

[48] https://racetozero.unfccc.int/green-hydrogen-catapult/.

[49] https://climatechampions.unfccc.int/wp-content/uploads/2022/11/Joint.Statement.pdf.

[50] https://climatechampions.unfccc.int/green-hydrogen-and-green-shipping/.

[51] https://www.gcc-sg.org/en-us/AboutGCC/Pages/Primarylaw.aspx.

[52] The GCC incorporates: the United Arab Emirates, Saudi Arabia, Qatar, Bahrain, Kuwait, and Oman.

[53] Annex B, https://unfccc.int/sites/default/files/resource/docs/cop3/l07a01.pdf#page=24, this has now been amended to include Belarus.

[54] https://unfccc.int/process/the-kyoto-protocol/the-doha-amendment.

[55] https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement.

[56] https://treaties.un.org/pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVII-7-d&chapter=27&clang=_en.

[57] https://www.energy.gov/articles/joint-statement-establishing-net-zero-producers-forum-between-energy-ministries-canada.

[58] https://www.energy.gov/articles/united-arab-emirates-joins-sixth-member-net-zero-producers-forum.

[59] https://www.irena.org/climatechange.

[60] https://www.irena.org/climatechange.

[61] https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/United%20Arab%20Emirates%20Second/UAE%20Second%20NDC%20-%20UNFCCC%20Submission%20-%20English%20-%20FINAL.pdf.

[62] https://www.uaecabinet.ae/en/details/news/uae-forms-council-for-climate-change-and-environment.

[63] https://u.ae/en/about-the-uae/strategies-initiatives-and-awards/federal-governments-strategies-and-plans/uae-energy-strategy-2050.

[64] Vice President and Prime Minister and Ruler of Dubai, His Highness Sheikh Mohammed bin Rashid Al Maktoum.

[65] https://wam.ae/en/details/1395302914826.

[66] MEED: GCC Clean hydrogen initiative, 23 February 2021.

[67] https://www.wam.ae/en/details/1395302935261.

[68] https://www.thenationalnews.com/business/energy/2022/09/26/uae-in-deal-to-develop-national-hydrogen-strategy.

[69] https://www.cop28.com/en/.

[70] https://www.thenationalnews.com/business/2023/02/22/uae-launches-two-initiatives-to-support-its-net-zero-goal/.

[71] Middle East Business Intelligence (MEED), 'MEED Business Review' Vol 08 No 3 (March 2023) 10 https://image.digitalinsightresearch.in/Uploads/ImageLibrary/Active/MEED/2023/March/PDFs/MBR_2303_Digital.pdf.

[72] Middle East Business Intelligence (MEED), 'MEED Business Review' Vol 08 No 3 (March 2023) 11 https://image.digitalinsightresearch.in/Uploads/ImageLibrary/Active/MEED/2023/March/PDFs/MBR_2303_Digital.pdf.

[73] Middle East Business Intelligence (MEED), 'MEED Business Review' Vol 08 No 3 (March 2023) 13 https://image.digitalinsightresearch.in/Uploads/ImageLibrary/Active/MEED/2023/March/PDFs/MBR_2303_Digital.pdf.

[74] Arabian Gulf Business Insight (AGBI), '$8.5 bn funding deals signed for Saudi green hydrogen project' (1 March 2023) https://www.agbi.com/articles/8-5bn-funding-deals-signed-for-saudi-green-hydrogen-project/.

[75] Abu Dhabi Media Office, 'Abu Dhabi Department of Energy's Low-Carbon Hydrogen Policy and Regulatory Framework to Accelerate UAE's National Hydrogen Strategy' (22 August 2022) https://www.mediaoffice.abudhabi/en/energy/abu-dhabi-department-of-energys-low-carbon-hydrogen-policy-and-regulatory-framework-to-accelerate-uaes-national-hydrogen-strategy/.

[76] Abu Dhabi Media Office, 'Abu Dhabi Department of Energy's Low-Carbon Hydrogen Policy and Regulatory Framework to Accelerate UAE's National Hydrogen Strategy' (22 August 2022) https://www.mediaoffice.abudhabi/en/energy/abu-dhabi-department-of-energys-low-carbon-hydrogen-policy-and-regulatory-framework-to-accelerate-uaes-national-hydrogen-strategy/.

[77] Middle East Business Intelligence (MEED), 'Abu Dhabi hydrogen regulation due in April' (07 March 2023) https://www.meed.com/abu-dhabi-hydrogen-regulation-due-in-april.

[78] Middle East Business Intelligence (MEED), 'Abu Dhabi hydrogen regulation due in April' (07 March 2023) https://www.meed.com/abu-dhabi-hydrogen-regulation-due-in-april.

[79] Abu Dhabi Department of Energy (DoE), 'Abu Dhabi Public Policy on Low-Carbon Hydrogen' (Draft August 2022) https://doe.gov.ae/-/media/Project/DOE/Department-Of-Energy/Media-Center-Publications/Policy/Abu-Dhabi-Public-Policy-on-Low-Carbon-Hydrogen.pdf.

[80] Abu Dhabi Media Office, 'Abu Dhabi Department of Energy's Low-Carbon Hydrogen Policy and Regulatory Framework to Accelerate UAE's National Hydrogen Strategy' (22 August 2022) https://www.mediaoffice.abudhabi/en/energy/abu-dhabi-department-of-energys-low-carbon-hydrogen-policy-and-regulatory-framework-to-accelerate-uaes-national-hydrogen-strategy/.

[81] Abu Dhabi Media Office, 'Abu Dhabi Department of Energy's Low-Carbon Hydrogen Policy and Regulatory Framework to Accelerate UAE's National Hydrogen Strategy' (22 August 2022) https://www.mediaoffice.abudhabi/en/energy/abu-dhabi-department-of-energys-low-carbon-hydrogen-policy-and-regulatory-framework-to-accelerate-uaes-national-hydrogen-strategy/.

[82] https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Saudi%20Arabia%20First/KSA-INDCs%20English.pdf.

[83] https://climateactiontracker.org/countries/saudi-arabia/pledges-and-targets/.

[84] https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Saudi%20Arabia%20First/KSA-INDCs%20English.pdf.

[85] https://www.vision2030.gov.sa/v2030/overview/.

[86] https://www.ief.org/_resources/files/events/third-ief-eu-energy-day/turki-al-shehri-24.02-repdo---ief_riyadh_v2-2.pdf.

[87] https://www.vision2030.gov.sa/v2030/overview/.

[88] MEED: Aramco hydrogen business at world-scale by 2030, 23 February 2021.

[89] Kingdom of Saudi Arabia: Saudi Vision 2030, 'National Industrial Development and Logistics Program (NIDLP)' (2022) https://www.vision2030.gov.sa/v2030/vrps/nidlp/.

[90] Kingdom of Saudi Arabia: Saudi Vision 2030, 'National Industrial Development and Logistics Program (NIDLP)' (2022) https://www.vision2030.gov.sa/v2030/vrps/nidlp/.

[91] Kingdom of Saudi Arabia, 'Energy & Sustainability' Vision 2030 (2022) https://www.vision2030.gov.sa/thekingdom/explore/energy/.

[92] Kingdom of Saudi Arabia, 'Energy & Sustainability' Vision 2030 (2022) https://www.vision2030.gov.sa/thekingdom/explore/energy/.

[93] Kingdom of Saudi Arabia, 'Energy & Sustainability' Vision 2030 (2022) https://www.vision2030.gov.sa/thekingdom/explore/energy/.

[94] Middle East Business Intelligence (MEED), 'Saudi reinvigorates power sector' (07 March 2023) https://www.meed.com/saudi-arabia-reinvigorates-power-generation-sector.

[95] https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Oman%20First%20NDC/OMAN%20INDCs.pdf.

[96] https://omanuna.oman.om/en/home-top-level/eparticipation/oman-vision-2040.

[97] https://www.2040.om/Oman2040-En.pdf.

[98] https://www.2040.om/Oman2040-En.pdf.

[99] https://www.chemengonline.com/large-scale-renewable-hydrogen-project-to-launch-in-oman/.

[100] State of Oman, Ministry of Energy and Minerals, 'Signing Ceremony of Oman's Green Hydrogen Projects' (15 March 2023) https://mem.gov.om/en-us/Media-Center/News/ArtMID/608/ArticleID/1323/Signing-Ceremony-of-Oman%e2%80%99s-Green-Hydrogen-Projects; see also Middle East Business Intelligence (MEED), 'Oman legacy hydrogen projects are worth $20bn' (17 March 2023) https://www.meed.com/oman-legacy-hydrogen-projects-are-worth-20bn.

[101] Middle East Business Intelligence (MEED), 'Oman legacy hydrogen projects are worth $20bn' (17 March 2023) https://www.meed.com/oman-legacy-hydrogen-projects-are-worth-20bn.

[102] State of Oman, Ministry of Energy and Minerals, 'Signing Ceremony of Oman's Green Hydrogen Projects' (15 March 2023) https://mem.gov.om/en-us/Media-Center/News/ArtMID/608/ArticleID/1323/Signing-Ceremony-of-Oman%e2%80%99s-Green-Hydrogen-Projects.

[103] https://issuu.com/lexisnexisuk/docs/lmela_2023_02_marapr_epdf, p. 8.

[104] State of Oman, Ministry of Energy and Minerals, 'Signing Ceremony of Oman's Green Hydrogen Projects' (15 March 2023) https://mem.gov.om/en-us/Media-Center/News/ArtMID/608/ArticleID/1323/Signing-Ceremony-of-Oman%e2%80%99s-Green-Hydrogen-Projects.

[105] Middle East Business Intelligence (MEED), 'Oman legacy hydrogen projects are worth $20bn' (17 March 2023) https://www.meed.com/oman-legacy-hydrogen-projects-are-worth-20bn.

[106] Middle East Business Intelligence (MEED), 'Oman signs $51bn of hydrogen deals' (15 March 2023) https://www.meed.com/oman-signs-51bn-hydrogen-deals.

[107] Middle East Business Intelligence (MEED), 'Oman legacy hydrogen projects are worth $20bn' (17 March 2023) https://www.meed.com/oman-legacy-hydrogen-projects-are-worth-20bn.

[108] Middle East Business Intelligence (MEED), 'Oman legacy hydrogen projects are worth $20bn' (17 March 2023) https://www.meed.com/oman-legacy-hydrogen-projects-are-worth-20bn.

[109] Middle East Business Intelligence (MEED), 'Oman legacy hydrogen projects are worth $20bn' (17 March 2023) https://www.meed.com/oman-legacy-hydrogen-projects-are-worth-20bn.

[110] Middle East Business Intelligence (MEED), 'Oman legacy hydrogen projects are worth $20bn' (17 March 2023) https://www.meed.com/oman-legacy-hydrogen-projects-are-worth-20bn.

[111] MarineLink, 'Dredge Firms Focus on Sustainability as ESG Issues Climb Agenda', (13 March 2023) https://www.marinelink.com/news/dredge-firms-focus-sustainability-esg-503558.

[112] MarineLink, 'Dredge Firms Focus on Sustainability as ESG Issues Climb Agenda', (13 March 2023) https://www.marinelink.com/news/dredge-firms-focus-sustainability-esg-503558.

[113] Middle East Business Intelligence (MEED), 'Oman legacy hydrogen projects are worth $20bn' (17 March 2023) https://www.meed.com/oman-legacy-hydrogen-projects-are-worth-20bn.

[114] Middle East Business Intelligence (MEED), 'Oman legacy hydrogen projects are worth $20bn' (17 March 2023) https://www.meed.com/oman-legacy-hydrogen-projects-are-worth-20bn.

[115] Middle East Business Intelligence (MEED), 'Oman legacy hydrogen projects are worth $20bn' (17 March 2023) https://www.meed.com/oman-legacy-hydrogen-projects-are-worth-20bn.

[116] https://www.gco.gov.qa/wp-content/uploads/2016/09/GCO-QNV-English.pdf.

[117] https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Qatar%20First/Qatar%20INDCs%20Report%20-English.pdf.

[118] https://www.gco.gov.qa/wp-content/uploads/2016/09/GCO-QNV-English.pdf.

[119] https://thepeninsulaqatar.com/article/12/10/2021/Qatar-Petroleum-rebranded-as-QatarEnergy.

[120] https://digitalhub.fifa.com/m/5adbe651c67c78a3/original/o2zbd8acyiooxyn0dwuk-pdf.pdf.

[121] Gulf Times, 'Qatar takes part in Arab League energy expert panel meeting' (15 March 2023) https://www.gulf-times.com/article/657559/qatar/qatar-takes-part-in-arab-league-energy-expert-panel-meeting.

[122] Gulf Times, 'Qatar takes part in Arab League energy expert panel meeting' (15 March 2023) https://www.gulf-times.com/article/657559/qatar/qatar-takes-part-in-arab-league-energy-expert-panel-meeting.

[123] Reuters, 'QatarEnergy, Chevron Phillips ink $6 bln Ras Laffan Petrochemicals deal' (09 January 2023) https://www.reuters.com/business/energy/qatarenergy-chevron-phillips-sign-agreement-6-bln-ras-laffan-petrochemicals-2023-01-08/.

[124] QatarEnergy, 'H1 2022 Investors Update Presentation' (November 2022) 9 https://www.qatarenergy.qa/en/MediaCenter/Publications/QatarEnergy%20H1%202022%20Investors%20Presentation.pdf.

[125] Qatar University, 'H2 Sustainability Energy Solutions: Research & Policy Group' (n.d.) http://www.qu.edu.qa/projects/h2hub.

[126] Qatar Tribune, 'Blue Hydrogen: A key player in the future of the energy transition' (13 February 2023) https://www.qatar-tribune.com/article/49499/business/blue-hydrogen-a-key-player-in-the-future-of-energy-transition.

[127] Qatar Tribune, 'Blue Hydrogen: A key player in the future of the energy transition' (13 February 2023) https://www.qatar-tribune.com/article/49499/business/blue-hydrogen-a-key-player-in-the-future-of-energy-transition.

[128] Qatar Tribune, 'Blue Hydrogen: A key player in the future of the energy transition' (13 February 2023) https://www.qatar-tribune.com/article/49499/business/blue-hydrogen-a-key-player-in-the-future-of-energy-transition.

[129] Bloomberg, 'Qatar to Tap Global Hydrogen Market with $1 billion plant' (31 August 2022) https://www.bloomberg.com/news/articles/2022-08-31/qatar-to-tap-global-hydrogen-market-with-1-billion-plant#xj4y7vzkg.

[130] Gulf News, 'Qatar to tap global hydrogen market with $1 billion plant' (31 August 2022) https://gulfnews.com/business/energy/qatar-to-tap-global-hydrogen-market-with-1-billion-plant-1.90238648.

[131] Bloomberg, 'Qatar to Tap Global Hydrogen Market with $1 billion plant' (31 August 2022) https://www.bloomberg.com/news/articles/2022-08-31/qatar-to-tap-global-hydrogen-market-with-1-billion-plant#xj4y7vzkg; see also Business, 'Qatar to tap global hydrogen market with $1 billion plant' (31 August 2022) https://gulfnews.com/business/energy/qatar-to-tap-global-hydrogen-market-with-1-billion-plant-1.90238648.

[132] Bloomberg, 'Qatar to Tap Global Hydrogen Market with $1 billion plant' (31 August 2022) https://www.bloomberg.com/news/articles/2022-08-31/qatar-to-tap-global-hydrogen-market-with-1-billion-plant#xj4y7vzkg.

[133] Gulf News, 'Qatar to tap global hydrogen market with $1 billion plant' (31 August 2022) https://gulfnews.com/business/energy/qatar-to-tap-global-hydrogen-market-with-1-billion-plant-1.90238648.

[134] QatarEnergy, 'H12022 Investors Update Presentation: Climate Change Mitigation Framework' (November 2022) 9 https://www.qatarenergy.qa/en/MediaCenter/Publications/QatarEnergy H1 2022 Investors Presentation.pdf.

[135] Renewables Now, 'QatarEnergy, Shell to develop joint hydrogen projects in the UK' (20 October 2021) https://renewablesnow.com/news/qatarenergy-shell-to-develop-joint-hydrogen-projects-in-uk-758058/.

[136] Renewables Now, 'QatarEnergy, Shell to develop joint hydrogen projects in the UK' (20 October 2021) https://renewablesnow.com/news/qatarenergy-shell-to-develop-joint-hydrogen-projects-in-uk-758058/.

[137] QatarEnergy, 'H12022 Investors Update Presentation: Climate Change Mitigation Framework' (November 2022). https://www.qatarenergy.qa/en/MediaCenter/Publications/QatarEnergy H1 2022 Investors Presentation.pdf; see also H2 Bulletin, 'QatarEnergy partners with H2Korea and Shell to invest in hydrogen solutions' (25 October 2021) https://www.h2bulletin.com/qatar-energy-partners-with-h2korea-and-shell-to-invest-in-hydrogen-solutions/.

[138] Energy, 'Nikkiso Clean Energy opens new facility in Qatar' (26 January 2023) https://energydigital.com/articles/Nikkiso-Clean-Energy-opens-new-facility-in-Qatar.

[139] https://leap.unep.org/countries/eg/national-legislation/egypts-national-strategy-adaptation-climate-change-and-disaster.

[140] https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Egypt%20First/Egyptian% 20INDC.pdf.

[141] https://www.researchgate.net/publication/339668565_Egypt's_nationally_determined_contributions_to_Paris_agreement_review_and_recommendations.

[142] https://mped.gov.eg/EgyptVision?lang=en.

[143] International Renewable Energy Agency (IRENA), 'Renewable Energy Outlook: Egypt. Executive Summary' (October 2018) https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/Oct/IRENA_Outlook_Egypt_2018_En_summary.pdf?la=en&hash=58DBAA614BE0675F66D3B4A2AC68833FF78700A0.

[144] Middle East Business Intelligence (MEED), 'Egypt to unveil new energy strategy' (16 March 2023) https://www.meed.com/egypt-to-unveil-new-energy-strategy.

[145] Middle East Business Intelligence (MEED), 'Egypt to unveil new energy strategy' (16 March 2023) https://www.meed.com/egypt-to-unveil-new-energy-strategy.

[146] Reuters, 'Egypt signs framework deals in bid to launch hydrogen industry' (16 November 2022) https://www.reuters.com/world/middle-east/egypt-signs-framework-deals-bid-launch-hydrogen-industry-2022-11-15/.

[147] European Bank for Reconstruction and Development (EBRD), 'Egypt Green Hydrogen SAE' (15 March 2023) https://www.ebrd.com/work-with-us/projects/psd/53558.html.

[148] European Bank for Reconstruction and Development (EBRD), 'Egypt Green Hydrogen SAE' (15 March 2023) https://www.ebrd.com/work-with-us/projects/psd/53558.html.

[149] https://maritime-executive.com/article/world-s-first-commercial-shipment-of-blue-hydrogen-delivered-to-korea.

[150] https://www.dw.com/en/germany-receives-first-hydrogen-shipment-from-uae/a-63524001.

[151] https://www.spglobal.com/platts/en/market-insights/latest-news/electric-power/101920-uae-investing-in-green-and-blue-hydrogenprojects-as-part-of-clean-energy-move-official.

[152] MEED: Dubai commissions hydrogen plan, 17 May 2021.

[153] https://www.esma.gov.ae/en-us/Media-Center/news/Pages/UAE-develops-first-technical-regulation-of-hydrogen-cellvehicles-regionally.aspx.

[154] MEED: United Arab Emirates announces hydrogen vehicles system, 21 March 2021.

[155] MEED: Masdar hydrogen plant design under way, 16 May 2021.

[156] https://www.thenationalnews.com/business/energy/adnoc-to-build-major-blue-ammonia-facility-in-ruwais-1.1228840.

[157] MEED: Mubadala and Snam to cooperate on hydrogen, 22 March 2021.

[158] MEED: UAE and German firm sign hydrogen pact, 18 January 2021.

[159] https://www.moei.gov.ae/en/media-centre/news/11/4/2021/a-cooperation-agreement-between-uae-and-japan-toexplore-the-opportunities-available-in-the-field-of-hydrogen-development.aspx#page=1.

[160] Al-Monitor, 'UAE, Egypt to develop major green hydrogen project in Mauritania' (8 March 2023) https://www.al-monitor.com/originals/2023/03/uae-egypt-develop-major-green-hydrogen-project-mauritania.

[161] Al-Monitor, 'UAE, Egypt to develop major green hydrogen project in Mauritania' (8 March 2023) https://www.al-monitor.com/originals/2023/03/uae-egypt-develop-major-green-hydrogen-project-mauritania.

[162] Al-Monitor, 'UAE, Egypt to develop major green hydrogen project in Mauritania' (8 March 2023) https://www.al-monitor.com/originals/2023/03/uae-egypt-develop-major-green-hydrogen-project-mauritania.

[163] The MENA region here defined as Iran, Israel, Jordan, Lebanon, Oman, Saudi Arabia, Algeria, Egypt and Morocco. Sources: IRENA, S&P Global Platts Analytics, S&P Global Market Intelligence. S&P Global Commodity Insights, 'Saudi Arabia's future city Neom plans hydrogen-based ecosystem' (09 February 2021) https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/electric-power/020921-saudi-arabias-future-city-neom-plans-hydrogen-based-ecosystem.

[164] The MENA region here defined as Bahrain, Iran, Iraq, Israel, Jordan, Lebanon, Oman, Qatar, Saudi Arabia, UAE, Algeria, Egypt and Morocco. Sources: IRENA, S&P Global Platts Analytics, S&P Global Market Intelligence. S&P Global Commodity Insights, 'Saudi Arabia's future city Neom plans hydrogen-based ecosystem' (09 February 2021) https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/electric-power/020921-saudi-arabias-future-city-neom-plans-hydrogen-based-ecosystem.

[165] Acwa Power, 'Neom Green Hydrogen Project' (2023) https://www.acwapower.com/en/projects/neom-green-hydrogen-project/.

[166] Middle East Business Intelligence (MEED), 'Saudi reinvigorates power sector' (07 March 2023) https://www.meed.com/saudi-arabia-reinvigorates-power-generation-sector.

[167] Middle East Business Intelligence (MEED), 'Saudi 30 GW solar parks are for gigaproject' (07 March 2023) https://www.meed.com/saudi-30gw-solar-parks-are-for-megaproject.

[168] Middle East Business Intelligence (MEED), 'MEED Business Review' Vol 08 No 3 (March 2023) 7 https://image.digitalinsightresearch.in/Uploads/ImageLibrary/Active/MEED/2023/March/PDFs/MBR_2303_Digital.pdf.

[169] Sovereign Wealth Fund Institute (SWFI), 'BILLIONS: Saudi Public Investment Fund Bets on Green Hydrogen' (2 March 2023) https://www.swfinstitute.org/news/95987/billions-saudi-public-investment-fund-bets-on-green-hydrogen.

[170] Hydrogen Insight, 'Neom becomes first gigawatt-scale green hydrogen project to secure funding, with $8.5 bn lined up' (02 March 2023) https://www.hydrogeninsight.com/production/neom-becomes-first-gigawatt-scale-green-hydrogen-project-to-secure-funding-with-8-5bn-lined-up/2-1-1412727.

[171] Arabian Gulf Business Insight (AGBI), '$8.5 bn funding deals signed for Saudi green hydrogen project' (1 March 2023) https://www.agbi.com/articles/8-5bn-funding-deals-signed-for-saudi-green-hydrogen-project/.

[172] S&P Global Commodity Insights, 'Saudi Arabia's future city Neom plans hydrogen-based ecosystem' (09 February 2021) https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/electric-power/020921-saudi-arabias-future-city-neom-plans-hydrogen-based-ecosystem.

[173] https://www.lexology.com/library/detail.aspx?g=831343a3-107d-4607-a72c-cfa79c4ee1b0.

[174] Peter Terium, the former CEO of Germany's RWE, now head of Neom energy. S&P Global Commodity Insights, 'Saudi Arabia's future city Neom plans hydrogen-based ecosystem' (09 February 2021) https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/electric-power/020921-saudi-arabias-future-city-neom-plans-hydrogen-based-ecosystem.

[175] Alarabiya News, 'Saudi Arabia to start construction of US $5bln green hydrogen plant in Neom' (17 March 2022) https://english.alarabiya.net/business/energy/2022/03/17/Saudi-Arabia-to-start-construction-of-5-bln-green-hydrogen-plant-in-Neom.

[176] Construction Week: Middle East, 'NEOM Green Hydrogen secures Saudi's first industrial operating license for Oxagon' (3 February 2023) https://www.constructionweekonline.com/business/neom-green-hydrogen-oxagon.

[177] Construction Week: Middle East, 'NEOM Green Hydrogen secures Saudi's first industrial operating license for Oxagon' (3 February 2023) https://www.constructionweekonline.com/business/neom-green-hydrogen-oxagon.

[178] Middle East Business Intelligence (MEED), 'Saudi reinvigorates power sector' (07 March 2023) https://www.meed.com/saudi-arabia-reinvigorates-power-generation-sector.

[179] Construction Week: Middle East, 'NEOM Green Hydrogen secures Saudi's first industrial operating license for Oxagon' (3 February 2023) https://www.constructionweekonline.com/business/neom-green-hydrogen-oxagon.

[180] Middle East Business Intelligence (MEED), 'Enowa signs first Neom hydrogen fueling station' (20 March 2023) https://www.meed.com/enowa-signs-first-neom-hydrogen-fueling-station.

[181] Aramco has a 17% shareholding in Hyundai Oilbank.

[182] MEED: Aramco signs hydrogen cooperation deal with Hyundai, 3 March 2021.

[183] MEED: Saudi Aramco ships blue ammonia to Japan, 28 September 2020.

[184] Sovereign Wealth Fund Institute (SWFI), 'BILLIONS: Saudi Public Investment Fund Bets on Green Hydrogen' (2 March 2023) https://www.swfinstitute.org/news/95987/billions-saudi-public-investment-fund-bets-on-green-hydrogen.

[185] Sovereign Wealth Fund Institute (SWFI), 'BILLIONS: Saudi Public Investment Fund Bets on Green Hydrogen' (2 March 2023) https://www.swfinstitute.org/news/95987/billions-saudi-public-investment-fund-bets-on-green-hydrogen.

[186] MEED: Oman starts hybrid hydrogen study, 25 January 2021.

[187] MEED: Oman awards green hydrogen study, 28 February 2021.

[188] https://www.greenport.com/news101/lng/sohar-plans-first-green-hydrogen-hub-in-oman.

[189] MEED: Middle East forges hydrogen path, 28 March 2021.

[190] https://renewablesnow.com/news/indias-acme-to-invest-usd-35bn-in-green-hydrogen-ammonia-production-in-oman-751711/.

[191] https://www.omanobserver.om/article/1118055/business/energy/scatec-acmes-oman-project-gets-worlds-first-green-hydrogen-certificate.

[192] https://www.renewableenergymagazine.com/hydrogen/yara-acme-and-scatec-sign-term-sheet-20220715.

[193] https://www.h2-view.com/story/plans-for-2-5bn-hydrogen-facility-in-oman-unveiled/.

[194] MEED: Firm plans $2.5bn hydrogen plant in Oman, 28 March 2021.

[195] https://www.chemengonline.com/large-scale-renewable-hydrogen-project-to-launch-in-oman/.

[196] MEED: Oman turns into a hydrogen hotspot, 19 May 2021.

[197] MEED: Siemens and Egypt plan green hydrogen pilot, 19 January 2021.

[198] ESI Africa, 'China to build US $5 billion hydrogen project in Egypt', (20 March 2023) https://www.esi-africa.com/renewable-energy/solar/china-to-build-5-billion-hydrogen-project-in-egypt/.

[199] Egypt Today, 'China's CIEG to establish giant $5-8 billion green hydrogen project in Egypt: Chairman' (11 March 2023) https://www.egypttoday.com/Article/1/123050/China%E2%80%99s-CIEG-to-establish-giant-5-8-billion-green-hydrogen.

[200] Construction Review Online, 'Plans underway for construction of giant $5-8 billion green hydrogen plant in Egypt' (14 March 2023). https://constructionreviewonline.com/news/cieg-set-to-establish-giant-5-8-billion-green-hydrogen-project-in-egypt/.

[201] Ahram Online, 'Egypt to announce package of incentives for green hydrogen projects' (1 March 2023) https://english.ahram.org.eg/NewsContent/3/16/490974/Business/Energy/Egypt-to-announce-package-of-incentives-for-green-.aspx.

[202] Ahram Online, 'Sisi orders expediting implementation of green energy projects with Australia's FFI' (10 September 2022). https://english.ahram.org.eg/NewsContent/3/16/475798/Business/Energy/Sisi-orders-expediting-implementation-of-green-ene.aspx.

[203] Ahram Online, 'Sisi orders expediting implementation of green energy projects with Australia's FFI' (10 September 2022). https://english.ahram.org.eg/NewsContent/3/16/475798/Business/Energy/Sisi-orders-expediting-implementation-of-green-ene.aspx.

[204] European Bank for Reconstruction and Development (EBRD), 'Egypt Green Hydrogen SAE' (15 March 2023) https://www.ebrd.com/work-with-us/projects/psd/53558.html.

[205] European Bank for Reconstruction and Development (EBRD), 'Egypt Green Hydrogen SAE' (15 March 2023) https://www.ebrd.com/work-with-us/projects/psd/53558.html.

[206] European Bank for Reconstruction and Development (EBRD), 'Egypt Green Hydrogen SAE' (15 March 2023) https://www.ebrd.com/work-with-us/projects/psd/53558.html.

[207] European Bank for Reconstruction and Development (EBRD), 'Egypt Green Hydrogen SAE' (15 March 2023) https://www.ebrd.com/work-with-us/projects/psd/53558.html.

# GLOSSARY

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|---|---|
| **ADNOC** | Abu Dhabi National Oil Company |
| **ADQ** | Abu Dhabi Developmental Holding Company |
| **Aramco** | Saudi Arabian Oil Company |
| **CCS** | carbon capture and storage |
| **CCUS** | carbon capture utilization and storage |
| **CEED** | China Energy Engineering Corporation |
| **DEME** | DEME International NV |
| **DEWA** | Dubai Electricity & Water Authority |
| **DoE** | Abu Dhabi Department of Energy |
| **EBRD** | European Bank for Reconstruction and Development |
| **ESMA** | Emirates Authority for Standardization and Metrology |
| **GCC** | Cooperation Council for the Arab States of the Gulf |
| **GHG** | greenhouse gas |
| **GW** | gigawatt |
| **IEA** | International Energy Agency |
| **INDC** | Intended Nationally Determined Contribution (Paris Agreement) |
| **IRENA** | International Renewable Energy Agency |
| **KNPC** | Kuwait National Petroleum Company |
| **LNG** | liquefied natural gas |
| **LPG** | liquefied petroleum gas |
| **L&T** | Larsen & Toubro |
| **MENA** | Middle East and North Africa region |
| **METI** | Ministry of Economy, Trade, and Industry |
| **MHI** | Mitsubishi Heavy Industries |
| **MOU** | Memorandum of Understanding |

| | |
|---|---|
| **MW** | megawatt |
| **NDCs** | Nationally Determined Contributions (Paris Agreement) |
| **NREP** | National Renewable Energy Programme |
| **OQ** | Oman Oil and Orpic Group |
| **OPAZ** | Oman Public Authority for Special Economic Zones and Free Zones |
| **PDO** | Petroleum Development Oman |
| **PIF** | Public Investment Fund |
| **PPP** | Public-Private Partnership |
| **PV** | Photovoltaic |
| **QP** | Qatar Petroleum |
| **SEZ** | Special Economic Zone |
| **SEZAD** | Special Economic Zone at Duqm, Oman |
| **SPC** | Special Purpose Company |
| **TAQA** | Abu Dhabi National Energy Company |
| **Tatweer** | The Oman Company for the Development of the Special Economic Zone at Duqm |
| **UNFCCC** | United Nations Framework Convention on Climate Change |

# AUTHORS


**Pawel Piotrowski**
*Partner*
Doha
+974.4.424.6109
pawel.piotrowski@klgates.com

**Joelle Salame**
*Associate*
Doha
+974.3.360.6120
joelle.salame@klgates.com

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